



BACHELOR OF SCIENCE (HONOURS) HORTICULTURE

CURRICULUM AND SYLLABUS

**(For students admitted from the academic year 2019-2020 onwards)
(Regulations 2019)**

UNDER CREDIT SYSTEM

**FACULTY OF AGRICULTURAL SCIENCES
SRM INSTITUTE OF SCIENCE AND TECHNOLOGY
KATTANKULATHUR - 603 203**

**FACULTY OF AGRICULTURAL SCIENCES
BACHELOR OF SCIENCE (Honours) HORTICULTURE
RULES, REGULATIONS AND COURSE SCHEME
(For Students admitted from the academic year 2019-2020 Onwards)**

1. COURSE OBJECTIVES

The course will enable the students to

- a. Learn the basics and applied concepts in the field of Horticulture and its allied divisions
- b. Familiar with socio-economic conditions of the farmers and their problems
- c. Impart diagnostic and remedial knowledge relevant to real field situation through practical training
- d. Understand the scope, functions and job responsibilities in various sectors of Horticulture and allied field
- e. Develop confidence, entrepreneurial skill and competence to solve real farm problems

2. ELIGIBILITY FOR ADMISSION

H.Sc./Equivalent-Academic stream: Candidates seeking admission into B.Sc. (Hons.) degree programme must have passed the higher secondary examinations (10+2) conducted by any recognized board/University, with any one of the following subject group:

Group I : Physics, Chemistry, Biology and Mathematics

Group II : Physics, Chemistry and Biology

Group III : Physics, Chemistry and Mathematics

Group IV : Physics, Chemistry, Botany and Zoology

Group V : Physics, Chemistry and Forestry

Group VI : Physics, Chemistry, Biology and Agriculture

Group VII: Physics, Chemistry and Agriculture

H.Sc.-Vocational Stream: Biology and Agricultural Practices as vocational subject including theory and practicals

Eligible Minimum Qualifying Marks: 50% aggregate marks

3. DURATION OF THE COURSE

The duration of the course would be of four academic years. Each academic year consists of two consecutive semesters. The duration of each semester is 110-112 working days. The first year of study shall be the first and second semester following student's admission. The second year of study shall be the third and fourth semesters; the third year, the fifth and sixth semesters and the fourth year, the seventh and eighth semesters.

The structure of the B.Sc. (Hons.) Horticulture undergraduate programme, Academic/Ward Counsellor and Faculty Advisor, Class Committee, Registration/Enrollment for courses, Maximum duration of the programme, Temporary break of study from a programme, Discipline, Attendance, Condonation of attendance, Examinations, Assessment procedure, Registration for End Semester Examinations, Passing requirements, Reappearance/Arrear Examination, Course-Wise grading of students, Eligibility for the award of the degree, Classification of the degree award, Review, Revision of Regulations and Curriculum, Question paper pattern would be followed as per the norms mentioned in the "**Bachelor of Science (Honours) Regulation - 2019**" under the Faculty of Agricultural Sciences except the norms in AR.2.14 which shall be modified as follows

AR.2.14: A **credit** in theory means **one hour** of class room lecture and a credit in practical means **two and half hours** of laboratory or workshop or field work per week.

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY
FACULTY OF AGRICULTURAL SCIENCES
B.Sc. (Hons.) HORTICULTURE DEGREE PROGRAMME (2019 - 2023)
COURSE WISE CURRICULUM

COMPULSORY CORE (64 Credits)

HORTICULTURE					
S. No.	Course Code	Course Title	Credit Hours	Total Credit	Semester
1.	HOR19101	Fundamentals of Horticulture	2+1	3	I
2.	HOR19102	Botany of Horticultural Crops	1+1	2	I
3.	HOR19103	Study Tour - I	0+1	1	I
4.	HOR19201	Propagation of Horticultural Crops	1+1	2	II
5.	HOR19202	Production Technology of Tropical and Subtropical Fruit Crops	2+1	3	II
6.	HOR19301	Temperate Fruit Crops	1+1	2	III
7.	HOR19302	Tropical and Subtropical Vegetables	2+1	3	III
8.	HOR19303	Commercial Floriculture	2+1	3	III
9.	HOR19304	Spices and Condiments	2+1	3	III
10.	HOR19401	Dry Land Horticulture	1+1	2	IV
11.	HOR19402	Breeding of Fruit and Plantation Crops	2+1	3	IV
12.	HOR19403	Potato and Tuber Crops	1+1	2	IV
13.	HOR19404	Ornamental Horticulture	1+1	2	IV
14.	HOR19405	Plantation Crops	2+1	3	IV
15.	HOR19406	Precision Farming and Protected Cultivation	2+1	3	IV
16.	HOR19407	Study Tour - II	0+1	1	IV
17.	HOR19501	Orchard and Estate Management	1+1	2	V
18.	HOR19502	Temperate Vegetable Crops	1+1	2	V
19.	HOR19503	Breeding of Vegetable, Tuber and Spice Crops	2+1	3	V
20.	HOR19504	Principles of Landscape Architecture	1+1	2	V
21.	HOR19505	Medicinal and Aromatic Crops	2+1	3	V
22.	HOR19506	Fundamentals of Food Technology	1+1	2	V
23.	HOR19601	Breeding and Seed Production of Flower and Ornamental Plants	2+1	3	VI
24.	HOR19602	Postharvest Management of Horticultural Crops	2+1	3	VI
25.	HOR19603	Processing of Horticultural Crops	1+2	3	VI
26.	HOR19604	Seed Production of Vegetable, Tuber and Spice Crops	2+1	3	VI

SUPPORTIVE COURSE (75 Credits)

AGROECOLOGY					
S. No.	Course Code	Course Title	Credit Hours	Total Credit	Semester
1.	AGE19105	Introduction to Agroecology	1+0	1	I
2.	AGE19106	Environmental Protection and Disaster Management	2+1	3	I
3.	AGE19202	Introduction to Major Field Crops	1+1	2	II
4.	AGE19203	Introduction to Microbiology	2+1	3	II
5.	AGE19303	Introductory Agroforestry	1+1	2	III
6.	AGE19406	Agro-meteorology and Climate Change	1+1	2	IV
7.	AGE19502	Water Management in Horticultural Crops	1+1	2	V
8.	AGE19605	Organic Farming	2+1	3	VI

NATURAL RESOURCE MANAGEMENT					
S. No.	Course Code	Course Title	Credit Hours	Total Credit	Semester
1.	NRM19101	Fundamentals of Soil Science	1+1	2	I
2.	NRM19301	Soil Fertility and Nutrient Management	1+1	2	III
3.	NRM19402	Soil, Water and Plant Analysis	1+1	2	IV

CROP HEALTH					
S. No.	Course Code	Course Title	Credit Hours	Total Credit	Semester
1.	CRH19101	Introduction to Plant Biochemistry	2+1	3	I
2.	CRH19204	Introduction to Crop Physiology	2+1	3	II
3.	CRH19301	Fundamentals of Entomology	2+1	3	III
4.	CRH19302	Fundamentals of Plant Pathology	2+1	3	III
5.	CRH19303	Growth and Development of Horticultural Crops	1+1	2	III
6.	CRH19402	Diseases of Fruit, Plantation, Medicinal and Aromatic Crops	2+1	3	IV
7.	CRH19403	Nematode Pests of Horticultural Crops and their Management	1+1	2	IV
8.	CRH19503	Insect Pests of Fruit, Plantation, Medicinal and Aromatic Crops	2+1	3	V
9.	CRH19504	Diseases of Vegetable, Ornamental and Spice Crops	2+1	3	V
10.	CRH19603	Insect Pests of Vegetable, Ornamental and Spice Crops	2+1	3	VI
11.	CRH19604	Weed Management in Horticultural Crops	1+1	2	VI

GENETICS AND PLANT BREEDING					
S. No.	Course Code	Course Title	Credit Hours	Total Credit	Semester
1.	GPB19201	Principles of Genetics and Cytogenetics	2+1	3	II
2.	GPB19302	Principles of Plant Breeding	2+1	3	III
3.	GPB19402	Elementary Plant Biotechnology	1+1	2	IV

AGRICULTURAL SOCIAL SCIENCES					
S. No.	Course Code	Course Title	Credit Hours	Total Credit	Semester
1.	AGS19202	Fundamentals of Agricultural Economics	1+1	2	II
2.	AGS19502	Horti-Business Management	2+0	2	V
3.	AGS19603	Entrepreneurship Development and Business Management	1+1	2	VI
4.	AGS19604	Fundamentals of Extension Education	1+1	2	VI

SKILL EDUCATION					
S. No.	Course Code	Course Title	Credit Hours	Total Credit	Semester
1.	SKE19102	Communication Skills and Personality Development	1+2	3	I
2.	SKE19301	Information and Communication Technology	1+1	2	III

SUPPLEMENTARY COURSES (7 Credits)

SUPPLEMENTARY COURSES					
S. No.	Course Code	Course Title	Credit Hours	Total Credit	Semester
1.	SUP19201	Introduction to Livestock and Poultry Production	2+1	3	II
2.	SUP19503	Farm Power and Machinery	1+1	2	V
3.	SUP19602	Apiculture, Sericulture and Lac Culture	1+1	2	VI

ALLIED COURSES (4 Credits)

MATHEMATICS					
S. No.	Course Code	Course Title	Credit Hours	Total Credit	Semester
1.	MAT19101	Elementary Mathematics	1+1	2	I
2.	MAT19201	Elementary Statistics	1+1	2	II

EXTENSION ACTIVITY (Non-Gradual Courses)

PHYSICAL AND HEALTH EDUCATION				
S. No.	Course Code	Course Title	Credit Hours	Semester
1.	PHE19101	Physical Education	0+0	I - IV
2.	PHE19102	National Service Scheme	0+0	I - IV
3.	PHE19103	National Cadet Corps	0+0	I - IV
4.	PHE19104	Yoga For Human Excellence	0+0	I

STUDENT READY (41 Courses)

Student READY					
S. No.	Course Code	Course Title	Credit hours	Total Credit	Semester
1.	STR19702	All India Study Tour	0+1	1	VII
2.	STR19703	Student READY - Placement in Villages	0+10	10	VII
3.	STR19704	Student READY - Placement in Industries	0+10	10	VII
4.	STR198++	Experiential Learning - I	0+10	10	VIII
5.	STR198++	Experiential Learning - II	0+10	10	VIII

++ Any two of courses as elective

EXPERIENTIAL LEARNING (ANY TWO COURSES)					
S.No.	Course Code	Course Title	Credits Hours	Total Credit	Semester
1.	STR19801	Bio-inoculants Production Technology	0+10	10	VIII
2.	STR19802	Production Technology of Bio-control Agents	0+10	10	VIII
3.	STR19803	Mushroom Cultivation Technology	0+10	10	VIII
4.	STR19804	Commercial Beekeeping	0+10	10	VIII
5.	STR19805	Commercial Sericulture	0+10	10	VIII
6.	STR19807	Commercial Seed Production	0+10	10	VIII
7.	STR19808	Commercial Horticulture	0+10	10	VIII
8.	STR19809	Floriculture and Landscape Architecture	0+10	10	VIII
9.	STR19810	Protected Cultivation of High Value Horticulture crops	0+10	10	VIII
10.	STR19811	Agriculture Waste Management	0+10	10	VIII
11.	STR19812	Food Processing	0+10	10	VIII
12.	STR19813	Processing of Fruit and Vegetables for Value Addition	0+10	10	VIII
13.	STR19814	Poultry Production Technology	0+10	10	VIII

Abstract

Sl. No	Career Stream	Total Credits
1.	Compulsory Core	64
2.	Supportive Course	75
3.	Supplementary Courses	7
4.	Allied Courses	4
5.	Extension Activity	0
6.	STUDENT READY	41
Total		191

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY
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B.Sc. (Hons.) HORTICULTURE DEGREE PROGRAMME (2019 - 2023)
SEMESTER WISE CURRICULAM

FIRST SEMESTER						
Career Stream Title	Course Code	Title of the Course	Credit Hours			
			Theory (T)	Practical (P)	Total (T+P)	Credit
Compulsory Core	HOR19101	Fundamentals of Horticulture	2	1	3	3
	HOR19102	Botany of Horticultural Crops	1	1	2	2
	HOR19103	Study Tour - I	0	1	1	1
Supportive Course	AGE19105	Introduction to Agroecology	1	0	1	1
	AGE19106	Environmental Protection and Disaster Management	2	1	3	3
	NRM19101	Fundamentals of Soil Science	1	1	2	2
	CRH19101	Introduction to Plant Biochemistry	2	1	3	3
	SKE19102	Communication Skills and Personality Development	1	2	3	3
Allied Course	MAT19101	Elementary Mathematics	1	1	2	2
Extension Activity	PHE19104	Yoga For Human Excellence	0	0	0	0
Total			11	9	20	20

SECOND SEMESTER						
Career Stream Title	Course Code	Title of the Course	Credit Hours			
			Theory (T)	Practical (P)	Total (T+P)	Credit
Compulsory Core	HOR19201	Propagation of Horticultural Crops	1	1	2	2
	HOR19202	Production Technology of Tropical and Subtropical Fruit Crops	2	1	3	3
Supportive Course	AGE19202	Introduction to Major Field Crops	1	1	2	2
	AGE19203	Introduction to Microbiology	2	1	3	3
	CRH19204	Introduction to Crop Physiology	2	1	3	3
	GPB19201	Principles of Genetics and Cytogenetics	2	1	3	3
	AGS19202	Fundamentals of Agricultural Economics	1	1	2	2
Supplementary Course	SUP19201	Introduction to Livestock and Poultry Production	2	1	3	3
Allied Course	MAT19201	Elementary Statistics	1	1	2	2
Total			14	9	23	23

THIRD SEMESTER						
Career Stream Title	Course Code	Title of the Course	Credit Hours			
			Theory (T)	Practical (P)	Total (T+P)	Credit
Compulsory Core	HOR19301	Temperate Fruit Crops	1	1	2	2
	HOR19302	Tropical and Subtropical Vegetables	2	1	3	3
	HOR19303	Commercial Floriculture	2	1	3	3
	HOR19304	Spices and Condiments	2	1	3	3
Supportive Course	CRH19301	Fundamentals of Entomology	2	1	3	3
	CRH19302	Fundamentals of Plant Pathology	2	1	3	3
	CRH19303	Growth and Development of Horticultural Crops	1	1	2	2
	GPB19302	Principles of Plant Breeding	2	1	3	3
	NRM19301	Soil Fertility and Nutrient Management	1	1	2	2
	AGE19303	Introductory Agroforestry	1	1	2	2
	SKE19301	Information and Communication Technology	1	1	2	2
Total			17	11	28	28

FOURTH SEMESTER						
Career Stream Title	Course Code	Title of the Course	Credit Hours			
			Theory (T)	Practical (P)	Total (T+P)	Credit
Compulsory Core	HOR19401	Dry Land Horticulture	1	1	2	2
	HOR19402	Breeding of Fruit and Plantation Crops	2	1	3	3
	HOR19403	Potato and Tuber Crops	1	1	2	2
	HOR19404	Ornamental Horticulture	1	1	2	2
	HOR19405	Plantation Crops	2	1	3	3
	HOR19406	Precision Farming and Protected Cultivation	2	1	3	3
	HOR19407	Study Tour - II	0	1	1	1
Supportive Course	AGE19406	Agro-meteorology and Climate Change	1	1	2	2
	NRM19402	Soil, Water and Plant Analysis	1	1	2	2
	CRH19402	Diseases of Fruit, Plantation, Medicinal and Aromatic Crops	2	1	3	3
	CRH19403	Nematode Pests of Horticultural Crops and their Management	1	1	2	2
	GPB19402	Elementary Plant Biotechnology	1	1	2	2
Extension Activity	PHE19101	Physical Education	0	0	0	0
	PHE19102	National Service Scheme	0	0	0	0
	PHE19103	National Cadet Corps	0	0	0	0
Total			15	12	27	27

FIFTH SEMESTER						
Career Stream Title	Course Code	Title of the Course	Credit Hours			
			Theory (T)	Practical (P)	Total (T+P)	Credit
Compulsory Core	HOR19501	Orchard and Estate Management	1	1	2	2
	HOR19502	Temperate Vegetable Crops	1	1	2	2
	HOR19503	Breeding of Vegetable, Tuber and Spice Crops	2	1	3	3
	HOR19504	Principles of Landscape Architecture	1	1	2	2
	HOR19505	Medicinal and Aromatic Crops	2	1	3	3
	HOR19506	Fundamentals of Food Technology	1	1	2	2
Supportive Course	CRH19503	Insect Pests of Fruit, Plantation, Medicinal and Aromatic Crops	2	1	3	3
	CRH19504	Diseases of Vegetable, Ornamental and Spice Crops	2	1	3	3
	AGE19502	Water Management in Horticultural Crops	1	1	2	2
	AGS19502	Horti-Business Management	2	0	2	2
Supplementary Course	SUP19503	Farm Power and Machinery	1	1	2	2
Total			16	10	26	26

SIXTH SEMESTER						
Career Stream Title	Course code	Title of the Course	Credit Hours			
			Theory	Practical	Total (T+P)	Credit
Compulsory Core	HOR19601	Breeding and Seed Production of Flower and Ornamental Plants	2	1	3	3
	HOR19602	Postharvest Management of Horticultural Crops	2	1	3	3
	HOR19603	Processing of Horticultural Crops	1	2	3	3
	HOR19604	Seed Production of Vegetable, Tuber and Spice Crops	2	1	3	3
Supportive Course	CRH19603	Insect Pests of Vegetable, Ornamental and Spice Crops	2	1	3	3
	CRH19604	Weed Management in Horticultural Crops	1	1	2	2
	AGE19605	Organic Farming	2	1	3	3
	AGS19603	Entrepreneurship Development and Business Management	1	1	2	2
	AGS19604	Fundamentals of Extension Education	1	1	2	2
Supplementary Course	SUP19602	Apiculture, Sericulture and Lac Culture	1	1	2	2
Total			15	11	26	26

SEVENTH SEMESTER						
Student READY: Rural Horticultural Work Experience						
Career Stream Title	Course code	Title of the Course	Credit Hours			
			Theory	Practical	Total (T+P)	Credit
Student Ready	STR19702	All India Study Tour	0	1	1	1
	STR19703	Student READY- Placement in Villages	0	10	10	10
	STR19704	Student READY - Placement in Industries	0	10	10	10
Total			0	21	21	21

EIGHT SEMESTER						
Student READY: Experimental Learning Programme						
Career Stream Title	Course code	Title of the Course	Credit Hours			
			Theory	Practical	Total (T+P)	Credit
Student Ready	STR198++	Experiential Learning - I#	0	10	10	10
	STR198++	Experiential Learning - II#	0	10	10	10
Total			0	20	20	20

#Any one of the two courses chosen as elective by the student from the table of Experiential Learning programme under curriculum, ++ last two digits of course code

EXPERIENTIAL LEARNING (ANY TWO COURSES)					
S. No.	Course Code	Course Title	Credits Hours	Total Credit	Semester
1.	STR19801	Bio-inoculants Production Technology	0+10	10	VIII
2.	STR19802	Production Technology of Bio-control Agents	0+10	10	VIII
3.	STR19803	Mushroom Cultivation Technology	0+10	10	VIII
4.	STR19804	Commercial Beekeeping	0+10	10	VIII
5.	STR19805	Commercial Sericulture	0+10	10	VIII
6.	STR19807	Commercial Seed Production	0+10	10	VIII
7.	STR19808	Commercial Horticulture	0+10	10	VIII
8.	STR19809	Floriculture and Landscape Architecture	0+10	10	VIII
9.	STR19810	Protected Cultivation of High Value Horticulture Crops	0+10	10	VIII
10.	STR19811	Agriculture Waste Management	0+10	10	VIII
11.	STR19812	Food Processing	0+10	10	VIII
12.	STR19813	Processing of Fruit and Vegetables for Value Addition	0+10	10	VIII
13.	STR19814	Poultry Production Technology	0+10	10	VIII

ABSTRACT

S. No.	Semester	Credit Hours		Total Credit (T+P)
		Theory	Practical	
1.	I	11	9	20
2.	II	14	9	23
3.	III	17	11	28
4.	IV	15	12	27
5.	V	16	10	26
6.	VI	15	11	26
7.	VII	0	21	21
8.	VIII	0	20	20
	Total	88	103	191

Total credits to be earned for the degree: 191

Course Code	HOR19101	Course Name	Fundamentals of Horticulture	Course Category	C	Compulsory Core	L	T	P	C
							2	0	1	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Horticulture	Data Book / Codes/Standards			Nil

Course Learning Rationale (CLR):		The purpose of learning this course is to:			Learning			Program Learning Outcomes (PLO)														
CLR-1 :	Outline the scope and importance of horticulture				1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	Summarize different propagation methods in horticulture				Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Horticulture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems through horticulture	Ability to implement knowledge gained in the applied field of horticulture	Ability to understand social and ethical responsibilities of horticulture
CLR-3 :	Explain different climatic zone in horticulture crops																					
CLR-4 :	Paraphrase different planting system																					
CLR-5 :	Recognize the benefits of irrigation and fertigation methods in horticulture																					
CLR-6 :	Outline the plan and layout of orchard																					
Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:																				
CLO-1 :	Describe skills on tools and implements used in horticulture				3	90	80	M								M	H		H	H	H	H
CLO-2 :	Recognize skill for solving field problems				1	95	85	H								L	H		H	H	H	H
CLO-3 :	Give original examples of cultivable horticulture crops in different zones of climacteric condition				2	80	70	M		L	L					L	H		H	H	H	H
CLO-4 :	Narrate to handle postharvest losses in fruits and vegetable				3	75	65	M			L	L				M	H		H	H	H	H
CLO-5 :	Paraphrase training and pruning methods in horticulture crops				2	75	60	L	L							M	H		H	H	H	H
CLO6 :	Outline skills to identify major physiological disorder in horticulture crops				2	75	65	L						H		M	H		H	H	H	H

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		8	8	7	6	4
S-1	SLO-1	Horticulture – definitions, divisions	Role of soil – physical properties in horticultural crop production	Nursery techniques	Bearing habits of horticultural crops	Protected cultivation in horticulture – definition
	SLO-2	Scope and importance of Horticulture	Chemical properties in horticultural crop production	production of healthy planting materials		Objectives and structures
S 2	SLO-1	Global and national scenario of area, production	Role of climatic factors in horticultural crop production	Planning of orchard	Principles and methods of training in horticultural crops	Hydroponics
	SLO-2	Export and import of horticultural crops		Layout for orchard establishment		Aeroponics
S 3-4	SLO-1	Lab1: Study of different features of an orchard	Lab5: Layout and study of nutrition garden	Lab9: Identification of manures, fertilizers and methods of application	Lab12: Study of bearing habits in horticultural crops	Lab15: Study of maturity standards, harvesting, grading, packing and storage of horticultural crops
	SLO-2					
S-5	SLO-1	Classification of horticultural crops	Biotic stress	Planting systems	Principles and methods of pruning in horticultural crops	Maturity indices, harvesting
	SLO-2	Nutritive value of horticultural crops	Management in horticultural crops	planting of horticultural crops		Post-harvest handling of horticultural crops
S-6	SLO-1	Vegetable gardens – nutrition garden/kitchen garden	Abiotic stress and management in horticultural crops	High Density Planting	Factors influencing fruitfulness	Packing of horticultural crops

Duration (hour)	Learning Unit / Module 1		Learning Unit / Module 2		Learning Unit / Module 3		Learning Unit / Module 4		Learning Unit / Module 5	
	8		8		7		6		4	
	SLO-2	Other types of gardens				Clonal orchards		Unfruitfulness in horticultural crops		Storage of horticultural crops
S 7-8	SLO-1	Lab2: planning and layout of orchard	Lab6: Preparation of nursery bed, seed treatment and sowing of vegetable seeds			Lab10: Preparation and application of growth regulators in horticultural crops		Lab13: Methods of training and pruning in horticultural crops		Lab16: Visit to commercial orchards/nurseries and cold storage unit
	SLO-2									
S-9	SLO-1	Horticultural therapy				Water management in horticultural crops		Rejuvenation of old orchards and Top working		Processing of horticultural crops
	SLO-2									
S-10	SLO-1	Horticulture zones of India				Nutrient management in horticultural crops		Special horticultural practices		
	SLO-2	Horticulture zones of Tamil Nadu								
S 11-12	SLO-1	Lab3: Study of tools and implements used for horticultural crop production	Lab7: Preparation of pits and planting of fruit plants			Lab11: Studies on physiological disorders and their management in fruit and vegetable crops		Lab14: Study on structures used in protected cultivation		
	SLO-2									
S-13	SLO-1	Institutions involved in horticultural research and development				Soil fertility management horticultural crops				
	SLO-2	Commodity boards								
S-14	SLO-1	-				Weed management in horticultural crops				
	SLO-2	-				Mulching in horticultural crops				
S 15-16	SLO-1	Lab4: Identification of various horticultural crops	Lab8: Study of different irrigation methods in horticultural crops			-		-		-
	SLO-2					-		-		-
S-17	SLO-1	-				Growth regulators and their role in horticultural crops		-		-
	SLO-2	-						-		-
S-18	SLO-1	-				Cropping systems – intercropping		-		-
	SLO-2	-				Multi-tier cropping		-		-
S-19	SLO-1	-				Principles of organic horticulture		-		-
	SLO-2	-						-		-

Learning Resources	1. Chadha, K.L. (2019). Handbook of Horticulture. Vol. I (2 nd revised edition). New Delhi: ICAR. pp 1 – 299.
	2. Kumar, N. (2020). Introduction to Horticulture (7 th revised edition). New Delhi: Oxford & I.B.H. Publishing. pp. 1 – 452.

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember	40 %	30 %	35%	30 %
	Understand				
Level 2	Apply	40 %	40 %	35%	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	30%	30 %
	Create				
	Total	100 %	100 %	100%	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. Amol Chaudhari Manager R&D Farm Jain irrigation system Ltd. Udumalpet	Dr Vijay Rakesh Reddy, S. Scientist (Horticulture) ICAR-IIHR, Bengaluru	Dr. B. Gopu

THEORY

Unit I - Basic concepts of horticulture

Scope and importance – state, national and global scenario of horticultural crops divisions of horticulture – area and production – export and import – classifications of horticultural crops – nutritive value of horticultural crops – vegetable garden – nutrition garden/kitchen garden and other types of gardens - horticultural therapy – horticultural zones of India and Tamil Nadu – Institutions involved in horticultural research and development – commodity boards

Unit II - Soil and climatic factors on crop production

Soil and climate – physical and chemical properties of soil – climatic factors – light, temperature, photoperiod, relative humidity, rainfall, altitude, micro climate – biotic and abiotic stress in crop production.

Unit III – Nursery techniques and crop management

Nursery techniques for production of healthy planting materials – planning and layout of orchard – planting systems – HDP in fruit crops. Water management – Nutrient management - Soil fertility management – weed management – mulching - application of growth regulators – cropping systems – intercropping and multi-tier cropping – principles of organic horticulture.

Unit IV - Growth and development

Important phases of growth and development – bearing habits. Principles and methods of training and pruning of horticultural crops – rejuvenation of old orchards and top working – factors influencing fruitfulness and unfruitfulness – special horticultural practices.

Unit V - Protected cultivation and postharvest handling

Protected cultivation definition, objectives and structures – hydroponics – aeroponics – maturity indices – harvesting, grading and post-harvest handling –processing, value addition packing and storage of horticultural produce.

Theory Lecture Schedule

1. Horticulture – definitions, divisions, scope and importance of Horticulture
2. Global and national scenario of area, production, export and import of horticultural crops
3. Classification and nutritive value of horticultural crops
4. Vegetable gardens – nutrition garden/kitchen garden and other types of gardens
5. Horticultural therapy
6. Horticulture zones of India and Tamil Nadu
7. Institutions involved in horticultural research and development – commodity boards
8. Role of soil – physical and chemical properties in horticultural crop production
9. Role of climatic factors in horticultural crop production
10. Biotic stress and management in horticultural crops
11. Abiotic stress and management in horticultural crops
12. Nursery techniques for production of healthy planting materials
13. Planning and layout for orchard establishment
14. Planting systems and planting of horticultural crops
15. High Density Planting in fruit crops
16. Water management in horticultural crops
17. **In – Semester examination**
18. Nutrient management in horticultural crops
19. Soil fertility management in horticultural crops
20. Weed management and mulching in horticultural crops
21. Growth regulators and their role in horticultural crops
22. Cropping systems – intercropping and multi-tier cropping
23. Principles of organic horticulture
24. Bearing habits of horticultural crops
25. Principles and methods of training in horticultural crops

26. Principles and methods of pruning in horticultural crops
27. Factors influencing fruitfulness and unfruitfulness in horticultural crops
28. Rejuvenation of old orchards and top working
29. Special horticultural practices
30. Protected cultivation in horticulture – definition, objectives and structures
31. Hydroponics and aeroponics in horticultural crops
32. Maturity indices, harvesting and post-harvest handling of horticultural crops
33. Packing and storage of horticultural crops
34. Processing and value addition of horticultural crops

Practical Schedule

1. Study of different features of an orchard
2. Planning and layout of an orchard
3. Study of tools and implements used for horticultural crop production
4. Identification of various horticultural crops
5. Layout and study of nutrition garden/kitchen garden
6. Preparation of nursery bed, seed treatment and sowing of vegetable seeds
7. Preparation of pits and planting of fruit crops
8. Study of different irrigation methods in horticultural crops
9. Identification of manures, fertilizers and methods of application
10. Preparation and application of growth regulators in horticultural crops
11. Studies on physiological disorders and their management in fruit and vegetable crops
12. Study of bearing habits in horticultural crops
13. Methods of training and pruning in horticultural crops
14. Study on structures used in protected cultivation
15. Study of maturity standards, harvesting, grading, packing and storage of horticultural crops
16. Visit to commercial orchards/nurseries and cold storage unit
17. **University Practical Examination**

Text Books

1. Adams, C.R., M. P. Early, J. Brook and K. Bamford. (2014) Principles of Horticulture. Routledge, 2nd edition pp.1-416
2. Bansil. P.C. (2008). Horticulture in India. CBS Publishers and Distributors, New Delhi. 1st edition pp.1-503
3. Jitendra Singh, (2017) Fundamental of Horticulture, Kalyani Publishers, New Delhi. pp.1-524
4. Chadha, K.L. (2019). Handbook of Horticulture. Vol. I (2nd revised edition). New Delhi: ICAR. pp 1 – 299.
5. Kumar, N. (2020). Introduction to Horticulture (7th revised edition). New Delhi: Oxford & I.B.H. Publishing. pp. 1 – 452.

Reference Books

1. Chadha, K.L. (2001). Handbook of Horticulture, ICAR, New Delhi. 1st edition pp.1-593
2. Christopher, E.P. (2015). Introductory Horticulture, Biotech Books, New Delhi. pp.1-490
3. Jacob John.P. (2008). A hand book of post harvest management of fruits and vegetables. Dayapublishers. 2nd edition pp. 147.
4. Singh, D.K. (2008). Hi-tech horticulture. Agrotech publishers, Udaipur
5. Rajan, S. and B.L. Markose. (2007). Propagation of horticultural crops. New India 2nd edition pp.320.

Web Reference

1. <http://aggie-horticulture.tamu.edu/propagation/propagation.html>
2. <http://www.britannica.com/>
3. <http://www.horticulture.com.au/export/hmac.asp>
4. <http://www.horticultureworld.net/hort-india.htm>
5. <http://www.fao.org/>

Journals

1. Indian Horticulture
2. Acta Horticulture
3. Indian Journal of Horticulturae
4. ScientiaHorticulturae
5. Journal of Horticulture Sciences and Biotechnology

Course Nature: Theory based Practical							
Total Marks (100)							
Sl.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	05	05	05	-	15
Grand Total							100

Course Code	HOR19102	Course Name	Botany of Horticultural Crops	Course Category	C	Compulsory Core	L	T	P	C
							1	0	1	2

Pre-requisite Courses	NIL	Co-requisite Courses	NIL	Progressive Courses	NIL
Course Offering Department	Horticulture	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning	Program Learning Outcomes (PLO)
CLR-1 :	Outline the Systemic Botany	1 2 3	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
CLR-2 :	Describe floral biology of fruit crops	Level of Thinking (Bloom)	Horticulture Knowledge
CLR-3 :	Describe the floral biology of vegetable crops	Expected Proficiency (%)	Problem Analysis
CLR-4 :	Paraphrase the dissection of flowers	Expected Attainment (%)	Design & Development
CLR-5 :	Discuss the different families		Analysis, Design, Research
CLR-6 :	Identify the botany of different flowers		Modern Tool Usage
			Society & Culture
			Environment & Sustainability
			Ethics
			Individual & Team Work
			Communication
			Project Mgt. & Finance
			Life Long Learning
			Ability to solve scientific problems
			Ability to implement knowledge gained
			Ability to understand social and ethical responsibilities
			H H H H H H H H H H H H H H H
			H H H H H H H H H H H H H H H
			M L L L L L L L L L L L L L L
			M L L L L L L L L L L L L L L
			L L L L L L L L L L L L L L L
			L L L L L L L L L L L L L L L

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLO-1 :	Summarize flowers based on crop	1	95	85
CLO-2 :	Describe botany of Horticultural crops	1	80	75
CLO-3 :	Describe the classification of Families	1	75	65
CLO-4 :	Outline dissection procedures	2	75	65
CLO-5 :	Outline pollination mechanism	2	90	80
CLO6 :	Describe economical part of a crop	1	95	90

Duration (hour)	Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
	4	3	3	3	3
S-1	SLO-1	Systemic botany	Anacardiaceae	Solanaceae (tomato, brinjal, chilli, potato), Malvaceae,	Piperaceae ,Zingiberaceae
	SLO-2	Nomenclature	Rutaceae, Musaceae	Cucurbitaceae	Orchidaceae (vanilla, dendrobium orchid) and Apiaceae (coriander)
S-2,3	SLO-1	Lab1:Anacardiaceae (mango), Rutaceae (acid lime, sweet orange and mandarin) and Musaceae	Lab5:Solanaceae (tomato, brinjal, chilli, potato) and Malvaceae	Lab8:Brassicaceae (cabbage, cauliflower, radish), Chenopodiaceae and Amaranthaceae	Lab11:Myristicaceae, Lauraceae, Leguminosae and Caesalpiniaceae
	SLO-2				Lab14:Asteraceae (chrysanthemum, marigold, gerbera, golden rod, aster)
S-4	SLO-1	Terminologies	Moraceae, Vitaceae, Caricaceae,	Moringaceae, Fabaceae (peas, French beans), Alliaceae (onion, garlic),	Myristicaceae, Lauraceae,
	SLO-2	Morphological distribution	Euphorbiaceae (aonla), Myrtaceae (guava) and Sapotaceae	Brassicaceae , Chenopodiaceae and Amaranthaceae	Leguminosae and Caesalpiniaceae
S-5,6	SLO-1	Lab2:Moraceae, Vitaceae and Caricaceae	Lab6:Cucurbitaceae (pumpkin, watermelon, muskmelon, ridge gourd, bitter gourd, cucumber)	Lab9:Convolvulaceae, Umbelliferae, Araceae (elephant foot yam, colocasia) and Dioscoreaceae (yam, medicinal dioscorea)	Lab12:Camelliaceae, Rubiaceae, Palmae (coconut, arecanut, palmyrah, oil palm) and Sterculiaceae
	SLO-2				Lab15:Caryophyllaceae, Iridiaceae, Apocynaceae and Geraniaceae

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		4	3	3	3	3
S-7	SLO-1	Sexual reproduction in flowering plants -	Bromeliaceae, Punicaceae, Annonaceae (custard apple)	Convolvulaceae, Umbelliferae	Camelliaceae, Rubiaceae, Palmae	Geraniaceae
	SLO-2	Modes of pollination	Rhamnaceae and Rosaceae	Araceae (elephant foot yam, colocasia) and Dioscoreaceae	Sterculitaceae	,Labiatae (coleus, patchouli, mint) and Scrophulariaceae
S-8,9	SLO-1	Lab3:Euphorbiaceae (aonla), Myrtaceae (guava) and Sapotaceae	Lab7:Moringaceae and Fabaceae (peas, French beans) and Alliaceae (onion, garlic	Lab10:Piperaceae (pepper, betelvine) Zingiberaceae (cardamom, turmeric, ginger), Orchidaceae (vanilla, dendrobium orchid) and Apiaceae (coriander)	Lab13:Oleaceae (malligai, mullai, jathimalli), Amaryllidaceae and Acanthaceae	Lab16:Graminae (lemongrass, citrononella, palmarosa, vetiver), Labiatae (coleus, patchouli, mint) and Scrophulariaceae
	SLO-2					
S-10	SLO-1	Fertilization and fruit set				
	SLO-2	ICBN Rules				
S-11	SLO-1	Lab4:Bromeliaceae, Punicaceae, Annonaceae (custard apple), Rhamnaceae and Rosaceae (apple, pear and rose)				
	SLO-2					

Learning Resources	1. Jansi Rani, P. Subramanian, S., Veeraragavatham and S. Thamburaj, (1997). Botany of vegetable crops. Coimbatore. KRS Screen Printers. 2. RatikantaMaiti, AllamRamaswamy, Desari Rajkumar. (2018). Botany of Vegetable crops. American Academic Press.. (pp. 1 – 251)

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In semester (20%)	Practical (15%)		
Level 1	Remember	40 %	30 %	35 %	30 %
	Understand				
Level 2	Apply	40 %	40 %	35 %	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	30 %	30 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	Dr. P. Preethi, Scientist (Fruit Science), ICAR – Directorate of Cashew Research,, Puttur – 574202 E-mail: pppreethifruitscience@gmail.com	Dr. B. Gopu Dr. S. Anandhi Mrs. C. Kanimozhi Mr. Harish. A

THEORY

Unit I - Introduction to terminologies and concepts

Systematic botany– terminology, morphological description and classification – root, stem, leaf, inflorescence, flower and fruit – Sexual reproduction in flowering plants – modes of pollination – fertilization and fruit set - asexual/vegetative reproduction. Principles involved in nomenclature - ICBN rules and recommendations with special reference to names of cultivated plants hybrids / varieties of names.

Unit II - Botany of fruit crops

Botany, floral biology, pollination, fruit set and economic parts in the families of Anacardiaceae (mango), Rutaceae (acid lime, sweet orange and mandarin), Musaceae (banana), Moraceae (fig, jack), Vitaceae (grape), Caricaceae (papaya), Euphorbiaceae (aonla), Myrtaceae (guava), Sapotaceae (sapota), Bromeliaceae (pineapple), Punicaceae (pomegranate), Annonaceae (custard apple), Rhamnaceae (ber) and Rosaceae (apple, pear and rose).

Unit III - Botany of vegetable crops

Botany, floral biology, pollination, fruit set and economic part in the families of Solanaceae (tomato, brinjal, chilli, potato), Malvaceae, Cucurbitaceae (pumpkin, watermelon, muskmelon, ridge gourd, bitter gourd, cucumber), Moringaceae, Fabaceae (peas, French beans), Alliaceae (onion, garlic), Brassicaceae (cabbage, cauliflower, radish), Chenopodiaceae, Amaranthaceae, Convolvulaceae (sweet potato), Araceae (elephant foot yam, colocasia), Dioscoreaceae (yam, medicinal dioscorea).

Unit IV - Botany of spices and plantation crops

Botany, floral biology, pollination, fruit set and economic part in the families of Piperaceae (pepper, betelvine), Zingiberaceae (cardamom, turmeric, ginger), Orchidaceae (Vanilla, Dendrobium orchid), Apiaceae (Umbelliferae) (coriander), Myristicaceae, Lauraceae, Leguminosae, Caesalpiniaceae, Camelliaceae, Rubiaceae, Arecaceae (Palmae) (coconut, arecanut, palmyrah, oil palm), Sterculiaceae (Cocoa).

Unit V - Botany of flower, medicinal and aromatic crops

Botany, floral biology, pollination, fruit set and economic part in the families of Oleaceae (malligai, mullai, jathimalli), Asteraceae (chrysanthemum, marigold, gerbera, golden rod, aster), Amaryllidaceae, Acanthaceae, Caryophyllaceae, Iridaceae, Apocynaceae, Poaceae (Graminae), (lemongrass, citrononella, palmarosa, vetiver), Geraniaceae, Lamiaceae (Labiatae) (coleus, patchouli, mint), Scrophulariaceae.

Theory Lecture Schedule

1. Systematic botany-principles involved in nomenclature
2. Terminology, morphological description and classification based on root, stem, leaf, inflorescence, flower and fruit
3. Sexual reproduction in flowering plants – modes of pollination – fertilization and fruit set – asexual/vegetative reproduction
4. Principles involved in nomenclature - ICBN rules and recommendations – special reference to names of hybrids and cultivated plants
5. Botany, floral biology, pollination, fruit set and economic parts in the families of Anacardiaceae (mango), Rutaceae (acid lime, sweet orange and mandarin) and Musaceae
6. Moraceae (fig, jack), Vitaceae, Caricaceae, Euphorbiaceae (aonla), Myrtaceae (guava) and Sapotaceae
7. Bromeliaceae, Punicaceae, Annonaceae (custard apple), Rhamnaceae and Rosaceae (apple, pear and rose)
8. Solanaceae (tomato, brinjal, chilli, potato), Malvaceae, Cucurbitaceae (pumpkin, watermelon, muskmelon, ridge gourd, bitter gourd, cucumber)
9. **In - Semester Examination**
10. Moringaceae, Fabaceae (peas, French beans), Alliaceae (onion, garlic), Brassicaceae (cabbage, cauliflower, radish), Chenopodiaceae and Amaranthaceae
11. Convolvulaceae, Umbelliferae, Araceae (elephant foot yam, colocasia) and Dioscoreaceae (yam, medicinal dioscorea)
12. Piperaceae (pepper, betelvine) Zingiberaceae (cardamom, turmeric, ginger), Orchidaceae (vanilla, dendrobium orchid) and Apiaceae (coriander)
13. Myristicaceae, Lauraceae, Leguminosae and Caesalpiniaceae
14. Camelliaceae, Rubiaceae, Palmae (coconut, arecanut, palmyrah, oil palm), Sterculiaceae
15. Oleaceae (malligai, mullai, jathimalli), Asteraceae (chrysanthemum, marigold, gerbera, golden rod, aster), Amaryllidaceae and Acanthaceae
16. Caryophyllaceae, Iridaceae, Apocynaceae, Graminae, (lemongrass, citrononella, palmarosa, vetiver),
17. Geraniaceae, Labiatae (coleus, patchouli, mint) and Scrophulariaceae

Practical Schedule

Observation and description of the taxonomy and morphological characters of the crops in the families

1. Anacardiaceae (mango), Rutaceae (acid lime, sweet orange and mandarin) and Musaceae
2. Moraceae, Vitaceae and Caricaceae
3. Euphorbiaceae (aonla), Myrtaceae (guava) and Sapotaceae
4. Bromeliaceae, Punicaceae, Annonaceae (custard apple), Rhamnaceae and Rosaceae (apple, pear and rose)
5. Solanaceae (tomato, brinjal, chilli, potato) and Malvaceae
6. Cucurbitaceae (pumpkin, watermelon, muskmelon, ridge gourd, bitter gourd, cucumber)
7. Moringaceae and Fabaceae (peas, French beans) and Alliaceae (onion, garlic)
8. Brassicaceae (cabbage, cauliflower, radish), Chenopodiaceae and Amaranthaceae
9. Convolvulaceae, Umbelliferae, Araceae (elephant foot yam, colocasia) and Dioscoreaceae (yam, medicinal dioscorea)
10. Piperaceae (pepper, betelvine) Zingiberaceae (cardamom, turmeric, ginger), Orchidaceae (vanilla, dendrobium orchid) and Apiaceae (coriander)
11. Myristicaceae, Lauraceae, Leguminosae and Caesalpiniaceae
12. Camelliaceae, Rubiaceae, Palmae (coconut, arecanut, palmyrah, oil palm) and Sterculiaceae
13. Oleaceae (malligai, mullai, jathimalli), Amaryllidaceae and Acanthaceae
14. Asteraceae (chrysanthemum, marigold, gerbera, golden rod, aster)
15. Caryophyllaceae, Iridaceae, Apocynaceae and Geraniaceae
16. Graminae (lemongrass, citrononella, palmarosa, vetiver), Labiatae (coleus, patchouli, mint) and Scrophulariaceae
17. **University Practical Examination**

Text Books

1. Jansi Rani, P. Subramanian, S., Veeraragavathatham and S. Thamburaj, (1997). Botany of vegetable crops. Coimbatore: KRS Screen Printers.
2. Mauseth, J.D. (2009). Botany: An introduction to plant biology. Jones and Bartlett Publishers, MA.
3. RatikantaMaiti, Allam Ramaswamy, Desari Rajkumar. (2018). Botany of Vegetable crops. USA: American Academic Press.(pp. 1 – 251)
4. Spichiger, R., Savolainen, V., Figeat, M., Jeanmond, D. (2004). Systematic Botany of flowering plants. USA: Science Publishers Inc.,

Reference books

1. Joseph Y. Bergen, (1990). Fundamentals of Botany. Jaipur:Arihant Publishers.
2. Kumar, R.A., Lakshmanan, V.Thondaiman. (2014). Botany of Vegetable crops. New Delhi: Narendra Publishing House.(pp. 1- 184).
3. Ponnuswami, V. Padmadevi, K. Muthukumar, S. (2012). Botany of Horticultural crops. New Delhi: Narendra Publishing House.
4. Rameshkumar, A., V. Lakshmanan and T. N. Balamohan. (2011). Botany of Vegetable Crops. New Delhi: New Delhi Publishers.

Web Reference:

1. www.sanfoundry.com
2. www.books.google.com
3. www.ucafr.com
4. www.senecaahs.com

Journals

1. Indian Journal of Horticulture
2. Journal of South Indian Horticulture
3. Journal of Plant biology
4. Journal of Plant research
5. Journal of Systemics and Evolution

Course Nature: Theory based Practical							
Total Marks (100)							
Sl.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	05	05	05	-	15
Grand Total							100

Course Code	Course Title	T	P	Credit
HOR19103	Study Tour - I	0	1	1
Course Orientation: Exposure visits, Spot Study, Skill Education				

STUDY TOUR – I

Students will be taken for a five days trip to Bengaluru and Hosur to visit ICAR-National Bureau of Soil Survey and Landuse Planning (NBSSLUP); ICAR-Indian Institute of Horticulture (IIHR); University of Agricultural Sciences, GKVK; Commercial horticulture units; NGOs for exposing themselves to learn the activities pertaining to the field of horticulture.

Course Nature: Practical			
Total Marks (100)			
Sl.No.	Category	Assessment Tools	Marks
1	Practical-Internal	Purely internal based on the participation, involvement and contribution of students in the activities pertaining to the course and the assessment criteria be as follows,	
		Written Test	40
		Behaviour (Punctuality and Discipline)	20
		Observation Note Book	25
		Viva-Voce	10
		Attendance	05
Grand Total			100

Course Code	AGE19105	Course Name	Introduction to Agroecology	Course Category	S	Supportive Course	L	T	P	C
							1	0	0	1

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Agroecology	Data Book / Codes/Standards			Nil

Course Learning Rationale (CLR):		The purpose of learning this course is to:		
CLR-1 :	Explain the principles of agroecology			
CLR-2 :	Discuss biodiversity and ecosystem services			
CLR-3 :	Illustrate the synergies between pest and soil fertility management			
CLR-4 :	Paraphrase soil health			
CLR-5 :	Outline the status of agroecosystem in changing climate			

Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:		
CLO-1 :	Ability to relate agroecology principles to the existing agriculture systems			
CLO-2 :	Identify optimum utilisation of ecosystem services and protect the ecosystem			
CLO-3 :	Summarize crop biodiversity, manage pest control without affecting soil fertility			
CLO-4 :	Summarize soil fertility and give original examples for a crop rotation specific to a region			
CLO-5 :	Describe climate resilient farming practices			

Learning		
1	2	3
Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
1	80	75
2	75	70
3	80	70
3	80	75
2	80	70

Program Learning Outcomes (PLO)														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Agriculture Knowledge	Problem Analysis	Design& development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems	Ability to implement knowledge gained	Ability to understand social and ethical responsibilities
M					M	M		L	H		H	M	M	M
M				M	H	M		L	H		H	M	M	M
M					H	H		L	H		H	M	M	M
M					H	H		L	H		H	M	M	M
M					H	H		M	H		H	M	M	M

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		3	3	3	3	3
S-1	SLO-1	Agroecology Introduction; History of Agriculture; Food Security; conventional, traditional and alternative agriculture; Crop and animal production	Concepts and perspectives of agroecosystem; different agroecosystems; processes within agroecosystems; relationships with surrounding ecosystems; relationships between agroecosystems and the 'rest of the world'	Soil properties; importance of soil humus / organic matter and its management; soil health and healthy crops;	Farming systems; Rice based; Coastal; Rice-wheat; Highland mixed; Rainfed mixed;	Holistic resource management; preserving natural resources; water for agriculture; water saving agriculture;
	SLO-2	Agricultural Development Challenges; Agroecological Principles; mankind and agriculture; food systems; food sovereignty; Agroecology models	Agroecosystem diversity, stability, disturbance and succession; Flows of energy and materials (water, nutrients, carbon); Population dynamics of organisms; Natural selection and co-evolution;	Root growth and interaction with soil conditions; soil bio-fertility; soil carbon and policies; Contemporary crop production practices;	Dry rainfed; Pastoral; Tree crop Integrated Farming System; Biodiversity and ecological agriculture;	Ecological principles for resource management; Agroecology and Community; rural social movement;
S-2	SLO-1	Sustainable agriculture, permaculture, LEISA, Zero Budget Natural Farming (ZBNF), Input-Centric Agriculture; Knowledge Centric Agriculture;	biodiversity of biotic communities; natural resources for agriculture; Plants and environmental factors (light, temperature, water, wind); pollution and its impact.	Organic food production; social systems and agriculture; economic implications and long-term impacts of alternative systems	Species interactions in crop communities; animals in the agroecosystem; bees and pollination; Integrated Pest Management; Biological control; Ecological pest management	Role of Civil Society Organizations; Government Agricultural policies; Role of FAO, Role of International Institutes / Organizations.
	SLO-2	Conservation agriculture; resilient agriculture; Natural farming; Biodynamic agriculture; Future Farming				

Learning Resources	1. Palaniappan, S.P. and K. Annadurai (2010) Organic farming Scientific Publishers, India. pp 1-256	
	2. Stephen R.Gliessman, (1998) Agroecology: Ecological Process in Sustainable Agriculture. (2 nd Ed., Ann Arbor Press, Chelsea, Michigan. pp1-357	4. https://kupdf.net/download/agroecology-gliessman_59c5722508bbc57e126871ad_pdf
	3. Subbarao N.S (pb2020). Soil Microbiology. (pp1-426) Oxford and ibh pulishing. Delhi. Pp	5. https://kupdf.net/download/vertical-farming_595f6fa5dc0d6072632be308_pdf

	Level of Thinking	Continuous Learning Assessment (50% weightage)		Final theory Examination (50%)
		In semester (40%)	Assignment (10 %)	
Level 1	Remember	40 %	40 %	40 %
	Understand			
Level 2	Apply	40 %	40 %	40 %
	Analyze			
Level 3	Evaluate	20 %	20 %	20 %
	Create			
	Total	100 %	100 %	100 %

Course Designers		
Experts from Industry/social sector	Experts from Higher Technical Institutions	Internal Expert
Dr. H.Gopal, Tamil Nadu Agricultural University Chennai	Ms.Latha Elango, Shree Dhanalakshmi Bio-park, Santhavelpet, Vadalur-607303 9443208619	Dr. Kothai Seshathri, Professor-Agroecology

THEORY

Unit I - Agroecology

Introduction; History of Agriculture; Food Security; conventional, traditional and alternative agriculture; Crop and animal production; the Agricultural Development Challenges; Agroecological Principles; mankind and agriculture; food systems; food sovereignty; Agroecology models; Sustainable agriculture, permaculture, LEISA, Zero Budget Natural Farming (ZBNF), Input-Centric Agriculture; KnowledgeCentric Agriculture; conservation agriculture; alternative agriculture; resilient agriculture; Natural farming; Biodynamic agriculture; Future Farming

Unit II - Agroecosystem

Concepts and perspectives in agroecosystem; different agroecosystems; processes within agro-ecosystems; relationships with surrounding ecosystems; relationships between agro-ecosystems and the 'rest of the world'; agroecosystem diversity, stability, disturbance and succession; Flows of energy and materials (water, nutrients, carbon); Population dynamics of organisms; Natural selection and co-evolution; biodiversity of biotic communities; natural resources for agriculture; Plants and environmental factors (light, temperature, water, wind); pollution and its impactAgroecology Lecture Schedule

Unit III - Soil ecosystem

Soil properties; importance of soil humus / organic matter and its management; soil health and healthy crops; root growth and interaction with soil conditions; soil biofertility; soil carbon and policies; Contemporary crop production practices; organic food production; social systems and agriculture; economic implications and long-term impacts of alternative systems

Unit IV - Farming systems and species interactions

Farming systems; Rice based; Coastal; Rice-wheat; Highland mixed; Rainfed mixed; Dry rainfed; Pastoral; Tree crop Integrated Farming System; Biodiversity and ecological agriculture; Species interactions in crop communities; animals in the agroecosystem; bees and pollination; Integrated Pest Management; Biological control; Ecological pest management

Unit V - Resource management and social impacts

Holistic resource management; preserving natural resources; water for agriculture; water saving agriculture; ecological principles for resource management; Agroecology and Community; rural social movement; role of Civil Society Organizations; Government Agricultural policies; Role of FAO, Role of International Institutes/ Organizations

Lecture Schedule

1. Agroecology Introduction; History of Agriculture; Food Security; conventional, traditional and alternative agriculture; Crop and animal production
2. Agricultural Development Challenges; Agroecological Principles; mankind and agriculture; food systems; food sovereignty; Agroecology models
3. Sustainable agriculture, permaculture, LEISA, Zero Budget Natural Farming (ZBNF), Input-Centric Agriculture; Knowledge Centric Agriculture
4. Conservation agriculture; resilient agriculture; Natural farming; Biodynamic agriculture; Future Farming
5. Concepts and perspectives of agroecosystem; different agroecosystems; processes within agro-ecosystems; relationships with surrounding ecosystems; relationships between agro-ecosystems and the 'rest of the world'
6. Agroecosystem diversity, stability, disturbance and succession; Flows of energy and materials (water, nutrients, carbon); Population dynamics of organisms; Natural selection and co-evolution;
7. Biodiversity of biotic communities; natural resources for agriculture; Plants and environmental factors (light, temperature, water, wind); pollution and its impact
8. Soil properties; importance of soil humus / organic matter and its management; soil health and healthy crops;
9. **In-Semester Examination**
10. Root growth and interaction with soil conditions; soil bio-fertility; soil carbon and policies; Contemporary crop production practices;
11. Organic food production; social systems and agriculture; economic implications and long-term impacts of alternative systems
12. Farming systems; Rice based; Coastal; Rice-wheat; Highland mixed; Rainfed mixed;
13. Dry rainfed; Pastoral; Tree crop Integrated Farming System; Biodiversity and ecological agriculture;
14. Species interactions in crop communities; animals in the agroecosystem; bees and pollination; Integrated Pest Management; Biological control; Ecological pest management
15. Holistic resource management; preserving natural resources; water for agriculture; water saving agriculture;
16. Ecological principles for resource management; Agroecology and Community; rural social movement;
17. Role of Civil Society Organizations; Government Agricultural policies; Role of FAO, Role of International Institutes / Organizations.

Text Books

1. Palaniappan, S.P. and K. Annadurai (2010) Organic farmingScientific Publishers, India. pp 1-256
2. Stephen R.Gliessman, (1998) Agroecology: Ecological Process in Sustainable Agriculture. (2nd Ed., Ann Arbor Press, Chelsea, Michigan. pp1-357
3. Subbarao N.S (pb2020). Soil Microbiology. (pp1-426) Oxford and ibh pulishing. Delhi. Pp

4. Gliessman, S. R. 2007. Agroecology: Ecological Processes in Sustainable Agriculture. 2 nd . Ed., An Arbor Press, Chelsea, MI

Reference Books

1. Agroecology: Key Concepts Principles and Practices, (2015). Publishers: Third world network, Lusaka, Zambia and Sociedad Cientifica Latinoamericana de Agroecologia (SOCLA), California, U.S.A. ISBN 978-967-0747-11-8.
2. Sieglinde Snapp Barry Pound (2017). Agroecology and Rural Innovation for Development Agricultural Systems. In Agroecology and Rural Innovation for Development. 2nd Edition. : eBook ISBN: 9780128020951. Page 1-558.
3. Stephen R.Gliessman (2010). The conversion to sustainable Agriculture(Edited). CRC press, Taylor & Francis Group, California. pp 1-382.
4. https://kupdf.net/download/agroecology-gliessman_59c5722508bbc57e126871ad_pdf
5. https://kupdf.net/download/vertical-farming_595f6fa5dc0d6072632be308_pdf

Journals

1. Global Ecology and Conservation
2. International Journal of Ecology
3. Journal of Ecology and Environmental Sciences
4. Journal of Environmental Quality
5. Science direct (Is vertical farming the way to a greener life?) [https://doi.org/10.1016/S0262-4079\(19\)31112-1](https://doi.org/10.1016/S0262-4079(19)31112-1)

Websites

1. <http://www.fao.org/family-farming/detail/en/c/416262/>
2. <https://blog.forumias.com/answered-what-do-you-understand-by-the-term-agroecology-how-agroecology-is-a-better-alternative-to-other-climate-smart-agriculture-models/>
3. <https://www.researchgate.net/deref/http%3A%2F%2Fwww.tandfonline.com%2Foi%2Fwjsa20>
4. <https://www.ileia.org/wp-content/uploads/2016/06/FM32.3.pdf>
5. <https://www.cetri.be/Agroecology-as-an-alternative-to?lang=fr>
6. <https://www.agrifarming.in/profitable-crops-for-vertical-farming-a-full-guide>
7. <https://www.britannica.com/science/biodiversity-loss>

Course Nature: Theory						
Total Marks (100)						
Sl.No.	Category	Assessment Tools				
		In- Semester Examination	Assignment	Attendance	End-Semester Examination	Marks
1	Theory-Internal	40	5	5		50
2	Theory-External		-		50	50
Grand Total						100

Course Code	AGE19106	Course Name	Environmental Protection and Disaster Management	Course Category	S	Supportive Course	L	T	P	C
							2	0	1	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Agroecology	Data Book / Codes/Standards			Nil

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning			Program Learning Outcomes (PLO)														
CLR-1 :	Explain environmental and its relationships with human activities	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	Recognize natural resources and its associated problems	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems through ENS	Ability to implement knowledge gained in the applied field of ENS	Ability to understand social and ethical responsibilities of Environmental Sciences
CLR-3 :	Outline skills in managing ecosystems and biodiversity conservation																		
CLR-4 :	Understand various factors involved environmental pollution and control measures																		
CLR-5 :	Interpret social issues, human health and the environment																		
CLR-6 :	Discuss the foundations of hazards and associated phenomena of disaster management																		

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLO-1 :	Recite facts, concepts, and methods from multiple disciplines and apply to environmental problems	3	85	80		H				M	H	M		H		H	M	H	H
CLO-2 :	Recall the functions of ecosystems and identify the reasons for biodiversity loss and explain different biodiversity conservation measures	1	95	85		M		L		M	H	H	L	H		H	M	H	H
CLO-3 :	Identify the critical environmental issues with optimization techniques for the useful utilization of resources, pollution control and solid waste management	2	80	70		M				H	H	M	L	H		H	M	H	H
CLO-4 :	Discuss various environmental pollutants present in the environment	3	75	65		H		L	L	M	H	H	M	H		H	M	H	H
CLO-5 :	Identify concepts and methodologies to analyze and understand interactions between social and environmental processes, human health and sustainable development	2	75	60		L				M	H	H	M	H		H	M	H	H
CLO-6 :	Recognize knowledge and manage the different public health aspects of disaster events at a local, national and global levels	3	75	65		H	L		L	M	H	H	H	H		H	M	H	H

Duration (hour)	Learning Unit / Module 1		Learning Unit / Module 2		Learning Unit / Module 3		Learning Unit / Module 4		Learning Unit / Module 5	
	12		11		17		11		14	
S-1	SLO-1	Introduction to environment	Concept of an ecosystem		Air pollution		Social Issues and the environment		Natural Disasters- meaning and nature	
	SLO-2	Concepts and segments in environment	Structure and function of an ecosystem		Noise pollution		Sustainable development		Effects of floods, drought, cyclone	
S-2	SLO-1	Natural resources and associated problems	Types and characteristic features of terrestrial ecosystems		Soil pollution		Environment protection act in India		Effects of earthquakes, landslides, avalanches	
	SLO-2	Urban problems related to energy	Types and characteristic features of aquatic ecosystems		Control measures of soil pollution				Effects of volcanic eruptions, heat and cold waves	
S3-4	SLO-1	Lab 1: Waste water sample collection	Lab 4: Study of simple ecosystems		Lab 7: Determination of suspended particulate matter and important air pollutants		Lab 13: Case studies on successful implementation of sustainable development model		Lab 15: Quantitative risk assessment for natural hazards and preparation of environmental zonation map for cyclone	
	SLO-2						Issues involved in enforcement of environmental legislation		Manmade disasters	
S-5	SLO-1	Forest resources	Biodiversity- biogeographical classification of India		Water pollution –causes and effects					

Duration (hour)	Learning Unit / Module 1		Learning Unit / Module 2		Learning Unit / Module 3		Learning Unit / Module 4		Learning Unit / Module 5	
	12		11		17		11		14	
	SLO-2	Deforestation and case studies		Value of biodiversity		Control measures of water pollution		Role of an individual in prevention of pollution		Effects of manmade disasters
S-6	SLO-1	Water resources		Biodiversity at global, National and local levels		Marine pollution		Global treaties for environmental protection		Effects of climate change and global warming
	SLO-2	Effects of over-utilization of surface and ground water		Threats to biodiversity		Thermal pollution and Nuclear hazards		Conventions for environmental protection		Effects of sea level rise, acid rain and ozone layer depletion
S7-8	SLO-1			Lab 5: Biodiversity assessment in polluted and un polluted system		Lab 8: Estimation of acidity and alkalinity in water samples		Lab 14: Case studies on environmental issues and human health: Climate change		Lab 16: Visit to disaster affected area
	SLO-2	Lab 2: Biogas production								
S-9	SLO-1	Land resources		Conservation of biodiversity- In-situ and Ex-situ		Urban and industrial wastes		Water conservation-watershed management		Concept of disaster management
	SLO-2	Food resources		Biosphere Reserve - National parks and Wildlife Sanctuaries		Solid Waste Management		Wasteland reclamation		National disaster management framework and financial arrangements
S-10	SLO-1	Mineral resources		-		-		Human population and the environment		Effect to migrate disaster at national and global levels
	SLO-2	Role of an individual in conservation of natural resources		-		-		Family welfare programme		International strategy for disaster reduction
S-11-12	SLO-1			Lab 6: Visit to river / forest / grassland /hill/mountain to document environmental assets		Lab 9: Estimation of water hardness		-		-
	SLO-2	Lab 3: Visit to wind mill / hydro power / solar power generation units								
S-13	SLO-1	-		-		-		Environment and human health		Role of NGOs and community in disaster management
	SLO-2	-		-		-		Role of information technology in environment and human health		Role of organization in disaster management
S-14	SLO-1	-		-		-		-		Role of armed forces in disaster response and disaster management
	SLO-2	--		-		-		-		Police and other organizations in disaster response and management
S-15-16	SLO-1	-		-		Lab 10: Estimation of DO and BOD in water samples		-		-
	SLO-2	-		-						
S-17	SLO-1	-		-		-		-		Contingency planning for disaster risk reduction
	SLO-2	-		-		-		-		Weather forecasting and early warning systems
S-18	SLO-1	-		-		-		-		Existing schemes and government policies to tackle agricultural disasters
	SLO-2	-		-		-		-		Criteria and constrains of crop/animal insurance and credit guarantee schemes
S-19-20	SLO-1	-		-		Lab 11: Estimation of COD in water samples		-		-
	SLO-2	-		-						
S-21-22	SLO-1	-		-		Lab 12: Solid waste management: composting and vermicomposting		-		-
	SLO-2	-		-						

Learning Resources	1. Erach Bharucha. (2013). Text book for Environmental studies. New Delhi, India: University Grants Commission. pp.1-324.	2. Sharma, P.D. (2010). Ecology and Environment. Meerut, India: Rastogi Publications. pp. 1-600.

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember Understand	40 %	30 %	35 %	30 %
Level 2	Apply Analyze	40 %	40 %	35 %	40 %
Level 3	Evaluate Create	20 %	30 %	30 %	30 %
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. M. Panneer Selvam, Environmental Engineer, VIRDT, Dharmapuri.	Dr. A. Balusamy, Scientist, Division of Natural Resource Management, ICAR-Research Complex for North Eastern Hill Region	Dr. M. Sanjeevagandhi, Assistant Professor (ENS), SRMIST

THEORY

Unit I – Introduction to environmental science and natural resources

Environmental Science: Definition, scope and importance - Multidisciplinary nature of environmental science, Concepts and Segments; Global environmental initiatives and perspectives; Ecological footprint - Natural Resources: Renewable and non-renewable resources, Natural resources and associated problems - Energy resources: Growing energy needs, renewable and non-renewable energy sources, and use of alternate energy sources - Urban problems related to energy, Case studies - Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people - Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems - Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies - Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies; Role of an individual in conservation of natural resources - Equitable use of resources for sustainable lifestyles.

Unit II – Ecology and biodiversity

Ecosystems: Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem. Ecological succession, Food chains, food webs and ecological pyramids - Species interactions and Biogeochemical cycles - Introduction, types, characteristic features, structure and function of Forest ecosystem - Grassland ecosystem - Desert ecosystem - Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) - Biodiversity - Introduction, definition, genetic, species & ecosystem diversity and biogeographical classification of India - Value of biodiversity - Biodiversity at global, National and local levels, India as a mega-diversity nation - Hot-spots of biodiversity - Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts - Endangered and endemic species of India - Conservation of biodiversity - In-situ and Ex-situ conservation of biodiversity; Biosphere Reserve - National parks and Wildlife Sanctuaries; Botanical Garden; Biodiversity legislation.

Unit III– Environmental pollution and management

Environmental Pollution - Definition, cause, effects and control measures of Air pollution and Noise pollution - Definition, cause, effects and control measures of Soil pollution – Bioremediation - Definition, cause, effects and control measures of Water pollution - Definition, cause, effects and control measures of marine pollution, Thermal pollution and Nuclear hazards - Causes, effects and control measures of urban and industrial wastes and Solid Waste Management.

Unit IV – Social issues, human health and the environment

Social Issues and the Environment: From Unsustainable to Sustainable development, consumerism and waste products - Role of an individual in prevention of pollution - Environment Protection Act in India - Issues involved in enforcement of environmental legislation - Public awareness - Global treaties and Conventions for Environmental Protection - Water conservation, rain water harvesting, watershed management - Wasteland reclamation - Human Population and the Environment: population growth, variation among nations, population explosion, Family Welfare Programme - Environment and human health: Human Rights, Value Education, HIV/AIDS - Women and Child Welfare - Role of information technology in environment and human health.

Unit V– Disaster management

Natural Disasters - Meaning and nature of natural disasters, their types and effects - floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, heat and cold waves - Man Made Disasters- Nuclear disasters and holocaust, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, pollution, road accidents, rail accidents, air accidents, sea accidents - Issues and possible solutions for climate change, global warming, sea level rise, acid rain, ozone layer depletion, deforestation - Concept of disaster management, national disaster management framework; financial arrangements - Disaster Management- Effect to migrate disaster at national and global levels - International strategy for disaster reduction - Role of NGOs, community –based organizations and media - Central, state, district and local administration on disaster management - Armed forces, police and other organizations in disaster response and disaster management - Contingency Planning for Disaster Risk Reduction - Existing schemes and government policies to tackle agricultural disasters.

Theory - Lecture Schedule

1. Environmental Science: Definition, scope and importance - Multidisciplinary nature of environmental science, Concepts and Segments; Global environmental initiatives and perspectives; Ecological footprint
2. Natural Resources: Renewable and non-renewable resources, Natural resources and associated problems - Energy resources: Growing energy needs, renewable and non-renewable energy sources, and use of alternate energy sources - Urban problems related to energy, Case studies
3. Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people
4. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems
5. Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies
6. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies; Role of an individual in conservation of natural resources - Equitable use of resources for sustainable lifestyles
7. Ecosystems: Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem. Ecological succession, Food chains, food webs and ecological pyramids - Species interactions and Biogeochemical cycles
8. Introduction, types, characteristic features, structure and function of Forest ecosystem - Grassland ecosystem - Desert ecosystem - Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

9. Biodiversity - Introduction, definition, genetic, species & ecosystem diversity and biogeographical classification of India - Value of biodiversity
10. Biodiversity at global, National and local levels, India as a mega-diversity nation - Hot-spots of biodiversity - Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts - Endangered and endemic species of India
11. Conservation of biodiversity - In-situ and Ex-situ conservation of biodiversity; Biosphere Reserve - National parks and Wildlife Sanctuaries; Botanical Garden; Biodiversity legislation
12. Environmental Pollution - Definition, cause, effects and control measures of Air pollution and Noise pollution
13. Definition, cause, effects and control measures of Soil pollution – Bioremediation
14. Definition, cause, effects and control measures of Water pollution
15. Definition, cause, effects and control measures of marine pollution, Thermal pollution and Nuclear hazards
16. Causes, effects and control measures of urban and industrial wastes and Solid Waste Management
17. **In - Semester Examination**
18. Social Issues and the Environment: From Unsustainable to Sustainable development, consumerism and waste products
19. Environment Protection Act in India
20. Issues involved in enforcement of environmental legislation - Role of an individual in prevention of pollution
21. Global treaties and Conventions for Environmental Protection
22. Water conservation, rain water harvesting, watershed management - Wasteland reclamation
23. Human Population and the Environment: population growth, variation among nations, population explosion, Family Welfare Programme
24. Environment and human health: Human Rights, Value Education, HIV/AIDS - Women and Child Welfare - Role of information technology in environment and human health
25. Natural Disasters - Meaning and nature of natural disasters, their types and effects - floods, drought, cyclone
26. Earthquakes, landslides, avalanches, volcanic eruptions, heat and cold waves
27. Man Made Disasters- Nuclear disasters and holocaust, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, pollution, road accidents, rail accidents, air accidents, sea accidents
28. Issues and possible solutions for climate change, global warming, sea level rise, acid rain, ozone layer depletion
29. Concept of disaster management, national disaster management framework; financial arrangements
30. Disaster Management- Effect to migrate disaster at national and global levels - International strategy for disaster reduction
31. Role of NGOs, community –based organizations and media - Central, state, district and local administration on disaster management
32. Armed forces, police and other organizations in disaster response and disaster management
33. Contingency Planning for Disaster Risk Reduction: agronomic, engineering other non-engineering interventions - Weather forecasting and early warning systems, flood forecasting, agricultural drought monitoring and forecasting
34. Existing schemes and government policies to tackle agricultural disasters - Insurance and loan schemes: criteria and constraints of crop/animal insurance and credit guarantee schemes

Practical Schedule

1. Waste water sample collection, processing and preservation
2. Biogas production from organic wastes
3. Visit to wind mill / hydro power / solar power generation units
4. Study of simple ecosystems-pond, river, hill slopes - Crop adaptation to different ecosystems
5. Biodiversity assessment in polluted and unpolluted system
6. Visit to river/forest/grassland/hill/mountain to document environmental assets
7. Air sampling and determination of suspended particulate matter and important air pollutants
8. Estimation of acidity and alkalinity in water samples
9. Estimation of water hardness
10. Estimation of DO and BOD in water samples
11. Estimation of COD in water samples
12. Solid waste management: composting and vermicomposting of farm wastes
13. Case studies on successful implementation of sustainable development model
14. Case studies on environmental issues and human health: Climate change
15. Quantitative risk assessment for natural hazards and preparation of environmental zonation map for cyclone
16. Visit to areas affected by natural disaster
17. **University Practical Examination**

Text Books

1. Erach Bharucha. (2013). *Text book for Environmental studies*. New Delhi, India: University Grants Commission, pp.1-324.
2. Prasanthrajan, M & Mahendran, P.P. (2013). *A text book on Ecology and Environmental Science*. Udaipur, India: Agrotch Publishing Academy. pp.1- 285.

Reference Books

1. Bhattacharya, T. (2012). *Disaster Science and management*. New Delhi, India: Tata McGraw Hill Education private limited, pp.1-198.
2. De, A.K. (2010). *Environmental Chemistry*. New Delhi, India: New Age International Publishers. pp.1-384.
3. Khannna, B.K & Nina Khanna. (2011). *Disaster–Strengthening community Mitigation and Preparedness*. New Delhi, India: New India Publication Agency. pp.1-308.
4. Mani, N. (2017). *Environment, Climate change and Disaster management*. New Delhi, India: New Century publication. pp.1-276.
5. Sharma P.D. (2010). *Ecology and Environment*. Meerut, India: Rastogi Publications. pp. 1-600.
6. Tyler Miller & Scot Spoolman. (2009). *Living in the Environment (Concepts, Connections, and Solutions)*. Belmont, USA: Brooks/cole, Cengage learning publication.pp.1-816.

Web References

1. <http://ecoursesonline.iasri.res.in/course/view.php?id=486>
2. https://www.youtube.com/watch?v=2swlzu3rzll&list=PLoGgviqq4847IAo58jX32INd_UxDVW0YJ
3. <https://www.youtube.com/watch?v=DExlZTfKZAM&list=PLC4PaTsQilCbejXqJR7S59Ohk2OK1rgEG>
4. <https://www.youtube.com/watch?v=mIPBPG-5dUw>

Journals

1. Environment Pollution and Climate Change
2. Environmental Science: An Indian Journal
3. Journal of Earth Science & Climatic Change
4. Journal of Industrial Pollution Control
5. Research & Reviews: Journal of Ecology and Environmental Sciences

Course Nature: Theory based Practical							
Total Marks (100)							
Sl.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-	-	-	50	50
2	Theory-Internal	20	-	-	-	-	20
3	Practical-External	-	-	-	-	15	15
4	Practical-Internal	-	05	05	05	-	15
Grand Total							100

Course Code	NRM19101	Course Name	Fundamentals of Soil Science	Course Category	S	Supportive Course	L	T	P	C
							1	0	1	2

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Soil Science and Agricultural Chemistry	Data Book / Codes/Standards			Nil

Course Learning Rationale (CLR):		Learning			Program Learning Outcomes (PLO)														
The purpose of learning this course is to:		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	Define soil and its properties	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems in SSAC	Ability to implement knowledge gained in SSAC	Ability to understand social and ethical responsibilities
CLR-2 :	Describe the physical properties of soil				H			H			H		M	H		H	H	H	H
CLR-3 :	Describe the chemical properties of soil				H			H					L	H		H	H	H	H
CLR-4 :	Explain the biological properties of soil				M		M	M			H		L	H		H	H	H	H
CLR-5 :	Interpret the soil health and planning the land use.				M			H					M	H		H	H	H	H
Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	M							M	H		H	H	H	H
CLO-1 :	Outline the soil formation.					1	90	85											
CLO-2 :	Recognize the soil physical parameters.					2	95	85											
CLO-3 :	Interpret the chemistry of soil with nutrient availability.					2	80	70											
CLO-4 :	Describe the importance of soil biology in soil fertility.					3	85	75											
CLO-5 :	Paraphrase the soil health for better crop growth.					3	85	90											

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		3	3	3	3	4
S-1	SLO-1	Soil: Definition, functions, components	Soil Texture – Definition and classification	Organic and Inorganic soil colloids	Soil Ecology and Organisms	Soil physical and chemical properties: importance on plant growth
	SLO-2	Origin of Earth	Soil structure– Definition and classification	Ion exchange properties in soil	Soil biological properties and interactions	Soil biological properties: importance on plant growth
S-2,3	SLO-1	Lab. 1. Identification of rocks and minerals	Lab.4. Determination of BD by wax coating method	Lab.7. Determination of soil colour	Lab.10. Determination of infiltration rate of soil	Lab. 13. Estimation of soil organic carbon
	SLO-2					
S-4	SLO-1	Rocks and minerals: Definition, classification	Soil density and porosity	Layer silicate clays	Soil organic matter	Soil survey and Land Use planning
	SLO-2	Rocks and minerals: Formation	Soil consistency, plasticity, color, air, temperature	Origin and properties	Composition and properties	Remote sensing and GIS
S-5,6	SLO-1	Lab.2. Collection and processing of soil samples	Lab.5. Soil textural analysis – feel and hydrometer method	Lab.8. Determination of soil temperature	Lab. 11. Determination of hydraulic conductivity	Lab. 14. Determination of CEC
	SLO-2					
S-7	SLO-1	Soil forming processes	Soil water and classification	Soil reaction	Humus formation theories	Soil physical problems and its reclamation
	SLO-2	Soil forming factors	Soil moisture constants	Buffering and conductance	Soil enzymes	Soil chemical problems and its reclamation
S-8,9	SLO-1	Lab.3. Determination of BD, PD and porosity by cylinder method	Lab.6. Soil textural analysis – international pipette method	Lab.9. Determination of soil moisture – various methods	Lab.12. Determination of soil pH and EC	Lab. 15. Soil and Land Use maps
	SLO-2					

S-10	SLO-1					Soil sleuth
	SLO-2					Soil Science Research Institutes – National/International
S-11,12	SLO-1					Lab.16. Field visit
	SLO-2					

Learning Resources	1.	Brady, N.C and Raymond C. W. (2013). <i>The Nature and Properties of Soils</i> (15 th ed.). Pearson Education.pp. 1 - 1035.				
	2.	Indian Society of Soil Science. (2012). <i>Fundamentals of Soil Science</i> (2 nd ed.), New Delhi, ISSS, IARI.				

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In semester (20%)	Practical (15%)		
Level 1	Remember	40 %	30 %	35 %	30 %
	Understand				
Level 2	Apply	40 %	40 %	35 %	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	30 %	30 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. S. Suresh, Senior Agricultural Officer, STL, Kanchipuram.	Dr. M.V. Sriramachandrasekharan, Professor (SSAC), Annamalai University, Annamalaiagar – 608002.	Dr. R. Angelin Silviya, Dr. S.N.Chikkaraju

THEORY

Unit I - Origin of Soil

Soil: Definition, components, functions; Origin of Universe, Earth and life: theories and composition of Earth's Crust; Rocks and minerals: definition, classification and formation; Pedology: Soil Genesis, Soil forming processes, Soil forming factors.

Unit II - Soil Physical Properties

Soil Texture and Classes: Methods of Analysis, Assumptions and limitations; Soil Structure and classification, Factors influencing soil structures; Soil density, Consistency, Plasticity, Colour, Aeration and Temperature; Soil Water & classification; Soil drainage and its importance; Soil water constants and movement.

Unit III - Soil Chemical Properties

Organic and Inorganic soil colloids: Types and Significance; Ion Exchange properties; Layer Silicate clays: Origin, properties and differences; Soil reaction, buffering and conductance.

Unit IV - Soil Biological Properties

Soil Ecology, Soil Organisms, classification and Synergism/Antagonism effects; Soil Biological Properties: Soil Organic matter, Composition and Humus formation; Importance of Soil enzymes.

Unit V - Land Use Planning and Management

Importance of Soil Physical, Chemical and Biological properties on Plant growth, Introduction on Soil survey, Land Use Planning, Remote sensing and GIS; Soils with physical/chemical problems and its reclamation; Soil Sleuth; Soil Science Research Institutes - National/International.

Theory - Lecture schedule

1. Soil: Definition, components, Functions; Pedology and Edaphological concepts; The Origin of Universe, Earth and life: different theories; Earth's Crust and its composition
2. Rocks and Minerals - Definition, Classification and Formation
3. Soil Genesis - Soil forming processes: fundamental and specific pedogenic processes; Soil forming factors: active and passive factors; Soil profile and horizon formation
4. Soil Texture and Classes: Methods of Analysis, Assumptions and limitations; Soil Structure and classification, Factors influencing soil structures, its formation and evaluation
5. Soil density and porosity - factors influencing, soil consistency, plasticity, soil colour, soil aeration, Soil temperature
6. Soil water – classification, Soil drainage and its importance; soil water/moisture constants, soil water potential, movement and methods
7. Soil colloids: Organic and Inorganic; Its types and Significance; Development of colloidal charges; Ion Exchange properties
8. Layer Silicate clays: 1:1, 2:1, 2:1:1 – Origin, properties and differences.
9. **In-Semester Examination**
10. Importance of soil reaction, soil buffering and soil conductance in Agriculture.
11. Soil Biological Properties: Soil Ecology; Soil Organisms, classification; Interaction of soil organism – Synergism and Antagonism effects
12. Soil organic matter – Composition and importance
13. Humus formation theories; Soil enzymes – its functions and importance.
14. Importance of Soil physical, chemical and biological properties on plant growth
15. Introduction on soil survey and Land Use Planning, Remote sensing and GIS
16. Soils with physical/chemical problems and its reclamation
17. Soil Sleuth; Soil Science Research Institutes - National/International.

Practical schedule

1. Identification of rocks and minerals
2. Collection and processing of soil samples
3. Determination of Bulk density, Particle density and porosity by cylinder method
4. Determination of Bulk density by wax coating method
5. Soil textural analysis – feel and hydrometer method
6. Soil textural analysis – international pipette method
7. Determination of soil colour
8. Determination of soil temperature
9. Determination of soil moisture – various methods
10. Determination of infiltration rate of soil
11. Determination of hydraulic conductivity
12. Determination of soil pH and EC
13. Estimation of soil organic carbon
14. Determination of CEC
15. Soil and Land use maps
16. Visit to organic/forest soil
17. **University Practical Examination.**

Text Books

1. Biswas, T.D. and Mukherjee S.K. (2017). Text Book of Soil Science (2nded.). New Delhi: Tata McGraw Hill Publishing Co. Ltd. pp. 1 - 433.
2. Chopra, S.C and Kanwar J.S. (2014). Analytical Agricultural Chemistry. Ludhiana: Kalyani publishers.
3. Das, D.K. (2015). Introductory Soil Science (4thed.). Ludhiana, India: Kalyani Publisher
4. Indian Society of Soil Science. (2012). Fundamentals of Soil Science (2nded.). New Delhi: ISSS, IARI.
5. Sehgal, J. (2015). A textbook of pedology: Concepts and Applications. New Delhi: Kalyani Publishers.

Reference Books

1. Brady, N.C. and Raymond, C. W. (2013). The Nature and Properties of Soils (15thed.). Pearson Education. pp. 1 - 1035.
2. Epstein, E. and Bloom, A.J. (2005). Mineral Nutrition of Plants: Principles and perspectives (2nded.). Sunderland, MA: Sinauer Associates. pp. 1 - 380.
3. Jackson, M.L. (2012). Soil chemical analysis: Advanced course. Scientific Publisher.
4. John, L. H., Beaton J.D, Tisdale S.L and Nelson W.L. (2016). Soil Fertility and Fertilizers - An Introduction to Nutrient Management. (2nded.). New Delhi: PHL Learning Pvt. Ltd. pp. 1 - 433.
5. Tan K.H. (2018). Principles of Soil Chemistry, Special Indian edition (4thed.). Taylor & Francis.

Web References

1. <https://www.usda.gov/>
2. <https://www.springer.com/gp/environmental-sciences/soil-science>
3. <https://www.soils.org.uk/students>
4. https://youtu.be/zrjL5J_U1iE
5. <https://youtu.be/OcEuG-NzmqQ>

Journals

1. Journal of the Indian Society of Soil Science (ISSS)
2. Soil Science and Plant Nutrition
3. International journal of Plant and Soil Sciences
4. Journal of soil and water conservation

5. Journal of soils and crops

Course Nature: Theory based Practical							
Total Marks (100)							
Sl.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-	-	-	50	50
2	Theory-Internal	20	-	-	-	-	20
3	Practical-External	-	-	-	-	15	15
4	Practical-Internal	-	05	05	05	-	15
Grand Total							100

Course Code	CRH19101	Course Name	Introduction to Plant Biochemistry	Course Category	S	Supportive Course	L	T	P	C
							2	0	1	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biochemistry	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		
CLR-1 :	Describe scope and importance of Biochemistry.			
CLR-2 :	Summarize biomolecules.			
CLR-3 :	Paraphrase role of enzymes and hormones in plant growth.			
CLR-4 :	Explain metabolic pathways occurring in plants.			
CLR-5 :	Define the structure of nucleic acids.			

Learning			
1	2	3	
Thinking (Bloom)	Efficiency (%)	Attainment (%)	

Program Learning Outcomes (PLO)																	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Knowledge	Analysis	Development	Design, Research	Usage	Culture	&Sustainability		Team Work	Communication	& Finance	Learning	The scientific	Element maintained	Understand social responsibilities			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLO-1 :	Explain the role of biochemistry in agricultural sciences.	1	95	85
CLO-2 :	Give original examples of biomolecules that make up a plant.	2	80	75
CLO-3 :	Outline the importance of enzymes and hormones in plant growth.	3	75	65
CLO-4 :	Recall the metabolic pathways of plants.	3	75	65
CLO-5 :	Summarize the knowledge on the nucleic acids that compose the life	2	80	75
CLO-6 :	Recognize qualitative analysis and separation techniques of biomolecules	1	85	80

Duration (hour)	Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
	7	7	6	5	8
S-1	SLO-1 Importance of Biochemistry.	Importance and Classification of lipids.	Importance and Classification of Proteins.	General properties and Classification of Enzymes.	Glycolysis.
	SLO-2 Carbohydrates - Importance and Classification	Structure and properties of fatty acids, Rancidity.	Amino acids - Classification and structure.	Mechanisms of enzyme action.	TCA-cycle.
S-2	SLO-1 Structure of Monosaccharides, Reducing and oxidizing properties of Monosaccharides.	Plant Pigments.	Amphoteric nature and Isomerism of Amino acids	Michaelis & Menten and Line Weaver Burk equation & plots.	Glyoxalate cycle.
	SLO-2 Mutarotation, Isomerism, Optical activity.	Plant Pigments.	Color reactions of Amino acids	Allosteric enzymes, Co-factors, Co-enzymes.	Electron transport chain.
S-3	SLO-1 Structure of Disaccharides and Polysaccharides.	Sterols	Structure of Proteins - Primary and Secondary structure	Plant growth hormones.	Beta oxidation.
	SLO-2 Osazone formation.		Structure of Proteins - Secondary and Tertiary structure		Biosynthesis of Fatty acids
S-4	SLO-1				Structure of Nucleotides - DNA
	SLO-2				RNA - Types and Structure

Learning Resources	1.	<i>Buchanan, B. B., Gruissem, W. and Jones, R. L. 2002. Biochemistry and molecular biology of plants. 2nd Ed., Blackwell publications, UK.</i>
	2.	<i>Lehninger, Nelson, D. L. and Michael, M. C. 2004. Principles of Biochemistry. Freeman Publishers</i>

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember	40 %	30 %	35 %	30 %
	Understand				
Level 2	Apply	40 %	40 %	35 %	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	30 %	30 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
-	Dr. (Prof).S. Subramanian, UGC-BSR Faculty Fellow Department of Biochemistry, University of Madras, Chennai - 25.	Dr. V. Devika Dr. G. Jayanthi

THEORY

Unit I - Carbohydrates

Importance of Biochemistry. Properties of water, pH and buffer. Carbohydrates: Importance and classification. Structures of Monosaccharides, Reducing and oxidizing properties of Monosaccharides, Mutarotation, Isomerism, Optical activity; Structure of Disaccharides and Polysaccharides; Osazone formation.

Unit II - Lipids

Lipids: Importance and Classification; Structure and properties of fatty acids; Rancidity; Storage lipids and membrane lipids. Plant pigments: structure and function of chlorophyll and carotenoids; Sterols - Basic structure, Role of brassinosteroids in plants.

Unit III - Proteins

Proteins: Importance and Classification; Amino acids – Classification and Structure, Properties of amino acids - Physical properties - Amphoteric nature and Isomerism, Chemical Properties - Color reactions; Structure of Proteins – Primary, Secondary, Tertiary and Quaternary structure.

Unit IV – Enzymes and hormones

Enzymes: General properties; Classification; Mechanism of action; Michaelis & Menten and Lineweaver Burk equation & plots; Introduction to allosteric enzymes; Co-factors and Co-enzymes; Plant growth hormones - Auxins, Gibberellins, Cytokinins.

Unit V – Metabolic Pathways

Carbohydrate metabolism – Glycolysis, TCA-cycle, Glyoxylate cycle, Electron Transport Chain; Metabolism of lipids: Beta oxidation, Biosynthesis of fatty acids. Nucleic acids: Importance and classification; Structure of nucleotides, A, B & Z DNA; RNA: Types and secondary and tertiary structure.

Theory –Lecture Schedule

1. Importance of Biochemistry. Properties of water, pH and buffer.
2. Importance and classification of Carbohydrates.
3. Structure of Monosaccharides.
4. Reducing and Oxidizing properties of Monosaccharides.
5. Mutarotation, Optical activity, Isomerism.
6. Structure of Disaccharides and Polysaccharides..
7. Osazone formation.
8. Importance and classification of lipids.
9. Structure and properties of fatty acids.
10. Rancidity of lipids.
11. Storage lipids - Functions, Examples.
12. Membrane lipids - Functions, Examples.
13. Structure and functions of chlorophyll and carotenoids..
14. Brassinosteroids.
15. Importance and classification of Proteins.
16. Amino acids – Classification and Structure.
17. **In-Semester Examination**
18. Physical properties of Amino acids - Amphoteric nature and Isomerism.
19. Color reactions of amino acids.
20. Structure of Proteins
21. General properties and classification of Enzymes.
22. Mechanisms of enzyme action.
23. Michaelis & Menten and Lineweaver Burk equation & plots.

24. Introduction to allosteric enzymes;
25. Co-factors and Co-enzymes.
26. Plant growth hormones.
27. Glycolysis - Preparative phase, Payoff phase, Energetics.
28. TCA cycle - Reaction steps, Energetics.
29. Glyoxalate cycle - Reaction steps.
30. Electron Transport Chain - Reaction steps, Energetics.
31. Beta Oxidation of Fatty acids
32. Biosynthesis of Fatty acids.
33. DNA - Structure and Types
34. RNA - Structure and Types.

Practical Schedule

1. Preparation of standard solutions and reagents
2. Qualitative analysis of carbohydrates - Reducing sugars
3. Qualitative analysis of carbohydrates - Non - Reducing sugars
4. Quantitative estimation of glucose
5. Qualitative analysis of amino acids
6. Color reactions of amino acids
7. Quantitative estimation of proteins
8. Sorenson's formal titration of amino acid
9. Titration methods for the estimation of lipids
10. Determination of iodine number of vegetable oils
11. Effect of pH on enzyme concentration
12. Effect of temperature on enzyme concentration
13. Effect of substrate on enzyme concentration
14. Enzymes: Assay of amylase
15. Paper chromatography for separation of amino acids/carbohydrates
16. Thin layer chromatography demonstration for the separation of amino acids/carbohydrates
17. **University Practical Examination**

Text Books

1. Sadashiv, S & Manickam, A. Eds. 1996. Biochemical methods for Agricultural sciences. New age International publishers, New Delhi. pp. 256
2. Rameshwar, A. Eds. 2006. Practical Biochemistry: A Basic Course. Kalyani Publishers, Ludhiana. pp.204
3. Nelson, D. L. & Cox, M. M. Eds. 2004. Principles of Biochemistry. Freeman Publishers. London. pp 1198
4. Voet, D & Voet, J.G. 2004. Biochemistry. John Wiley & sons Incl, USA. pp. 1520.
5. Tymoczko, J. L., Berg, J. M & Stryer L. Ed. 2019 Biochemistry-A Short Course. Freeman Publishers. London. pp. 800
6. Buchanan, B. B., Gruissem, W. & Jones, R. L. Eds. 2002. Biochemistry and molecular biology of plants. Blackwell publications, UK. pp. 1280

Reference Books

1. Verma SK & Mohith Verma. Eds. 1995. A Textbook of Plant Physiology, Biochemistry and Biotechnology. pp - 768. S. Chand Publishers, Tamilnadu.
2. Akawaza T and Ashasi T. Eds. 2014. 1st Ed. The New Frontiers in Plant Biochemistry (Advances in Agricultural Biotechnology). pp- 257. Springer. Netherlands.
3. Hans-Walter Heldt Birgit Piechulla. Eds. 2011. Plant Biochemistry. pp - 656. Academic Press. US.
4. Nagaraj G. Ed. 2015. Agricultural Plant Biochemistry. pp - 266. New India Publishing Agency. New Delhi.

Web References

1. <http://www.biologydiscussion.com>
2. <https://courses.lumenlearning.com/>
3. <https://www.nature.com/scitable/topicpage/>
4. <https://www.agriinfo.in/>

Journals

1. Annual Review of Biochemistry
2. International Journal of Biochemistry and cell Biology
3. Biotechnology and Applied Biochemistry

Course Nature: Theory based Practical							
Total Marks (100)							
Sl. No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	05	05	05	-	15
Grand Total							100

Course Code	SKE19102	Course Name	Communication Skills and Personality Development	Course Category	S	Supportive course	L	T	P	C
							1	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Agriculture		Data Book / Codes/Standards	Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Explain the communication skills across settings, purposes, and audiences.
CLR-2 :	Describe the knowledge of communication theory and application.
CLR-3 :	Discuss critical thinking to develop innovative and well-founded perspectives related to the students' emphases.
CLR-4 :	Describe to maintain healthy and effective relationships
CLR-5 :	Interpret communication technology effectively in various settings and contexts.
CLR-6 :	Outline appropriate and professional ethical behavior

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:
CLO-1 :	Explain critical and innovative thinking.
CLO-2 :	Identify competence in oral, written, and visual communication.
CLO-3 :	Recognize effectively to cultural communication differences.
CLO-4 :	Describe communicate ethically.
CLO-5 :	Demonstrate positive group communication exchanges.
CLO6 :	Give original examples of opportunities in the field of communication

Learning		
1	2	3
Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
1	95	85
2	80	75
3	80	86
3	75	85
2	80	75

Program Learning Outcomes (PLO)														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Horticulture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems	Ability to implement knowledge gained	Ability to understand social and ethical responsibilities
H				H	M	H	H	H		H				
H				H		H	H	H		H				
M				H	M	H	H	H		H				
M	H			H		H	M	H		H				
H	H			H		H	H	H		H				

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		3	3	4	3	3
S-1	SLO-1	Structural Grammar: Introduction of Word Classes	Physical Attributes- Concentration, Eye contact, body language, Observation and questioning,	Individual and group presentations, impromptu presentation	Reading comprehension of general and technical articles	Strategies to manage the writing process
	SLO-2	classification of word classes, Content words and Function words	Task- Audio Visual Aids, Tasks involving in Talks and Lectures,	public speaking, Group discussion, Organizing seminars and conferences	Pronunciation, Vocabulary knowledge,	Précis Writing, Summarizing
S-2	SLO-1	Structure of Verb in English	Understanding Sentences and Dialogue;	Spoken English- Conversations of different situations in everyday life	fluency and reading speed	Abstracting, Creative Writing,
	SLO-2	Uses of Tenses; Study of Voice	Basic listening models- Competitive or combative listening	the concept of stress- stress shift in words and sentences	Types of reading and uses	Letter Writing,
S-3	SLO-1	Types of Conjunctions and Prepositions	passive and attentive listening,	Pronunciation - silent letters in words	Skimming	writing for clarity
	SLO-2	Sentence Patterns in English, Subject verb agreement	Active listening	words with silent letters	Scanning	Hints developments, Story through images
S-4	SLO-1	Idioms and Phrases,	reflective listening		Extensive reading	Autobiography of Concrete objects
	SLO-2	Homophones and Homonyms	Barriers in Listening skills	the basic intonation patterns.	Intensive reading	Slogans writing

Learning Resources	1. Bharati, T. Hariprasad, M. and Prakasam, 2008 V. Personality Development and Communicative English. Neelkamal Publications Pvt. Ltd, New Delhi. PP 1-350
	2. Biber, D., Conrad, S. and Leech, G. 2002a Longman Student Grammar of Spoken and Written English, London, Pearson. PP1-450

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In semester (20%)	Practical (15%)		
Level 1	Remember	40 %	30 %	35 %	30 %
	Understand				
Level 2	Apply	40 %	40 %	35 %	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	30 %	30 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
-	-	Dr. U.S.Akshara Govind Mr. Bharath Suresh Kumar

THEORY

Unit I - Language components

Structural Grammar: Introduction of Word Classes; classification of word classes, Content words and Function words, Structure of Verb in English; Uses of Tenses; Study of Voice; Types of Conjunctions and Prepositions; Sentence Patterns in English, Subject verb agreement. Idioms and Phrases, Homophones and Homonyms

Unit II - Listening

Physical Attributes- Concentration, Eye contact, body language, Observation and questioning, Task- Audio Visual Aids, Tasks involving in Talks and Lectures, Understanding Sentences and Dialogue; Basic listening models- Competitive or combative listening, passive and attentive listening, Active and reflective listening, Barriers in Listening skills

Unit III - Speaking

Individual and group presentations, impromptu presentation, public speaking, Group discussion, Organizing seminars and conferences, Spoken English- Conversations of different situations in everyday life; the concept of stress- stress shift in words and sentences; Pronunciation - silent letters in words and words with silent letters, the basic intonation patterns.

Unit IV - Reading

Reading comprehension of general and technical articles, Pronunciation, Vocabulary knowledge, fluency and reading speed, Types of reading- Skimming, Scanning, Extensive reading and Intensive reading.

Unit V - Writing

Strategies to manage the writing process, Précis Writing, Summarizing, Abstracting, Creative Writing, Letter Writing, writing for clarity, Hints developments, Story through images, Autobiography of Concrete objects, slogans

Theory - Lecture Schedule

1. Structural Grammar: Introduction of Word Classes, classification of word classes, Content words and Function words
2. Structure of Verb in English, Uses of Tenses
3. Study of Voice, Types of Conjunctions and Prepositions
4. Sentence Patterns in English, Subject verb agreement
5. Idioms and Phrases, Homophones and Homonyms
6. Physical Attributes- Concentration, Eye contact, body language, Observation and questioning, Task- Audio Visual Aids
7. Tasks involving in Talks and Lectures, Understanding Sentences and Dialogue
8. Basic listening models- Competitive or combative listening
9. **In - Semester Examination**
10. Passive and attentive listening, Active and reflective listening
11. Barriers in Listening skills
12. Individual and group presentations, Impromptu presentation, Public speaking, Group discussion
13. Organizing seminars and conferences
14. Spoken English- Conversations of different situations in everyday life
15. The concept of stress- stress shift in words and sentences
16. Pronunciation - silent letters in words and words with silent letters
17. The basic intonation patterns

Practical Schedule

1. Classification of word classes
2. Exercises in word classes
3. Sentence formations
4. Content words and function words exercises
5. Reading methods in general and technical aspects
6. Reading comprehension exercises

7. Vocabulary exercises
8. Individual presentation
9. Conversations of everyday life
10. Impromptu and group presentation
11. Exercises in Conjunctions
12. Exercises in Prepositions
13. Letter writing – informal and formal
14. Creative writing
15. Basic intonation patterns practicing
16. Fluency and speed reading exercise
17. Writing for clarity
18. Group discussions
19. Active and passive listening
20. Tasks involving in talks and lectures
21. Hints developments
22. Presentation on understanding sentences and dialogue formats
23. Non-verbal Communication Practices
24. Autobiography of concrete objects exercises
25. Practice in creating slogans writing for the relevant concepts
26. Listening skills exercises
27. Exercises in story based images
28. Summarizing and abstracting exercises
29. Precis Writing
30. Exercises in spotting the errors
31. Public speaking practices
32. Observation
33. Questioning
34. **University Practical Examination**

Text Books

1. Bharati, T. Hariprasad, M. and Prakasam, 2008 V. Personality Development and Communicative English. Neelkamal Publications Pvt. Ltd, New Delhi. PP 1-350
2. Biber, D., Conrad, S. and Leech, G. 2002a Longman Student Grammar of Spoken and Written English, London, Pearson. PP1-450
3. Eggins, S. E. and Slade, D. 1997. Analysing Casual Conversation, London, Cassell PP 1-500
4. Hewings, A. and Hewings, M. 2004 Grammar and Context, London, Routledge PP1-650
5. Mohan, K. and Meera, B. 1990. Developing Communication Skills. New Delhi. Macmillan PP1-480
6. Wren and Martin, S. 1935 Key to High School English Grammar and Composition- New Delhi Chand and Company Ltd., PP 1-700

Web Resources

1. www.reportingskills.com
2. www.writing-skills.com
3. www.negotiation.com
4. www.teachersdesk.com
5. www.flexiblelearning.net.au

Course Nature: Theory based Practical							
Total Marks (100)							
Sl.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-	-	-	50	50
2	Theory-Internal	20	-	-	-	-	20
3	Practical-External	-	-	-	-	15	15
4	Practical-Internal	-	05	05	05	-	15
Grand Total							100

Course Code	MAT19101	Course Name	Elementary Mathematics	Course Category	A	Allied Course	L	T	P	C
							1	0	1	2

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	MAT19201
Course Offering Department	Basic and Applied Sciences	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:			Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
CLR-1 :		Recall the fundamental mathematical concepts and skills			Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems through Mathematics	Ability to implement knowledge gained in Mathematics	Ability to understand social and ethical responsibilities of Mathematics
CLR-2 :		Define the mathematical calculations in agricultural research																				
CLR-3 :		Discuss calculations and models applicable to field trials																				
CLR-4 :		Outline the maxima, minima and definite integral in solving real time applications																				
CLR-5 :		Identify the matrices in problems of agricultural science																				
CLR-6 :		Identify the sequences and progressions in agricultural sciences																				
Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:																				
CLO-1 :		Identify the calculation of area of the field in any shape			2	90	80	M	H	-	L	-	-	-	-	H	-	-	H	H	H	-
CLO-2 :		Outline different types of straight line			2	95	85	-	M	-	-	-	-	-	-	M	-	-	H	M	-	-
CLO-3 :		Describe the circle, find equation of circle in different aspects and tangent and normal to the circle.			2	85	75	-	M	-	-	-	-	-	-	H	-	-	H	L	-	-
CLO-4 :		Explain the role of differentiation and integration in agricultural sciences			2	70	60	H	-	-	M	-	-	-	-	H	-	-	H	H	L	-
CLO-5 :		Explain matrices, sequences and progressions in problem solving			2	80	70	-	-	-	-	-	-	-	-	M	-	-	H	M	-	-
CLO6 :		Summarize to solve the field problems through integrated approach			2	80	70	M	-	-	-	-	-	-	-	L	-	-	H	M	L	-

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		3	3	4	2	4
S-1	SLO-1	Introduction, Distance formula, section formula (internal and external division).	Equation of circle whose centre and radius is known.	Binomial Theorem	Definition of Matrices.	Sequences and Series.
	SLO-2	Equation of co-ordinate axes, Equation of lines parallel to axes.	General equation of a circle,	Derivatives of sum, difference, product and quotient of two functions	Addition, Subtraction, Multiplication of Matrices	Arithmetic Progression.
S-2	SLO-1	Slope-intercept form of equation of line, Slope-point form of equation of line.	Equation of circle passing through three given points	Differentiation of functions of functions (Simple problem based on it), Logarithmic differentiation (Simple problem based on it).	Transpose and Inverse up to 3 rd order.	Geometric Progression.
	SLO-2	Two point form of equation of line - Intercept form of equation of line - General form of equation of line.	Equation of circle whose diameters is line joining two points (x ₁ , y ₁) & (x ₂ , y ₂).	Maxima and Minima of the functions of the form y=f (x) (Simple problems based on it).	Properties of determinants up to 3 rd order and their evaluation.	Harmonic Progression.
S-3	SLO-1	Point of intersection of two st. lines, Angles between two st. lines, Parallel lines, Perpendicular lines.	Tangent and Normal to a given circle at given point (Simple problems).	Integration of simple functions,		Fundamental principle of counting.
	SLO-2	Area of triangle and quadrilateral.	Condition of tangency of a line y = mx + c to the given circle x ² + y ² = a ² .	Integration of Product of two functions		Permutations, circular permutation.
S-4	SLO-1			Integration by parts,		Permutation with restrictions.
	SLO-2			Definite Integral (simple problems based on it).		Combinations

Learning Resources	1. Betty C. Rogers, Clifford M. Hokanson. (1999). <i>Mathematics for agriculture</i> (2 nd ed.). USA: Pearson Education. pp. 1-317
	2. Duraipandian. And Laxmi Duraipandiyan (2007). <i>Analytical Geometry 2 Dimensional</i> . Chennai: Emerald Publishers. pp. 1- 196

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember	40 %	30 %	30 %	40 %
	Understand				
Level 2	Apply	40 %	40 %	40 %	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	30 %	20 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	Dr. A. Govindarajan, Professor and Head, Department of Mathematics (E&T), SRMIST, Kattankulathur	Dr. M. Selva rani Ms. A. Muthulakshmi

THEORY

Unit I - Straight Line

Distance formula, section formula (internal and external division), Equation of co-ordinate axes, Equation of lines parallel to axes, Slope-intercept form of equation of line, Slope-point form of equation of line, Two point form of equation of line, Intercept form of equation of line, General form of equation of line, Point of intersection of two st. lines, Angles between two st. lines, Parallel lines, Perpendicular lines, Area of triangle and quadrilateral.

Unit II - Circle

Equation of circle whose centre and radius is known, General equation of a circle, Equation of circle passing through three given points, Equation of circle whose diameter is line joining two points (x_1, y_1) & (x_2, y_2) , Tangent and Normal to a given circle at given point (Simple problems), Condition of tangency of a line $y = mx + c$ to the given circle $x^2 + y^2 = a^2$.

Unit III - Calculus

Binomial Theorem, Derivatives of sum, difference, product and quotient of two functions, Differentiation of functions of functions (Simple problem based on it), Logarithmic differentiation (Simple problem based on it), Maxima and Minima of the functions of the form $y=f(x)$ (Simple problems based on it), Integration of simple functions, Integration of Product of two functions, Integration by parts, Definite Integral (simple problems based on it),

Unit IV - Matrices and Determinants

Definition of Matrices, Addition, Subtraction, Multiplication, Transpose and Inverse up to 3rd order, Properties of determinants up to 3rd order and their evaluation.

Unit V - Progressions and Permutations

Sequences and Series, Arithmetic Progression, Geometric Progression, Harmonic Progression, Fundamental principle of counting, Permutations, circular permutation, Permutation with restrictions, combinations.

Theory- Lecture Schedule

1. Introduction - Distance formula - section formula (internal and external division) - Equation of co-ordinate axes - Equation of lines parallel to axes.
2. Slope-intercept form of equation of line - Slope-point form of equation of line - Two point form of equation of line - Intercept form of equation of line - General form of equation of line.
3. Point of intersection of two st. lines, Angles between two st. lines, Parallel lines, Perpendicular lines, Area of triangle and quadrilateral.
4. Equation of circle whose centre and radius is known - General equation of a circle.
5. Equation of circle passing through three given points - Equation of circle whose diameter is line joining two points (x_1, y_1) & (x_2, y_2) .
6. Tangent and Normal to a given circle at given point (Simple problems) - Condition of tangency of a line $y = mx + c$ to the given circle $x^2 + y^2 = a^2$.
7. Binomial Theorem - Derivatives of sum, difference, product and quotient of two functions.
8. Differentiation of functions of functions (Simple problem based on it), Logarithmic differentiation (Simple problem based on it), Maxima and Minima of the functions of the form $y=f(x)$ (Simple problems based on it).
9. **In – semester Examination**
10. Integration of simple functions, Integration of Product of two functions
11. Integration by parts, Definite Integral (simple problems based on it).
12. Definition of Matrices, Addition, Subtraction, Multiplication of Matrices.
13. Transpose and Inverse up to 3rd order, Properties of determinants up to 3rd order and their evaluation.
14. Sequences and Series, Arithmetic Progression.
15. Geometric Progression, Harmonic Progression.
16. Fundamental principle of counting, Permutations, circular permutation, Permutation with restrictions.
17. Combinations.

Practical Schedule

1. Problems based on distance formula and section formula.
2. Problems in various forms of straight line and angle between two straight lines.
3. Problems in Equation of a Straight line.
4. Problems in Area of triangle and quadrilateral.
5. Problems based on Center and Radius of a Circle.
6. Equation of a circle passing through three given points.

7. Equation of a circle whose diameter is the line joining two points.
8. Tangent and Normal to a given circle at a given point. Condition of tangency of a line to the given circle.
9. Binomial Theorem, Derivatives of sum, difference, product and quotient of two functions, Differentiation of functions of functions (Simple problem based on it).
10. Logarithmic differentiation (Simple problem based on it), Maxima and Minima of the functions of the form $y=f(x)$ (Simple problems based on it).
11. Integration of simple functions, Integration of Product of two functions, Integration by parts, Definite Integral (simple problems based on it).
12. Definition of Matrices, Addition, Subtraction and Multiplication of Matrices.
13. Transpose and Inverse up to 3rd order, Properties of determinants up to 3rd order and their evaluation.
14. Sequences and Series, Arithmetic Progression, Geometric Progression, Harmonic Progression.
15. Fundamental principle of counting, Permutations, Circular permutation,
16. Permutation with restrictions, Combinations.
17. **University Practical Examination**

Text Books

1. Harikishan. (2008). *A textbook of Matrices*. Delhi: Atlantic Publisher. pp.1-229
2. Narayan Shanti. (2004). *Differential Calculus*. New Delhi: S.Chand and Co. Ltd. pp. 1 - 572
3. Narayan Shanti. (2004). *Integral Calculus*. New Delhi: S.Chand and Co. Ltd. pp. 1-360
4. Narayan Shanti. (2004). *A textbook of Matrices*. New Delhi:S.Chand and Co. Ltd. pp. 1-309
5. Tim Hill. (2018). *Essential Permutations and Combinations*. California: Create space independent publishing platform. pp. 1-88

References Books

1. Harikishan. (2006). *Coordinate Geometry of two dimensions*. Delhi: Atlantic Publisher. pp. 1- 137
2. Manickavasagam, P. T. K. & Narayanan. S (1997). *Calculus*. Vol I Madras: Viswanathan Publications. pp. 1-433
3. Mehta, B. C. & G. M. K. Madnani. (2008). (9th ed.). *Mathematics for Economists*. New Delhi: Sultan Chand & Sons.pp.1 - 731
4. Sharma, A. K. (2004). *Textbook of Matrix*. New Delhi: Discovery Publishing House. pp. 1-333

Web References

1. www.mathsisfun.com
2. www.mathinsight.org
3. <https://youtu.be/WEUL1v1Mxv0>
4. <https://youtu.be/SSyZYWDX0Mo>
5. <https://youtu.be/IS2vyb3Fps8>
6. <https://youtu.be/lvLpNG1Ncg>
7. https://youtu.be/Wm5a_Sa2GNY
8. <https://youtu.be/Dsi7x-A89Mw>
9. <https://youtu.be/iNty4CSFipU>

Journals

1. Mathematics for students of Agriculture.
2. International Journal of Mathematics and Statistics
3. Annals of Mathematics
4. Journal of Mathematical Sciences
5. International Journal of Mathematical Education in Science and Technology

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-	-	-	50	50
2	Theory-Internal	20	-	-	-	-	20
3	Practical-External	-	-	-	-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	PHE19101	Course Name	Physical Education	Course Category	E	Extension Activity	L	T	P	C
							0	0	0	0

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Physical and Health education	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Learning			Program Learning Outcomes (PLO)														
CLR-1:	Perform the Body Management Skills	Level of Thinking (Bloom)	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
CLR-2:	Illustrate Teamwork, Sportsmanship, and Cooperation		Expected	Proficiency	Attainment (%)	Physical Knowledge	Problem Analysis	Design & Development	Analysis, Design, Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems	Ability to implement knowledge gained	Ability to understand social and ethical responsibilities		
CLR-3:	Identify a range of movement skills to participate in a variety of physical activities.																				
CLR-4:	Illustrate and apply the movement concepts, principles and strategies in a range of physical activities																				
CLR-5:	Demonstrate safe practices during physical and daily activities																				
Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected	Expected	Attainment (%)																
CLO-1:	Recognize the value the benefits of living a physically active and healthy life.	2	80	75	H				H	H	H	H	H	H		H	L	M	M		
CLO-2:	Identify health-enhancing fitness through regular participation in physical activities.	2	80	75	H				H	H	H	H	H			H	H	H	H		
CLO-3:	Demonstrate safe practices during physical and daily activities with respect to themselves, others and the environment.	3	90	85	H		H	M	H	H			H	H	H		H	M	H	M	
CLO-4:	Demonstrate positive personal and social behaviour across different experiences	3	85	70	H				H	H			H	H			H	M	M	M	
CLO-5:	Summarise the rules and regulatiins of sports and games	2	90	85	H	M			H	H	H	H	H			H	H	H			
CLO6:	-																				

Lab/Practical (2 hrs.)	Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
	8	8	8	8	8
S-1,2	SLO-1 Lab: 1 Introduction to physical education: Posture, exercise for good posture	Lab: 5 Skill development in the outdoor games - football, volleyball and Hockey	Lab: 8 Skill development in the indoor games : shuttle and Badminton	Lab: 11 Rules and regulations of athletic events; Skill development in the athletic events	Lab:14 First-aid training
S-3,4	SLO-1 Lab: 2 Physical fitness exercises for agility, strength and coordination	Lab: 6 Skill development in Cricket	Lab: 9 Skill development in the indoor games: Chess	Lab: 12 Broad jump, high jump, triple jump, javelin throw, disc throw,;	Lab: 15Coaching for major outdoor games
S-5,6	SLO-1 Lab: 3 Endurance and speed Meaning and importance of Physical Education.	Lab: 7 Skill development in Ball badminton and Tennikoit.	Lab: 10 Skill development in the indoor games: Table tennis	Lab: 13 Shot put, short and long distance running; Safety education,	Lab : 16 Coaching for major indoor games and Athletics
S-7,8	SLO-1 Lab: 4 Importance of physical fitness Rules and regulations of important games.	-	-	-	-

Learning Resources	1. Crop Production Guide. (2020). Directorate of Agriculture, Chennai and Tamil Nadu Agricultural University, Coimbatore. pp. 1-460. 2. Mukund Joshi., (2015). Text Book of Field Crops. PHI Learning Private limited. New Delhi. pp. 1-28.	3. Rajendra Prasad. (2016). Textbook of Field Crops Production (Volume 1). Indian Council of Agricultural Research (ICAR), New Delhi. pp. 1-64. 4. Shouichi Yoshida. (1981). Fundamentals of Rice. IRRI. Philippines. pp. 1- 268.

	Level of Thinking	Final Practical Examination (100 %)
Level 1	<i>Remember</i>	35 %
	<i>Understand</i>	
Level 2	<i>Apply</i>	40 %
	<i>Analyze</i>	
Level 3	<i>Evaluate</i>	25 %
	<i>Create</i>	
	<i>Total</i>	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	Dr. R. Mohankrishnan, HOD/Assistant Professor Department of Physical Education, SRMIST	Dr. M. Senthil Kumar HOD/Assistant Professor Department of Yoga

THEORY

Semester I - Introduction to Physical Education

Introduction to physical education: Posture, exercise for good posture, physical fitness exercises for agility: strength, coordination, endurance and speed; Rules and regulations of important games.

Semester II – Skill Development in Indoor Games I

Skill development in any of the outdoor games: football, hockey, cricket, volleyball, ball badminton, throw ball, tennikoit.

Semester III - Skill Development in Indoor Games II

Skill development in any of the indoor games: shuttle badminton, chess and table tennis

Semester IV - Skill Development in Outdoor Games II

Rules and regulations of athletic events; Skill development in any of the athletic events : broad jump, high jump, triple jump, javelin throw, discuss throw, shot put, short and long distance running; Safety education, movement education, effective way of doing day-today activities;

First Aid

First-aid training; coaching for major outdoor and indoor games, athletics. Warming up and conditioning exercises are compulsory before the commencement of each class.

Reference Books

1. Aneja, O, P., (2012). Encyclopedia of Physical education, sports and exercise science. Khel Sahitya Kendra. pp.1- 344.
2. Pintu Modak, O, P., & Sharma, D, J., (2005). Encyclopedia of Sports and Games with latest rules and regulations. New Delhi: Khel Sahitya Kendra / Ksk Pub Dist. pp.1- 450.

Web-References

1. <https://thephysicaleducator.com/blog/>
2. [reddit.com/r/Physical Education](https://www.reddit.com/r/PhysicalEducation)

Journals

1. Journal of Physical Education and Sports Management
2. The Journal of Teaching in Physical Education

Course Nature: Practical			
Total Marks (100)			
S.No.	Category	Assessment Tools	Marks
1	Practical-Internal	Purely internal based on the participation, involvement and contribution of students in the activities pertaining to the course	
		Attendance	05
		Discipline	25
		Assignment I	15
		Assignment II	15
		Performance /participation	30
		Viva voce	10
Grand Total			100

Course Code	PHE19102	Course Name	National Service Scheme	Course Category	NG	Extension Activity	L	T	P	C
							0	0	0	0

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Physical and Health Education	Data Book / Codes/Standards			Nil

Course Learning Rationale (CLR):		The purpose of learning this course is to:			Learning			Program Learning Outcomes (PLO)																
CLR-1 :	Describe the community in which the the students work	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
CLR-2 :	Identify themselves in relation to their community				Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems	Ability to implement knowledge gained	Ability to understand social and ethical responsibilities					
CLR-3 :	Identify the needs and problems of the community and involve them in problem solving process																							
CLR-4 :	Explain a sense of social and civic responsibility																							
CLR-5 :	Demonstrate a practical solution to individual and community problems																							
Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:																						
CLO-1 :	Develop competence required for group living and sharing of responsibilities	1	90	85	H			H				H		M	H		H	H	H	H	H	H		
CLO-2 :	Demonstrate skills in mobilizing community participation	2	95	85	H			H						H	H		H	H	H	H	H	H		
CLO-3 :	Identify the leadership qualities and democratic attitude	2	80	70	M		M	M			H			H	H		H	H	H	H	H	H		
CLO-4 :	Demonstrate the capacity to meet emergencies and natural disasters	3	85	75	M			H						M	H		H	H	H	H	H	H		
CLO-5 :	Summarize national integration and social harmony	3	85	90	M									M	H		H	H	H	H	H	H		

Practicals

Semester I

Orientation

History, objectives, principles, symbol, badge; regular programmes under NSS, organizational structure of NSS, code of conduct for NSS volunteers, points to be considered by NSS volunteers awareness about health

NSS programmes and activities

Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analysing guiding financial patterns of scheme, youth programme/ schemes of GOI, coordination with different agencies and maintenance of diary

Understanding youth

Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change

Community mobilization

Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilisation involving youth-adult partnership

Social harmony and national integration

Indian history and culture, role of youth in nation building, conflict resolution and peacebuilding

Volunteerism and shramdan

Indian tradition of volunteerism, its need, importance, motivation and constraints; shramdan as part of volunteerism

Citizenship, constitution and human rights

Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information

Family and society

Concept of family, community (PRIs and other community based organisations) and society

Semester II

Importance and role of youth leadership

Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership

Life competencies

Definition and importance of life competencies, problem-solving and decision-making, inter personal communication

Youth development programmes

Development of youth programmes and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations

Health, hygiene and sanitation

Definition needs and scope of health education; role of food, nutrition, safe drinking water, water born diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programmes and reproductive health.

Youth health, lifestyle, HIV AIDS and first aid

Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid

Semester III

Vocational skill development

To enhance the employment potential and to set up small business enterprises skills of volunteers, a list of 12 to 15 vocational skills will be drawn up based on the local conditions and opportunities. Each volunteer will have the option to select two skill-areas out of this list

Issues related environment

Environmental conservation, enrichment and sustainability, climatic change, natural resource management (rain water harvesting, energy conservation, forestation, waste land development and soil conservations) and waste management

Disaster management

Introduction and classification of disaster, rehabilitation and management after disaster; role of NSS volunteers in disaster management

Entrepreneurship development

Definition, meaning and quality of entrepreneur; steps in opening of an enterprise and role of financial and support service institution.

Formulation of production oriented project

Planning, implementation, management and impact assessment of project

Documentation and data reporting

Collection and analysis of data, documentation and dissemination of project reports

Semester IV

Youth and crime

Sociological and psychological factors influencing youth crime, cyber crime, peer mentoring in preventing crime and awareness for juvenile justice

Civil/self defence

Civil defence services, aims and objectives of civil defence; needs and training of self defence

Resource mobilisation

Writing a project proposal of self fund units (SFUs) and its establishment

Additional life skills

Positive thinking, self confidence and esteem, setting life goals and working to achieve them, management of stress including time management.

Course Nature: Practical			
Total Marks (100)			
S.No.	Category	Assessment Tools	Marks
1	Practical-Internal	Purely internal based on the participation, involvement and contribution of students in the activities pertaining to the course	
		Attendance	05
		Participation	20
		Activities and Involvement	20
		Behaviour	15
		Written	40
Grand Total			100

* Registration in semester I, whereas result declaration in semester IV. Students are evaluated internally by course teacher at the end of each semester and the average would be taken for result declaration.

Course Code	PHE19103	Course Name	National Cadet Corps	Course Category	NG	Extension Activity-Non Gradual	L	T	P	C
							0	0	0	0

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department		Data Book / Codes/Standards			Nil

Course Learning Rationale (CLR):	The purpose of learning this course is to:

CLR-1 :	To develop character, comradeship, discipline, secular outlook, spirit of adventure
CLR-2 :	Understand the ideals of selfless service amongst the youth of the country
CLR-3 :	Identify the needs and problems of the community and involve them in problem solving process
CLR-4 :	Develop among themselves a sense of social and civic responsibility
CLR-5 :	To create a human resource of organized, trained and motivated youth

Learning

1	2	3
Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
1	90	85
2	70	85
2	75	95
3	90	80
3	85	85

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:

CLO-1 :	To provide leadership in all walks of life and always available for the service of the nation.
CLO-2 :	Gain skills in mobilizing community participation
CLO-3 :	Acquire leadership qualities and democratic attitude
CLO-4 :	To provide a suitable environment to motivate the youth to take up a career in the Armed Forces.
CLO-5 :	Practice national integration and social harmony

Program Learning Outcomes (PLO)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems	Ability to implement knowledge gained in NCC	Ability to understand social and ethical responsibilities
H	H		H			H	H	M	H		H	H	H	H
H	M		H		M	H	H	H	H		H	H	H	H
M	M	M	M		M	H	H	H	H		H	H	H	H
M	M	H	H		M	H	M	M	H		H	H	H	H
M	H		M		M	H	M	M	H		H	H	H	H

Practicals

Semester I

Orientation

Aims, objectives, organization of NCC and NCC song; DG's cardinals of discipline; Drill- aim, general words of command, attention, stands at ease, stand easy and turning; Sizing, numbering, forming in three ranks

NCC Activities

Open and close order march and dressing; Saluting at the halt, getting on parade, dismissing and falling out

Understanding Youth

Marching, length of pace, and time of marching in quick/slow time and halt; Side pace, pace forward and to the rear; Turning on the march and wheeling. Saluting on the march

Community Mobilization

Marking time, forward march and halt; Changing step, formation of squad and squad drill; Command and control, organization, badges of rank, honours and awards.

Semester II

Parade

Arms Drill- Attention, stand at ease, stand easy, Getting on parade, Dismissing and falling out, Ground/take up arms, examine arms; Shoulder from the order and vice-versa,

Characteristics of rifle

Present from the order and vice-versa; Saluting at the shoulder at the halt and on the march; Short/long trail from the order and viceversa; Guard mounting, guard of honour, Platoon/Coy Drill; Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning and sight setting; Loading, cocking and unloading.

Safety precautions

The lying position and holding; Trigger control and firing a shot, Range Procedure and safety precautions, Aiming and alteration of sight; Theory of groups and snap shooting, Firing at moving targets, Miniature range firing; Characteristics of Carbine and LMG.

Semester III

Field Defenses Obstacles

Introduction to map, scales and conventional signs; Topographical forms and technical terms; Grid system - Relief, contours and gradients, Cardinal points and finding north. Types of bearings and use of service protractor; Prismatic compass and its use; Setting a map, finding north and own position, Map to ground and ground to map; Knots and lashings, Camouflage and concealment, Explosives and IEDs; Field defenses obstacles, mines and mine lying; Bridging, waterman ship, Field water supplies, tracks and their construction; Nuclear, Chemical and Biological Warfare (NCBW); Judging distance.

Types of Communication

Description of ground and indication of landmarks, Recognition and description of target; Observation and concealment; Field signals; Section formations; Fire control orders, Fire and movement, Movement with/without arms; Section battle drill; Types of communication, media, latest trends and developments.

Semester IV

Nation Building

Nation Building- cultural heritage, religions, traditions and customs of India; National integration; Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizen; Leadership traits, types of leadership.

Personality Development

Character/personality development; Civil defense organization, types of emergencies, fire fighting, protection; Maintenance of essential services, disaster management, aid during development projects; Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning; Structure and function of human body, diet and exercise, hygiene and sanitation;

Environmental Conservation

Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health; Adventure activities; Basic principles of ecology, environmental conservation, pollution and its control; Precaution and general behaviour of girl cadets, prevention of untoward incidents, vulnerable parts of the body, self defense.

Course Nature: Practical			
Total Marks (100)			
S.No.	Category	Assessment Tools	Marks
1	Practical-Internal	Purely internal based on the participation, involvement and contribution of students in the activities pertaining to the course	
		Attendance	05
		Participation	20
		Activities and Involvement	20
		Behaviour	15
		Written	40
Grand Total			100

* Registration in semester I, whereas result declaration in semester IV. Students are evaluated internally by course teacher at the end of each semester and the average would be taken for result declaration

Course Code	PHE19104	Course Name	Yoga for Human Excellence			Course Category	NG	Extension Activity					L	T	P	C								
										0	0	0	0											
Pre-requisite Courses		Nil		Co-requisite Courses		Nil		Progressive Courses		Nil														
Course Offering Department		Physical and Health Education			Data Book / Codes/Standards			Nil																
Course Learning Rationale (CLR):		The purpose of learning this course is to:						Learning		Program Learning Outcomes (PLO)														
CLR-1 :	Explain the basic concepts and philosophy of yoga						1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	Summarize the historical knowledge and features of yoga						Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Knowledge on Yoga	Problem Analysis	Yoga's and Asanas	Methods of learning	Material needs	Society & Culture	Ecological Interactions	Morals and Ethics	Individual & Team Work	Communication	Attitude of self discipline	Life Long Learning	Ability to decision making	Mental and physical fitness	Camping and recreation and disseminating to others to earn mudras
CLR-3 :	Demonstrate the Indigenous ways of physical fitness																							
CLR-4 :	Outline the Importance of yoga and surya-namaskar in human life																							
CLR-5 :	Demonstrate free hand exercises and fitness with mudras																							
CLR-6 :	Recongnise the need of leisure, recreation and camping																							
Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:						2	80	80	M	M	L	L	M	M	H	H	M	H	H	H	H	H
CLO-2 :	Demonstrate physical and mental fitness						3	75	85	H	M	M	H	M	H	M	M	L	H	H	H	H	H	H
CLO-3 :	Present clarity in the thinking and decision making process						2	75	70	M	H	M	M	M	H	M	M	H	H	H	H	H	H	H
CLO-4 :	Demonstrate interaction with the society of co-existence						5	80	75	M	H	M	M	L	M	L	M	M	H	H	H	H	H	H
CLO-5 :	Associate the development of personality with good hygiene						4	85	80	M	M	M	M	M	M	M	M	M	H	H	H	H	H	H
CLO-6 :	Present self evaluation capacity and recreation with right attitudes						6	85	80	M	H	M	M	M	L	H	L	M	H	H	H	H	H	H
Duration (hour)		Learning Unit / Module 1		Learning Unit / Module 2		Learning Unit / Module 3		Learning Unit / Module 4		Learning Unit / Module 5														
6		6		6		6		6		6														
S-1-2	SLO-1 SLO-2	Lecture on History of Yoga and Concepts		Lecture on Indigenous way of physical fitness		Importance of Asanas and Surya namaskar		Free hand exercises		Guest lecture for motivation and self evaluation														
S-3-4	SLO-1 SLO-2	Practicing Pranayamas		Curative exercises		Practicing surya namaskar		Practicing Yoga mudras		Recreation camp														
S-5-6	SLO-1 SLO-2	Practicing Meditations and Yoga Kriyas		Games for social interactions		Practicing yoga		Practicing Yoga postures		Importance of co- existence with nature														
Learning Resources		1. Anil Sharma. (2007). Encyclopaedia of Health, Physical Education and Sports Sciences. (9 Volumes). Khel Sahitya Kendra. New Delhi. 2. Chaudhery, N.V. and R. Jain. (2012) Encyclopedia of Yoga Health and Physical Education (7 Volumes). Pragun Publication. New Delhi.										3. Aiyasamy, P.K. (2019). Science of Yoga (First Edition). Notion press. Chennai. Pp. 1-443.												

Level	Level of Thinking	Final Practical Examination (100%)
Level 1	Remember	40 %
	Understand	
Level 2	Apply	40 %
	Analyze	
Level 3	Evaluate	20 %
	Create	
	Total	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mrs. Latha, Yoga Guru, Magadheera Fitness & Yoga AYUSH QCI - Fitness centre Coimbatore, TN.	Dr. P. K. Ayyasmy, K.K.Pudur, Coimbatore.	Dr. Periasami N

Practical Schedule

1. Lecture on History of Yoga and Concepts
2. Lecture on Indigenous way of physical fitness
3. Importance of Asanas and Surya namaskar
4. Free hand exercises
5. Guest lecture for motivation and self evaluation
6. Practicing Pranayamas
7. Curative exercises Practicing surya namaskar
8. Practicing Yoga mudras
9. Recreation camp
10. Practicing Meditations and Yoga Kriyas
11. Games for social interactions
12. Practicing yoga
13. Practicing Yoga postures
14. Importance of co- existence with nature
15. Final practical examination

Text Books

1. Aiyasamy, P.K. (2019). Science of Yoga (First Edition). Notion press. Chennai. Pp. 1-443.

Reference Books

1. Anil Sharma. (2007). Encyclopaedia of Health, Physical Education and Sports Sciences. (9 Volumes). Khel Sahitya Kendra. New Delhi.
2. Chaudhery, N.V. and R. Jain. (2012) Encyclopedia of Yoga Health and Physical Education (7 Volumes). Pragun Publication. New Delhi.

Web-References

1. www.hridaya-yoga.fr/yoga-union-with-the-divine/?gclid=Cj0KCQiA_rfvBRCPARIsANIV66OP3KHTiJfPiBbc7X6OLw6k1LUg3DplkUFPo-Ig5P5AA0WmreyItYaAt_YEALw_wcB
2. www.ananda.org/meditation/meditation-support/articles/what-is-yoga/

3. www.honairesort.com/blog/what-is-the-importance-of-yoga-in-our-daily-life/
4. www.artofliving.org/in-en/benefits-sun-salutation
5. www.hindujagriti.org/hinduism-for-kids/238_surya_namaskar.html?gclid=Cj0KCQiA_rfvBRCPARIsANIV66PK0MPn4Cr78XO-XC4I8-5uRpdV5Op9auneRi7vgb8zPnve0KBEt4YaAvmHEALw_wcB
6. www.yogajournal.com/yoga-101/yoga-class-dos-and-don-ts
7. www.consciouslifestylemag.com/body-energy-systems-health/
8. www.chaitanyayoga.com/12%20Basic%20Asanas.html
9. www.artsandculture.google.com/exhibit/FgJSV8NUVt54LA

Journals

1. International Journal of Yoga
2. Indian Journal of Ancient Medicine and Yoga
3. Journal of Yoga and Physiotherapy
4. Journal of Yoga Studies
5. International Journal of Yoga and Allied Sciences: Indian Yoga

Course Nature: Practical			
Total Marks (100)			
S.No.	Category	Assessment Tools	Marks
1	Practical-Internal	Purely internal based on the participation, involvement and contribution of students in the activities pertaining to the course	
		Attendance	05
		Discipline	15
		Assignment	10
		Yoga & Postures	40
		Written	20
		Viva voce	10
Grand Total			100

Course Code	HOR19201	Course Name	Propagation of Horticultural Crops	Course Category	C	Compulsory Core	L	T	P	C
							1	0	1	2

Pre-requisite Courses	HOR19101	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Horticulture	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Define the knowledge on plant propagation
CLR-2 :	Discuss the use of various tools and implements for nursery production
CLR-3 :	Outline of propagation structures and rootstocks in plant multiplication
CLR-4 :	Summarize the activities pertaining to multiplication of several horticultural crops
CLR-5 :	Describe the commercial importance of plant growth regulators.
CLR-6 :	Describe the commercial importance of plant micro propagation

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:
CLO-1 :	Identify the tools and implements of propagation techniques
CLO-2 :	Describe the propagation methods in Horticultural crops
CLO-3 :	Describe sexual propagation
CLO-4 :	Identify the asexual propagation techniques
CLO-5 :	Identify the micro propagation techniques
CLO6 :	Outline different plant propagation structures

Learning		
1	2	3
Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
1	95	85
1	80	75
1	75	65
2	75	65
2	90	80
1	95	90

Program Learning Outcomes (PLO)														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Horticulture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems	Ability to implement knowledge gained	Ability to understand social and ethical responsibilities
H								H	M		H	H	H	H
H								L	H		H	H	H	H
M		L	L					L	H		H	H	H	H
M			L	L				M	H		H	H	H	H
L	L							M	H		H	H	H	H
L						H		M	H		H	H	H	H

Duration (hour)		Learning Unit / Module 1 3	Learning Unit / Module 2 3	Learning Unit / Module 3 3	Learning Unit / Module 4 4	Learning Unit / Module 5 3
S-1	SLO-1	Importance of Propagation	Advantages of sexual propagation	Plus tree identification	Grafting methods	Micro propagation
	SLO-2	Government schemes and Economics	Advantages of asexual propagation	Genetic variations	Rootstocks influence	Hardening of plants
S-2,3	SLO-1	Lab1: Media, containers, tools and implements for propagation	Lab5:Preparation of growth regulators for plant propagation	Lab9:Techniques and methods of propagation through grafting	Lab12: Collection and preparation of different types of explants and sterilization for micro propagation.	Lab15: Cost of establishment of propagation structures.
	SLO-2					
S-4	SLO-1	Nursery site selection	Micro and megasporogenesis	Cuttings	Budding methods	Quality management
	SLO-2	Propagation structures	Monoembryony and polyembryony	Use of growth regulators	Top working	Nursery act
S-5,6	SLO-1	Lab2:Propagation Structures	Lab6:Techniques and methods of propagation through cuttings	Lab10: Techniques and methods of propagation through budding.	Lab13:In vitro explant inoculation and sub culturing of plantlets	Lab16:Visit to private nurseries
	SLO-2					
S-7	SLO-1	Media and containers	Seed quality	Anatomy of cuttings	Stock scion relationship	Transport of Nursery propagules
	SLO-2	Soil sterilization	Dormancy	Physiology of cuttings	Bud incompatibility	Marketing of nursery propagules
S-8,9	SLO-1	Lab3:Preparation of nursery beds for raising rootstocks and seedlings, seed treatment, sowing and plug transplants	Lab7: Techniques and methods of propagation through layering	Lab11:Propagation through specialized plant parts	Lab14:Hardening of propagules	Lab17:Visit to tissue culture laboratory
	SLO-2					

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		3	3	3	4	3
S-10	SLO-1				Special propagules	
	SLO-2				Special propagules	
S-11-12	SLO-1	Lab4:Potting, Pot-bound condition, depotting, repotting of plants				
	SLO-2					

Learning Resources	1.	Rajan, S. and Markose, B.L. (2007). <i>Propagation of Horticultural Crops Volume 6 of Horticulture science series. New Delhi: New India Publishing..(pp. 1-251).</i>				
	2.	Sharma, R.R. (2005). <i>Propagation of Horticultural crops (Principles and practices). New Delhi: Kalyani Publishers. (pp.1 -272).</i>				

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In semester (20%)	Practical (15%)		
Level 1	Remember	40 %	30 %	35 %	30 %
	Understand				
Level 2	Apply	40 %	40 %	35 %	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	30 %	30 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Mohan, Horticulture Officer, The Nilgiris	Dr. P. Preethi, Scientist (Fruit Science), ICAR – Directorate of Cashew Research, Puttur – 574202	Dr. B. Gopu, Dr. S. Anandhi, Mrs. C. Kanimozhi

THEORY

Unit I -Introduction and components of propagation

Scope and importance of plant propagation - establishment of nursery - site selection - mist chamber - phytotron - humidifiers - greenhouse - glasshouse - polyhouse - shade net - cold frames - hot beds –media and containers - soil sterilization - manures and manuring - liquid manures - agencies involved in the nursery development - government schemes for development of nurseries.

Unit II -Sexual propagation

Importance, advantages and disadvantages - micro and megasporogenesis - apomixis - mono and polyembryony - seeds - quality - seed viability - longevity - germination - dormancy - types of dormancy - seed treatments - seed invigoration - seedling vigour.

Unit III- Asexual propagation – cutting and layering

Importance, advantages and disadvantages - methods of vegetative propagation - identification of plus trees – mother block and scion bank – raising clonal nursery - genetic variations - chimeras and types -types of cuttings - factors influencing rooting of cuttings - use of growth regulators - layering - advantages and disadvantages - methods of layering - anatomical and physiological basis of rooting.

Unit IV- Asexual propagation – grafting, budding and propagation through specialized plant parts

Grafting and budding methods - advantages and disadvantages - rootstocks - factors for successful graft union - selection, pre-curing and collection of scion - bud wood selection and certification - anatomical and physiological basis of graft / bud union – stock - scion relationship – influence of root stock on scion and scion on root stock – inter stock –graft incompatibility - top working - techniques of propagation through specialized plant parts – stem and root tubers - bulbs - corms - runners - suckers - crown - slips - rhizome - offshoots

Unit V - Micro propagation, Nursery registration act, quality management aftercare and marketing

Micro propagation- meristem culture, callus culture, anther culture, organogenesis, somaclonal variation. Hardening of plants in nurseries, Nursery registration act. Insect/pest/disease control in nursery, quality management and nursery certification –display, packing, transport and marketing.

Theory - Lecture Schedule

1. Scope and importance of plant propagation, Agencies involved in the development of nursery, government schemes and economics.
2. Establishment of nursery and site selection. Propagation structures, mist chamber, shade net, phytotron, humidifiers, green house, poly house, hot beds.
3. Media and containers, Soil sterilization, manures and manuring and liquid manures
4. Advantages and disadvantages of sexual and asexual propagation.
5. Micro and megasporogenesis, apomixes, monoembryony and polyembryony
6. Seed quality, dormancy, types of dormancy, Seed viability, germination, longevity, seedling vigour and seed invigoration
7. Identification of plus trees, mother block, scion bank and clonal nursery, Genetic variations, chimeras and types
8. Types of cuttings, factors influencing rooting of cuttings and use of growth regulators.
9. **In- Semester Examination**
10. Anatomical and physiological basis for rooting in cuttings and layering
11. Rootstocks and factors for successful graft union. Advantages, disadvantages and methods of grafting
12. Budding methods and techniques Selection, precuring and collection of scion, bud wood and certification, top working
13. Influence of stock on scion, scion on stock, interstock and methods of graft and bud incompatibility
14. Propagation through specialized plant parts viz., tubers, corms, bulbs, rhizome, runner, crown, slip, sucker and offshoots.
15. Micropropagation- meristem culture, callus culture, anther culture, organogenesis, somaclonal variation hardening of plants in nurseries. Constraints in micro-propagation
16. Quality management, quality standards and Nursery Act
17. Aftercare, packing, transport and marketing.

Practical Schedule

1. Media, containers, tools and implements for propagation
2. Propagation structures viz., mist chamber, poly house, shade net house, cold frames and hot beds and their maintenance
3. Preparation of nursery beds for raising rootstocks and seedlings, seed treatment, sowing and plug transplants
4. Potting, Pot-bound condition, depotting, repotting of plants
5. Preparation of growth regulators for plant propagation
6. Techniques and methods of propagation through cuttings
7. Techniques and methods of propagation through layering
8. Techniques and methods of propagation through grafting

9. Techniques and methods of propagation through budding.
10. Propagation through specialized plant parts
11. Collection and preparation of different types of explants and sterilization for micropropagation.
12. *In vitro explant* inoculation and subculturing of plantlets
13. Hardening of propagules
14. Cost of establishment of propagation structures.
15. Visit to private nurseries
16. Visit to tissue culture laboratory
17. **University Practical Examination.**

Text Books

1. Bose, T. K., Mitra, S. K., Sadhu, M. K., Das, P. and Sanyal, D. (1986). Propagation of Tropical & Subtropical Horticultural crops, Volume 1. Kolkatta: Naya Udyog Publisher. (3rd ed. pp. 1-612).
2. Chadha, K. L. (2002). Hand book of Horticulture. New Delhi: ICAR. (2nd ed. pp. 1-299)
3. Guy W. Adriance and Feed R. Brison, Propagation of Horticultural Plants. Axis Books (India).
4. Hudson T. Harmann, Dale E. Kester, Fred T. Davies, Jr. and Robert L. Geneve. (1968). Plant Propagation – Principles and Practices New Delhi: PHI Learning Private Limited. (7th ed. pp.1-702).
5. Mukherjee, S. K. and Manjumdar, P. K. (1973). Propagation of fruit crops. New Delhi: ICAR.
6. Sadhu, M.K.(1989). Plant Propagation. New Delhi: Wiley Easter Ltd.(pp.1-286).

Reference Books

1. Rajan, S. and Markose, B.L. (2007). Propagation of Horticultural Crops Volume 6 of Horticulture science series New Delhi: New India Publishing (pp. 1-251).
2. Sharma, R.R. (2005). Propagation of Horticultural crops (Principles and practices). New Delhi: Kalyani Publishers. (pp.1 -272).
3. Sharma, R. R., Mani Srivastava. (2004). Plant Propagation and Nursery management. International book Distributing Company. (pp.1-488).

Web Reference

1. www.brittanica.com
2. www.hillagric.ac.in
3. www.icar.gov.in
4. www.resourcecentral.org
5. www.gardentia.net
6. www.tmcnehs.gov.in
7. www.sciencedirect.com

Journals

1. Journal of Horticulture Sciences and Biotechnology
2. Indian Journal of Horticulture
3. Journal of South Indian Horticulture
4. Journal of Plant biology
5. Journal of Plant research
6. Journal of Systemics and Evolution

Course Nature: Theory based Practical							
Total Marks (100)							
Sl.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	05	05	05	-	15
Grand Total							100

Course Code	HOR19202	Course Name	Production Technology of Tropical and Subtropical Fruit Crops	Course Category	C	Compulsory Core	L	T	P	C
							2	0	1	3

Pre-requisite Courses	HOR19101	Co-requisite Courses	Nil	Progressive Courses	HOR19301					
Course Offering Department	Horticulture			Data Book / Codes/Standards	Nil					

Course Learning Rationale (CLR):		The purpose of learning this course is to:			Learning			Program Learning Outcomes (PLO)																					
CLR-1 :		Define the scope, importance and export potential of tropical and subtropical fruit crops			Level of Thinking (Bloom)	2	Expected Proficiency (%)	3	Expected Attainment (%)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15					
CLR-2 :		Summarize the knowledge on varieties and cultivation technologies of tropical and subtropical fruit crops								Horticulture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems through Fruit Science	Ability to implement knowledge gained in the applied field of Fruit Science	Ability to understand social and ethical responsibilities of Fruit Science					
CLR-3 :		Describe the knowledge on high density planting of tropical and subtropical fruit crops																											
CLR-4 :		Identify the physiological disorders in tropical and subtropical fruit crops																											
CLR-5 :		Identify the production constraints in tropical and subtropical fruit crops																											
CLR-6 :		Outline the harvest and post-harvest handling of tropical and subtropical fruit crops																											
Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:																											
CLO-1 :		Outline the scope, importance and classification of fruit crops			1	80	70	M									L	H		H	H	H	H	H					
CLO-2 :		Describe the training and pruning practices in tropical fruit crops			2	90	85	H				H					M	H		H	H	H	H	H					
CLO-3 :		Explain different high planting density followed in tropical and subtropical fruit crops			2	95	80	H		H							M	H		H	H	H	H	H					
CLO-4 :		Paraphrase the cultivation aspects of tropical and subtropical fruit crops.			3	95	80	H						H			L	H		H	H	H	H	H					
CLO-5 :		Summarize post-harvest handling of tropical and subtropical fruit crops			3	90	80	M									L	H		H	H	H	H	H					
CLO6 :		Identify the problems in tropical and subtropical fruit crops			1	75	65	L	H					H			H	H		H	H	H	H	H					

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		6	6	6	7	6
S-1	SLO-1	Scope of tropical and subtropical fruit cultivation	Banana - genomic classification - species and cultivars. propagation techniques	Sapota - species and cultivars. Soil and climatic requirements	Mandarin – species and cultivars propagation techniques –planting density and cropping systems.	Rambutan –species and cultivars. propagation techniques –planting density and cropping systems.
	SLO-2	Importance of tropical and subtropical fruit cultivation	Banana –planting density and cropping systems. Planting and after care	Sapota – propagation techniques – planting density	Mandarin – training and pruning – Physiological disorders and remedies – maturity indices, harvesting and yield	Rambutan –training and pruning – Physiological disorders and remedies – maturity indices, harvesting and yield
S 2	SLO-1	Classification of tropical fruits	Banana – Nutrients, water and weed management – use of plant growth regulators	Sapota – Planting and after care – nutrients, water and weed management.	Jackfruit –species and cultivars– propagation techniques - planting density and cropping systems.	Carambola –species and cultivars. – propagation techniques – spacing, planting density
	SLO-2	Classification of sub tropical fruits	Banana – Physiological disorders and remedies – maturity indices, harvesting and yield – production constraints.	Sapota – Training and pruning – use of plant growth regulators – harvesting and yield	Jackfruit – Planting and after care – training and pruning – Physiological disorders - harvesting and yield	Carambola – Planting and after care- training and pruning –Physiological disorders and remedies – maturity indices, harvesting and yield
S 3-4	SLO-1	Lab 1: Description and identification of mango varieties	Lab 4:Selection, pre-treatment, planting and special intercultural operations in banana	Lab 7:Description and identification of sapota varieties, propagation, training and pruning	Lab 11:Physiological disorders and remedies in major tropical and subtropical fruit crops	Lab 14:Study of maturity indices in major tropical and sub tropical fruit crops
	SLO-2					

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		6	6	6	7	6
S 5	SLO-1	Tropical and sub-tropical zones of India	Guava – species and cultivars - propagation techniques – main field preparation – spacing	Grapes - species and cultivars - – propagation techniques – main field preparation	Avocado –species and cultivars. – propagation techniques – spacing, planting density	Durian –species and cultivars. – propagation techniques –spacing, planting density
	SLO-2	Tropical and sub-tropical zones of Tamil Nadu	Guava – planting density - planting and after care – nutrients, water and weed management	Grapes – spacing, planting density and cropping systems. Planting and after care	Avocado –Planting and after care - training and pruning – Physiological disorders - harvesting and yield	Durian – Planting and after care - training and pruning – Physiological disorders - harvesting and yield
S 6	SLO-1	Area, production and export potential of tropical crops	Guava – Training and pruning – crop regulation – use of plant growth regulators.	Grapes – Training and pruning – Bud forecasting - flowering, pollination and fruit set – use of plant growth regulators	Pineapple –species and cultivars. propagation techniques –spacing, planting density	Bilimbi – species and cultivars. – propagation techniques – spacing, planting density
	SLO-2	Area, production and export potential of subtropical fruit crop	Guava - Physiological disorders and remedies – maturity indices, harvesting and yield	Grapes – Physiological disorders and remedies – maturity indices, harvesting and yield – production constraints.	Pineapple –Planting and after care - training and pruning – Physiological disorders - harvesting and yield	Bilimbi – Planting and after care - training and pruning – Physiological disorders - harvesting and yield
S 7-8	SLO-1	Lab 2:Practices in propagation, planting and training and pruning in mango	Lab 5:Description and identification of guava varieties, propagation techniques, training and pruning, special intercultural operations	Lab 8:Description and identification of grape varieties, propagation techniques, training and pruning	Lab 12:Description and identification of varieties of jack fruit, avocado, pineapple and litchi	Lab 15:Production economics for major tropical fruit crops
	SLO-2					
S-9	SLO-1	Mango – varieties propagation techniques	Papaya – species and cultivars.– propagation techniques	Acid lime – species and cultivars. propagation techniques	Mangosteen –species and cultivars. – propagation techniques –planting density	Passion fruit –species and cultivars. – propagation techniques –planting density
	SLO-2	Mango –planting density and cropping systems – HDP – Planting and after care - training and pruning	Papaya – Planting density and cropping systems. Planting and after care – nutrients, water and weed management	Acid lime –spacing, planting density and cropping systems. Planting and after care - nutrients, water and weed management	Mangosteen –Planting and after care - training and pruning – Physiological disorders - harvesting and yield	Passion fruit –Planting and after care - training and pruning – Physiological disorders - harvesting and yield
S-10	SLO-1	Mango – Flowering and bearing behavior – use of plant growth regulators – Physiological disorders	Papaya – Flowering, pollination and fruit set – use of plant growth regulators	Acid lime – Training and pruning – use of plant growth regulators	Litchi –species and cultivars. – propagation techniques – spacing, planting density	Breadfruit–species and cultivars. – propagation techniques – spacing, planting density
	SLO-2	Mango – maturity indices, harvesting and yield – production constraints – off season mango production.	Papaya – Physiological disorders and remedies – maturity indices, harvesting and yield – production constraints	Acid lime – Physiological disorders and remedies – maturity indices, harvesting and yield – production constraints	Litchi –Planting and after care - training and pruning – Physiological disorders - harvesting and yield	Breadfruit–. Planting and after care - training and pruning – Physiological disorders - harvesting and yield
S-11-12	SLO-1	Lab 3:Banana varieties, their genome classification and scoring techniques	Lab 6:Description and identification of papaya varieties, propagation, thinning and papain extraction	Lab 9:Description and identification of varieties, propagation techniques, training and pruning of citrus	Lab 13:Study of propagation techniques, planting systems, training and pruning in major sub tropical fruit crops	Lab 16:Visit to tropical fruit orchards/sub-tropical fruit zones
	SLO-2					
S-13	SLO-1			Sweet orange – species and cultivars. propagation techniques – spacing, planting density	Loquat –species and cultivars. – propagation techniques – spacing, planting density	Rose apple –species and cultivars. – propagation techniques – spacing, planting density systems.
	SLO-2			Sweet orange – Planting and after care – training and pruning –Physiological disorders –harvesting and yield	Loquat – Planting and after care - training and pruning – Physiological disorders - harvesting and yield	Rose apple –Planting and after care - training and pruning – Physiological disorders - harvesting and yield
S 14-15	SLO-1			Lab 10:Manures, fertilizers, biofertilizers and PGR application in major tropical fruit crops		
	SLO-2					

Learning Resources	1. Chadha, K.L. (2019). Handbook of Horticulture. Vol. I (2 nd revised edition) New Delhi: ICAR. pp. 1 - 299. 2. Prasad, S & Bhardwaj, R. L. (2015). Production technology of fruit crops. India: Agrobios. pp. 1 - 438.

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember Understand	40 %	30 %	35 %	30 %
Level 2	Apply Analyze	40 %	40 %	35 %	40 %
Level 3	Evaluate Create	20 %	30 %	30 %	30 %
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Mohan, Horticulture Officer, The Nilgiris	Dr. A. Rameshkumar, Associate Professor (Horticulture) Central University of Tamil Nadu, Thiruvavur	Dr. B. Gopu

THEORY

Unit I Scope and importance of tropical and sub tropical fruits

Scope and importance – Classification of tropical and sub tropical fruits. Tropical and subtropical zones of India and Tamil Nadu – Area, production, productivity and export potential

Unit II Tropical fruits (mango, banana and guava)

Composition and uses – origin and distribution – species and cultivars. climate and soil requirements – propagation techniques – rootstocks – main field preparation – spacing, planting density – cropping systems – HDP – after care – nutrients, water and weed management – training and pruning – canopy management – bearing behavior – special horticultural techniques including use of plant growth regulators – Physiological disorders and remedies – plant protection – maturity indices and harvesting, grading, packing and storage –production constraints.

Unit III Tropical fruits (papaya, sapota, grapes, acid lime and sweet orange)

Composition and uses – origin and distribution – species and cultivars. climate and soil requirements –propagation techniques – rootstocks – main field preparation – spacing, planting density – cropping systems – after care – nutrients, water and weed management – training and pruning – special horticultural techniques including use of plant growth regulators – Physiological disorders and remedies – plant protection – maturity indices and harvesting, grading, packing and storage – production constraints.

Unit IV Subtropical fruits (mandarin orange, jack fruit, avocado, pineapple, mangosteen, litchi and loquat)

Composition and uses – origin and distribution – species and cultivars. climate and soil requirements – propagation techniques – rootstocks – main field preparation – spacing, planting density – cropping systems – after care – nutrients, water and weed management – training and pruning – special horticultural techniques including use of plant growth regulators – Physiological disorders and remedies – plant protection – maturity indices and harvesting, grading, packing and storage – production constraints.

Unit V Subtropical fruits (rambutan, carambola, durian, bilimbi, passion fruit, breadfruit and rose apple)

Composition and uses – origin and distribution – species and cultivars. climate and soil requirements – propagation techniques – rootstocks – main field preparation – spacing, planting density – cropping systems – after care – nutrients, water and weed management – training and pruning – special horticultural techniques including use of plant growth regulators – Physiological disorders and remedies – plant protection – maturity indices and harvesting, grading, packing and storage.

Theory - Lecture Schedule

1. Scope and importance of tropical and subtropical fruit cultivation
2. Classification of tropical and sub tropical fruits
3. Tropical and sub-tropical zones of India and Tamil Nadu
4. Area, production, productivity and export potential of tropical and subtropical fruit crops
5. Mango – Composition and uses – origin and distribution – species and cultivars. soil and climatic requirements - propagation techniques - main field preparation – spacing, planting density and cropping systems – HDP – Planting and after care - nutrients, water and weed management – training and pruning
6. Mango – Flowering and bearing behavior – use of plant growth regulators – Physiological disorders and remedies – maturity indices, harvesting and yield – production constraints – off season mango production.
7. Banana – Composition and uses – origin and distribution – genomic classification – Hill banana –species and cultivars. Soil and climatic requirements – propagation techniques – main field preparation – spacing, planting density and cropping systems. Planting and after care
8. Banana – Nutrients, water and weed management – use of plant growth regulators – Physiological disorders and remedies – maturity indices, harvesting and yield – production constraints.
9. Guava – Composition and uses – origin and distribution – species and cultivars. Soil and climatic requirements – propagation techniques – main field preparation – spacing, planting density and cropping systems. Planting and after care – nutrients, water and weed management
10. Guava – Training and pruning – crop regulation – use of plant growth regulators – Physiological disorders and remedies – maturity indices, harvesting and yield – production constraints
11. Papaya – Composition and uses – origin and distribution – species and cultivars. Soil and climatic requirements – propagation techniques – main field preparation – spacing, planting density and cropping systems. Planting and after care – nutrients, water and weed management
12. Papaya – Flowering, pollination and fruit set – use of plant growth regulators – Physiological disorders and remedies – maturity indices, harvesting and yield – production constraints
13. Sapota – Composition and uses – origin and distribution – species and cultivars. Soil and climatic requirements – propagation techniques – main field preparation – spacing, planting density and cropping systems.
14. Sapota – Planting and after care – nutrients, water and weed management. Training and pruning – use of plant growth regulators – maturity indices, harvesting and yield – production constraints
15. Grapes – Composition and uses – origin and distribution – species and cultivars. Soil and climatic requirements – propagation techniques – main field preparation – spacing, planting density and cropping systems. Planting and after care – nutrients, water and weed management

16. Grapes – Training and pruning – Bud forecasting - flowering, pollination and fruit set – use of plant growth regulators – Physiological disorders and remedies – maturity indices, harvesting and yield – production constraints.
17. **In - semester examination**
18. Acid lime – Composition and uses – origin and distribution – species and cultivars. Soil and climatic requirements – propagation techniques – main field preparation – spacing, planting density and cropping systems. Planting and after care – nutrients, water and weed management
19. Acid lime – Training and pruning – use of plant growth regulators – Physiological disorders and remedies – maturity indices, harvesting and yield – production constraints.
20. Sweet orange –Composition and uses – origin and distribution – species and cultivars. Soil and climatic requirements – propagation techniques – main field preparation – spacing, planting density and cropping systems. Planting and after care – nutrients, water and weed management – training and pruning – use of plant growth regulators – Physiological disorders and remedies – maturity indices, harvesting and yield – production constraints
21. Mandarin – Composition and uses – origin and distribution – species and cultivars. Soil and climatic requirements – propagation techniques – main field preparation – spacing, planting density and cropping systems. Planting and after care – nutrients, water and weed management – training and pruning – use of plant growth regulators – Physiological disorders and remedies – maturity indices, harvesting and yield – production constraints
22. Jackfruit – Composition and uses – origin and distribution – species and cultivars. Soil and climatic requirements – propagation techniques – main field preparation – spacing, planting density and cropping systems. Planting and after care – nutrients, water and weed management – training and pruning – use of plant growth regulators – Physiological disorders and remedies – maturity indices, harvesting and yield – production constraints
23. Avocado – Composition and uses – origin and distribution – species and cultivars. Soil and climatic requirements – propagation techniques – main field preparation – spacing, planting density and cropping systems. Planting and after care – nutrients, water and weed management – training and pruning – use of plant growth regulators – Physiological disorders and remedies – maturity indices, harvesting and yield – production constraints
24. Pineapple – Composition and uses – origin and distribution – species and cultivars. Soil and climatic requirements – propagation techniques – main field preparation – spacing, planting density and cropping systems. Planting and after care – nutrients, water and weed management – training and pruning – use of plant growth regulators for year round production of pineapple fruits to cater the processing industry. Physiological disorders and remedies – maturity indices, harvesting and yield – production constraints
25. Mangosteen – Composition and uses – origin and distribution – species and cultivars. Soil and climatic requirements – propagation techniques – main field preparation – spacing, planting density and cropping systems. Planting and after care – nutrients, water and weed management – training and pruning – use of plant growth regulators – Physiological disorders and remedies – maturity indices, harvesting and yield
26. Litchi – Composition and uses – origin and distribution – species and cultivars. Soil and climatic requirements – propagation techniques – main field preparation – spacing, planting density and cropping systems. Planting and after care – nutrients, water and weed management – training and pruning – use of plant growth regulators – Physiological disorders and remedies – maturity indices, harvesting and yield
27. Loquat – Composition and uses – origin and distribution – species and cultivars. Soil and climatic requirements – propagation techniques – main field preparation – spacing, planting density and cropping systems. Planting and after care – nutrients, water and weed management – training and pruning – use of plant growth regulators – Physiological disorders and remedies – maturity indices, harvesting and yield
28. Rambutan – Composition and uses – origin and distribution – species and cultivars. Soil and climatic requirements – propagation techniques – main field preparation – spacing, planting density and cropping systems. Planting and after care – nutrients, water and weed management – training and pruning – flowering, pollination and fruit set – use of plant growth regulators – Physiological disorders and remedies – maturity indices, harvesting and yield
29. Carambola – Composition and uses – origin and distribution – species and cultivars. Soil and climatic requirements – propagation techniques – main field preparation – spacing, planting density and cropping systems. Planting and after care – nutrients, water and weed management – training and pruning – flowering, pollination and fruit set – use of plant growth regulators – Physiological disorders and remedies – maturity indices, harvesting and yield
30. Durian – Composition and uses – origin and distribution – species and cultivars. Soil and climatic requirements – propagation techniques – main field preparation – spacing, planting density and cropping systems. Planting and after care – nutrients, water and weed management – training and pruning flowering, pollination and fruit set – use of plant growth regulators – Physiological disorders and remedies – maturity indices, harvesting and yield
31. Bilimbi – Composition and uses – origin and distribution – species and cultivars. Soil and climatic requirements – propagation techniques – main field preparation – spacing, planting density and cropping systems. Planting and after care – nutrients, water and weed management – training and pruning – flowering, pollination and fruit set – use of plant growth regulators – Physiological disorders and remedies – maturity indices, harvesting and yield
32. Passion fruit – Composition and uses – origin and distribution – species and cultivars. Soil and climatic requirements – propagation techniques – main field preparation – spacing, planting density and cropping systems. Planting and after care – nutrients, water and weed management – training and pruning – use of plant growth regulators – Physiological disorders and remedies – maturity indices, harvesting and yield
33. Breadfruit– Composition and uses – origin and distribution – species and cultivars. Soil and climatic requirements – propagation techniques – main field preparation – spacing, planting density and cropping systems. Planting and after care – nutrients, water and weed management – training and pruning – flowering, pollination and fruit set – use of plant growth regulators – Physiological disorders and remedies – maturity indices, harvesting and yield
34. Rose apple – Composition and uses – origin and distribution – species and cultivars. Soil and climatic requirements – propagation techniques – main field preparation – spacing, planting density and cropping systems. Planting and after care – nutrients, water and weed management – training and pruning – flowering, pollination and fruit set – use of plant growth regulators – Physiological disorders and remedies – maturity indices, harvesting and yield

Practical Schedule

1. Description and identification of mango varieties
2. Practices in propagation, planting and training and pruning in mango
3. Description and identification of banana varieties, their genome classification and scoring techniques
4. Selection, pre-treatment, planting and special intercultural operations in banana
5. Description and identification of guava varieties, propagation techniques, training and pruning, special intercultural operations
6. Description and identification of papaya varieties, sex forms, propagation, thinning and papain extraction
7. Description and identification of sapota varieties, propagation, training and pruning
8. Description and identification of grape varieties, propagation techniques, training and pruning

9. Description and identification of varieties, propagation techniques, training and pruning of acid lime, sweet orange and mandarin
10. Manures, fertilizers, biofertilizers and PGR application in major tropical fruit crops
11. Physiological disorders and remedies in major tropical and subtropical fruit crops
12. Description and identification of varieties of jack fruit, avocado, pineapple and litchi
13. Study of propagation techniques, planting systems, training and pruning in major sub tropical fruit crops
14. Study of maturity indices in major tropical and sub tropical fruit crops
15. Production economics for major tropical fruit crops
16. Visit to tropical fruit orchards/sub-tropical fruit zones
17. **University Practical Examination**

Text Books

1. Chadha, K.L. (2019). Handbook of Horticulture. Vol. I (2nd revised edition) New Delhi: ICAR. pp. 1 - 299.
2. Chattopadhyay, T.K. (2014). A text book on Pomology. Vol. II (Tropical fruits). Ludhiana: Kalyani Publishers. pp. 1 - 334.
3. Kumar, N. (2020). Introduction to Horticulture (7th revised edition). New Delhi: Oxford & I.B.H. Publishing. pp. 1 - 452
4. Prasad, S & Bhardwaj, R. L. (2015). Production technology of fruit crops. India: Agrobios. pp. 1 - 438.

Reference Books

1. Dhillon, W.S. (2013). Fruit production in India. Delhi: Narendra Publishing House. pp. 1-704.
2. Radha, T & Mathew, L. (2007). Fruit Crops (Horticulture Science Series - Vol. 3) New Delhi: New India Publishing Agency. pp. 1 - 429.

Web References

1. http://agritech.tnau.ac.in/horticulture/horti_fruits.html
2. <http://ecourses.iasri.res.in>
3. <http://nrcb.res.in/>
4. <http://www.ccringp.org.in/ccringp/>
5. <http://www.ishs.org>
6. <https://www.cish.res.in/>
7. <https://www.youtube.com/watch?v=uYIclJP4ME>
8. <https://www.youtube.com/watch?v=xJr3fmtNIXg>

Journals

1. ActaHorticulturae
2. HortScience
3. HortTechnology
4. Indian Horticulture
5. Indian J. Horticulture
6. Journal of Horticultural Sciences
7. Journal of the American Society for Horticultural Science

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-	-	-	50	50
2	Theory-Internal	20	-	-	-	-	20
3	Practical-External	-	-	-	-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		4	3	4	2	3
S-8,9	SLO-1	Lab 3. Identification of tools and implements	Lab 7. Practicing different methods of seed treatments for major field crops	Lab 10. Identification of weeds, weeding practices and handling of weeding tools and implements	-	Lab 16. Visit to nearby Agricultural Research Station / Farmer's field
	SLO-2					
S-10	SLO-1	Seed treatment and sowing methods	-	Package of practices of Sorghum and Cumbu	-	-
	SLO-2	Plant population and crop geometry	-	Finger millet cultivation technology	-	
S-11,12	SLO-1	Lab 4. Acquiring skills on handling primary and secondary tillage implements	-	Lab 11. Practicing different irrigation methods	-	
	SLO-2				-	-

Learning Resources	1.	Yellamanda Reddy, T. and. Sankara Reddy, G.H. (2017). Principles of Agronomy. Kalyani publishers, Ludhiana. pp. 1- 685.
	2.	Chidda Singh, Prem Singh and Rajbir Singh. (2018). Modern Techniques of Raising Field Crops. Oxford and IBH Publishing Co Pvt.Ltd; 2nd edition. New Delhi. pp. 1-569.
	3.	Rajendra Prasad. (2016). Textbook of Field Crops Production (Volume 1 & 2). Indian Council of Agricultural Research (ICAR), New Delhi. pp. 1-1008.
	4.	Srinivasan Jeyaraman. 2018. Field crops production and management (Volume I & 2). Oxford and IBH Publishers. India. pp. 1-1068.

Level of Thinking		Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember	40 %	30 %	30 %	35 %
	Understand				
Level 2	Apply	40 %	40 %	35 %	35 %
	Analyze				
Level 3	Evaluate	20 %	30 %	35 %	30 %
	Create				
Total		100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Sivakumar, Madras iyerthottam organic farm, Kondappanaickenpalayam, Sathyamangalam, Tamil Nadu 638503.	Dr. S. Sanbagavalli, Associate Professor (Agronomy), Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore - 3	Dr. S. Marimuthu Dr. N. Krishnaprabu Dr. D. Selvakumar

THEORY

Unit I - Principles of Crop Production

Agronomy-Definition, scope and importance - Factors affecting crop production-Classification of field crops -Tillage and till: objectives and different kinds of tillage - Seeds and sowing: different methods - Crop geometry.

Unit II - Integrated Crop Management

Manures and Fertilizers: methods of application - Irrigation methods - Weeds: principles and methods of weed management - Cropping pattern and cropping systems - Integrated Farming System (IFS).

Unit III - Major Cereals and Nutri-Cereals

Major cereals (Rice, Wheat, Maize) and nutri-cereals (Sorghum, Pearl millet, Finger millet) their origin, geographic distribution, economic importance, soil and climatic requirement, varieties, cultivation practices and yield.

Unit IV - Major Pulses and Oil Seeds

Major pulse crops (Bengal gram, Redgram, Blackgram, Greengram and Cowpea) their origin, geographic distribution, economic importance, soil and climatic requirement, varieties, cultivation practices and yield; Production technology of major oil seed crops (Groundnut, Sunflower, Sesame) their origin, geographic distribution, economic importance, soil and climatic requirement, varieties, cultivation practices and yield.

Unit V - Fibre, Sugar, Forage and Green Manure Crops

Cotton, sugarcaneand forage crops (Cumbunapier hybrid, Fodder maize, Fodder cowpea and Hedge Lucerne) and Green manure crops (Sunnhemp, Glyricidia and Daincha) their origin, geographic distribution, economic importance, soil and climatic requirement, varieties, cultivation practices and yield

Theory - Lecture Schedule

1. Agronomy - definition - scope and importance - major classifications of crops.
2. Factors affecting crop production - climatic - edaphic - biotic- physiographic and socio-economic factors.
3. Tillage - Definition - objectives - types of tillage - modern concepts of tillage - main field preparation.
4. Seeds - Seed rate - sowing methods - Germination - Crop stand establishment - Planting geometry.
5. Manures and fertilizers - role, types and methods of applications
6. Weeds - Definition - harmful and beneficial effects of weeds – methods of weeds management - IWM.
7. Irrigation - time and methods of irrigation - Cropping pattern and cropping system - IFS.
8. Rice - Origin - geographic distribution - economic importance - varieties - soil and climatic requirement - cultural practices - yield - economic benefits
9. **In-Semester examination**
10. Special type of Rice cultivation – SRI, Aerobic rice cultivation.
11. Wheat and Maize - Origin, geographic distribution, classification - economic importance, soil and climatic requirement, varieties, cultural practices and yield.
12. Sorghum, Pearl millet and Ragi - Origin, geographic distribution, economic importance, soil and climatic requirement, varieties, cultural practices and yield.
13. Redgram, Blackgram, Greengram, Cowpea and Bengal gram - Origin, geographic distribution, economic importance, soil and climatic requirement, varieties, cultural practices and yield.
14. Groundnut, Sesame, Sunflower - Origin, geographical distribution, economic importance, soil and climatic requirements - varieties, cultural practices yield.
15. Cotton and sugarcane- Origin, geographical distribution, economic importance, soil and climatic requirements - varieties, cultural practices yield.
16. Fodder sorghum, Cumbunapier, Guinea grass, Fodder cowpea and Hedge Lucerne - Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield.
17. Sunnhemp, Daincha and Glyricidia- Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield.

Practical Schedule

1. Study of Wet land, garden land and dry land farming systems
2. Identification of seeds, manures and fertilizers.
3. Identification of tools and implements.
4. Acquiring skills on handling primary and secondary tillage implements
5. Practicing different methods of land configuration for raising nursery for wet land crops
6. Practicing different methods of land configuration for raising nursery garden land crops.
7. Practicing different methods of seed treatments for major field crops

8. Working out seed rate, manure, and fertilizer requirement for different crops.
9. Practicing intercultural operations in different field crops
10. Identification of weeds, weeding practices and handling of weeding tools and implements.
11. Practicing different irrigation methods
12. Observations on growth parameters for important field crops
13. Observing harvesting and maturity symptoms for major field crops
14. Study of yield parameters and estimation of yield in major field crops
15. Working out cost and returns of important field crops
16. Visit to nearby Agricultural Research Station / Farmer's field
17. **University Practical Examination**

Text Books

1. Ahlawat, I.P.S., Om Prakash and Saini, G.S. (2010). *Scientific Crop Production in India*. Rama publishing House, Meerut. pp. 1-680.
2. Cassius Foster. (2017). *Introduction to Agronomy*. Larsen and Keller Education Publishers, New York, USA. pp. 1-270
3. Chidda Singh, Prem Singh and Rajbir Singh. (2020). *Modern Techniques of Raising Field Crops*. Oxford and IBH Publishing Co Pvt.Ltd, New Delhi. pp. 1-596.
4. Mukund Joshi. (2015). *Text Book of Field Crops*. PHI Learning Private limited. New Delhi. pp. 1-537.
5. Rajendra Prasad. (2017). *Textbook of Field Crops Production (Volume 1 & 2)*. Indian Council of Agricultural Research (ICAR), New Delhi. 1-1008.
6. Reddy. S.R. (2014). *Principles of Crop Production*. Kalyani Publishers, Ludhiana. 794p.
7. Yellamanda Reddy, T. and Sankara Reddy, G.H. (2017). *Principles of Agronomy*. Kalyani publishers, Ludhiana. pp. 1-685

Reference Books

1. Alabaster Jenkins. (2016). *Agronomy and crop production*. Syrawood publishing house, UK, pp. 1-205.
2. Crop Production Guide. (2020). Directorate of Agriculture, Chennai and Tamil Nadu Agricultural University, Coimbatore. pp. 1-460.
3. ICAR. (2011). *Handbook of Agriculture*. Indian Council of Agricultural Research, New Delhi.
4. Reddy, S.R. (2012). *Agronomy of field crops*. Kalyani publishers, New Delhi. pp.1-443.
5. Singh. S.S. (2015). *Crop management under irrigated and rainfed conditions*. Kalyani Publishers, New Delhi. pp. 1-574.
6. Srinivasan Jeyaraman. (2018). *Field crops production and management (Volume I & 2)*. Oxford and IBH Publishers. India. pp. 1-1068.
7. Yellamanda Reddy, T. and Sankara Reddy, G.H. (2017). *Principles of Agronomy*. Kalyani publishers, Ludhiana. pp. 1-685.

Web References

1. www.crida.org
2. <http://millets.res.in/>
3. tnau.ac.in/nprc-vamban
4. www.cgjar.org
5. www.tnau.ac.in/agriporal
6. www.rkmp.irri.org
7. <https://www.agrimoon.com/wp-content/uploads/Introduction-to-major-field-crops.pdf>

Journals

1. Indian Journal of Agronomy
2. Journal of Agronomy and Crop science
3. Agronomy Journal
4. Advances in Agronomy
5. Journal of Cereal Science
6. Journal of crop and weed
7. Field Crop Research
8. Legume Research

Course Nature: Theory based Practical							
Total Marks (100)							
S. No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-	-	-	50	50
2	Theory-Internal	20	-	-	-	-	20
3	Practical-External	-	-	-	-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	AGE19203	Course Name	Introduction to Microbiology	Course Category	S	Supportive Course	L	T	P	C
							2	0	1	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Agroecology-Microbiology	Data Book / Codes/Standards			Nil

Course Learning Rationale (CLR):		The purpose of learning this course is to:			Learning			Program Learning Outcomes (PLO)																
CLR-1 :	Explain the Historical and recent developments in the field of Microbiology	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
CLR-2 :	Describe the techniques of staining reactions, media preparation and culturing of microorganisms																							
CLR-3 :	Outline the principles and applications of different types of microscopy																							
CLR-4 :	Understand the ultra-structure, nutritional requirements and growth of the bacteria																							
CLR-5 :	Describe the metabolism and genetics of bacteria																							
CLR-6 :	Summarize the characteristics of Archaeobacteria, algae and viruses																							

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLO-1 :	Identify the differentiation of prokaryotic and eukaryotic cells	1	95	80
CLO-2 :	Perform the different staining techniques	3	95	90
CLO-3 :	Apply the skills on handling of microorganisms in the laboratory	3	90	80
CLO-4 :	Recall the ultra-structure of bacteria, Archaeobacteria, Algae and Virus	1	80	70
CLO-5 :	Recognize the nutritional requirements for microbial growth	2	75	60
CLO-6 :	Explain the operon concept	2	75	65

Duration (hour)	Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
	12	14	13	14	13
S-1	SLO-1 Scope of Microbiology	Microscopy-Principles	Bacteria-Shape	Bacterial metabolism-Aerobic respiration	Archaeobacteria – Ecology & Structure
	SLO-2 Role of Microbes in Agriculture	Light Microscopy	Bacteria- Arrangement	Bacterial metabolism- Anaerobic respiration	Major groups of Archaeobacteria
S 2	SLO-1 Historical Development-19 th century	Types of light Microscope-Phase contrast	Bacteria-Ultra structure	Fermentation in bacteria-Acid fermentation	Algae –Structure & its classification
	SLO-2 Historical development-19 th century-continued	Types of light Microscope-Fluorescent	Bacteria-Components	Fermentation in bacteria- Alcohol Fermentation	Cyanobacteria-Ultrastructure & Economic Importance
S 3-4	SLO-1 Lab 1: Microscopy-Handling of light Microscope	Lab 4: Isolation of microorganism-serial dilution & Plating technique	Lab 7: Preservation of microorganisms	Lab 10: Microbial Growth-Turbidometry	Lab 13: Isolation of bacteriophages
	SLO-2				
S 5	SLO-1 Historical Development-20 th century	Electron Microscopy-Principles	Reproduction in bacteria	Bacterial photosynthesis-Green bacteria	Structure of virus
	SLO-2 Historical development-20 th century-	Electron Microscopy- Scanning Probe Microscope	Bacteria-Growth Curve	Bacterial photosynthesis-Purple bacteria	Classification of viruses
S-6	SLO-1 Historical Development-20th century	Atomic force Microscopy	Batch culture	Genetic elements in bacteria-Bacterial Chromosome	Bacterial Virus : bacteriophages
	SLO-2 Historical Development-20th century-continued	confocal scanning laser microscopy	Continuous culture	Genetic elements in bacteria-Plasmid & Transposons	Multiplication cycle of bacteriophages

Duration (hour)		Learning Unit / Module 1 12	Learning Unit / Module 2 14	Learning Unit / Module 3 13	Learning Unit / Module 4 14	Learning Unit / Module 5 13
S 7-8	SLO-1	Lab 2:Aseptic Techniques	Lab 5: Isolation - Enrichment culture technique	Lab 8: Staining Techniques-Positive & Negative	Lab 11: Bacteria –Morphological & Physiological Characteristics	Lab 14: Isolation of cyanobacteria
	SLO-2					
S 9	SLO-1	Evolutionary relationship-living organisms	Staining techniques-Principles	Synchronous culture	Mutation-Principles & Types	Lytic pages
	SLO-2	Classification of microorganisms	Staining techniques-Types	Diauxic growth	Mutagens-Types	Lysogenic phages
S10	SLO-1	Group of Microorganisms	Methods of sterilization-Physical	Factors affecting microbial growth	Genetic recombination-Transformation	-
	SLO-2	Prokaryotes and Eukaryotes	Methods of sterilization-chemical	Measurement of growth	Genetic recombination- Transduction	-
S11-12	SLO-1	Lab3:Preparation of growth media	Lab 6 : Purification of bacteria, fungi and Actinobacteria	Lab 9: Differential Staining Technique-Gram Staining	Lab 12: Biochemical characterization of bacteria	Lab 15: Isolation of Genomic DNA
	SLO-2					
S13	SLO-1	-	Isolation of microorganism	Nutritional types of bacteria	Genetic recombination-conjugation	-
	SLO-2	-	Purification of microorganisms	Energetics in bacteria	Conjugation-Genetic Map	-
S13	SLO-1	-	Enrichment culture techniques	-	-	-
	SLO-2	-	Preservation techniques	-	-	-
S14-15	SLO-1	-		-	-	Lab 16: Isolation of bacterial mutants-UV radiation
	SLO-2					

Learning Resources	1.	Dubey, R. C., & Maheshwari, D. K. (2013). A textbook of Microbiology(4 th Edn.), New Delhi, India: S. Chad and Company ISBN-10: 9788121926201. pp:1-1056.
	2.	Pelczar, M.J., Jr, Chan, E.C.S. and Krieg, N.R. (1997). Microbiology, Concepts and Application(6 th edn.). United States: McGraw Hill. ISBN-10: 0070492581. pp :1-896.
	3.	Tauro, P., Kapoor, K.K. and Yadav, K.S. (2019). Introduction to Microbiology (3 rd Edn.,). United States: John Wiley & Sons, pp:1-424.

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In semester (20%)	Practical internal (15%)		
Level 1	Remember	60 %	30 %	35 %	60 %
	Understand				
Level 2	Apply	30 %	40 %	35 %	30 %
	Analyze				
Level 3	Evaluate	10 %	30 %	30 %	10 %
	Create				
	Total	100 %	100 %	100%	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Kooriraja Muniyasamy Yadav Microbiologist-Senior Executive, SGS India Private Limited, Chennai-58	Dr.Ejilane Associate Professor, Department of Agricultural Microbiology Tamil Nadu Agricultural University	Dr. Anbukarasi K Dr. Melvin Joe M

THEORY

Unit I - Microbial World

Scope of Microbiology: Role of microbes in Agriculture, food and environment; Contributions of Antony Van Leeuwenhoek, Refutation of abiogenesis, Louis Pasteur, John Tyndall, Robert Koch, Edward Jenner, Joseph Lister, Alexander Fleming and Waksman; Landmark achievements in 20th century: proposal of one gene one enzyme hypothesis, discovery of double helix structure of DNA, discovery of recombinant DNA technology; Development of Microbiology in India; Evolutionary relationship among the living organisms: Classification of microorganism, Whittaker's Five Kingdom and Carl Woese systems; Groups of Microorganisms, Differentiate between prokaryotes and eukaryotes.

Unit II - Microbiological techniques

Microscopy: General principles of light microscopy, optical, dark field, Phase Contrast, fluorescence Microscopy; electron microscopes; three dimensional imaging: Stereo Microscope, Scanning Probe Microscope, Atomic force and confocal scanning laser microscopy; Stains and staining: Staining techniques; principle and types of stains: simple, negative, differential and structural staining; Sterilization and disinfection techniques: principles and methods of sterilization; Isolation, enrichment and purification techniques of bacteria, yeast, moulds and actinobacteria; Preservation of microbial culture.

Unit III - Bacteria: structure, growth and nutrition

Bacteria: size, shape and arrangement, cell structure and its components, reproduction in bacteria, Bacterial growth: growth cycles of Population, Batch and continuous culture, synchronous culture, Diauxic growth and measurement of growth; Environment on growth: temperature, oxygen, pH and salts; Nutritional types of bacteria.

Unit IV - Bacteria: metabolism and genetics

Bacterial metabolism: Aerobic respiration: glycolysis, TCA cycle, EntnerDoudoroff pathway, pentose phosphate pathway, electron transport chain and anaerobic respiration; Fermentation in bacteria; bacterial photosynthesis: green and purple bacteria; Genetic elements of bacteria: bacterial chromosomal DNA, plasmid and transposons; Mutation and its types; Mutagen: physical and chemical; Genetic recombination: Transformation, transduction and conjugation.

Unit V - Archaeobacteria, algae and viruses

Achaea: ecology, cell wall, cell membrane and Major Groups of archaea; Algae: ultrastructure and classification of algae, reproduction of algae, General structure of cyanobacteria and its economic importance in Agriculture; Viruses: General properties of viruses, bacterial viruses; overview of bacteriophages, morphology and multiplication cycles of bacteriophages, lytic and temperate phages.

Theory - Lecture Schedule

1. Scope of Microbiology- Role of microbes in Agriculture, food and environment.
2. Contributions of Antony Van Leeuwenhoek, Refutation of abiogenesis, Louis Pasteur
3. John Tyndall, Robert Koch, Edward Jenner, Joseph Lister, Alexander Fleming and Waksman.
4. Landmark achievements in 20th century: proposal of one gene one enzyme hypothesis: discovery of double helix structure of DNA: discovery of recombinant DNA technology
5. Evolutionary relationship - concepts and developments in classification of microorganisms
6. Groups of Microorganisms, Differentiate between prokaryotes and eukaryotes.
7. Microscopy; principles – resolving power and magnification. Light microscopy
8. Different types of microscopes - UV, Dark Field, Phase Contrast, Fluorescence
9. Electron Microscopes; Atomic and Confocal Scanning Laser Microscopy
10. Staining techniques - principle and types of stains, staining techniques- simple, negative, differential and structural methods
11. Sterilization – principle – physical agents and chemical methods
12. Isolation, Purification and enrichment culture techniques; preservation techniques
13. Bacteria: size, shape and arrangement,
14. Bacteria: Cell structure and its components
15. Reproduction in bacteria - Bacterial growth, population growth and growth cycle– generation time and specific growth rate
16. Batch and continuous culture -chemostat and turbidostat; synchronous culture, Diauxic growth
17. **In-Semester Examination**
18. Factors influencing growth -temperature requirements - aerobes and anaerobes –methods of assessment of growth
19. Nutritional types of bacteria; Energetics in bacteria. Metabolic pathways of bacteria
20. Aerobic respiration and Anaerobic respiration
21. Fermentative mode of respiration

22. Bacterial photosynthesis: green and purple bacteria
23. Genetic elements in bacteria – Bacterial chromosome and plasmid
24. Transposons and its types
25. Mutation in bacteria – principles and types,
26. Mutagens – physical, chemical and biological
27. Genetic recombination – Transformation
28. Genetic recombination -Transduction – generalized and specialized
29. Genetic recombination –Conjugation
30. Archaea: ecology, cell wall, cell membrane and Major Groups of archaea
31. Algae: Ultra structure and classification of algae, reproduction of algae.
32. General structure of cyanobacteria and its economic importance in Agriculture
33. Viruses: General properties of viruses: Structure and classification of virus
34. Bacterial viruses, overview of bacteriophages; Lytic and lysogenic cycles; lytic and temperate phages.

Practical Schedule

1. Safety in Microbiology laboratory: Microscopy-Handling of light Microscope
2. Aseptic Techniques: Working with equipments and apparatus
3. Preparation of growth media for bacteria, fungi and actinobacteria
4. Isolation of microorganisms by serial dilution and plating technique
5. Isolation of microorganisms by Enrichment culture technique
6. Purification of bacteria, fungi and Actinobacteria
7. Preservation of bacteria, fungi and Actinobacteria
8. Staining Technique: Positive and Negative Staining
9. Staining Technique: Differential and Capsule Staining
10. Assessment of microbial growth by Turbidometry
11. Morphological and Physiological characteristics of bacteria
12. Biochemical Characterization of bacteria
13. Isolation of bacteriophages
14. Isolation of Cyanobacteria
15. Isolation of Genomic DNA from bacteria
16. Isolation of bacterial mutants by UV irradiation
17. **University Practical Examination**

Text Book

1. Dubey, R. C., & Maheshwari, D. K. (2013). A textbook of Microbiology (4th Edn.), New Delhi, India: S. Chad and Company,. ISBN-10: 9788121926201. pp:1-1056.
2. Pelczar, M.J., Jr, Chan, E.C.S. and Krieg, N.R. (1997). Microbiology, Concepts and Application(6th edn.). United States: McGraw Hill. ISBN-10: 0070492581. pp :1-896.
3. Tauro, P., Kapoor, K.K. and Yadav, K.S. (2019). Introduction to Microbiology(3rd Edn.). United States:John Wiley & Sons, pp:1-424.

Reference Books

1. Atlas, R.M. (1997). Microbiology: Fundamentals and Applications (2nded.). London : Collier Macmillan, (ISBN 02 3045507) pp:1-879.
2. Madigan, M.T, Martinko, J. M., Dunlap, P.V., Clark ,D.P.,(Ed.)(2008).BrockBiology of Microorganisms(12th Edn.,).United States:Benjamin-Cummings Pub Co, ISBN-10: 032164963X. pp:1-1043.
3. Pommerville. J.C. (2016).Fundamentals of Microbiology(3rd Edn.,) .Burlington, Canada :Jones & Barlett Learning. ISBN-13: 978-1-284-05709-6. pp: 1-944.
4. Shors.T. (2017.) Understanding Viruses(3rd Edn.,pp1-944). Burlington, Canada :Jones & Barlett Learning., ISBN 9781284025927.pp:1-776.
5. Stanier, R.Y., Adelberg, E.D. and Ingraham, J.L. (1976). General Microbiology (5th Edn.), U.S.A. MacMillan Publishers, ISBN-10: 0333220145. pp.1-876.
6. Willey, J. M., Sherwood, L., Woolverton, C.J. (2016). Prescott's Microbiology (10th Edn.). U.S.A: McGraw-Hill, ISBN-10: 1259281590. pp. 1-1104.

Web Sources

1. <http://ecoursesonline.iasri.res.in/course/view.php?id=128>
2. <http://ecoursesonline.iasri.res.in/Courses/Agricultural%20Microbiology/AMBE101/Start%20to%20read%20the%20Course.html>
3. https://ecourses.icar.gov.in/e-Leaarningdownload3_new.aspx?Degree_Id=01
4. <http://www.microbes.info>
5. <http://microbelibrary.com>
6. <https://www.nature.com/nmicrobiol/>
7. <https://microbiologyonline.org/>
8. <https://5f1a1942-a62cb3a1a-s-sites.googlegroups.com/site/igcascellbiology/practicals/Microscopy.pdf?attachauth=ANoY7cplFpYU6nm2aG6EtSE9Im7GZ8rVjvmw7Ur>

Journals

1. Indian Journal of Microbiology
2. Annals of Microbiology
3. FEMS Microbiology Reviews
4. Journal of Applied Microbiology
5. Annual reviews of Microbiology

Course Nature: Theory based Practical							
Total Marks (100)							
Sl.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-	-	-	50	50
2	Theory-Internal	20	-	-	-	-	20
3	Practical-External	-	-	-	-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	CRH19204	Course Name	Introduction to Crop Physiology	Course Category	S	Supportive Course	L	T	P	C
							2	0	1	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Department of Crop Improvement	Data Book / Codes/Standards			Nil

Course Learning Rationale (CLR):		The purpose of learning this course is to:			Learning			Program Learning Outcomes (PLO)														
CLR-1 :	Describe the functions of water in the plant system				1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	Discuss the classification of minerals and mechanism of absorption				Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems	Ability to implement knowledge gained	Ability to understand social and ethical responsibilities
CLR-3 :	Summarize mineral nutrition in plant health																					
CLR-4 :	Define the Photosynthetic mechanisms and hormonal biosynthetic pathways																					
CLR-5 :	Outline the physiological response of plant under abiotic stress																					
CLR-6 :	Identify the knowledge on abiotic stress tolerance mechanism and adaptation																					
Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:			2	85	80	H	L	L	M	M	L	M	M	H	H	L	H	H	H	H
CLO-1 :	Define the knowledge on various plant water relations in whole plant level				3	85	80	H	H	M	H	M	L	H	L	H	H	M	H	H	H	H
CLO-2 :	Identify the various nutritional deficiencies and disorders				2	80	70	M	L	L	M	M	L	L	M	H	H	L	H	H	H	H
CLO-3 :	Summarize the classification of carbon metabolism				2	85	75	M	H	L	M	H	L	M	L	H	H	M	H	H	H	H
CLO-4 :	Understand the role of PGR in growth and development in plants				3	85	75	H	H	L	H	L	M	M	L	H	H	L	H	H	H	H
CLO-5 :	Describe the knowledge on hormonal formulation and application methods				3	80	75	H	H	M	M	M	L	M	L	H	H	L	H	H	H	H
CLO-6 :	Outline the abiotic stress physiology to recommend management practices																					

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		13	10	13	18	11
S1	SLO-1	Importance of Crop Physiology	Mineral nutrition of plants	Light reaction of photosynthesis	Phases of growth	Physiological of changes during drought
	SLO-2	Cell and cell organelles	Mechanism of nutrient uptake	Photophosphorylation - Z scheme	Factors affecting growth	Compatible osmolytes and alleviation
S2	SLO-1	Structure and role of water	Physiological functions of macronutrients	Dark Reaction of photosynthesis	Biosynthetic pathway and role of auxins	Physiological of changes during high and low temperature stress
	SLO-2	Water potential and its components	Physiological disorders of macronutrients	C3, C4 and CAM pathways and differences	Biosynthetic pathway and role of gibberellins	Membrane properties and adaptation
S 3-4	SLO-1	Lab-1: Preparation of solutions	Lab-5: Measurement of water imbibition by seed mass test	Lab-8: Measurement of transpiration and photosynthesis by IRGA	Lab-11: Estimation of relative water content	Lab-14: Bioassay for gibberellin and cytokinin
	SLO-2					
S 5	SLO-1	Mechanisms of water absorption	Physiological functions of micronutrients	Factors affecting photosynthesis	Biosynthetic pathway and role of cytokinin	Physiological of changes during salt stress
	SLO-2	Pathways of water movement	Physiological disorders of micronutrients	Photorespiration pathway	Biosynthetic pathway and role of ethylene and ABA	Compartmentalization and alleviation
S 6	SLO-1	Translocation of water	Root feeding and fertigation	Phloem transport	Biosynthetic pathway and role of Brassinosteroids and salicylic acid	Physiological of changes during Flooding stress
	SLO-2	mechanisms of xylem transport	Soilless culture and aeroponics	Source and sink strength and their manipulations	New Generation PGRs , Growth retardants and inhibitors, commercial uses	Physiological of changes during UV radiation stress

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		13	10	13	18	11
S 7-8	SLO-1	Lab-2: Study of leaf epidermal, xylem and phloem cells	Lab-6: Estimation of Photosynthetic pigments	Lab-9: Diagnosis of nutritional and physiological disorders in crops	Lab-12: Measurement of osmosis and plasmolysis	Lab-15: Estimation of chlorophyll stability index
	SLO-2					
S 9	SLO-1	Transpiration and its significance		Respiration, Glycolysis	Photoperiodism	Global warming and greenhouse gases
	SLO-2	Stomatal physiology		TCA cycle	Chailakhyan's theory of flowering	Physiological effects on crop productivity
S 10	SLO-1			Photo and oxidative phosphorylation	Forms of phytochrome	
	SLO-2			Electron transport chain and energy budgeting	Pr and Pfr, regulation of flowering	
S 11-12	SLO-1	Lab-3: Determination of stomatal index and stomatal frequency	Lab-7: Determination of photosynthetic efficiency in crops	Lab-10: Rapid tissue test for mineral nutrients	Lab-13: Growth analysis	Lab-16: Estimation of proline content
	SLO-2					
S 13	SLO-1			Fatty acid synthesis	Theories of vernalization	
	SLO-2			Fatty acid breakdown	Lysenko and Hormonal theories	
S 14	SLO-1				Physiological aspects of growth	
	SLO-2				Physiological aspects of development	
S 15-16	SLO-1	Lab-4: Measurement of plant water potential				
	SLO-2					
S 17	SLO-1				Growth analysis	
	SLO-2				Physiological growth parameters	
S 18	SLO-1				Seed germination	
	SLO-2				seed dormancy and breaking method	
S 19-20	SLO-1					
	SLO-2					
S 21	SLO-1				Physiological and biochemical changes of Senescence	
	SLO-2				Physiological and biochemical changes of abscission	
S 22	SLO-1				Physiology of fruit ripening	
	SLO-2				Factors affecting ripening and manipulations	

Learning Resources	1. Jain, V.K. (2017). <i>Fundamentals of Plant Physiology</i> (19 th ed.), New Delhi, S.Chand & Company Ltd. pp.1-736.
	2. Taiz, L. & Zeiger, E. (2014). <i>Plant Physiology</i> (6th ed.). Massachusetts, USA, Oxford University Press, Sinauer Associates, Inc. pp.1-761.

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember	40 %	30 %	35 %	30 %
	Understand				
Level 2	Apply	40 %	40 %	35 %	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	30 %	30 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Pandian, Bayer Crop Science, Kerala	Dr. C.N.Chandrasekhar, Dept. of Crop Physiology, TNAU, Coimbatore	Ms. P. Mohanasundari

THEORY

Unit I - Introduction and importance of crop physiology in horticulture

Plant cell: an overview, organelles: plasma membrane, chloroplast, mitochondria, peroxisome and vacuole, Structure and role of water, water potential and its components, diffusion and osmosis; imbibition, plasmolysis, Field Capacity and Permanent Wilting Point, Absorption of water, Mechanisms of water absorption, Pathways of water movement, Apoplast and symplast, Translocation of water, ascent of sap and its mechanisms; Transpiration and Stomatal physiology: structure of stomatal pore, mechanisms of stomatal opening and closing, guttation, antitranspirants.

Unit II - Mineral nutrition of plants

Criteria of essentiality; classification of nutrients: macro, micro, mobile, immobile and beneficial elements; Physiological functions and deficiency symptoms of nutrients, nutrient uptake mechanism; Hidden hunger, Foliar nutrition, root feeding and fertigation, sand culture, hydroponics and aeroponics.

Unit III - Photosynthesis

Light and dark reactions, Photosystems, red drop and Emerson enhancement effect, Photolysis of water and photophosphorylation, Z scheme, C3, C4 and CAM plants; Photosynthetic pathways of C3, C4 and CAM plants, difference between three pathways, Factors affecting photosynthesis, Photorespiration pathway and its significance, Phloem transport, Munch hypothesis, Phloem loading and unloading, Source and sink strength and their manipulations. Respiration: Glycolysis, TCA cycle and electron transport chain; Oxidative phosphorylation; difference between photo and oxidative phosphorylation; energy budgeting; respiratory quotient. Fat metabolism: fatty acid synthesis and breakdown.

Unit IV - Plant growth regulators

Physiological roles and agricultural uses; Hormones: classifications, biosynthetic pathway and role of auxins, gibberellins, cytokinins, ethylene and ABA, Novel and new generation PGRs, Brassinosteroids and salicylic acid, Growth retardants, Commercial uses of PGRs; Photoperiodism: short, long and day neutral plants, Chailakhyan's theory of flowering, Forms of phytochrome, Pr and Pfr, regulation of flowering; Vernalisation: Theories of vernalisation, Lysenko theories, Seed germination: physiological and biochemical changes, seed dormancy and breaking methods, Senescence and abscission, physiological and biochemical changes, Physiology of fruit ripening, climacteric and non-climacteric fruits, factors affecting ripening, Manipulations; Physiological aspects of growth and development of major crops; growth analysis, role of physiological growth parameters in crop productivity.

Unit V - Stress physiology

Physiological changes and adaptations to drought, flooding, high and low temperature, salinity and UV radiation; compatible osmolytes; membrane properties; compartmentalization; stress alleviation; Global warming; greenhouse gases; physiological effects on crops; Carbon Sequestration.

Theory - Lecture Schedule

1. Introduction and importance of Crop Physiology in Horticulture, an over view of Plant cell.
2. Structure and role of water, water potential and its components, Diffusion, Osmosis, imbibition, Plasmolysis, Field Capacity and Permanent Wilting Point
3. Mechanisms of water absorption, Pathways of water movement, Apoplast and symplast
4. Translocation of water, ascent of sap, mechanisms of xylem transport
5. Transpiration, significance, Stomatal physiology: structure of stomata with mechanisms of stomatal opening and closing, guttation, antitranspirants
6. Mineral nutrition of plants, criteria of essentiality, classification of nutrients, macro, micro, mobile and immobile, beneficial elements, mechanism of nutrient uptake
7. Physiological functions and disorders of macronutrients, Hidden hunger
8. Physiological functions and disorders of micronutrients
9. Foliar nutrition- root feeding and fertigation, sand culture, hydroponics and aeroponics
10. Light reaction of photosynthesis, photolysis of water and photophosphorylation - Z scheme
11. Dark Reaction of photosynthesis, C3, C4 and CAM pathways and differences.
12. Factors affecting photosynthesis, Photorespiration, pathway and its significance
13. Phloem transport, Munch hypothesis, Phloem loading and unloading, Source and sink strength and their manipulations
14. Respiration, Glycolysis, TCA cycle.
15. Photo and oxidative phosphorylation, Electron transport chain, energy budgeting, respiratory quotient.
16. Fat metabolism: fatty acid synthesis and breakdown
17. **In-Semester Examination**
18. Growth, phases of growth, factors affecting growth.
19. Hormones and plant growth regulators (PGR): physiological roles and agricultural uses, Biosynthetic pathway and role of auxins and gibberellins

20. Plant growth regulators (PGR): physiological roles and agricultural uses, Biosynthetic pathway and role of cytokinin, ethylene and ABA
21. Novel growth regulators viz., Brassinosteroids and salicylic acid, New Generation PGRs, Growth retardants and inhibitors, commercial uses of PGRs
22. Photoperiodism, short, long and day neutral plants, Chailakhyan's theory of flowering
23. Forms of phytochrome, Pr and Pfr, regulation of flowering
24. Vernalisation, theories of vernalization, Lysenko and Hormonal theories, devernalization
25. Physiological aspects of growth and development of major crops
26. Growth analysis, role of physiological growth parameters in crop productivity
27. Seed germination, physiological and biochemical changes, seed dormancy and breaking methods
28. Physiological and biochemical changes of Senescence and abscission
29. Physiology of fruit ripening, climacteric and non-climacteric fruits, factors affecting ripening and manipulations
30. Drought, physiological changes, adaptation, compatible osmolytes, alleviation
31. High and low temperature stress, physiological changes, membrane properties, adaptation
32. Salt stress, physiological changes, adaptation, compartmentalization, alleviation
33. Flooding and UV radiation stresses, physiological changes and adaptation
34. Global warming, greenhouse gases, physiological effects on crop productivity, Carbon Sequestration

Practical Schedule

1. Preparation of solutions
2. Study of leaf epidermal, xylem and phloem cells
3. Determination of stomatal index and stomatal frequency
4. Measurement of plant water potential
5. Measurement of water imbibition by seed mass test
6. Estimation of Photosynthetic pigments
7. Determination of photosynthetic efficiency in crops
8. Measurement of transpiration and photosynthesis by IRGA
9. Diagnosis of nutritional and physiological disorders in crops
10. Rapid tissue test for mineral nutrients
11. Estimation of relative water content
12. Measurement of osmosis and plasmolysis
13. Growth analysis
14. Bioassay for gibberellin and cytokinin
15. Estimation of chlorophyll stability index
16. Estimation of proline content
17. **University Practical Examination**

Text Books

1. Hopkins, W.G. & Huner, N.P.A. (2008). Introduction to Plant Physiology (4th ed.,) USA, John Wiley & Sons. pp.1-523.
2. Jain, V.K. (2017). Fundamentals of Plant Physiology (19th ed.,) New Delhi, S. Chand & Company Ltd. pp.1-736.
3. Pandey, S. N. & B. K. Sinha, (2006). Plant Physiology. New Delhi, Vikas Publishing House Private Limited. pp.1-704.
4. Salisbury, B., Frank & W.C. Ross. (1992). Plant Physiology (4th ed.,) CA, Wadsworth Publishing Co., Belmont. pp.1-682.
5. Taiz, L. & Zeiger, E. (2014). Plant Physiology (6th ed.,) Massachusetts, USA, Oxford University Press, Sinauer Associates, Inc. pp.1-761.

Reference Books

1. Basra, A. S. (2004). Plant Growth Regulators in Agriculture & Horticulture. New York, HAWARTH press. pp.1-264.
2. Delvin, R.M (1986). Plant Physiology (4th ed.,), New Delhi, CBS. pp.1-577.
3. Gardner, F.P., Pearce, R.B. & Mitchell, R.L. (1984). Physiology of Crop Plants (2nd ed.,), Jodhpur. Scientific Publishers. pp.1-327.

4. Jacobs, W. P. (1979). Plant Hormones and Plant Development. Cambridge Univ. London. pp.1-339.
5. Leopold, A.C. & P.E. Kriedemann, (1985). Plant growth and development. (3rd ed.), New York, MC. Graw Hill. pp.1-545.
6. Ray Noggle, G. & Fritz, G. J., (1991). Introductory Plant Physiology (2nd ed.), New Delhi, Prentice Hall of India Pvt. Ltd. pp.1-704.
7. Richard, N. Artica. (2004). Plant Growth Substances, New Delhi, CBS. pp. 1-332

Web Reference

1. <http://www.plantphys.org>
2. <http://6e.plantphys.net>
3. https://www.youtube.com/playlist?list=PL3BijB3Hruj8KksJrH_CVMjUYk5KyMp5O
4. <https://www.frontiersin.org/journals/physiology/sections/plant-physiology>
5. Plant physiology lecture, Cornell University: https://www.youtube.com/watch?v=RT-w2xHVI_E

Journals

1. Indian Journal of Plant Physiology
2. Journal of Plant Biochemistry and Biotechnology
3. Journal of Plant Physiology
4. Plant Biochemistry and Physiology
5. Plant Physiology
6. Plant Physiology and Biochemistry

Course Nature: Theory based Practical							
Total Marks (100)							
Sl.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	05	05	05	-	15
Grand Total							100

Course Code	GPB19201	Course Name	Principles of Genetics and Cytogenetics	Course Category	S	<i>Supportive Course</i>	L	T	P	C
							2	0	1	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Genetics and Plant Breeding	Data Book / Codes/Standards			Nil

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning			Program Learning Outcomes (PLO)														
CLR-1 :	Define the history and evolution of genetics and cytogenetics	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	Interpret trait and its transmission to progenies	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems through Soil science	Ability to implement knowledge gained in the applied field of Soil	Ability to understand social and ethical responsibilities of Soil science
CLR-3 :	Summarize the chromosome behaviour and effects of their irregularities																		
CLR-4 :	Discuss the Importance of genetics in crop improvement																		
CLR-5 :	Recall the current trends in functional and molecular genetics																		
Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:																		
CLO-1 :	Understand the cell structure, chromosome function	1	90	85	H			H			H		M	H		H	H	H	H
CLO-2 :	Identify the importance of genetics in crop improvement	2	95	85	H			H					L	H		H	H	H	H
CLO-3 :	Summarize the Mendel's principles of heredity	2	80	70	M		M	M			H		L	H		H	H	H	H
CLO-4 :	Recognize the modern concepts of genetics.	3	85	75	M			H					M	H		H	H	H	H

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		16	16	12	11	12
S-1	SLO-1	Definition: Genetics cytogenetics	Pre-Mendelian ideas about heredity	Quantitative inheritance	Sex linked inheritance	DNA, the genetic material
	SLO-2	History of developments in genetics	Theories	Multiple factor hypothesis	Sex limited inheritance	RNA as genetic material
S-2	SLO-1	Physical basis of heredity	Mendel's experiments and laws of inheritance.	Polygenes	Chromosomal theory of sex determination	Structure of DNA
	SLO-2	Cell and cell organelles	Rediscovery of Mendel's work	Transgressive segregation	Sex determination in plants	Central dogma of life
S-3,4	SLO-1	Lab.1 Principles of killing and fixing, preparation of stains and preservatives	Lab. 5. Studying pollen fertility and viability	Lab. 8. Genetic ratio studies	Lab.11. recessive epistasis and duplicate recessive epistasis	Lab.14. Estimation of linkage
	SLO-2					
S-5	SLO-1	Cell division – Mitosis	Terminologies	Linkage	Genic balance theory of Bridges	Proof for semi conservative method of DNA replication
	SLO-2	Meiosis	-	Chromosomal theory of linkage of Morgan	Hormonal theory	Steps involved in DNA replication
S-6	SLO-1	Chromosome structure	Chromosomal theory of inheritance	Crossing over	Cytoplasmic inheritance	RNA types
	SLO-2	Chromosome banding	Allelic interactions	Stern's experiment	Plasmid inheritance	Protein synthesis
S-7,8	SLO-1	Lab.2 Studying the stages of mitosis and meiosis	Lab. 6. Permanent slides preparation	Lab. 9. Study of dihybrid ratio	Lab.12. Study of duplicate and additive epistasis	Lab 15: Problems on two point test cross, three point test cross
	SLO-2					
S-9	SLO-1	Types of chromosomes	Deviation from Mendelian inheritance	Strength of linkage	Mutation	Regulation of gene expression
	SLO-2	Special chromosomes	Bateson and Punnett's experiment	Recombination	Importance of mutation	Transposable genetic elements - Ac - Ds system in maize
S-10	SLO-1	Chromosomal aberration	Recessive epistasis	Double cross over		Functional genomics

Duration (hour)	Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
	16	16	12	11	12
	SLO-2	Variation in chromosome structure	Duplicate dominant epistasis	Genetic map	Phenomics
S-11,12	SLO-1	Lab.3. Studying smear techniques and observing the mitotic phases in root tips of onion	Lab. 7. Principles of dominance, recessive, back cross, test cross, incomplete, co-dominance	Lab 10 Study of simple interaction of genes	Lab 13: Multiple alleles
	SLO-2				Lab 16: Studies on sex linked inheritance in Humans and Drosophila
S - 13	SLO-1	Euploid	Duplicate recessive epistasis		
	SLO-2	Aneuploid	Dominant and recessive epistasis		
S - 14	SLO-1	Polyloid	Lethal genes		
	SLO-2	Evolution	Multiple alleles		
S-15,16	SLO-1	Lab.4. Fixing and observing different meiotic phases in the inflorescence of corn			
	SLO-2				

Learning Resources	1. Gupta P.K. (2007). Cytogenetics. Meerut: Rastogi Publications. pp. 1- 432. 2. Singh, B.D. (2004). Fundamentals of genetics. Chennai: Kalyani Publishers, pp. 1- 976. 3. Stansfield, W.D. (1990). Theory and problems of genetics. New York: Mc-Graw Hill Book Co. pp. 1- 458.

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In semester (20%)	Practical (15%)		
Level 1	Remember	40 %	30 %	35 %	30 %
	Understand				
Level 2	Apply	40 %	40 %	35 %	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	30 %	30 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. S M .Prabhu, Ph. D. Senior Breeder (Paddy Breeding and Transgenic), R&D centre, Rasi Seeds (P) Ltd., Attur, Salem – 636141.	Dr. T. Sabesan Associate rofessor Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Annamalai nagar , Chidambaram - 608 002 sabavani@gmail.com	Dr. G. Selvakumar , Assistant Professor (GPB) Dr. R. Mahendran, Assistant Professor (GPB) Dr. J. Vanitha, Tutor (GPB)

THEORY

Unit I – History, chromosomes, types and chromosomal aberration

Definition of genetics, heredity, inheritance, cytology, cytogenetics; Brief history of developments in genetics and cytogenetics. Physical basis of heredity: Structure and function of cell and cell organelles. Cell reproduction: mitosis, meiosis and its significance, cell cycle. Gametogenesis in plants: Microsporogenesis, microgametogenesis, megasporogenesis, microgametogenesis. Syngamy in plants: fusion of male and female gametes, embryo development, identical and fraternal twins. Chromosome structure, chemical composition, nucleosome, centromere, telomere, euchromatin, heterochromatin, NOR, satellite chromosome. Karyotype, ideogram and chromosome banding. Types of chromosomes based on position of centromere. Types of chromosomes based on structure and function: normal and special chromosomes - polytene, lampbrush, based on the role in sex determination: autosomes and allosomes. Other types of chromosomes - B, ring and isochromosomes. Chromosomal aberration: Variation in chromosome structure – deletion, duplication, inversion and translocation. Chromosomal aberration: Variation in chromosome number – euploid, aneuploid, types of aneuploids and their origin; Nondisjunction -Klinefelter syndrome and Turner syndrome; Definition of eugenics and eutherics. Polyploid - auto and allopolyploids, their characters; meaning of genome; evolution of wheat, triticale, cotton, tobacco, brassica.

Unit II - Mendelian genetics and deviation from mendelian inheritance

Pre-Mendelian ideas about heredity – Vapour and fluid theory, Magnetic power theory, Preformation theory, Lamarck's theory, Darwin's theory, Germplasm theory and Mutation theory. Mendelian genetics–Mendel's principles of heredity, deviation from Mendelian inheritance, Non allelic interaction without modification in Mendelian ratio – Bateson and Punnett's experiment on fowl comb shape. Non allelic interaction with modification in Mendelian ratio – i.) Dominant epistasis (12:3:1), ii.) Recessive epistasis (9:3:4), iii.) Duplicate and additive epistasis (9:6:1), iv.) Duplicate dominant epistasis (15:1), v) Duplicate recessive epistasis (9:7), vi.) Dominant and recessive epistasis (13:3). Pleiotropy, threshold characters, co-dominance, penetrance and expressivity. Chromosome theory of inheritance, gene interaction. Multiple alleles.

Unit III –Quantitative inheritance, linkages and crossing over

Quantitative inheritance – Multiple factor hypothesis – Nilsson Ehle experiment on wheat kernel colour. Polygenes – transgressive segregation, comparison of quantitatively and qualitatively inherited characters; modifiers; Types of gene action controlling quantitative traits. Linkage - coupling and repulsion; Experiment on Bateson and Punnett – Chromosomal theory of linkage of Morgan – Complete and incomplete linkage, Linkage group. Crossing over – significance of crossing over; cytological proof for crossing over - Stern's experiment; Factors controlling crossing over. Strength of linkage and recombination; Two point and three point test cross. Double cross over, interference and coincidence; genetic map, physical map.

Unit IV - Sex determination, cytoplasmic inheritance and mutation

Sex determination: Autosomes and sex chromosomes - chromosomal theory of sex determination- different types – sex determination in human, fowl, butterfly, grasshopper, honey bee, fumea; Sex determination in plants – *Melandrium*, papaya, maize. Genic balance theory of Bridges, quantitative theory, hormonal theory, barr bodies, metabolic differentiation theory; Gynandromorphs – sex reversal in chicken. Sex linked inheritance – criss cross inheritance – reciprocal difference; holandric genes; sex influenced and sex limited inheritance. Cytoplasmic inheritance and maternal effects: features of cytoplasmic inheritance, chloroplast, mitochondrial - plastid colour in *Mirabilis jalapa* - iojap gene of maize, cytoplasmic male sterility in rice, kappa particles of paramecium - plasmid and episomic inheritance. Mutation – characteristics of mutation – micro and macro mutation – CIB technique - molecular basis of mutation- Transition and transversion; major physical and chemical mutagens.

Unit V - Modern concepts of genetics

Structure of DNA – Watson and Crick model – Central dogma of life. Proof for semi conservative method of DNA replication; Models of DNA replication; steps involved in DNA replication. RNA types - mRNA, tRNA, rRNA; genetic codes. Protein synthesis – transcription, Translation. DNA, the genetic material – Griffith's experiment, experiment of Avery, McCleod and McCarthy – confirmation by Hershey and Chase; RNA as genetic material – Frankel, Conrat and Singer experiment. Regulation of gene expression – operon model of Jacob and Monod; Structural genes and regulator genes. Cistron, muton and recon. Complementation test; exons, introns – split genes – Transposable genetic elements - Ac - Ds system in maize. Prelude on Functional genomics, Metagenomics, Transcriptomics, Proteomics, Metabolomics Phenomics, forward genetics, reverse genetics - TILLING and EcoTILLING, GMO and Genome editing – CRISPR Cas9.

Theory – Lecture Schedule

1. Definition of genetics, heredity, inheritance, cytology, cytogenetics; Brief history of developments in genetics and cytogenetics
2. Physical basis of heredity: Structure and function of cell and cell organelles – Differences between Prokaryotes and Eukaryotes
3. Cell division – mitosis, meiosis and their significance, cell cycle; zygote formation and embryo development - identical and fraternal twins
4. Chromosome structure, chemical composition, nucleosome, centromere, telomere, euchromatin, heterochromatin, NOR, satellite chromosome, karyotype, ideogram – chromosome banding
5. Types of chromosomes based on position of centromere, based on structure and function: normal and special chromosomes - polytene, lampbrush, based on the role in sex determination: autosomes and allosomes, Other types of chromosomes - B, ring and isochromosomes.
6. Chromosomal aberration: Variation in chromosome structure – deletion, duplication, inversion and translocation – genetic and cytological implications
7. Chromosomal aberration: Variation in chromosome number – euploid, aneuploid, types of aneuploids and their origin; Nondisjunction - Klinefelter syndrome and Turner syndrome; Definition of eugenics and eutherics
8. Polyploid - auto and allopolyploids, their characters; meaning of genome; evolution of wheat, Triticale, cotton, tobacco, *Brassica*

9. Pre-Mendelian ideas about heredity – Vapour and fluid theory, Magnetic power theory, Preformation theory, Lamarck's theory, Darwin's theory, Germplasm theory and Mutation theory
10. Mendel's experiments and laws of inheritance. Rediscovery of Mendel's work
11. Terminologies: gene, allele, locus, homozygous, heterozygous, hemizygous, genotype, phenotype, monohybrid, dihybrid, trihybrid, polyhybrid
12. Chromosomal theory of inheritance. Allelic interactions – Dominance vs recessive, complete dominance, codominance, incomplete dominance, over dominance
13. Deviation from Mendelian inheritance – Non allelic interaction without modification in Mendelian ratio – Bateson and Punnett's experiment on fowl comb shape. Non allelic interaction with modification in Mendelian ratio – i.) Dominant epistasis (12:3:1)
14. ii.) Recessive epistasis (9:3:4) iii.) Duplicate and additive epistasis (9:6:1). iv.) Duplicate dominant epistasis (15:1)
15. v) Duplicate recessive epistasis (9:7) vi.) Dominant and recessive epistasis (13:3); Summary of epistatic ratios (i) to (vi)
16. Lethal genes, Pleiotrophy, penetrance and expressivity, phenocopy: Multiple alleles, blood group in humans, coat colour in rabbits, self incompatibility in plants; pseudo alleles, isoalleles
17. **In Semester Examination**
18. Quantitative inheritance – Multiple factor hypothesis – Nilsson Ehle experiment on wheat kernel colour
19. Polygenes – transgressive segregation, comparison of quantitatively and qualitatively inherited characters; modifiers; Types of gene action controlling quantitative traits
20. Linkage - coupling and repulsion; Experiment on Bateson and Punnett – Chromosomal theory of linkage of Morgan – Complete and incomplete linkage, Linkage group
21. Crossing over – significance of crossing over; cytological proof for crossing over - Stern's experiment; Factors controlling crossing over
22. Strength of linkage and recombination; Two point and three point test cross
23. Double cross over, interference and coincidence; genetic map, physical map
24. Sex determination: Autosomes and sex chromosomes - chromosomal theory of sex determination- different types – sex determination in human, fowl, butterfly, grasshopper, honey bee, fumea; Sex determination in plants – *Melandrium*, papaya, maize
25. Genic balance theory of Bridges, quantitative theory, hormonal theory, barr bodies, metabolic differentiation theory; Gynandromorphs – sex reversal in chicken
26. Sex linked inheritance – criss cross inheritance – reciprocal difference; holandric genes; sex influenced and sex limited inheritance
27. Cytoplasmic inheritance and maternal effects – features of cytoplasmic inheritance, chloroplast, mitochondrial - plastid colour in *Mirabilis jalapa* - iojap gene of maize, cytoplasmic male sterility in rice, kappa particles of paramecium - plasmid and episomic inheritance
28. Mutation – characteristics of mutation – micro and macro mutation – CIB technique - molecular basis of mutation- Transition and transversion; major physical and chemical mutagens
29. DNA, the genetic material – Griffith's experiment, experiment of Avery, McCleod and McCarthy – confirmation by Hershey and Chase; RNA as genetic material – Frankel, Conrat and Singer experiment
30. Structure of DNA – Watson and Crick model – Central dogma of life
31. Proof for semi conservative method of DNA replication; Models of DNA replication; steps involved in DNA replication
32. RNA types - mRNA, tRNA, rRNA; genetic code, protein synthesis - transcription. Translation
33. Regulation of gene expression – operon model of Jacob and Monod; Structural genes and regulator genes. Cistron, muton and recon; Complementation test; exons, introns – split genes – Transposable genetic elements - Ac - Ds system in maize
34. Prelude on Functional genomics, Metagenomics, Transcriptomics, Proteomics, Metabolomics Phenomics, forward genetics, reverse genetics - TILLING and EcoTILLING, GMO and Genome editing – CRISPR Cas9

Practical Schedule

1. Principles of killing and fixing, preparation of stains and preservatives.
2. Studying the stages of mitosis and meiosis.
3. Studying smear techniques and observing the mitotic phases in root tips of onion.
4. Fixing and observing different meiotic phases in the inflorescence of corn.
5. Studying pollen fertility and viability.
6. Permanent slides preparation.
7. Principles of dominance, recessive, back cross, test cross, incomplete, co-dominance and lethal factors explaining with one model – principles of chi-square test.
8. Genetic ratio studies – monohybrid – incomplete dominance and test cross ratio and in combination of one or two above.
9. Study of dihybrid ratio – dominance, incomplete dominance and test cross ratio and in combination
10. Study of simple interaction of genes – comb character in fowls, dominant epistasis,
11. Study of recessive epistasis and duplicate recessive epistasis.
12. Study of duplicate and additive epistasis, duplicate dominant epistasis, duplicate recessive epistasis and dominant and recessive epistasis.
13. Multiple alleles and polygenic inheritance
14. Estimation of linkage with F₂ and test cross data, coupling and repulsion phases

15. Problems on two point test cross, three point test cross
16. Studies on sex linked inheritance in Humans and Drosophila
17. **University Practical Examination**

Text Books

1. Gupta P.K. (2007). *Cytogenetics*. Meerut: Rastogi Publications. pp. 1- 432.
2. Singh, B.D. (2004). *Fundamentals of genetics*. Chennai: Kalyani Publishers, pp. 1- 976.
3. Stansfield, W.D. (1990). *Theory and problems of genetics*. New York: Mc-Graw Hill Book Co. pp. 1- 458.
4. Strickberger. M.W. (1996). *Genetics*. New Delhi: Prentice-Hall of India Pvt. Ltd. pp. 1- 245.
5. Verma, P.S. & Agarwal, V.K. (2010). *Genetics*. New Delhi: S.Chand and Company Ltd. pp. 1- 1294.

Reference Books

1. Anthony J.F. Griffiths, William M. Gelbart, Richard C. Lewontin & Jeffrey H. Miller. (2002). *Modern Genetic Analysis* (Second Edition). United States: W. H. Freeman. pp. 1- 736.
2. Benjamin Lewin. (2007). *Genes IX*. Oxford: Oxford University Press. pp. 1- 909.
3. Daniel Sundararaj, Thulasidas, G. & Stephen Dorairaj, M. (1997). *Introduction to Cytogenetics and Plant Breeding*. Chennai: Popular Book Depot. pp. 1- 362.
4. Gardner E. J., Simmons M. J., & Peter Snustad, D. (2015). *Principles of Genetics*. USA: John Wiley and sons. pp. 1- 746.
5. Gupta, P.K. (1993). *Genetics*. Meerut: Rastogi publications. pp. 1- 631.
6. Russel, P.J. (2000). *Fundamentals of genetics*. USA: Addition Wesley Longman Publishers. pp. 1- 527.
7. Singh, R.J. (2002). *Plant cytogenetics*. USA: CRC Press. pp. 1- 488.

Web References

1. <https://www.cliffsnotes.com/study-guides/biology/biology/classical-mendelian-genetics/principles-of-genetics>
2. <https://www.jax.org/education-and-learning/clinical-and-continuing-education/cccp-non-cancer-resources/core-principles-in-genetics-2004>
3. https://www2.palomar.edu/anthro/mendel/mendel_1.htm
4. <https://www.youtube.com/watch?v=2ycwGQUjmJY&list=PLKIDmF-ilyAkT0rhgMzSvGmqQz5licCMs>

Journals

1. Genetic Principles and Genetic Variations
2. Principles of genetics
3. Journal of Genetics
4. Genetics Research

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	05	05	05	-	15
Grand Total							100

Course Code	AGS19202	Course Name	Fundamentals of Agricultural Economics	Course Category	S	Supportive Course	L	T	P	C
							1	0	1	2

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Agricultural Social Sciences		Data Book / Codes/Standards	Nil	

Course Learning Rationale (CLR):		The purpose of learning this course is to:			Learning			Program Learning Outcomes (PLO)														
CLR-1 :	Define the basic concepts in farm economic managements	Level of Thinking (Bloom)	2	3	1	2	3	Agriculture Knowledge	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	Discuss the economics of scale and cost of cultivation																					
CLR-3 :	Identify the knowledge on farm planning and budgeting																					
CLR-4 :	Understand the basic concepts in market and its role in agriculture																					
CLR-5 :	Describe the managerial aspects of farm planning and organizing																					
CLR-6 :	Identify to explore various types of business strategies and entrepreneurship concepts and define the learning methods and goals																					
Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:			Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems	Ability to implement knowledge gained in the applied field of Horticulture Business Management	Ability to understand social and ethical responsibilities
CLO-1 :	Discuss the students to production economics principles and their applications.																					
CLO-2 :	Understand the knowledge on analyze the cost of cultivation																					
CLO-3 :	Explain the agricultural decision making in farm management																					
CLO-4 :	Recall students to economic principles relevant for agribusiness and their applications for decision making																					
CLO-5 :	Interpret the knowledge on basic guideline for project preparation																					
CLO6 :	Summarize the knowledge on marketing management and financial management																					

Duration (hour)		Learning Unit / Module 1 9	Learning Unit / Module 2 12	Learning Unit / Module 3 9	Learning Unit / Module 4 9	Learning Unit / Module 5 9
S-1	SLO-1	Economics: Meaning, scope and subject matter	Concept of Demand	Laws of returns	Distribution theory	Money: Barter system of exchange and its problems
	SLO-2	micro and macroeconomics	kinds of demand	Law of variable proportions	Concepts of Rent and Quasi rent	classification of money
S-2-3	SLO-1	Lab: 1 Exercise on Law of Diminishing Marginal Utility.	Lab: 4 Estimation of own price, income and cross price elasticities of demand	Lab:8 Market Structure and Price determination	Lab:11 Approaches to computation of National Income	Lab:14 Measures of Standard of Living and Human Development
	SLO-2					
S-4	SLO-1	Goods and services - classification and characteristics	Cardinal and ordinal utility	Supply: Stock versus supply	National income	Agricultural and public finance
	SLO-2	meaning and characteristics, demand, utility.	law of diminishing marginal utility	elasticity of supply	concepts of national income	Economic systems
S-5-6	SLO-1	Lab:2 Exercise on Law of Equi-Marginal Utility.	Lab: 5 Estimation of consumer surplus.	Lab:9 Rent: Theories of Rent	Lab:12 Estimation of Growth Rate of Population	Lab:15 Food Grain Production
	SLO-2					
S-7	SLO-1	Meaning and definition of Agricultural economics	Consumer's equilibrium	Market structure	Population: Importance, Malthusian	Public revenue
	SLO-2	Agricultural planning and development in the country.	Concept of consumer surplus	Price determination	Optimum population theories,	Micro versus macro finance
S-8-9	SLO-1		Lab:6 Cost concepts:	Lab:10 Interest: Theories of Interest		Lab:16Physical Quality of Life Index

Duration (hour)	Learning Unit / Module 1		Learning Unit / Module 2		Learning Unit / Module 3		Learning Unit / Module 4		Learning Unit / Module 5	
	9		12		9		9		9	
	SLO-2	Lab:3 Indifference Curve Analysis: Properties, budget line and consumer equilibrium.					Lab:13 Consumer price index and Wholesale price index			
S-10	SLO-1	-	Elasticity of demand		-		-		-	
	SLO-2	-	Factors influencing elasticity of demand		-		-		-	
S-11-12	SLO-1	-	Lab:7 Supply: Estimation of supply elasticity		-		-		-	
	SLO-2	-								

Learning Resources	1. Dewett, K, K., (2004). <i>Modern Economic Theory</i> , New Delhi: Syamlal Charitable Trust. pp. 1- 1024.	3. Seth, M. L., (2005). <i>Principles of Economics</i> , New Delhi: Lakshmi Narain Agarwal Co., Agra, pp. 1- 888.
	2. Samuelson, P., (2004). <i>Economics</i> , (18/e), New Delhi: Tata Mc-graw-Hill. pp. 1-205.	4. Subba Reddy, S., & Raghu Ram, P., (2011). <i>Agricultural Finance and Management</i> , New Delh: Oxford & IBH. pp. 1-268.

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In semester (20%)	Practical (15%)		
Level 1	Remember Understand	40 %	30 %	30 %	40 %
Level 2	Apply Analyze	40 %	40 %	40 %	40 %
Level 3	Evaluate Create	20 %	30 %	30 %	20 %
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. K.Arun, Business Manager, EDII Periyakulam Horti Business Incubation Forum, Periyakulam	Dr. Venkatesa Palanisamy, Professor and Head, Centre for Agricultural and Rural Development Studies Department of Agricultural Rural Management, TNAU, Coimbatore	Dr. Anbarassan A Dr. Periasami N

THEORY

Unit 1- Introduction and scope

Economics: Meaning, scope and subject matter, definitions, activities, approaches to economic analysis, micro and macro economics, positive and normative analysis; nature of economic theory, rationality assumption, concept of equilibrium, economic laws as generalization of human behavior.

Unit II- Basic concepts of economics

Basic concepts: Goods and services, desire, want, demand, utility, cost and price, wealth, capital, income and welfare; Agricultural economics: meaning, definition, characteristics of agriculture, importance and its role in economic development; Agricultural planning and development in the country: agricultural policies, National Institute of Agricultural Economics and Policy Research (ICAR-NIAP).

Unit III - Concepts of demand, consumption and production

Demand: meaning, law of demand, schedule and demand curve, determinants, utility theory, law of diminishing marginal utility, equi-marginal utility principle, consumer's equilibrium, derivation of demand curve and concept of consumer surplus; Elasticity of demand: concept, measurement of price elasticity, income elasticity and cross elasticity; Production: definition, process, creation of utility, factors of production and input output relationship; laws of returns, law of variable proportions and law of returns to scale; Cost: concepts, short run and long run cost curves; Supply: stock v/s supply, law of supply, schedule, supply curve, determinants of supply and elasticity of supply.

Unit IV- Exchange and theory of distribution

Market structure: meaning and types of market, basic features of perfectly competitive and imperfect markets, price determination under perfect competition, short run and long run equilibrium of firm and industry, shut down and break-even point; Distribution theory: meaning, factor market and pricing of factors of production; concepts of rent, wage, interest and profit; Agricultural marketing reforms: APMC, e-NAM, rural markets; uzhavar sandhai; regulated markets, role and its functions.

Unit V- Macroeconomics

National income: meaning, importance, circular flow, concepts of national income accounting, approaches to measurement, difficulties in measurement; Importance of Malthusian and Optimum population theories, natural and socioeconomic determinants, current policies and programmes on population control; Money: barter system of exchange and its problems, evolution, meaning and functions of money, classification of money supply, general price index; inflation and deflation; banking: role in modern economy, types of banks, functions of commercial and central bank, credit creation policy; Agricultural and public finance : meaning, micro v/s macro finance and need for agricultural finance: NABARD: role and its function in agriculture, public revenue and public expenditure; tax: meaning, direct and indirect taxes, agricultural taxation, VAT and GST; economic systems: concepts of economy, functions, important features of capitalistic, socialistic and mixed economies and elements of economic planning.

Theory - Lecture Schedule

1. Economics: Meaning, scope and subject matter, definitions, activities, approaches to economic analysis; micro and macroeconomics, positive and normative analysis. Nature of economic theory; rationality assumption, concept of equilibrium, economic laws as generalization of human behavior.
2. Goods and services - classification and characteristics, desire, want – meaning and characteristics, demand, utility, cost and price, wealth, capital, income and welfare.
3. Meaning and definition of Agricultural economics, characteristics of agriculture, importance and its role in economic development. Agricultural planning and development in the country.
4. Concept of Demand: kinds of demand, law of demand, demand schedule and demand curve, determinants.
5. Cardinal and ordinal utility; law of diminishing marginal utility, equi-marginal utility principle, Indifference curve analysis and properties, budget line: definition, assumptions, limitations and applications.
6. Consumer's equilibrium and derivation of demand curve, concept of consumer surplus and its importance.
7. Elasticity of demand: concept and measurement of price elasticity, income elasticity and cross elasticity. Factors influencing elasticity of demand, Importance of elasticity of demand. Standard of Living: Definition, Engel's Law of Family Expenditure.
8. Theory of Production: process, creation of utility, factors of production definition and characteristics - Input Output Relationship.
9. **In- Semester Examination**
10. Laws of returns: Law of variable proportions and law of returns to scale. Cost: Cost concepts, short run and long run cost curves.
11. Supply: Stock versus supply, law of supply, supply schedule, supply curve, determinants of supply, elasticity of supply.
12. Market structure: meaning and types of market, basic features of perfectly competitive and imperfect markets. Price determination under perfect competition; short run and long run equilibrium of firm and industry, shut down and break even points.
13. Distribution theory: meaning, factor market and pricing of factors of production. - Concepts of Rent and Quasi rent - Wages: Real wage and money wage - Interest: Pure interest and gross interest – Profit: Meaning of economic profit.
14. National income: Meaning and importance, circular flow, concepts of national income - accounting and approaches to measurement, difficulties in measurement.

15. Population: Importance, Malthusian and Optimum population theories, natural and socio-economic determinants, current policies and programmes on population control.
16. Money: Barter system of exchange and its problems, evolution, meaning and functions of money, classification of money, money supply, general price index, inflation and deflation. Banking: Role in modern economy, types of banks, functions of commercial and central bank, credit creation policy.
17. Agricultural and public finance: meaning, micro versus macro finance, need for agricultural finance, public revenue and public expenditure. Tax: meaning, direct and indirect taxes, agricultural taxation, VAT and GST. Economic systems: Concepts of economy and its functions, important features of capitalistic, socialistic and mixed economies, elements of economic planning.

Practical Schedule

1. Exercise on Law of Diminishing Marginal Utility.
2. Exercise on Law of Equi-Marginal Utility.
3. Indifference Curve Analysis: Properties, budget line and consumer equilibrium.
4. Demand schedule: Graphical derivation of individual and market demand, Measurement of Arc and Point elasticities of demand.
5. Estimation of own price, income and cross price elasticities of demand
6. Estimation of consumer surplus.
7. Law of Diminishing Marginal Returns: Relationship among TPP, APP and MPP.
8. Cost concepts: Total cost, total fixed costs, total variable cost, average costs, marginal costs and Graphical derivation of cost curves - Estimation of total revenue and profit.
9. Supply: Estimation of supply elasticity. Estimation of Producers Surplus
10. Market Structure and Price determination under Perfect market and imperfect market.
11. Rent: Theories of Rent: Ricardian and Modern Theories of Rent - Wages: Marginal Productivity Theory and Demand and Supply Theory of Wages.
12. Interest: Theories of Interest: Keynesian and Modern Theories of Interest – Profit: Risk - Bearing Theory of Profit
13. Approaches to computation of National Income: Analysis of trends in National income and study of structural changes in the economy.
14. Estimation of Growth Rate of Population and Food Grain Production
15. Consumer price index and Wholesale price index: Estimation of price indices.
16. Measures of Standard of Living and Human Development : Human Development Index – Physical Quality of Life Index – Gender Development Index
17. **University Practical Examination**

Text Books

1. Dewett, K. K., (2004). Modern Economic Theory, New Delhi: Syamlal Charitable Trust. pp. 1 1024.
2. Samuelson, P., (2004). Economics, (18/e), New Delhi: Tata Mc-graw-Hill. pp. 1-205.

Reference Books

1. Seth, M. L.,(2005).Principles of Economics, New Delhi: Lakshmi Narain Agarwal Co., Agra.Pp. 1- 888.
2. Subba Reddy, S.,&Raghu Ram, P.,(2011). Agricultural Finance and Management, New Delh: Oxford & IBH. Pp. 1-268.

Web-References

1. www.economicshelp.org
2. www.fp.unmas.ac.id/wp-content/uploads/2018/03/principles-of-agricultural-economics.pdf
3. www.sparknotes.com/economics

Journals

1. American Agricultural Economic Review
2. Indian Journal of Agricultural Economics

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-	-	-	50	50
2	Theory-Internal	20	-	-	-	-	20
3	Practical-External	-	-	-	-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	SUP19201	Course Name	Introduction to Livestock and Poultry Production	Course Category	S	Supplementary Course	L 2	T 0	P 1	C 3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Animal Husbandry	Data Book / Codes/Standards			

Course Learning Rationale (CLR):		The purpose of learning this course is to:			Learning			Program Learning Outcomes (PLO)														
CLR-1 :	Apply the Knowledge on different types of livestock and Poultry				1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	Describe the animal population and rearing system				Thinking (Bloom)	Efficiency (%)	Attainment (%)	Animal husbandry	Problem Analysis	Design, Research	Usage	Culture	Environment & Sustainability	Ethics	Team Work	Communication	Management & Finance	Learning	Scientific	Implementation	Understand social responsibilities	
CLR-3 :	Discuss the information on diversified poultry																					
CLR-4 :	Explain the knowledge on different livestock management system																					
CLR-5 :	Paraphrase feed formulation and nutritional management																					
CLR-6 :	Determine disease management and bio security measures																					

Course Learning Outcomes (CLO):	<i>At the end of this course, learners will be able to:</i>	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLO-1 :	Outline the skills on different rearing system	3	90	80
CLO-2 :	Understand the knowledge on management of different age group of animal	1	95	85
CLO-3 :	Recognize the poultry sector	2	80	70
CLO-4 :	Explain the animal handling and management	3	75	65
CLO-5 :	Recall the clean milk production and milk processing methods	2	75	60
CLO6 :	Discuss the development of entrepreneurship skills	2	75	65

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		2	14	6	3	7
S-1	SLO-1	Common terminology	Cattle and buffalo breeds	Sheep and goat breeds	Breeds of swine	Breeds and strains of chicken
	SLO-2	Livestock census	Breeding	Rearing system	Economic traits	Brooding and litter management
S-2	SLO-1	Government programs	Reproduction	Floor space and housing	Breeding system	Broiler and layers
	SLO-2	Livestock rearing system	Housing – floor space	Breeding methods	Creep feeding	Hatchery management
S-3	SLO-1	Significance of livestock in Indian economy	Nutritional management	Care and management	Reproduction management	Diversified poultry –Phytobiotics
	SLO-2	Culling methods	Clean Milk production – milking methods	Farm routine operation	Disease management	Disease – bacterial – viral – management
S-4	SLO-1	-	Phytobiotics	Sheep and Goat difference		Rabbit – Breeds – nutrition and breeding
	SLO-2	-	Bacterial and viral disease – Treatment	Disease- prevention – treatment		Reproduction- disease management

Learning Resources	1. ICAR. (2002). Handbook of Animal Husbandry (4th ed).Delhi. New: ICAR.pp- 1-1549 2. G.C. Banerjee (2013). A Text Book of Animal Husbandry (8 th ed). New Delhi: Oxford and IBH Publishing Company Private Limited.,pp- 1-1079

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In semester (20%)	Practical (15%)		
Level 1	Remember Understand	40 %	30 %	35 %	30 %
Level 2	Apply Analyze	40 %	40 %	35 %	40 %
Level 3	Evaluate Create	20 %	30 %	30 %	30 %
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
<i>Dr.P.Niresh</i> Manager – Technical, Poultry Disease Diagnostic Laboratory Venkateswara Hatecherries Pvt.Ltd , Bangalore Mobile :9942564066	<i>Dr.T.Vasanthakumar</i> Assistant Professor, Livestock Farm complex,Orathanadu, Thanjavur (Dt), Mobile :9025250970	<i>Dr. G.Prabakar</i> Assistant Professor

THEORY

Unit I - Introduction to Livestock Farming

Common terms used in animal husbandry, livestock sector in India, Significance of Livestock in Indian Economy, livestock and poultry Census, Different livestock development programs of Government of India and Tamil Nadu; livestock rearing system - Farming system- Culling.

Unit II - Management of Cattle, Buffalo and Bullock

Important cattle and buffalo breeds; classification: indigenous and exotic; Breed characteristics; Breeding: Cross breeding, Upgrading, Economic traits of cattle; Estrus Cycle; Artificial insemination; Introduction to Embryo transfer, Housing, Space requirement for calf and adult stock, System and types of housing; Feeding and Management of young animal, Heifer, Pregnant, Milch animal and working animals; Nutrition – Ration – Balanced Ration - Characteristics of ration and classification of feed and fodder – composition of concentrate mixture for different stage – total mixed Ration Milking methods: Clean milk production, factors affecting milk composition; Common diseases of cattle – classification– symptoms – prevention and control measures- Phytobiotics used in ruminants

Unit III - Management of Sheep and Goat

Breeds, sheep and goat classification; Economic traits: system of rearing; Housing Management: Floor space requirement, Breeding management- Care and Management of young and adult stock; - Nutrition, Routine operation, sheep and goat difference- Common diseases, prevention and control.

Unit IV - Management of Swine

Classification of breeds: Economic traits, Housing, Breeding system, creep feeding; Care and Management of Adult and Young Stock: common disease, prevention and control;

Unit V - Poultry and Rabbit Management

Classification of breeds - Commercial Strains of broilers and layers – Housing – brooding – deep litter and cage system – care and Management of broilers and layers -Nutrition of Chick, grower, Layer and broiler –Phytobiotics- Incubation and Hatching of Eggs - Common Diseases - Control and prevention. Diversified poultry production.Rabbit- Breeds- Housing- Nutrition – Breeding and Reproduction- Disease- prevention and control.

Theory - Lecture Schedule

1. Introductions-Common terms- significance of livestock and poultry in Indian economy-livestock and poultry census. Different livestock development programmes of Government of India and Tamil Nadu.
2. Various livestock rearing systems-extensive – semi intensive, intensive. Various farming system - mixed- integrated and specialized farming. Culling.
3. Definition of breed-classification of indigenous and exotic cattle breeds- Gir- Sahiwal-Sindhi-Dual purpose- Hariyana- Tharparkar- Kankrej- Drought-Kankeyam- Umbalachery and Bargur- breed characteristics
4. Various synthetic cattle breed. Indian buffalo breeds- Murrah-Surthi- Niliravi –Jaffarabadi-breed characteristics
5. Breeding-cross breeding-upgrading-economic traits of cattle and buffalo
6. Estrous cycle – signs of estrous - artificial insemination-merits and demerits-Principles and outline of embryo transfer
7. Housing management-farm site selection and floor space requirement for calves, heifer, milch animal and work bullocks.
8. Systems of housing-single row system-double row system- head to head and tail to tail-merits and demerits.
9. Care and management of new born calf and heifers
10. Care and management of pregnant animal and lactating animals.
11. Care and management of dry cows and work bullock.
12. Nutrition-definition-ration-balanced ration-desirable characteristics of a ration. Classification of feed stuffs-concentrate and roughage-comparison.Silage and Hay making
13. Model composition of concentrate mixture of young and adult stock-age wise feed and fodder requirement-Importance of green fodder. Phytobiotics for ruminants.
14. Milking methods-clean milk production-factors affecting milk yield and composition
15. Diseases-classification-viral, bacterial and metabolic-general control and preventive measures.
16. Viral diseases-foot and mouth and bacterial diseases, anthrax, hemorrhagic septicemia- black quarter - metabolic- tympanites, acidosis, ketosis and milk fever.
17. **In semester examination.**
18. Goat farming-classification of breeds of Indian and exotic origin - Economic traits.
19. Sheep Farming - classification of breeds of Indian and exotic origin - Economic traits.
20. Systems of rearing-housing management - type design- floor diagram-space requirement for adult and young stock.
21. Care and management of ram, ewe and lamb-nutrition- feeds and fodder for small ruminants
22. Care and management of buck, doe and kid- nutrition- flushing. Common ailments of sheep and goat-sheep pox-foot and mouth-blue tongue-enterotoxaemia –Ecto and endo parasites.

23. Swine husbandry –Common breeds of exotic origin-nomenclature alone-economic traits- housing of Swine.
24. Care and management of sow, boar and piglets-nutrition- creep feeding. Disease prevention and control of swine diseases –hog cholera, foot and mouth, ecto and endo parasites.
25. Classification of breeds viz. layer, broiler and dual purpose-nomenclature of commercial strains of layer and broiler. Care and management of new arrivals-brooder management.
26. Systems of housing- deep litter and cage system- floor space requirement-common litter material-litter management-merits and demerits.
27. Care and management of layers, broilers- vaccination schedule.
28. Preservation of eggs- Incubation and hatching of eggs
29. Nutrition-feed formulation-composition of chick, grower, layer, broiler starter and Finisher Mash-Feed Conversion Ratio /dozen egg or kg of meat production, Phytobiotics in poultry production.
30. Classification of disease –viral – bacterial - protozoan- causative organisms, symptoms and prevention – viral diseases- Ranikhet – IBD-avian flu.
31. Bacterial disease- E. coli- Coryza - salmonellosis- protozoan– coccidiosis- causative organism, symptoms and preventive measures.
32. Breeds- Housing - Breeding system – Nutritional requirement
33. Reproduction and breeding management
34. Sexing – Disease- Pasteurellosis - Coccidiosis- Mange-Prevention and control

Practical Schedule

1. Study of external parts of livestock
2. Identification of livestock and poultry
3. Common restraining methods of livestock
4. Disbudding, Dehorning, Castration and Dentition of livestock
5. Study of different livestock and poultry housing
6. Selection of dairy cow and work bullock
7. Determination of specific gravity, fat composition
8. Demonstration of value-added milk products
9. Identification of feeds & fodder – Preparation of concentrate mixtures
10. Economics of dairy, goat and swine Farming
11. Study of external parts of fowl, Techniques used in poultry industry
12. Preparation of brooder house, economics of layer and broiler farming
13. Debeaking, delousing, deworming and vaccination schedule for poultry
14. Identification of layer and non- layer birds, Demonstration of dressing of broilers, different cut-up- parts.
15. Demonstration of incubator
16. Visit to a modern dairy and commercial layer and broiler farms

Text Book

1. ICAR. (2002). *Handbook of Animal Husbandry*(4th ed).New Delhi: ICAR, New Delhi.pp-1-1549
2. G.C. Banerjee (2013). *A Text Book of Animal Husbandry* (8th ed). New Delhi: Oxford and IBH Publishing Company Private Limited.,pp- 1-1079
3. Lesson,S and Summers,J.D(2001).*A text book of Scott Nutrition of the chicken* (4thed):Canada University books.pp-1-586
4. Reddy D.V. (2001).*Principles of animal nutrition and feed technology* (2nd ed).New Delhi: Oxford and IBH Publishing Company Private Limited.pp-1-425.

Reference Books

1. Sastry, N.S.R., Thomas, C.K. (2005). *Livestock Production Management* (3rd ed). Ludhiana: Kalyani Publishers.pp-1-850
2. Gopalakrishnan, C.A., and Lal, D.M.M., (1992). *Livestock and Poultry Enterprises for Rural Development*. Ghaziabad, Uttar Pradesh: Vikas Publications Private Limited.pp-1-1096.
3. Sreenivasaiah, P.V. (2006). *Scientific Poultry Production* (3rd ed).Lucknow: International Book Distributing Co.pp- 1-1487.

Web References

1. <https://www.drvtet.in/p/e-books.html>
2. <https://www.coursera.org/lecture/livestock-farming/1-3-farming-101-the-basics-of-livestock-production-wfhyL>
3. <http://www.tanuv.ac.in/e-learning/objectivities.html>
4. <https://ecourses.icar.gov.in/>

Journals

1. Indian Veterinary Journal
2. Indian Journal of Animal Science
3. Indian Journal of Animal Research
4. Poultry Science
5. World Poultry Science

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	MAT19201	Course Name	Elementary Statistics	Course Category	A	Allied Course	L	T	P	C
							1	0	1	2

Pre-requisite Courses	MAT19101	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Basic and Applied Sciences	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):		Learning			Program Learning Outcomes (PLO)														
The purpose of learning this course is to:		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	Recall the fundamental statistical concepts and skills	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems through Mathematics	Ability to implement knowledge gained in Mathematics	Ability to understand social and ethical responsibilities of Mathematics
CLR-2 :	Apply the statistical calculations in agricultural research				M	H	-	L	-	-	-	-	H	-	-	H	H	H	-
CLR-3 :	Explain the calculations and models applicable to field trials				-	M	-	-	-	-	-	-	M	-	-	H	M	-	-
CLR-4 :	Outline CRD, RBD in solving real time applications				-	M	-	-	-	-	-	-	H	-	-	H	L	-	-
CLR-5 :	Describe the applications of test of hypothesis in problems of agricultural science				H	-	-	M	-	-	-	-	H	-	-	H	H	L	-
CLR-6 :	Paraphrase the application of sampling theory in all problems of agricultural sciences				-	-	-	-	-	-	-	-	M	-	-	H	M	-	-
Course Learning Outcomes (CLO):		2	90	80	M	-	-	-	-	-	-	L	-	-	H	M	L	-	-
CLO-1 :	Define the Basics of probability and statistics	2	95	85	-	M	-	-	-	-	-	-	M	-	-	H	M	-	-
CLO-2 :	Describe the model and analyze the system using random variables	3	85	75	-	M	-	-	-	-	-	-	H	-	-	H	L	-	-
CLO-3 :	Explain the test of hypothesis	3	70	60	H	-	-	M	-	-	-	-	H	-	-	H	H	L	-
CLO-4 :	Apply the statistical models in the agriculture field	2	80	70	-	-	-	-	-	-	-	-	M	-	-	H	M	-	-
CLO-5 :	Explain the techniques related in sampling	2	80	70	M	-	-	-	-	-	-	-	L	-	-	H	M	L	-
CLO6 :	Determine the fundamentals between discrete and continuous distributions																		

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		3	4	5	2	2
S-1	SLO-1	Introduction – Measures of central tendency: arithmetic mean, geometric mean, harmonic mean.	Sampling theory – population – sample – parameter and statistic – sampling distribution - sampling vs complete enumeration.	Null and alternative hypothesis – types of errors - critical region and tests of significance.	Correlation – Scatter diagram - Karl Pearson's correlation coefficient.	Analysis of Variance (ANOVA) – assumptions – one way and two way classifications.
	SLO-2	Median and mode –Merits and demerits	Types of sampling - simple random sampling selection using random numbers Stratified - Systematic sampling	Large sample test – single mean and difference between two means.	Spearman's rank Correlation - computation and properties.	Basic principles of experimental designs
S-2	SLO-1	Measures of dispersion: Range, Quartile deviation, Mean deviation.	Probability distributions –	Test for Single proportion	Regression – simple linear regression – fitting of simple linear regression equation.	Completely Randomized Design (CRD)
	SLO-2	standard deviation, and coefficient of variation - Skewness and kurtosis	Discrete distributions: Bernoulli	Difference between two proportions	Properties of regression coefficient.	Randomized Block Design (RBD)
S-3	SLO-1	Diagrammatic representation of data; One, Two and Three dimensional diagrams with applications.	Binomial distribution	Small sample tests – F-test -		

Duration (hour)	Learning Unit / Module 1		Learning Unit / Module 2		Learning Unit / Module 3		Learning Unit / Module 4		Learning Unit / Module 5	
	3		4		5		2		2	
	SLO-2	Graphical representation of data; Histogram, frequency polygon, frequency curve, ogives	Poisson distribution		t-test for testing the significance of single mean					
S-4	SLO-1		Continuous distribution:		Independent t test					
	SLO-2		Normal distribution		Paired t test					
S-5	SLO-1				Chi square test for testing the association of r x c contingency table					
	SLO-2									

Learning Resources	1.	Gupta, S. C. & Kapoor, V. K. (2014). <i>Fundamentals of Mathematical Statistics</i> . New Delhi: Sultan chand and sons. pp. 1-682
	2.	Rangaswamy, R.(1995). <i>A Text Book of Agricultural Statistics</i> . Hyderabad: New Age International Publishing Limited. pp. 1- 526

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In semester (20%)	Practical (15%)		
Level 1	Remember	40 %	30 %	30 %	40 %
	Understand				
Level 2	Apply	40 %	40 %	40 %	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	30 %	20 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
		Dr. M. Selva rani Ms. A. Muthulakshmi

THEORY

Unit I: Descriptive statistics

Introduction, Measures of central tendency, arithmetic mean, geometric mean, harmonic mean, median and mode –Merits and demerits. Measures of dispersion: Range, Quartile deviation, Mean deviation, standard deviation, and coefficient of variation, Skewness and kurtosis, Merits and demerits- Diagrammatic representation of data, Graphical representation of data; Histogram, frequency polygon, frequency curve, ogives.

Unit II: Sampling theory and probability distributions

Sampling theory, population, sample, parameter and statistic, sampling distribution, sampling vs complete enumeration, Types of sampling, simple random sampling, selection using random numbers, Stratified, Systematic sampling. Probability distributions, Discrete distributions: Bernoulli, Binomial and Poisson. Continuous distribution: Normal distribution, definitions and properties.

Unit III: Testing of hypothesis

Null and alternative hypothesis, types of errors, critical region and tests of significance. Large sample test, single mean and difference between two means, single proportion and difference between two proportions. Small sample tests, F-test, t-test for testing the significance of single mean – independent and paired t test, chi square test for testing the association of $r \times c$ contingency table.

Unit IV: Correlation and regression

Correlation, Scatter diagram, Karl Pearson's correlation coefficient, Spearman's rank correlation, computation and properties. Regression, simple linear regression, fitting of simple linear regression equation, properties of regression coefficient.

Unit V: Analysis of variance and experimental designs

Analysis of Variance (ANOVA), assumptions, one way and two way classifications. Basic principles of experimental designs, Completely Randomized Design (CRD), Randomized Block Design (RBD), Split plot design (SPD) and Latin Square Design (LSD).

Theory - Lecture Schedule

1. Introduction – Measures of central tendency: arithmetic mean, geometric mean, harmonic mean, median and mode –Merits and demerits
2. Measures of dispersion: Range, Quartile deviation, Mean deviation, standard deviation, and coefficient of variation - Skewness and kurtosis
3. Diagrammatic representation of data; One, Two and Three dimensional diagrams with applications. Graphical representation of data; Histogram, frequency polygon, frequency curve, ogives.
4. Sampling theory – population – sample – parameter and statistic – sampling distribution - sampling vs complete enumeration –Types of sampling - simple random sampling selection using random numbers Stratified - Systematic sampling
5. Probability distributions – Discrete distributions: Bernoulli
6. Binomial and Poisson distribution,
7. Continuous distribution: Normal distribution
8. Null and alternative hypothesis – types of errors - critical region and tests of significance - Large sample test – single mean and difference between two means.
9. **Mid Semester Examination**
10. Single proportion and difference between two proportions
11. Small sample tests – F-test - t-test for testing the significance of single mean
12. Independent and paired t test
13. Chi square test for testing the association of $r \times c$ contingency table
14. Correlation – Scatter diagram - Karl Pearson's correlation coefficient – Spearman's rank Correlation - computation and properties
15. Regression – simple linear regression – fitting of simple linear regression equation – properties of regression coefficient.
16. Analysis of Variance (ANOVA) – assumptions – one way and two way classifications. Basic principles of experimental designs
17. Completely Randomized Design (CRD) – Randomized Block Design (RBD)

Practical Schedule

1. Computation of arithmetic mean, geometric mean, harmonic mean, median and mode
2. Computation of range, standard deviation, variance, coefficient of variance
3. Histogram, frequency polygon, frequency curve, ogives.

4. Selection of sample using simple random sampling method, Simple problems in Bernoulli distribution
5. Simple problems in Binomial distribution and Poisson distribution
6. Simple problems in Normal distribution
7. Large sample test – test for single proportion and difference between two proportions
8. Large sample test – test for single mean and difference between two means
9. Small samples test – t-test for single mean – t test for difference between two sample means (equal variances only)
10. Paired t-test
11. Chi square test
12. Computation of Karl Pearson's correlation coefficient
13. Fitting of simple linear regression equation y on x – correlation and regression
14. Analysis of Completely Randomised Design (CRD) – for equal replications only
15. Analysis of Randomised Block Design (RBD) and FRBD
16. Analysis of Split plot design and Latin Square Design (LSD)
17. Practical Exam

Text Books

1. Chandel S. R. S. (2014). *A Handbook of Agricultural Statistics*. Kanpur: Achal Prakashan Mandir. pp. 1-87
2. Gupta, S.P. (2004). *Statistical Method*. New Delhi: Sultan chand and sons. pp. 1-1476.
3. Nageswara Rao, G. (2007). *Statistics for Agricultural Sciences*. Hyderabad: B.S. Publications. pp. 1- 512
4. Panse, V.G. & Sukhatme, P. V. (1954). *Statistical Methods for Agricultural Workers*. India: Indian Council of Agricultural Research. pp. 1- 361
5. Vittal P. R. (2012). *Mathematical Statistics*. Chennai: Margham Publications. pp. 1 – 950

References Books

1. Agrawal B.L. (2005). *Basic Statistics*. New Delhi: New age International Ltd. pp. 1- 656
2. Dhamu, K.P. & Ramamoorthy, K. (2009). *Fundamentals of Agricultural Statistics*. India: Scientific Publishers. pp. 1- 130
3. Gupta, S.P. (1978). *Elementary Statistical Method*. New Delhi: Sultan chand and sons. pp. 1-438
4. Kailasam, G. & Gangaiselvi, R. (2010). *Applied Statistics*. New Delhi: Kalyani Publishers. pp. 1 -200
5. Vijay K. Rohatgi, Ehsanes Saleh A.K.M.D. (2008). *An Introduction to Probability and Statistics*, (2nded.). New Jersey: John Wiley and sons Inc. pp.1 - 631

Web References

1. www.statisticshowto.com
2. www.mathisfun.com
3. www.mathinsight.org
4. <http://www.statistics.com/resources/glossary/>
5. www.statsoft.com
6. http://www.iasri.res.in/ebook/EB_SMAR/index.html
7. www.statsci.org/jourlist.html

Journals

1. The Indian journal of Statistics
2. International journal of Mathematics and Statistics
3. Annals of Statistics
4. Probability Theory and related fields
5. International Journal of Agricultural and Statistical sciences.
6. Journal of the Indian society of Agricultural Statistics
7. Journal of Statistics and Management Systems

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	HOR19301	Course Name	Temperate Fruit Crops	Course Category	C	Compulsory Core	L	T	P	C
							1	0	1	2

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Horticulture	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning	Program Learning Outcomes (PLO)
CLR-1 :	Outline the scope, importance and export potential of temperate fruit crops	1 2 3	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
CLR-2 :	Describe the knowledge on varieties and cultivation technologies of temperate fruit crops	Level of Thinking (Bloom)	Horticulture Knowledge
CLR-3 :	Discuss the physiological disorders and special production problems in temperate fruit crops	Expected Proficiency (%)	Problem Analysis
CLR-4 :	Explain the knowledge on the high density planting of temperate fruit crops	Expected Attainment (%)	Design & Development
CLR-5 :	Recognize the benefits of post-harvest handling of temperate fruit crops		Analysis, Design, Research
CLR-6 :	Paraphrase the special production problems in temperate fruit crops		Modern Tool Usage
			Society & Culture
			Environment & Sustainability
			Ethics
			Individual & Team Work
			Communication
			Project Mgt. & Finance
			Life Long Learning
			Ability to solve scientific problems through Fruit Science
			Ability to implement knowledge gained in the applied field of Fruit Science
			Ability to understand social and ethical responsibilities of Fruit Science
CLO-1 :	Recall important temperate fruit crops	1 80 70	M
CLO-2 :	Outline the training and pruning practices in temperate fruit crops	2 90 85	H
CLO-3 :	Explain different planting density followed in temperate fruit crops	2 95 80	H
CLO-4 :	Describe the cultivation aspects of temperate crops.	3 95 80	H
CLO-5 :	Summarize the post-harvest handling techniques of temperate fruit crops	2 90 80	M
CLO6 :	Discuss problem identification in temperate fruit crops	1 75 65	L

Duration (hour)	Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
	4	3	3	3	3
S-1	SLO-1 Introduction to temperate fruit crops	Peach Introduction, varieties	Strawberry Introduction, varieties	Persimmon Introduction, varieties	Macadamia nut and pecan nut: Introduction, Varieties
	SLO-2 Classification of temperate fruits	Peach Cultivation techniques	Strawberry Cultivation techniques	Persimmon Cultivation techniques	Cultivation techniques
S-2-3	SLO-1 Lab 1: Nursery management practices	Lab 5: Varieties of pear and peach	Lab 8: Varieties of apricot and almond	Lab 11: Varieties of hazel nut, chest nut and Queens land nut	Lab 14: Physiological disorders
	SLO-2				
S-4	SLO-1 Apple Introduction, varieties,	Plum Introduction, varieties	Apricot Introduction, varieties	Almond Introduction, varieties	Pistachio, Hazel and chest nut: Introduction, Varieties
	SLO-2 Apple Propagation and rootstock	Plum Cultivation techniques	Apricot Cultivation techniques	Almond Cultivation techniques	Cultivation techniques
S-5-6	SLO-1 Lab 2: Planting systems and root stock characteristics	Lab 6: Varieties of plum and cherry	Lab 9: Varieties of Kiwi and persimmon	Lab 12: Use of growth regulators	Lab 15: Plant protection
	SLO-2				
S-7	SLO-1 Apple: HDP	Cherry Introduction, varieties	Kiwi Introduction, varieties	Walnut Introduction, varieties	Rejuvenation
	SLO-2 Apple: Canopy management	Cherry Cultivation techniques	Kiwi Cultivation techniques	Walnut Cultivation techniques	Special production problems
S-8-9	SLO-1 Lab 3: Training and pruning practices	Lab 7: Varieties of strawberry	Lab 10: varieties of walnut, pistachio nut and pecan nut	Lab 13: Nutrient management	Lab 16: Visit to temperate fruit orchards
	SLO-2				
S-10	SLO-1 Pear Introduction, varieties	-	-	-	-
	SLO-2 Pear Cultivation techniques	-	-	-	-
S-11	SLO-1 Lab 4: Varieties of apple	-	-	-	-
	SLO-2				

Learning Resources	1.	Chadha, K.L. 2019. <i>Handbook of Horticulture. Vol. I (2nd revised edition). New Delhi: ICAR. pp 1 - 299.</i>
	2.	Prasad, S & R. L. Bhardwaj. 2015. <i>Production technology of fruit crops. India: Agrobios. pp. 1 – 438.</i>

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In semester (20%)	Practical (15%)		
Level 1	Remember	40 %	30 %	35 %	30 %
	Understand				
Level 2	Apply	40 %	40 %	35 %	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	30 %	30 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Mohan Horticulture Officer, The Nilgiris	Dr. A. Rameshkumar Associate Professor (Horticulture), Central University of Tamil Nadu Thiruvavur	Dr. B. Gopu

THEORY

Unit I Scope and importance of temperate fruit crops

Introduction to temperate fruit crops – classification of temperate fruits – area, production, productivity and export potential of temperate fruit crops

Unit II Production technology of apple, pear, peach, plum

Composition and uses - origin and distribution – species and varieties -soil and climate with reference to chilling requirement for flowering, warm winter varieties - propagation – rootstocks-main field preparation – spacing, planting density and cropping systems. HDP and meadow orchards - planting and after care - nutrients, water and weed management - training and pruning – canopy management – incompatibility - pollinizers –flowering and pollination use of plant growth regulators – physiological disorders and remedies – maturity indices and harvest - post harvest handling and storage.

Unit III Production technology of cherry, strawberry, apricot, persimmon, kiwi, almond

Composition and uses – Origin and distribution – Species and cultivars – Varieties- Soil and climatic requirements – Propagation techniques– Rootstock influence- Main field preparation – Spacing - Planting density - Planting and after care – Cropping systems - Nutrients, water and weed management – Training and pruning – Flowering, pollination and fruit set – Use of plant growth regulators – Physiological disorders and remedies – Maturity indices and harvest – Post harvest handling – Ripening and storage.

Unit IV Production technology of walnut, macadamia nut, pecan nut, pistachio nut, Hazel nut and chest nut

Composition and uses – Origin and distribution – Species and cultivars – Varieties- Soil and climatic requirements – Propagation techniques– Rootstock influence- Main field preparation – Spacing - Planting density - Planting and after care – Cropping systems - Nutrients, water and weed management – Training and pruning – Flowering, pollination and fruit set – Use of plant growth regulators – Physiological disorders and remedies – Maturity indices and harvest – Post harvest handling – Ripening and storage.

Unit V Production problems in temperate fruit crops

Re-planting problems - Rejuvenation and special production problems - control of pre-harvest fruit drop - Plant protection measures in temperate fruit crops.

Theory - Lecture schedule

1. Introduction to temperate fruit crops – classification of temperate fruits – area, production, productivity and export potential of temperate fruit crops.
2. Apple: Introduction- Origin and distribution - Composition and uses - Area and production – Varieties - Climate and soil requirements - Root stocks (Dwarf, Semi-dwarf, Vigorous and other root stocks) – Propagation - Planting methods
3. Apple: Training and Pruning - Manures and fertilizers - After care - Flowering - Induction of early flowering - Use of growth regulators in flowering - Pre harvest drop - Blossom and fruit thinning – Factors effecting colour development - Maturity indices - Harvesting - Post- harvest handling - Different grades - Storage - Physiological disorders
4. Pear: Introduction – origin and distribution – composition and uses- species and varieties - soil and climate requirements - propagation - rootstocks- main field preparation - spacing, planting density and cropping systems. planting and after care - nutrients, water and weed management - training and pruning – canopy management- incompatibility - pollinizers - use of plant growth regulators, physiological disorders and remedies, maturity indices and harvest - post harvest handling and storage.
5. Peach: Introduction – origin and distribution – composition and uses- species and varieties - soil and climate requirements - propagation - rootstocks- main field preparation - spacing, planting density and cropping systems. planting and after care - nutrients, water and weed management - training and pruning – canopy management- incompatibility - pollinizers - use of plant growth regulators, physiological disorders and remedies, maturity indices and harvest - post harvest handling and storage.
6. Plum: Introduction- Origin and distribution - Species and varieties- Difference between European plums and Japanese plums - Types of European plums, - Composition and uses- Area and production - Climate and soil requirements - Root stocks- Propagation Training and pruning - Flowering - Pollination and fruit set - Maturity indices- Harvesting – Postharvest handling and storage- Physiological disorders.
7. Cherry: Introduction – origin and distribution – composition and uses- species and varieties –Sweet cherries and sour cherries- soil and climate requirements - propagation - rootstocks- main field preparation - spacing, planting density and cropping systems. planting and after care - nutrients, water and weed management - training and pruning – canopy management- incompatibility - pollinizers - use of plant growth regulators, physiological disorders and remedies, maturity indices and harvest - post harvest handling and storage.
8. Strawberry: Introduction- Origin and distribution - Species and varieties- Composition and uses- Ploidy series - Climate and soil requirements - Vegetative propagation- Rising of runners- Different systems of planting-Matted rows - Spaced beds and Hill system – Mulching Flowering - Pollination - Defoliation - Deblossoming operation - Fruit set - Maturity indices - Harvesting and Post harvest management - Physiological disorder.
9. **In semester examination**
10. Apricot: Introduction – origin and distribution – composition and uses- species and varieties - soil and climate requirements - propagation - rootstocks- main field preparation - spacing, planting density and cropping systems. planting and after care - nutrients, water and weed management - training and pruning – canopy management- incompatibility - pollinizers - use of plant growth regulators, physiological disorders and remedies, maturity indices and harvest - post harvest handling and storage.

11. Kiwi: Introduction – origin and distribution – composition and uses- species and varieties - soil and climate requirements - propagation - rootstocks- main field preparation - spacing, planting density and cropping systems. planting and after care - nutrients, water and weed management - training and pruning – canopy management- incompatibility - pollinizers - use of plant growth regulators, physiological disorders and remedies, maturity indices and harvest - post harvest handling and storage.
12. Persimmon: Introduction – origin and distribution – composition and uses- species and varieties - soil and climate requirements - propagation - rootstocks- main field preparation - spacing, planting density and cropping systems. planting and after care - nutrients, water and weed management - training and pruning – canopy management- incompatibility - pollinizers - use of plant growth regulators, physiological disorders and remedies, maturity indices and harvest - post harvest handling and storage.
13. Almond: Origin and distribution - Composition and uses - Area and production - Varieties- Climate and soil requirements - Root stocks -Propagation- Planting methods-Training and Pruning- Manures and fertilizers - After care - Flowering - Pollination and fruit set - Use of growth regulators in flowering - Maturity indices - Harvesting(Mechanical)- Post- harvest handling - Storage - Physiological disorders - Kernel use - Shelling yield- Grades of kernels for the international trade.
14. Walnut: Introduction – origin and distribution – composition and uses- species and varieties - soil and climate requirements - propagation - rootstocks- main field preparation - spacing, planting density and cropping systems. planting and after care - nutrients, water and weed management - training and pruning – canopy management- incompatibility - pollinizers - use of plant growth regulators, physiological disorders and remedies, maturity indices and harvest - post harvest handling and storage.
15. Queens land nut (Macadamia nut) and pecan nut: Introduction – origin and distribution – composition and uses- species and varieties - soil and climate requirements – propagation - rootstocks- main field preparation - spacing, planting density and cropping systems. planting and after care - nutrients, water and weed management - training and pruning – canopy management- incompatibility - pollinizers - use of plant growth regulators, physiological disorders and remedies, maturity indices and harvest - post harvest handling and storage.
16. Pistachio nut, Hazel nut and chest nut: Introduction – origin and distribution – composition and uses- species and varieties - soil and climate requirements – propagation - rootstocks- main field preparation - spacing, planting density and cropping systems. planting and after care - nutrients, water and weed management - training and pruning – canopy management- incompatibility - pollinizers - use of plant growth regulators, physiological disorders and remedies, maturity indices and harvest - post harvest handling and storage.
17. Re-planting problems - Rejuvenation and special production problems - control of pre-harvest fruit drop - Important insect pests and diseases – Plant protection measures in temperate fruit crops.

Practical Schedule

1. Description and identification of varieties of apple
2. Planting systems and root stock characteristics of apple
3. Description and identification of varieties of pear and peach
4. Description and identification of varieties of plum and cherry
5. Description and identification of varieties of strawberry
6. Description and identification of varieties of kiwi and persimmon
7. Description and identification of varieties of apricot and almond
8. Description and identification of varieties of walnut, pecan nut and pistachio nut
9. Description and identification of varieties of hazel nut, chest nut and Queens land nut
10. Nursery management practices for temperate fruit crops
11. Training and pruning practices followed in temperate fruit crops
12. Nutrient management in temperate fruit crops
13. Use of growth regulators in temperate fruit crops
14. Physiological disorders in temperate fruit crops
15. Visit to temperate fruit orchards
16. Economics for cultivation of temperate fruit crops
17. **University Practical Examination**

Text Books

1. Chadha, K.L. 2019. Handbook of Horticulture. Vol. I (2nd revised edition). New Delhi: ICAR. pp 1 - 299.
2. Chattopadhyay T.K. 2013. A text book on Pomology. Vol. IV (Devoted to Temperate fruits). Ludhiana: Kalyani Publishers.
3. Kumar, N. 2020. Introduction to Horticulture (7th revised edition). New Delhi: Oxford & I.B.H. Publishing. pp. 1 – 452.
4. Prasad, S & R. L. Bhardwaj. 2015. Production technology of fruit crops. India: Agrobios. pp. 1 – 438.

Reference Books

1. Dhillon W.S. 2013. Fruit production in India. Delhi: Narendra Publishing House. pp. 1-704

2. Kishore, D. K., K. Satish & K. Sharma. 2006. Temperate Horticulture: Current Scenario. New Delhi: New India Publishing Agency. pp. 1 – 554.
3. Melvin N.W. 2009. Temperate-Zone Pomology: Physiology and Culture (3rd edition). USA: Timber Press.

Web References

1. http://agritech.tnau.ac.in/horticulture/horti_fruits.html
2. <http://ecourses.iasri.res.in>
3. <http://www.ishs.org>
4. <https://icar.org.in/content/icar-central-institute-temperate-horticulture-srinagar>
5. <https://www.iaritoppers.com/2019/06/temperate-fruits-icar-e-course-pdf-download-e-krishi-shiksha.html>
6. <https://www.youtube.com/watch?v=-VnjWvxgUDY>

Journals

1. ActaHorticulturae
2. HortScience
3. HortTechnology
4. Indian Horticulture
5. Indian J. Horticulture
6. Journal of Horticultural Sciences
7. Journal of the American Society for Horticultural Science

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	05	05	05	-	15
Grand Total							100

Course Code	HOR19302	Course Name	Tropical and Subtropical Vegetables	Course Category	C	Compulsory Core	L	T	P	C
							2	0	1	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Horticulture	Data Book / Codes/Standards			Nil

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning			Program Learning Outcomes (PLO)														
CLR-1 :	Outline the significance with vegetable crop production under tropics	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	Summarize the importance of varieties and hybrids of tropical vegetables	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Horticulture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems	Ability to implement knowledge gained	Ability to understand social and ethical responsibilities
CLR-3 :	Understand the essential of crop regulation practices in vegetables				L									H		H	H	H	H
CLR-4 :	Determine the potential value chain in commercial crop production				H	M		L			H		M	H		H	H	H	H
CLR-5 :	Describe solution for nutrient and physiological disorders				H	M		L					H		H	H	H	H	H
CLR-6 :	Explain the different vegetable gardens and nutritional importance of vegetables				H	H		L	L		M		M	H		H	H	H	H
Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:				M	M								H		H	H	H	M
CLO-1 :	Determine the role of vegetables in human diet and nutrition	1	90	80	H	L								H		H	H	H	H
CLO-2 :	Paraphrase the layout of different vegetable gardens for urban farm	3	90	85															
CLO-3 :	Recognize the plan a suitable vegetable cultivation technology for a particular region	3	95	85															
CLO-4 :	Understand the commercial vegetable cultivation	3	95	90															
CLO-5 :	Apply the skills on new vegetable crops to a non-traditional region of cultivation with the idea on varietal wealth and market	1	75	60															
CLO-6 :	Describe the techniques of post-harvest handling of tropical vegetable crops	1	75	65															

Duration (hour)		Learning Unit / Module 1 4T + 2P	Learning Unit / Module 2 9T + 4P	Learning Unit / Module 3 10T + 5P	Learning Unit / Module 4 5T + 2P	Learning Unit / Module 5 5T + 3P
S-1	SLO-1	Scope and Importance of tropical and subtropical vegetables	Tomato – introduction, importance, varieties and hybrids	Bitter gourd – Introduction, varieties, climate and soil, grafting	French beans – importance, varieties, climate, soil, season, field preparation	Moringa – importance, varieties, climate, soil, season, field preparation
	SLO-2	Institutions and classification of vegetables	Tomato - climate, soil, nursery	Bitter gourd – cultural practices, physiological disorders, harvesting and post-harvest handling	French beans – cultural practices, harvesting, post harvesting handling, physiological disorders	Moringa – cultural practices, harvesting, post harvesting handling, physiological disorders
S-2	SLO-1	Nutrition, kitchen and truck gardens	Tomato – transplanting, field preparation, spacing	Bottle gourd – Introduction, varieties, climate and soil, grafting	Cowpea – importance, varieties, climate, soil, season, field preparation	Amaranthus – importance, varieties, climate, soil, season, field preparation
	SLO-2	Roof, market and floating gardens	Tomato - cultural practices	Bottle gourd – cultural practices, physiological disorders, harvesting and post-harvest handling	Cowpea – cultural practices, harvesting, post harvesting handling, physiological disorders	Amaranthus – cultural practices, harvesting, post harvesting handling, physiological disorders
S-3-4	SLO-1	LAB - Identification and description of tropical and subtropical seeds	LAB - Botany, identification and description of varieties and hybrids of tomato and brinjal	LAB - Botany, identification and description of varieties and hybrids of Leafy vegetables	LAB - Nutrient deficiencies and physiological disorders in vegetable crops.	LAB - Seed extraction in vegetable crops
	SLO-2					

Duration (hour)		Learning Unit / Module 1 4T + 2P	Learning Unit / Module 2 9T + 4P	Learning Unit / Module 3 10T + 5P	Learning Unit / Module 4 5T + 2P	Learning Unit / Module 5 5T + 3P
S-5	SLO-1	Types of vegetable farming	Tomato – PGR, physiological disorders, harvesting, post-harvest handling, storage	Snake gourd - cultivation technology	Indian bean – importance, varieties, climate, soil, season, field preparation	Chekkurmanis - Production technology
	SLO-2	Vertical farming	Tomato - seed extraction	Ivy gourd - cultivation technology	Indian bean – cultural practices, harvesting, post harvesting handling	Sorrel – Production technology
S-6	SLO-1	Organic cultivation, GAP in vegetable production	Brinjal – introduction, importance, varieties, climate, soil	Ridge gourd - cultivation technology	Cluster bean – importance, varieties, climate, soil, season, field preparation	Portulaca – cultivation technology
	SLO-2	Export standards, Vegetable grafting	Brinjal - nursery, transplanting, field preparation	Sponge gourd - cultivation technology	Cluster bean – cultural practices, harvesting, post harvesting handling	Curry leaf – cultivation technology
S-7-8	SLO-1	LAB - Planning and layout of kitchen/nutrition garden.	LAB - Botany, identification and description of varieties and hybrids of chilli, capsicum and bhendi	LAB - Nursery management, sowing, field preparation and transplanting/direct sowing of tropical and subtropical vegetable crops	LAB - Maturity indices, harvesting and post-harvest management of tropical and subtropical vegetable crops	LAB - Visit to commercial vegetable growing area / markets
	SLO-2					
S-9	SLO-1		Brinjal – cultural practices, PGR	Pointed gourd - cultivation technology	Winged bean – importance, varieties, climate, soil, season, field preparation	Basella – cultivation technology
	SLO-2		Brinjal - physiological disorders, post-harvest handling, storage	Chow chow - cultivation technology	Winged bean – cultural practices, harvesting, post harvesting handling	Roselle – cultivation technology
S-10	SLO-1		Chilli – introduction, importance, varieties, climate, soil	Ash gourd - cultivation technology		LAB - Project preparation for commercial cultivation of tropical vegetable crops.
	SLO-2		Chilli - nursery, transplanting, field preparation	Pumpkin - cultivation technology		
S-11-12	SLO-1		LAB - Botany, identification and description of varieties and hybrids of cucurbits	LAB – Manure and Fertilizer application and its calculation in vegetable crops		
	SLO-2					
S-13	SLO-1		Chilli – cultural practices, PGR	Watermelon – Introduction, varieties, climate and soil,		
	SLO-2		Chilli - physiological disorders, post-harvest handling, storage	Watermelon – cultural practices, physiological disorders, harvesting and post-harvest handling		
S-14	SLO-1		Capsicum - introduction, importance, varieties, climate, soil, nursery, transplanting, field preparation	Muskmelon – Introduction, varieties, climate and soil,		
	SLO-2		Capsicum - cultural practices, PGR, physiological disorders, post-harvest handling, storage, shade net cultivation	Muskmelon – cultural practices, physiological disorders, harvesting and post-harvest handling		
S-15-16	SLO-1		LAB - Botany, identification and description of varieties and hybrids of legume vegetable crops	LAB - Weed management and use of herbicides in vegetable cultivation		
	SLO-2					
S-17	SLO-1		Bhendi - introduction, importance, varieties, climate, soil, field preparation, sowing	Cucumber – Introduction, varieties, climate and soil,		

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		4T + 2P	9T + 4P	10T + 5P	5T + 2P	5T + 3P
	SLO-2		Bhendi - cultural practices, PGR, physiological disorders, post-harvest handling, storage	Cucumber – cultural practices, physiological disorders, harvesting and post-harvest handling		
S-18	SLO-1			Squashes – Introduction, varieties, climate and soil,		
	SLO-2			Squashes – cultural practices, physiological disorders, harvesting and post-harvest handling		
S-19	SLO-1			LAB - Preparation of growth regulator spray solution and their usage in vegetable crops		
	SLO-2					

Learning Resources	1.	Thamburaj, S. and Narendra Singh. (2001). A textbook of vegetable tuber crops and spices. ICAR. New Delhi. pp 1-469
	2.	Pranab Hazra, A. Chattopadhyay, K. Karmakar and S. Dutta. (2010). "Modern technology in vegetable production" New India Publishing Agency, New Delhi. pp 1-424

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In semester (20%)	Practical (15%)		
Level 1	Remember	60 %	50 %	50 %	60 %
	Understand				
Level 2	Apply	25 %	30 %	30 %	30 %
	Analyze				
Level 3	Evaluate	15 %	20 %	20 %	10 %
	Create				
	Total	100 %	100 %	100 %	100 %

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
		Mr. Harish. A

THEORY

Unit I - Scope and importance of tropical vegetables

Tropical vegetables: scope and importance, area and production, global and national scenario, institutions involved in vegetable crops research, export potential and export standards; classification of vegetable crops; vegetable gardens: nutrition garden, kitchen garden, truck garden, market garden, roof garden, floating garden; types of vegetable farming: precision farming, river bed cultivation, rain-fed cultivation, vertical farming; organic farming: Good Agricultural Practices (GAP) and Vegetable grafting.

Unit II - Solanaceous and malvaceous crops

Tomato, brinjal, chilli, capsicum and bhendi: Area, production, economic importance and export potential; description of varieties and hybrids, ecophysiological requirements, seed rate, nursery practices, field preparation, direct sowing/transplanting, spacing, planting/cropping systems; water, weed and nutrient management; physiological disorders and nutrient deficiencies; plant growth regulators; maturity indices, harvest and yield; post-harvest and storage.

Unit III - Cucurbitaceous crops

Bitter gourd, bottle gourd, snake gourd, Ivy gourd, ridge gourd, sponge gourd, pointed gourd, chow – chow, ash gourd, pumpkin, watermelon, musk melon, cucumber and squashes: Area, production, economic importance and export potential; description of varieties and hybrids, ecophysiological requirements, seed rate, nursery practices, field preparation, direct sowing/transplanting, spacing, planting/cropping systems; water, weed and nutrient management; special practices; physiological disorders and nutrient deficiencies; sex expression in cucurbits; plant growth regulators; maturity indices, harvest and yield; post-harvest and storage.

Unit IV – Legume vegetable crops

French beans, Cowpea, Indian bean, Cluster bean and winged bean: Area, production, economic importance and export potential; description of varieties and hybrids, ecophysiological requirements, seed rate, nursery practices, field preparation, direct sowing/transplanting, spacing, planting/cropping systems; water, weed and nutrient management; special practices; physiological disorders and nutrient deficiencies; plant growth regulators; maturity indices, harvest and yield; post-harvest and storage.

Unit V – Leafy vegetables

Moringa, Amaranthus, chekkurmanis, curry leaf, portulaca, Basella, sorrel and Roselle: Area, production, economic importance and export potential; description of varieties and hybrids, ecophysiological requirements, seed rate, nursery practices, field preparation, direct sowing/transplanting, spacing, planting/cropping systems; water, weed and nutrient management; special practices; physiological disorders and nutrient deficiencies; plant growth regulators; maturity indices, harvest and yield; post-harvest and storage.

Theory – Lecture schedule

1. Scope and importance of vegetable crops. Area, production, global and national scenario, industrial importance, export potential and export standards of tropical and subtropical vegetable crops and institutions involved in vegetable crops research. Classification of vegetable crops.
2. Vegetable production in nutrition garden, kitchen garden, truck garden, market garden, roof garden and floating garden
3. Types of vegetable farming - precision farming, river bed cultivation, rain-fed cultivation, vertical farming
4. Organic vegetable production, GAP in vegetable production and Vegetable grafting
5. Tomato - Area and production, composition and uses, climate and soil requirements, season, varieties and hybrids, seed rate, nursery practices
6. Tomato - preparation of field, spacing, planting systems and transplanting, Manuring and nutrient management, water and weed management, mulching, fertigation, staking
7. Tomato - nutrient deficiencies and physiological disorders, growth regulators, constraints in production, maturity indices, harvest, yield, post-harvest handling, storage, marketing and seed extraction.
8. Brinjal - Area and production, composition and uses, climate and soil requirements, season, varieties and hybrids, seed rate, nursery practices, preparation of field, spacing, planting systems and transplanting.
9. Brinjal - Manuring and nutrient management, water and weed management, mulching, fertigation, nutrient deficiencies, physiological disorders, growth regulators, constraints in production, maturity indices harvest, yield, post-harvest handling, storage and marketing
10. Chilli - Area and production, composition and uses, climate and soil requirements, season, varieties and hybrids, seed rate, nursery practices, preparation of field, spacing, planting systems and transplanting.
11. Chilli - Manuring and nutrient management, water and weed management, mulching, fertigation, nutrient deficiencies, physiological disorders, growth regulators, constraints in production, maturity indices harvest, yield, post-harvest handling, storage and marketing
12. Capsicum - Area and production, composition and uses, climate and soil requirements, season, varieties and hybrids, seed rate, nursery practices, preparation of field, spacing, planting systems and transplanting manuring and nutrient management, water and weed management, mulching, fertigation, nutrient deficiencies, physiological disorders, growth regulators, constraints in production, maturity indices harvest, yield, post-harvest handling, storage and marketing
13. Bhendi - Area and production, composition and uses, climate and soil requirements, season, varieties and hybrids, seed rate, preparation of field, spacing, sowing, manuring and nutrient management, water and weed management, mulching, fertigation, nutrient deficiencies and physiological disorders, growth regulators, constraints in production, maturity indices harvest, yield, post-harvest handling, storage and marketing

32. Chekkurmanis and sorrel - Composition and uses, climate and soil requirements, season, varieties, seed rate, preparation of field, spacing, sowing, manuring and nutrient management, water and weed management, nutrient deficiencies, physiological disorders, growth regulators, constraints in production, maturity indices harvest, yield, post-harvest handling, storage and marketing
33. Portulaca and curry leaf - Composition and uses, climate and soil requirements, season, varieties, seed rate, preparation of field, spacing, sowing, manuring and nutrient management, water and weed management, nutrient deficiencies, physiological disorders, growth regulators, constraints in production, maturity indices harvest, yield, post-harvest handling, storage and marketing
34. Basella and Roselle - Composition and uses, climate and soil requirements, season, varieties, propagation, seed rate, preparation of field, spacing, sowing / planting, manuring and nutrient management, water and weed management, nutrient deficiencies, physiological disorders, growth regulators, constraints in production, maturity indices harvest, yield, post-harvest handling, storage and marketing

Practical Schedule

1. Identification and description of tropical and subtropical seeds
2. Planning and layout of kitchen/nutrition garden.
3. Botany, identification and description of varieties and hybrids of tomato and brinjal
4. Botany, identification and description of varieties and hybrids of chilli, capsicum and bhendi
5. Botany, identification and description of varieties and hybrids of cucurbits
6. Botany, identification and description of varieties and hybrids of legume vegetable crops
7. Botany, identification and description of varieties and hybrids of leafy vegetables
8. Nursery management, sowing, field preparation and transplanting/direct sowing of tropical and subtropical vegetable crops
9. Manure and Fertilizer application and its calculation in vegetable crops
10. Weed management and use of herbicides in vegetable cultivation
11. Preparation of growth regulator spray solution and their usage in vegetable crops
12. Nutrient deficiencies and physiological disorders in vegetable crops.
13. Maturity indices, harvesting and post-harvest management of tropical and subtropical vegetable crops
14. Seed extraction in vegetable crops
15. Visit to commercial vegetable growing area or vegetable research station, Palur
16. Project preparation for commercial cultivation of tropical vegetable crops.
17. **University Practical Examination.**

Text Books

1. Gopalakrishnan, T.R., (2007). "Vegetable Crops" New India publishing agency, New Delhi. pp 1-360
2. Hazra, P. and M. G., Som. (1999). Technology for vegetable production and improvement, NayaProkash, Calcutta. pp 1-395
3. Hazra, P., A. Chattopadhyay, K. Karmakar and S. Dutta. (2010). "Modern technology in vegetable production" New India Publishing Agency, New Delhi. pp 1-424
4. Thamburaj, S. and Narendra Singh. (2001). A textbook of vegetable tuber crops and spices. ICAR. New Delhi. pp 1-469

Reference Books

1. NeerajPratap Singh. (2005). "Basic concepts of vegetable science", International Book Distributing Co., New Delhi. pp 1-760
2. Uma Shankar Singh, (2008). "Indian vegetables", Anmol publications Pvt., Ltd., New Delhi. pp 1-318
3. Vishnu Swarup, (2006). Vegetable science and technology in India. Kalyani publishers, New Delhi. pp 1-656

Web-References

1. <http://ecoursesonline.iasri.res.in/course/view.php?id=137>
2. <http://ecoursesonline.iasri.res.in/course/view.php?id=154>
3. <https://www.iivr.org.in/>
4. <https://icar.org.in/>
5. <https://www.iihr.res.in/>
6. <https://avrdc.org/>
7. <https://avrdc.org/links/>
8. <https://www.ctcri.org/#>

9. https://www.ishs.org/ishs-article/1107_37
10. <http://msucares.com/crops/hightunnels/index.html>
11. <http://www.docstoc.com/docs/49102917/The-use-of-supplemental-lightingfor-vegetable-crop-production>

Journals

1. Vegetable sciences
2. Acta Horticulturae
3. Indian Journal of Horticulture
4. Indian Horticulture
5. Progressive Horticulture
6. International Journal of Vegetable Science
7. Scientia Horticulturae

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	HOR19303	Course Name	Commercial Floriculture	Course Category	C	Compulsory Core	L	T	P	C
							2	0	1	3

Pre-requisite Courses	HOR19101, HOR19201	Co-requisite Courses	NIL	Progressive Courses	HOR19601
Course Offering Department	Horticulture	Data Book / Codes/Standards			Nil

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning
CLR-1 :	Understand the scope and importance of commercial flower crops	1 2 3
CLR-2 :	Describe the loose flowers, cut flowers, foliage and flowering fillers.	
CLR-3 :	Discuss the production technology of different flower crops.	
CLR-4 :	Explain the knowledge on cultivation of flower crops under protected cultivation.	
CLR-5 :	Understand the post harvest handling of flower crops.	
CLR-6 :	Determine the value addition of flower crops.	

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLO-1 :	Identify the commercial flower crops.	1	95	85
CLO-2 :	Explain the crop management of Commercial flower crops.	1	80	75
CLO-3 :	Describe the flower forcing techniques.	1	75	65
CLO-4 :	Recognize the floral concrete extraction from the commercial flowers.	2	75	65
CLO-5 :	Summarize the post harvest treatment of flower crops.	2	90	80
CLO6 :	Explain the flower arrangements and dry flower techniques.	3	95	90

Program Learning Outcomes (PLO)														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Horticulture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to become a entrepreneur in the field of Floriculture	Ability to Produce cut flowers at Protected structures	Ability to produce value added products from the commercial flowers
H								H	M		H	H	H	H
H								L	H		H	H	H	H
M		L	L					L	H		H	H	H	H
M			L	L				M	H		H	H	H	H
L	L							M	H		H	H	H	H
L						H		M	H		H	H	H	H

Duration (hour)	Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
	8	3	11	5	6
S-1	SLO-1 Scope & Importance of Commercial flowers	Minor loose flower- Crossandra	Flower forcing techniques	Gladiolus- Importance and uses	Cut foliage- cultivation aspects
	SLO-2 Export potential of commercial flowers	Crossandra- Cultivation	Methods	Gladiolus- cultivation aspects	Cut fillers- cultivation aspects
S-2	SLO-1 Industrial importance- Commercial flowers	Gomphrena- cultivation	Protected cultivation	China aster- cultivation aspects	Flowering fillers- cultivation aspects
	SLO-2 Institutional aid- Commercial flowers	Nerium- Cultivation	Dutch rose- Importance	Dahlia- cultivation aspects	Flowering fillers- cultivation aspects
S-3,4	SLO-1 LAB 1: Rose-Identification and description of varieties	LAB4: Tuberose & Marigold- Identification and description of varieties	LAB7: Carnation & Gerbera- Identification and description of varieties	LAB10: Gladiolus- Identification and description of varieties	LAB13: Tinting of flowers
	SLO-2				
S-5	SLO-1 Loose flower- Importance & use of Rose	Celosia- Cultivation aspects	Dutch rose- Varieties	Heliconia- Importance and uses	Floral concrete
	SLO-2 Rose –Introduction and species	Barlaria- Cultivation aspects	Dutch rose- Cultivation	Heliconia -cultivation aspects	Floral concrete extraction
S-6	SLO-1 Rose- Varieties		Carnation- Importance	Bird of paradise- Importance and uses	Value addition of flowers
	SLO-2 Rose- Management		Carnation- Varieties	Bird of paradise cultivation aspects	Value addition of flowers
S-7,8	SLO-1 LAB2: Jasmine- Identification and description of varieties	LAB5: Identification and description of varieties of Minor loose flowers	LAB8: Cut Chrysanthemum Identification and description of varieties	LAB11: Visit to cut flower units	LAB14: Drying and preservation of flowers
	SLO-2				
S-9	SLO-1 Jasmine- Importance		Carnation- Importance	Alstromeria- cultivation aspects	Dry flowers- Introduction
	SLO-2 Jasmine- cultivation aspects		Carnation – cultivation aspects	Alstromeria- cultivation aspects	Dry flowers-Methods
S-10	SLO-1 Chrysanthemum- Importance		Gerbera- Importance		Dry flowers- Storage

Duration (hour)	Learning Unit / Module 1		Learning Unit / Module 2		Learning Unit / Module 3		Learning Unit / Module 4		Learning Unit / Module 5	
	8		3		11		5		6	
	SLO-2	Chrysanthemum- Cultivation aspects			Gerbera- cultivation aspects					Dry flowers- export potential
S-11,12	SLO-1	LAB3: Chrysanthemum Identification and description of varieties	LAB6: Dutch rose- Identification and description of varieties		LAB9: Orchids and Anthurium- Identification of varieties		LAB12: Post harvest handling of flowers		LAB15: Visit to loose flower markets	
	SLO-2									
S - 13	SLO-1	Tuberose- Importance			Cut chrysanthemum- Importance					
	SLO-2	Tuberose- Cultivation aspects			Cut chrysanthemum-cultivation aspects					
S - 14	SLO-1	Marigold- Importance			Cut chrysanthemum- Photoperiodism					
	SLO-2	Marigold- Cultivation aspects			Cut chrysanthemum- Forcing techniques					
S-15,16	SLO-1	LAB16Preparation of project report for major loose and cut flower production			Orchids-Importance					
	SLO-2				Orchids- cultivation aspects					
S-17	SLO-1				Anthurium-Importance					
	SLO-2				Anthurium-cultivation aspects					
S-18	SLO-1				Lillium-Importance					
	SLO-2				Lillium--cultivation					

Learning Resources	1.	Bhattacharjee, S.K., (2004). Advanced commercial floriculture. Vol. I and II.
	2.	Bhattacharjee, S.K., (2004). Post harvest technology of flowers and ornamental plants.

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In semester (20%)	Practical (15%)		
Level 1	Remember	40 %	30 %	35 %	30 %
	Understand				
Level 2	Apply	40 %	40 %	35 %	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	30 %	30 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Gorthi Nagarjuna Naidu General Manager(TANFLORA) naidugorthi@gmail.com	Dr. P. Preethi Scientist (Fruit Science) ICAR – Directorate of Cashew Research, Puttur – 574202	Mrs. C. Kanimozhi

THEORY

Unit I – Production technology of major loose flower crops (rose, jasmine, chrysanthemum, tuberose and marigold)

Scope and importance: scenario of international and national floral industry; institutions and developmental agencies involved in promotion of floriculture- TANFLORA, NHM, NHB, APEDA; export potential; Cropping system in flower crops. Origin and distribution, area and production; varieties and hybrids; soil and climate; propagation; planting systems and methods; training and pruning; special horticultural practices; weed, nutrient and water management; growth regulators; harvest and yield; post harvest and value addition; plant protection.

Unit II – Production technology of minor loose flower crops (crossandra, nerium, gomphrena, celosia and barlaria)

Origin and distribution, area and production; varieties and hybrids; soil and climate; propagation; planting systems and methods; training and pruning; special horticultural practices; weed, nutrient and water management; growth regulators; harvest and yield; post harvest and value addition; plant protection.

Unit III – Production technology of cut flowers in protected cultivation (dutch rose, carnation, gerbera, cut chrysanthemum, orchids, anthurium and liliun)

Scope and importance; Origin and distribution, area and production; varieties and hybrids; soil and climate; media and environment- Fumigation - field preparation - planting systems – nutrition and fertigation - weed management – training and pruning – special horticultural practices - role of growth regulators- flower forcing techniques - physiological disorders and its control measures- harvest index and yield; post harvest and value addition; plant protection.

Unit IV – Production technology of cut flowers in open cultivation (gladiolus, china aster, dahlia, bird of paradise, heliconia and alstroemeria)

Introduction and uses – varieties – media and environment- Fumigation - field preparation - planting systems – nutrition and fertigation - weed management – training and pruning – special horticultural practices - role of growth regulators- flower forcing techniques - physiological disorders and its control measures- harvest index and yield-post harvest and value addition-plant protection.

UNIT V – Production technology of cut foliage and fillers

Varieties and hybrids; soil and climate; propagation; planting systems and methods; training and pruning; special horticultural practices; nutrient and water management; growth regulators; inter cultivation; harvest and yield; post harvest and value addition; plant protection; dry flower production.

Theory - Lecture Schedule

1. Scope and importance of commercial floriculture in India – area and production – export statistics – Cropping systems in flower crops.
2. Industrial importance – floriculture industry in India and Tamil Nadu – Institutions and developmental agencies involved in promotion of floriculture – TANFLORA, NHM, NHB, APEDA.
3. Rose- introduction and uses – origin and history- species and varieties - soil and climate and planting systems - weed, nutrition and irrigation management – training and pruning.
4. Rose– special horticultural practices - role of growth regulators- harvest index and yield- post harvest management and storage- plant protection.
5. Jasmine- introduction and uses – varieties - soil and climate and planting systems - weed, nutrition and irrigation management – training and pruning- special horticultural practices - role of growth regulators- harvest index and yield- post harvest management and storage- plant protection.
6. Chrysanthemum - introduction and uses – varieties - soil and climate and planting systems - weed, nutrition and irrigation management – training and pruning – special horticultural practices - role of growth regulators- harvest index and yield- post harvest management and storage- plant protection.
7. Tuberose - introduction and uses – varieties - soil and climate and planting systems - weed, nutrition and irrigation management – special horticultural practices - role of growth regulators- harvest index and yield- post harvest management and storage- plant protection.
8. Marigold - introduction and uses – varieties - soil and climate and planting systems - weed, nutrition and irrigation management –special horticultural practices - role of growth regulators- harvest index and yield- post harvest management and storage- plant protection.
9. Crossandra - introduction and uses – varieties - soil and climate and planting systems - weed, nutrition and irrigation management –special horticultural practices - role of growth regulators- harvest index and yield- post harvest management and storage- plant protection.
10. Gomphrena & Nerium - introduction and uses – varieties - soil and climate and planting systems - weed, nutrition and irrigation management – training and pruning –role of growth regulators- harvest index and yield- post harvest management and storage- plant protection.
11. Celosia and Barlaria - introduction and uses – varieties - soil and climate and planting systems - weed, nutrition and irrigation management –special horticultural practices - role of growth regulators- harvest index and yield- post harvest management and storage- plant protection.
12. Flower forcing and factors affecting flower production under controlled atmospheric conditions.
13. Dutch rose - introduction and uses – varieties – media and environment- Fumigation - field preparation - planting systems – nutrition and fertigation - weed management – training and pruning.
14. Dutch rose- special horticultural practices - role of growth regulators- physiological disorders and its control measures- harvest index and yield- post harvest management and storage- plant protection.
15. Carnation- introduction and uses – varieties – media and environment- Fumigation - field preparation - planting systems – nutrition and fertigation - weed management – training and pruning.

16. Carnation- special horticultural practices - role of growth regulators- physiological disorders and its control measures- harvest index and yield- post harvest management and storage- plant protection.
17. **In-Semester examination**
18. Gerbera - introduction and uses – varieties – media and environment- Fumigation - field preparation - planting systems – nutrition and fertigation - weed management – training and pruning – special horticultural practices - role of growth regulators- physiological disorders and its control measures- harvest index and yield- post harvest management and storage- plant protection.
19. Cut Chrysanthemum- introduction and uses – varieties – media and environment- Fumigation - field preparation - planting systems – nutrition and fertigation - weed management- training and pruning.
20. Cut Chrysanthemum- - special horticultural practices - role of growth regulators- physiological disorders and its control measures- harvest index and yield- post harvest management and storage- plant protection.
21. Orchids- introduction and uses – varieties – media and environment- planting systems – nutrition and fertigation - weed management – training and pruning – special horticultural practices - role of growth regulators- physiological disorders and its control measures- harvest index and yield- post harvest management and storage- plant protection.
22. Anthurium - introduction and uses – varieties – media and environment- planting systems – nutrition and fertigation - weed management – special horticultural practices - role of growth regulators- physiological disorders and its control measures- harvest index and yield- post harvest management and storage- plant protection.
23. Lillium - introduction and uses – varieties – media and environment- planting systems – nutrition and fertigation - weed management – special horticultural practices - role of growth regulators- physiological disorders and its control measures- harvest index and yield- post harvest management and storage- plant protection.
24. Gladiolus- introduction and uses – varieties – media and environment- Fumigation - field preparation - planting systems – nutrition and fertigation - weed management – training and pruning – special horticultural practices - role of growth regulators- flower forcing techniques - physiological disorders and its control measures- harvest index and yield- post harvest management and storage- plant protection.
25. China Aster & Dahlia - introduction and uses – varieties – media and environment- field preparation - planting systems – nutrition and fertigation - weed management – training and pruning – special horticultural practices - role of growth regulators- flower forcing techniques - physiological disorders and its control measures- harvest index and yield- post harvest management and storage-plant protection.
26. Heliconia - introduction and uses – varieties – media and environment- field preparation - planting systems – nutrition and fertigation - weed management – training and pruning – special horticultural practices - role of growth regulators- physiological disorders and its control measures- harvest index and yield- post harvest management and storage- plant protection.
27. Bird of Paradise- introduction and uses – varieties – media and environment- field preparation - planting systems – nutrition and fertigation - weed management – training and pruning – special horticultural practices - role of growth regulators- physiological disorders and its control measures- harvest index and yield- post harvest management and storage- plant protection.
28. Alstromeria - introduction and uses – varieties – media and environment- field preparation - planting systems – nutrition and fertigation - weed management – training and pruning – special horticultural practices - role of growth regulators- physiological disorders and its control measures- harvest index and yield- post harvest management and storage- plant protection.
29. Cut Foliage - Foliage fillers - Asparagus, Dracaena - introduction and uses – varieties – propagation - planting systems and methods – nutrition and water management - role of growth regulators- harvest index and yield- post harvest management and storage- plant protection.
30. Flowering fillers- Limonium- Gypsophila- introduction and uses – varieties – propagation - planting systems and methods – nutrition and water management - role of growth regulators- harvest index and yield- post harvest management and storage- plant protection.
31. Methods of floral concrete extraction
32. Value addition in flower crops.
33. Dry Flower Technology- Principles and Techniques.
34. Dry flower Technology- Export potential

Practical Schedule

1. Rose–identification and description of species/varieties – propagation and planting – special intercultural operation.
2. Jasmine -identification and description of species/varieties – propagation and planting – special intercultural operation.
3. Chrysanthemum - identification and description of species/varieties - propagation and planting- special intercultural operation.
4. Marigold and Tuberose - identification and description of species/varieties - propagation and planting -special intercultural operation.
5. Crossandra, Nerium and Gomphrena - identification, description of species/varieties, nursery raising and planting.
6. Dutch Rose- identification and description of species/varieties – propagation and planting – special intercultural operation.
7. Cut Chrysanthemum- identification and description of species/varieties – propagation and planting – special intercultural operation.
8. Carnation and Gerbera - identification and description of species/varieties – media – planting- special intercultural operation.
9. Gladiolus - identification and description of species/varieties – media – planting- special intercultural operation.
10. Anthurium and Orchids – identification and description of species/varieties – media preparation – planting- special intercultural operation.
11. Post-harvest handling of cut flowers.
12. Tinting of cut flowers.
13. Drying and preservation of flowers.
14. Visit to flower growing and flower markets areas - loose flowers.

15. Visit to cut flower production units & markets.
16. Preparation of project report for major loose and cut flower production.
17. **University Practical Examination.**

Text Books

1. Bhattacharjee, S.K., (2010). *Advanced commercial floriculture*. Vol. Aaviskar. (1sted.) pp. 1 – 798.
2. Bose, T.K., Yadav, L.P., Pal. P., Parthasarathy, V.A., Das. P., (2003). *Commercial flowers*. Vol. I and II., Kolkata-6: Nayaudyog.
3. Bose, T. K. and Yadav, P. (1989). *Commercial flowers*. Calcutta: Naya Prakash. pp 874.
4. Ponnusamy. V and Aruna . P. (2011). *Post Harvest Techniques and Management of dry flowers*. New Delhi: NIPA. pp.1-240.
5. Sachin Tyagi, I. and Sanjay Sajhay. (2020). *Protected cultivation of flowers*. New Delhi: NIPA. pp. 1-132.

Reference Books

1. Bhattacharjee and De. L.C. (2004). *Advanced Commercial Floriculture*. Vol. I & II.
2. Lakshman Chandra. D. E. (2011). *Value addition in flowers and orchids*. New Delhi: NIPA Publishers. pp. 1 to 306.
3. Prasad, S. and Kumar, U (2003). *Commercial floriculture*. Jodhpur: Agrobios.
4. Sheela. V. L. (2008). *Flowers for Trade*. New Delhi: NIPA Publishers. pp. 1-336.
5. Suresh K Malhotra Lallan Ram.(2017). *Advances in Floriculture and Landscape Gardening*. Nagaland: Central Institute of Horticulture. pp.1 - 322.

Web Reference:

1. www.apeda.gov.in
2. www.ispc.co.in
3. www.krishijagran.com
4. www.agrimoon.com
5. www.imarcgroup.org
6. www.oakhillgardens.com
7. <https://youtu.be/6YKzwnroZRC>
8. <https://youtu.be/hoSrs1hL15M>
9. <https://youtu.be/w8-uyzryqMA>

Journals

1. Indian Journal of Horticulture
2. Journal of South Indian Horticulture
3. Journal of Ornamental Horticulture.
4. The American Journal of Horticulture and Floriculture Research
5. Journal of Floriculture and Landscaping

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	05	05	05	-	15
Grand Total							100

Course Code	HOR19304	Course Name	Spices and Condiments	Course Category	C	Compulsory Core	L	T	P	C
							2	0	1	3

Pre-requisite Courses	HOR9101	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Horticulture	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		
CLR-1 :	Understand the scope and importance of spices and condiments			
CLR-2 :	Discuss the production technology of importance of spices and condiments			
CLR-3 :	Explain the nursery management and propagation techniques of spices and condiments			
CLR-4 :	Determine the field management of spices and condiments			
CLR-5 :	Summarize the post-harvest technology and processing of spices and condiments			
CLR-6 :	Paraphrase the knowledge on value addition of spices and condiments			

Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:		
CLO-1 :	Describe the skills on commercial production techniques of spices and condiments that can be adopted to specific geographical region			
CLO-2 :	Explain nursery management of various spices and condiments			
CLO-3 :	Discuss propagation techniques of various spices and condiments			
CLO-4 :	Summarize the package and practices of spices and condiments			
CLO-5 :	Determine the pre and post-harvest technique of various spices and condiments			
CLO6 :	Recognize spices and condiments field and work out the benefits of cost ratio			

Learning			
1	2	3	
Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	

Program Learning Outcomes (PLO)														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems through Horticulture	Ability to implement knowledge gained in the field of spices and condiments	Ability to understand social and ethical responsibilities of Production Technology of Spices & condiments
M	M	M	M	M	M	H	M	M	H	M	H	H	H	M
H	M	M	M	M	H	H	H	H	H	H	H	H	H	H
H	H	M	M	M	H	M	H	H	H	H	H	H	H	M
M	M	M	M	M	M	M	M	M	H	M	H	H	H	M
M	M	M	M	M	M	M	M	M	H	M	H	H	H	M
M	M	M	M	M	M	M	M	M	H	M	H	H	H	M

Duration (hour)	Learning Unit / Module 1 3T+4P	Learning Unit / Module 2 9T+3P	Learning Unit / Module 3 6T+3P	Learning Unit / Module 4 10T+3P	Learning Unit / Module 5 5T+3P
S-1	SLO-1 Introduction to spices and condiments	Introduction to black pepper	Introduction to clove and its propagation technique	Introduction to coriander and its propagation technique	Introduction to rosemary and its propagation technique
	SLO-2 Export and import status	Propagation technique of black pepper	Management of field, harvest and post-harvest of clove	Management of field, harvest and post-harvest of coriander	Management of field, harvest and post-harvest of rosemary
S-2	SLO-1 Classification of spices	Field establishment and management of black pepper field	Introduction to nutmeg and its propagation technique	Introduction to tamarind and its propagation technique	Introduction to thyme and its propagation technique
	SLO-2 Active principles of spices	Harvest and post harvest technology of black pepper	Management of field, harvest and post-harvest of nutmeg	Management of field, harvest and post-harvest of tamarind	Management of field, harvest and post-harvest of thyme
S-3	Practical-1 Identification of species and varieties and rapid multiplication technique of black pepper	Seed treatment, field preparation and sowing of Coriander and Fenugreek under shade net	Practices in propagation and top working of Nutmeg and Allspice	Propagation, training and pruning of Vanilla	Economics of spice crops
S-4					
S-5	SLO-1 Institution working on spices and condiments	Introduction to betelvine and its propagation technique	Introduction to cinnamon and its propagation technique	Introduction to coriander	Introduction to saffron
	SLO-2 Role of commodity boards	Management of field, harvest and post-harvest of betelvine	Management of field, harvest and post-harvest of cinnamon	Propagation technique of coriander	Propagation technique of saffron

Duration (hour)		Learning Unit / Module 1 3T+4P	Learning Unit / Module 2 9T+3P	Learning Unit / Module 3 6T+3P	Learning Unit / Module 4 10T+3P	Learning Unit / Module 5 5T+3P
S-6	SLO-1		Introduction to cardamom	Introduction to allspice and its propagation technique	Field establishment and management of coriander field	Field establishment and management of saffron field
	SLO-2		Propagation technique of cardamom	Management of field, harvest and post-harvest of allspice	Harvest and post harvest technology of coriander	Harvest and post harvest technology of saffron
S-7	Practical-2	Identification of varieties and propagation of Cardamom	Seed treatment, field preparation and sowing of Fennel and Cumin	Varieties description, practices in propagation, nursery preparation of Curry leaf and Tamarind	Grading of spice crops	Visit to Spice Board and IISR, Calicut
S-8						
S-9	SLO-1		Field establishment and management of cardamom field	Introduction to curry leaf and its propagation technique	Introduction to fenugreek and its propagation technique	Introduction to asafoetida and its propagation technique
	SLO-2		Harvest and post harvest technology of cardamom	Management of field, harvest and post-harvest of curry leaf	Management of field, harvest and post-harvest of fenugreek	Management of field, harvest and post-harvest of asafoetida
S-10	SLO-1		Introduction to ginger	Introduction to tamarind and its propagation technique	Introduction to fennel and its propagation technique	
	SLO-2		Propagation technique of ginger	Management of field, harvest and post-harvest of tamarind	Management of field, harvest and post-harvest of fennel	
S-11	Practical-3	Curing and processing of Turmeric	Varieties description, harvesting and processing of Cinnamon and Clove	Propagation, harvesting and processing of Thyme and Rosemary	Techniques in extraction of essential oil and oleoresin from important spices	Visit to processing unit/ essential oil and oleoresin extraction units
S-12						
S-13	SLO-1		Field establishment and management of ginger field		Introduction to cumin and its propagation technique	
	SLO-2		Harvest and post harvest technology of ginger		Management of field, harvest and post-harvest of cumin	
S-14	SLO-1		Introduction to turmeric		Introduction to dill and its propagation technique	
	SLO-2		Propagation technique of turmeric		Management of field, harvest and post-harvest of dill	
S-15	Practical-4	Description of varieties and rapid multiplication technique of Ginger	Varieties description, harvesting and processing of Cinnamon and Clove			
S-16						
S-17	SLO-1		Field establishment and management of turmeric field		Introduction to celery and its propagation technique	
	SLO-2		Harvest and post harvest technology of turmeric		Management of field, harvest and post-harvest of celery	
S-18	SLO-1				Introduction to ajwain and its propagation technique	
	SLO-2				Management of field, harvest and post-harvest of ajwain	

Learning Resources	1. Kumar, N, Md. Abdul Khader, Rangasamy, P., and Irulappan, I. (2017). <i>Spices, Plantation Crops, Medicinal and Aromatic plants</i>, Rajalakshmi Publications, Nagercoil. pp 1-51 2. Sharangi, A. (2018). <i>Indian Spices: The Legacy, Production and Processing of India's Treasured Export</i>. Springer International Publishing. pp 1-461

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember	50 %	30 %	35 %	30 %
	Understand				
Level 2	Apply	30 %	40 %	35 %	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	30 %	30 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
<i>Dr. Subbiah, Retired professor TNAU, Consultant of Spices, Plantation, Medicinal and Aromatic crops, Theni, Tamil Nadu</i>	<i>Dr. N. Mini Raj, Professor, Department of Plantation crops & Spices, Kerala Agricultural University, Thrissur, Kerala</i>	<i>Dr. Akoijam Ranjita Devi Dr. B. Gopu</i>

THEORY

Unit I: Importance and classification of spices and condiments

Introduction, history of spices, definition of spices and condiments, important spice crops of India, importance, role of spices in human nutrition, industry, exports and imports of spices in improving the national economy. Classification of Spices - Different classifications based on economic importance, cultivation methods, family, longevity of spice plants, type of the spice, origin and flavour, plant part used, active principle. Role of spices board, Pepper Export Promotion Council, Institutes working on spices and condiments, role of organizations for improvement of spices and condiments.

Unit II: Production technology of major spice crops

Origin and distribution, area and production, uses, botany, varieties, soil and climate, propagation, intercrop and mixed crop, shade and shade regulation, training and pruning, role of growth regulators, nutritional management, irrigation, weed control, maturity indices, harvesting, post harvest technology and value added products.

Crops: Black pepper, Betel vine, Cardamom, Turmeric and Ginger.

Unit III: Production technology of tree spices

Importance, origin and distribution, area and production, importance, uses, botany, varieties, soils and climate, propagation, nursery management, planting, staking, weeding, manuring, irrigation, pruning, mixed cropping system, harvesting, curing and processing, grading, packing, storage and value added products.

Crops: Clove, Nutmeg, Cinnamon, All spice, Curry leaf and Tamarind

Unit IV: Production technology seed spices

Importance, origin and distribution, area and production, uses, botany, varieties, soil and climate, field preparation, season, seed rate, spacing, seed treatment and sowing, nutritional management, thinning, irrigation, hoeing, weeding, harvesting and threshing and value added products.

Crops: Coriander, Fenugreek, Fennel, Cumin, Dill, Celery, Bishop weed

Unit V: Production technology herbal and other spices

Importance, origin and distribution, area and production, uses, botany, varieties, soil and climate, field preparation, season, seed rate, spacing, seed treatment and sowing, nutritional management, thinning, irrigation, hoeing, weeding, harvesting and threshing and value added products.

Crops: Rosemary, Thyme, Vanilla, Saffron and Asafoetida

Theory – Lecture Schedule

1. Introduction, history of spices, definition of spices and condiments, important spice crops of India (List of the crops with Common name, Botanical name and family), importance, role of spices in human nutrition, industry, exports and imports of spices in improving the national economy.
2. Classification of Spices - Different classifications based on economic importance, cultivation methods, family, longevity of spice plants, type of the spice, origin and flavour, plant part used, active principle.
3. Institutes working on spices and condiments, role of organizations for improvement of spices and condiments like IISR, ICAR, DCASD and Spices Board.
4. Black Pepper – origin and distribution, area and production, uses, botany, types of shoots, varieties, soil and climate, propagation with seed, vegetative method – cuttings, layering, rapid multiplication method, bush pepper, intercrop and mixed crop.
5. Black Pepper – Establishment of pepper garden, planting of standard plants, planting of the vines, shade and shade regulation, training and pruning of pepper vines. Role of growth regulators, nutritional management, irrigation, weed control, maturity indices, harvesting, post harvest technology, despiking, blanching, black pepper, white pepper, drying and curing various forms of black pepper. Packing, storage and value added products.
6. Betel vine – origin and distribution, area and production, uses, botany, soil and climate, varieties, propagation, season, preparation field and planting, training of live standard, trailing of vines, lowering of vines, intercrop and mixed crop, nutritional management, irrigation, weed control, maturity indices, harvesting, post harvest technology and value added products.
7. Cardamom – origin and distribution, area and production, uses, botany, varieties, small and large cardamom, types of cardamom like, Malabar, Mysore and Vazukka, soil and climate, selection of site, propagation, seed and vegetative method like suckers.
8. Cardamom – planting, mulching, weeding, trashing, shade regulation, earthing up, nutrient and irrigation management, role of growth regulators, inter cropping and mixed cropping, harvesting indices, yield and post harvest technology – bleached cardamom.
9. Ginger – origin and distribution, area and production, importance, uses, botany, varieties, soil and climate, propagation, selection of land and preparation, planting season, seed rate, spacing, methods – bed system and ridge and furrow system, seasons, earthing up, mulching, systems of cultivation like rotations and mixed cropping.
10. Ginger – irrigation, nutrient management, harvesting and curing, green ginger, dry ginger – bleached and unbleached ginger, preserved ginger. Storage, grades of ginger, value added products like soft drink ginger candy, murabba, pickles, ginger wine, preservation of seed rhizome.
11. Turmeric – origin and distribution, area and production, importance, uses, botany, species, varieties, soil and climate, propagation, selection of mother rhizome, selection of land and preparation. Methods of cultivation like bed system, ridge and furrow system planting – seasons, seed rate, spacing, mulching, earthing up.

12. Turmeric- irrigation, nutrient management, weeding, shade provision, cropping systems like inter cropping, rotations, role of growth regulators, harvesting and processing (curing, polishing, colouring), packing and storage, grades of turmeric, value added products like turmeric powder, oil and oleoresin, preservation of seed rhizome.
13. Clove – origin and distribution, area and production, importance, uses, botany, varieties, soil and climate, propagation by seed – selection of mother cloves, nursery management, planting, staking, weeding, manuring, irrigation, pruning, mixed cropping system, harvesting, curing and processing, grading, packing and storage, value added products like clove bud oil, clove stem oil, clove leaf oil, clove root oil, oil of mother clove.
14. Nutmeg – origin and distribution, area and production, importance, uses, botany, varieties, soils and climate, propagation, seed and vegetative method, nursery techniques, planting, cropping system like mixed cropping, manuring, weeding, intercultural, sex problem, top working, harvesting, post harvest technology, grading, packing and value added products.
15. Cinnamon – importance, origin and distribution, area and production, uses, species of cinnamomum, difference between cinnamon bark and cassia bark, varieties, soil and climate, propagation – seed, cuttings, layers, nursery management, planting, weeding, manuring, irrigation, coppicing, harvesting, post harvest technology – cutting and peeling, preparation of quills, drying, grading – quills, quillings, featherings, chips, packing, storage and value added products
16. All Spice – introduction, area and production, uses, botany, varieties, soil and climate, propagation like seed and vegetative method – budding, approach grafting, planting, weeding, manuring, harvesting, post harvest technology like drying and curing and value added products like berry oil, leaf oil, oleoresin.
17. **In-semester examination**
18. Curry Leaf– introduction, area and production, uses, botany, varieties, soil and climate, propagation like seed, planting, weeding, pruning, manuring, harvesting and post harvest technology.
19. Tamarind - introduction, area and production, uses, botany, varieties, soil and climate, propagation like seed and vegetative method – softwood grafting and air layering, planting, weeding, training and pruning, manuring, harvesting, post harvest technology and value added products.
20. Coriander - importance, origin and distribution, area and production, uses, botany, varieties, soil and climate, field preparation, seasons, seed rate, spacing, seed treatment and sowing.
21. Coriander - nutritional management, thinning, irrigation, hoeing, weeding, harvesting, threshing and value added products.
22. Fenugreek – importance, origin and distribution, area and production, uses, botany, varieties, soil and climate, field preparation, seasons, seed rate, spacing, seed treatment and sowing, nutritional management, thinning, irrigation, hoeing, weeding, harvesting and threshing, value added products.
23. Fennel – importance, origin and distribution, area and production, uses, botany, varieties, soil and climate, field preparation, seasons, seed rate, spacing, seed treatment and sowing, nutritional management, thinning, irrigation, hoeing, weeding, earthing up, harvesting, threshing and value added products.
24. Cumin – importance, origin and distribution, area and production, uses, botany, varieties, soil and climate, field preparation, seasons, seed rate, spacing, sowing, nutritional management, thinning, irrigation, hoeing, and weeding, harvesting, threshing and value added products.
25. Dill – importance, origin and distribution, area and production, uses, botany, varieties, soil and climate, field preparation, seasons, seed rate, spacing, sowing, nutritional management, thinning, weeding, irrigation, harvesting, and value added products.
26. Celery – importance, origin and distribution, area and production, uses, botany, varieties, soil and climate, field preparation, seasons, seed rate, spacing, sowing, nutritional management, blanching, thinning, weeding, earthing up, irrigation, harvesting and value added products.
27. Bishops weed (Ajwain) – importance, origin and distribution, area and production, uses, botany, varieties, soil and climate, field preparation, seasons, seed rate, spacing, sowing, nutritional management, weeding, earthing up, irrigation, harvesting and value added products.
28. Rosemary - Importance and uses, origin, distribution, botany, varieties, soil, climate, land preparation, propagation, transplanting, spacing, manures and fertilizers, irrigation, interculture, harvesting, yield.
29. Thyme - Importance and uses, origin, distribution, botany, varieties, soil, climate, land preparation, propagation, transplanting, spacing, manures and fertilizers, irrigation, interculture, harvesting and yield.
30. Vanilla – importance, area and production, uses, botany (labellum, rostellum), varieties, constraints of production, propagation by cuttings, soil and climate, land preparation, planting, staking, training, manuring, flowering and pollination-hand pollination
31. Vanilla –harvesting, curing and processing and types of vanilla like Mexican, Bourbon and Indonesian vanilla, value added products like vanilla pods, vanilla essence, vanilla sugar, vanilla oleoresins, grading, packing and storage.
32. Saffron – importance, area and production, uses, botany, varieties, propagation, soil and climate, land preparation, planting, weeding, manuring
33. Saffron –picking, drying, grading, packing and storage.
34. Asafoetida - introduction, area and production, uses, botany, varieties, soil and climate, propagation, preparation of land and planting, manuring, irrigation and weeding, tapping, processing, packing, storage and value added products.

Practical Schedule

1. Identification of species and varieties and rapid multiplication technique of black pepper
2. Identification of varieties and propagation of Cardamom
3. Curing and processing of Turmeric
4. Description of varieties and rapid multiplication technique of Ginger
5. Seed treatment, field preparation and sowing of Coriander and Fenugreek under shade net
6. Seed treatment, field preparation and sowing of Fennel and Cumin

7. Varieties description, harvesting and processing of Cinnamon and Clove
8. Practices in propagation and top working of Nutmeg and Allspice
9. Varieties description, practices in propagation, nursery preparation of Curry leaf and Tamarind
10. Propagation, harvesting and processing of Thyme and Rosemary
11. Propagation, training and pruning of Vanilla
12. Grading of spice crops
13. Techniques in extraction of essential oil and oleoresin from important spices
14. Economics of spice crops
15. Visit to Spice Board and IISR, Calicut
16. Visit to processing unit/ essential oil and oleoresin extraction units
17. **University Practical Examination**

Text Books

1. Kumar, N. (2018). Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants. CBS Publishers; 2nd edition. pp 1-351
2. Jitendra Singh (2008). Spices and Plantation Crops. Aavishkar Publishers and Distributors, Jaipur. pp 1-465
3. Nybe, E.V., N. Miniraj and Peter, K.V. (2007). Spices – Horticulture Science Series Vol. 5. New India Publishing Agency, New Delhi. pp 1-320
4. Sharangi, A. (2018). Indian Spices: The Legacy, Production and Processing of India's Treasured Export. Springer International Publishing. pp1-461

Reference Books

1. Chadha, K.L and P. Rethinam (ed.) (1994). Advances in Horticulture. Vol. 10 & 11. Spices and Plantation Crops, ICAR publications, New Delhi. pp1-9410
2. Purseglove, J. W., E.G. Brown, C. L. Green and S. R. J. Robbins. (1991). Spices, Vol. I and II. Longman Scientific and Technical, England. pp 1-813

Web references

1. <http://www.spices.rec.in>
2. www.iisr.org
3. www.kissankerala.net
4. https://ecourses.icar.gov.in/e-Leaarningdownload3_new.aspx?Degree_Id=07
5. <https://www.youtube.com/watch?v=5ysVe15sFSs>
6. <https://www.youtube.com/watch?v=sMrBnwISK-M>
7. <https://www.youtube.com/watch?v=4UDRFlyAUgo>

Journals

1. Indian J. Arecanut, Spices and Medicinal Plants
2. Spice India
3. Indian Journal of Horticulture
4. Journal of Spices and Aromatic Crops

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	CRH19301	Course Name	Fundamentals of Entomology	Course Category	S	Supportive Course	L	T	P	C
							2	0	1	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Crop Protection	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:			Learning			Program Learning Outcomes (PLO)														
CLR-1 :	Discuss the contributions of different scientists in the development field of Entomology				1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	Understand the position of insect in animal kingdom and their relationship with other arthropods and reason behind the insect dominance				Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems	Ability to implement knowledge gained in the Agricultural Entomology	Ability to understand social and ethical responsibilities of Agricultural Entomology
CLR-3 :	Recall the information on different insect morphological feature and their mouth parts for the control of pests in pesticide application																					
CLR-4 :	Describe the techniques of physiology of insects																					
CLR-5 :	Paraphrase the knowledge on taxonomical feature of insects																					
CLR-6 :	Recall the taxonomical classification of 29 group of insects orders																					
Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:																				
CLO-1 :	Explain the position of insects and their relationships with other arthropods				3	90	80	M								M	H		H	H	H	H
CLO-2 :	Perform the basic morphological feature of different group of insects				1	95	85	H								L	H		H	H	H	H
CLO-3 :	Recognize the wings morphological feature so that insects can be classified based on the wing morphological feature				2	80	70	M		L	L					L	H		H	H	H	H
CLO-4 :	Discuss the knowledge on physiology of insects so that students can able to recommend the pesticide to control insects				3	75	65	M			L	L				M	H		H	H	H	H
CLO-5 :	Explain the taxonomical classification of insects				2	75	60	L	L							M	H		H	H	H	H
CLO6 :	Understand the taxonomical classification of 29 orders				2	75	65	L						H		M	H		H	H	H	H

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		4	9	25	12	14
S-1	SLO-1	History and Importance, Position of insects in the animal kingdom	Insect body wall - its structure and function, cuticular appendages.	Digestive system - structure of alimentary canal and its modifications in certain groups. Digestive enzymes, digestion and absorption of nutrients.	Taxonomy principles and procedures of classification and nomenclature of insects.	Psocoptera, Mallophaga and Siphunculata.
	SLO-2	Reason for insect dominance	Moulting process in insects.	Lab:4 Mouth parts of cockroach, modifications in the mouth parts in plant bug, female mosquito, honeybee, thrips, antlion grub, housefly, moths and butterflies	Lab:10 Observing the characters of Apterygota - Collembola and Thysanura and Exopterygota -Odonata and Ephemeroptera and Phasmida	Lab: 13 Observing the characters of orders Thysanoptera and Diptera (Cecidomyiidae, Agromyzidae, Tephritidae, Asilidae, Tabanidae, Tachinidae, Hippoboscidae, Culicidae, Syrphidae and Muscidae)
S-2	SLO-1	Lab:1 Observations on external features of grasshopper / cockroach	Lab:2 Methods of insect collection, preservation, pinning, labelling, display and storage	Excretory system in insects - malpighian tubules - accessory excretory organs and physiology of excretion.	Distinguishing characters of insect orders — Apterygota - Collembola and Thysanura	Endopterygota — Lepidoptera and families of agricultural importance..

Duration (hour)	Learning Unit / Module 1		Learning Unit / Module 2		Learning Unit / Module 3		Learning Unit / Module 4		Learning Unit / Module 5	
	4		9		25		12		14	
	SLO-2		Structure of insect head and its appendages.		Respiratory system in insects - structure of trachea - tracheoles - types of respiratory system - types of spiracles - respiration in aquatic and Endoparasitic insects.		Exopterygota — Ephemeroptera, Odonata and Phasmida		Coleoptera and families of agricultural importance	
S-3	SLO-1		Structure of insect thorax and its appendages.		Lab:5 Structure of thorax and abdomen and their appendages —modifications in insect		Lab:11 Dictyoptera, Dermaptera, Embioptera, Orthoptera (Acrididae, Tettigonidae, Gryllidae and Gryllotalpidae), Mallophaga and Siphunculata		Lab:14 Observing the characters of Hymenoptera (Tenthredinidae, Apidae, Sphecidae, Vespidae, Formicidae, Xylocopidae, Chalcididae, Megachilidae, Ichneumonidae, Bethyidae, Braconidae, Agaonidae, Evaniidae, Encyrtidae, Eulophidae and Trichogrammatidae).	
	SLO-2		Lab:3 Types of insect head and antenna		Circulatory system in insects - haemocoel and dorsal vessel - circulation of blood - composition of haemolymph - haemocytes and their functions.		Dictyoptera, Dermaptera, Embioptera		Diptera and families of agricultural importance.	
S-4	SLO-1		Structure of insect abdomen and its appendages.		Nervous system in insects - structure of neuron – types of nervous systems		Orthoptera (Families of Agricultural Importance) and Isoptera — social life in termites		Hymenoptera and families of agricultural importance.	
	SLO-2		-		Lab:6 legs and wings — wing venation, regions and angles — wing coupling.		Lab: 12 Exopterygota — Isoptera and Hemiptera — Homoptera (Cicadidae, Cicadellidae, Delphacidae, Aphididae, Cercopidae, Membracidae, Aleyrodidae, Coccidae, Diaspididae, Pseudococcidae, Kerridae and Psyllidae); Heteroptera (Reduviidae, Pentatomidae, Miridae, Coreidae, Pyrrhocoridae, Lygaeidae, Nepidae, Belastomatidae, Gerridae, Cimicidae, Tingidae),		Lab: 15 Observing the characters of Coleoptera (Curculionidae, Apionidae, Cicindellidae, Carabidae, Staphylinidae, Dytiscidae, Coccinellidae, Gyrinidae, Lampyridae, Hydrophilidae, Scarabaeidae, Dynastidae, Cerambycidae, Melolonthidae, Anobiidae, Tenebrionidae, Bruchidae, Meloidae, Cetoniidae, Buprestidae, Elateridae and Bostrychidae).	
S-5	SLO-1				Conduction of nerve impulses - axonic and synaptic transmissions.		Hemiptera (Families of Agricultural Importance) and Thysanoptera.		Neuroptera (Families of Agricultural Importance), Strepsiptera and Siphonaptera.	
	SLO-2				Male and female reproductive systems in insects – structure and modifications. Spermatogenesis and Oogenesis.				Lab: 16 Observing the characters of Lepidoptera (Nymphalidae, Lycaenidae, Pieridae, Papilionidae, Satyriidae, Crambidae, Pyraustidae, Noctuidae, Arctiidae, Bombycidae, Cochliidae, Geometridae, Gelechiidae, Pterophoridae, Saturniidae, Sphingidae, Lymantriidae and Hesperidae), Observing the characters of Neuroptera (Chrysopidae, Myrmeliontidae, Mantispidae, Ascalaphidae), Siphonoptera.	
S-6	SLO-1				Lab:7 Types of immature stages of insects.					
	SLO-2				Types of reproduction - oviparous, viviparous, paedogenesis, polyembryony, oviporous and parthenogenesis.					

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		4	9	25	12	14
S-7	SLO-1			Types of metamorphosis – Growth and development. Immature stages of insects		
	SLO-2			Lab: 8 Study of digestive system.		
S-8	SLO-1			Structure of sense organs - types of sensilla - photoreceptors; chemoreceptors and mechanoreceptors		
	SLO-2			Exocrine and endocrine glands and their function - effect on metamorphosis and reproduction		
S-9	SLO-1			Lab:9 Study of male and female reproductive systems.		
	SLO-2			Tropism and Biocommunication in insects - Sound and light production		

Learning Resources	1.	Alpheus, S. PACKARD. (1898). Text Book of Entomology, The MacMillan Company Ltd, London. pp1-752
	2.	Ragumoorthi, K.N., Balasubramani, V and Srinivasan. M.R. (2017). Insecta an introduction, A.E. Publications. pp1-224

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember	40 %	30 %	35 %	30 %
	Understand				
Level 2	Apply	40 %	40 %	35 %	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	30 %	30 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. K. Ramesh Ph.D Principal Biologist –Rice Insecticide and Nematicide, South Asia Co-chair for insecticide resistance action committee (IRAC), India Corteva Agrisciences (Dow Dupont), Madhapur, Hyderabad, India e- mail : ramesh.kaliaperumal@corteva.com mobile : 9952885708	Dr. Kumar K, Professor and Head, Department of Agricultural Entomology, PAJANCOA&RI, Karaikal-609603	Dr. L. Ramazeame Ph.D (Assistant Professor) Agricultural Entomology

THEORY

Unit I– History and importance

Entomology as a science - its importance in Agriculture. History of Entomology in India, Position of insects in the animal kingdom and their relationship with other classes of Arthropoda, Reasons for insect dominance.

Unit II– Morphology

General organization of insect body wall - structure and function, cuticular appendages, moulting. Body regions - insect head, thorax and abdomen, their structures and appendages

Unit III– Anatomy and physiology

Elementary knowledge of digestive, excretory, respiratory, circulatory, nervous and reproductive systems in insects. Sense organs and their functions, Exocrine and endocrine glands. Life cycle of insects- immature stages - types of reproduction – metamorphosis growth and development.

Unit IV– Taxonomy of apterygota and exopterygota

Taxonomy, Classification and nomenclature of insects. Distinguishing characters of agriculturally important orders and families of Apterygotes- Collembola and Thysanura, Exopterygotes - Ephemeroptera, Odonata, Orthoptera, Phasmida, Dictyoptera, Embioptera, Dermaptera, Hemiptera, Isoptera, Psocoptera, Mallophaga, Siphunculata and Thysanoptera.

Unit V–Taxonomy of endopterygota

Distinguishing characters of agriculturally important families of Lepidoptera, Coleoptera, Diptera, Hymenoptera, Siphonaptera, Strepsiptera and Neuroptera.

Theory – Lecture Schedule

1. Study of insects and their importance in Agriculture. History of Entomology in India Position of insects in the animal kingdom - relationship with other members of Arthropoda.
2. Insect dominance - structural, morphological and physiological factors responsible for dominance.
3. Insect body wall - its structure and function cuticular appendages.
4. Moulting process in insects.
5. Structure of insect head and its appendages.
6. Structure of insect thorax and its appendages.
7. Structure of insect abdomen and its appendages.
8. Digestive system - structure of alimentary canal and its modifications in certain groups. Digestive enzymes, digestion and absorption of nutrients.
9. Excretory system in insects - malpighian tubules - accessory excretory organs and physiology of excretion.
10. Respiratory system in insects - structure of trachea - tracheoles - types of respiratory system - types of spiracles - respiration in aquatic and Endoparasitic insects.
11. Circulatory system in insects - haemocoel and dorsal vessel - circulation of blood - composition of haemolymph - haemocytes and their functions.
12. Nervous system in insects - structure of neuron – types of nervous systems.
13. Conduction of nerve impulses - axonic and synaptic transmissions.
14. Male and female reproductive systems in insects – structure and modifications. Spermatogenesis and Oogenesis.
15. Types of reproduction - oviparous, viviparous, paedogenesis, polyembryony, oviporous and parthenogenesis.
16. Types of metamorphosis – Growth and development. Immature stages of insects.
17. **In- semester examination**
18. Structure of sense organs - types of sensilla - photoreceptors; chemoreceptors and mechanoreceptors
19. Exocrine and endocrine glands and their function - effect on metamorphosis and reproduction
20. Tropism and Biocommunication in insects — Sound and light production.
21. Taxonomy principles and procedures of classification and nomenclature of insects.
22. Distinguishing characters of insect orders — Apterygota - Collembola and Thysanura
23. Exopterygota — Ephemeroptera, Odonata and Phasmida,
24. Dictyoptera, Dermaptera, Embioptera
25. Orthoptera (Families of Agricultural Importance) and Isoptera — social life in termites
26. Hemiptera (Families of Agricultural Importance)

27. Thysanoptera.
28. Psocoptera, Mallophaga and Siphunculata.
29. Endopterygota — Lepidoptera and families of agricultural importance.
30. Coleoptera and families of agricultural importance.
31. Diptera and families of agricultural importance.
32. Hymenoptera and families of agricultural importance.
33. Neuroptera (Families of Agricultural Importance)
34. Strepsiptera and Siphonaptera.

Assignment

Each student has to submit a minimum of 100 preserved insects representing various orders and families

Practical – Schedule

1. Observations on external features of grasshopper / cockroach
2. Methods of insect collection, preservation, pinning, labelling, display and storage
3. Types of insect head and antenna
4. Mouth parts of cockroach, modifications in the mouth parts in plant bug, female mosquito, honeybee, thrips, antlion grub, housefly, moths and butterflies
5. Structure of thorax and abdomen and their appendages —modifications in insect
6. Legs and wings — wing venation, regions and angles — wing coupling.
7. Types of immature stages of insects.
8. Study of digestive system.
9. Study of male and female reproductive systems.
10. Observing the characters of Apterygota - Collembola and Thysanura and Exopterygota -Odonata and Ephemeroptera and Phasmida
11. Dictyoptera, Dermaptera, Embioptera, Orthoptera (Acrididae, Tettigonidae, Gryllidae and Gryllotalpidae), Mallophaga and Siphunculata
12. Exopterygota —Isoptera and Hemiptera — Homoptera (Cicadidae, Cicadellidae, Delphacidae, Aphididae, Cercopidae, Membracidae, Aleyrodidae, Coccidae, Diaspididae, Pseudococcidae, Kerridae and Psyllidae); Heteroptera (Reduviidae, Pentatomidae, Miridae, Coreidae, Pyrrhocoridae, Lygaeidae, Nepidae, Belastomatidae, Gerridae, Cimicidae, Tingidae),
13. Observing the characters of orders Thysanoptera and Diptera (Cecidomyiidae, Agromyzidae, Tephritidae, Asilidae, Tabanidae, Tachinidae, Hippoboscidae, Culicidae, Syrphidae and Muscidae)
14. Observing the characters of Hymenoptera (Tenthredinidae, Apidae, Sphecidae, Vespidae, Formicidae , Xylocopidae, Chalcididae, Megachilidae, Ichneumonidae, Bethyidae, Braconidae, Agaonidae, Evaniidae, Encyrtidae, Eulophidae and Trichogrammatidae).
15. Observing the characters of Coleoptera (Curculionidae, Apionidae, Cicindellidae, Carabidae, Staphylinidae, Dytiscidae, Coccinellidae, Gyrinidae, Lampyriidae, Hydrophilidae, Scarabaeidae, Dynastidae, Cerambycidae, Melolonthidae, Anobiidae, Tenebrionidae, Bruchidae, Meloidae, Cetoniidae, Buprestidae, Elateridae and Bostrychidae).
16. Observing the characters of Lepidoptera (Nymphalidae, Lycaenidae, Pieridae, Papilionidae, Satyriidae, Crambidae, Pyraustidae, Noctuidae, Arctiidae, Bombycidae, Cochliidae, Geometridae, Gelechiidae, Pterophoridae, Saturniidae, Sphingidae, Lymantriidae and Hesperidae) ,Observing the characters of Neuroptera (Chrysopidae, Myrmeliontidae, Mantispidae, Ascalaphidae), Siphonoptera.
17. **University Practical Examination**

Text Books

1. Alpheus ,S PACKARD. 1898. Text Book of Entomology , The MacMillan Company Ltd, London.pp1-752
2. Sehgal, P.K. 2017. Fundamentals of Agricultural Entomology. Kalyani publisher, Kolkata. pp1-399
3. Wigglesworth, V.B. 2013. Insect Physiology. Springer, Netherlands (Originally published by Chapman and Hall, London, 1974).pp1-192

Reference Books

1. Borror, D.J., D.M. Delong and C.A. Triple Horn (1976) An introduction to the study of insects (IV Edition). Holt, Rinehart and Winston, New York, London and Sydney. pp1 – 852.
2. Chapman, R.F (1981) The Insects: Structure Function. Edward Arnold (publishers) Ltd, London.pp1-354
3. Cedric Gillott (2005) Entomology (Third Edition). Springer, Netherlands, pp1-834
4. Nayar. K.K., T.N. Ananthakrishnan and B.V. David (1976) General and Applied Entomology. Tata Mc-Graw Hill publishing Company Ltd, New Delhi, pp1-589
5. Richards O.W. and R.G. Davies (1977) Imm's General Text Book of Entomology Vol. I and II. Chapman and Hall Publication, London, pp1-942

Web References

1. <http://www.itis.usda.gov/it is/>
2. <http://www.bluehen.ags.udel.edu.insects/description/entohoma.html>
3. <http://www.ex.ac.uk/gilramel/anatomy.html>
4. <http://www.uark.edu/academics/undergrad.html>
5. <http://www.cabi-publishing.org>
6. <https://youtu.be/WPeIF61BkvQ>

Journals

1. International Journal of Insect Morphology and Embryology
2. Insect Morphology and Phylogeny
3. Journal of Insect Science

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	CRH19302	Course Name	Fundamentals of Plant Pathology	Course Category	S	Supportive Course	L 2	T 0	P 1	C 3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	CRH19402
Course Offering Department	Plant Pathology		Data Book / Codes/Standards	Nil	

Course Learning Rationale (CLR):		The purpose of learning this course is to:		
CLR-1 :	Outline of the history, terms and concepts of plant pathology			
CLR-2 :	Paraphrase the fungi and their classification			
CLR-3 :	Identify different symptoms caused by fungi			
CLR-4 :	Discuss different plant pathogenic organisms and symptoms caused by bacteria, virus, viroids, algae, etc			
CLR-5 :	Understand the different epidemiological factors responsible for plant diseases			
CLR-6 :	Explain various approaches on integrated disease management			

Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:		
CLO-1 :	Interpret different crop related pathogen issues			
CLO-2 :	Explain symptoms of nematode infection			
CLO-3 :	Identify the type of pathogenic organism based on symptoms and microscopic observation			
CLO-4 :	Recall the knowledge on environmental factors responsible for plant disease			
CLO-5 :	Explain the plant stress phenomenon, and recommend the best cultural, chemical, and biological control methods towards management			
CLO6 :	Potential for a business entrepreneur			

Learning		
1	2	3
Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)

Program Learning Outcomes (PLO)														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems	Ability to implement knowledge gained in the applied field	Ability to understand social and ethical responsibilities
M								L	H		H	H	H	H
H		M						H	H		H	H	H	H
M	M							M	H		H	H	H	H
M								L	H		H	H	H	H
L	L							L	H		H	H	H	H
L						H		L	H		H	H	H	H

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		9	24	8	7	16
S-1	SLO-1	Introduction and History - Plant Pathology	General characters of fungi	Phytopathogenic bacteria-Classification	Crop disease epidemiology	IDM- Crop inspection, Seed certification
	SLO-2	Socio-economic importance of plant pathology	Fungal Reproduction	Phytopathogenic bacteria-Symptoms	Interaction between host, parasite and environment	IDM - Quarantine
S-2	SLO-1	Terms and concepts in plant pathology	Classification of Protozoa	Infection process- Plant pathogenic bacteria	Boom and bust cycle	IDM - Mechanical, Physical methods
	SLO-2	Causes of Plant Disease	Life cycle- Plasmodiophora brassicae	Survival and dispersal- Plant pathogenic bacteria	Disease cycle – important plant pathogen	IDM - Cultural methods
S-3 & 4	SLO-1	Lab 1- Microscopy	Lab 3- Fungal Reproduction	Lab 9 – Symptoms – Bacteria, Phytoplasma	Lab 11- isolation- fungi and bacteria	Lab 13- Fungicidal solution- preparation and application
	SLO-2	Parasitism and Infection Process	Classification of Chromista	Phytoplasma- symptoms	Disease surveillance	Types of plant resistance
S-5	SLO-1	Survival and dispersal	Life cycle- Pythium and Phytophthora	Fastidious vascular bacteria-Symptoms	Disease assessment	Mechanism – Plant Resistance
	SLO-2	Host pathogen interaction	General Characters - Albugo and Peronospora	Virus, viroid - Symptoms		IDM - Chemical methods
S-6	SLO-1	Role of toxins and enzymes in pathogenesis	General Characters – Pseudoperonospora and Plasmopara	Algae and Phanerogamic parasites- Symptoms		IDM – Biological method
	SLO-2					

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		9	24	8	7	16
S-7 & 8	SLO-1	Lab 2- General Characters of fungi	Lab 4 – Host parasite relationship- Protozoa and Chromista	Lab 10 – Symptoms – Virus and Phanerogamic parasites	Lab 12- Classification of fungicides	Lab 14- Mass production Trichoderma and Pseudomonas
	SLO-2					
S-9	SLO-1	Infectious disease	Classification of Chytridiomycota	-	-	Contact fungicide- classification
	SLO-2	Non infectious disease	Classification of Zygomycota	-	-	Systemic fungicide- classification
S-10	SLO-1	-	Classification of Taphrina, Capnodium, Mycosphaerella	-	-	Fungicide application method
	SLO-2	-	Classification of Alternaria, Botryosphaeria and Venturia.	-	-	Precautions and safety measures in storage and handling of fungicides.
S-11 & 12	SLO-1	-	Lab 5- Host parasite relationship- Zygomycota and Dothidiomycetes	-	-	Lab 15- Cross protection
	SLO-2	-				
S-13	SLO-1	-	Classification of Eurotium, Talaromyces, Erysiphe, and Leveillula	-	-	IDM- Biological control
	SLO-2	-	Classification of Phyllactinia, Uncinula, Podosphaera and Sphaerotheca	-	-	IDM- Botanicals and Anti-viral principles
S-14	SLO-1	-	Classification of Fusarium and Verticillium	-	-	Integrated crop management- I
	SLO-2	-	Classification of Glomerella, and Macrophomina	-	-	Integrated crop management- I
S-15 & 16	SLO-1	-	Lab 6- Host parasite relationship- Powdery mildew	-	-	Lab 16- Survey, assessment - plant diseases
	SLO-2	-				
S-17	SLO-1	-	Classification- Basidiomycota	-	-	-
	SLO-2	-	General Characters- Basidiomycota	-	-	-
S-18	SLO-1	-	Classification - Rust fungi	-	-	-
	SLO-2	-	Symptoms- Rust Fungi	-	-	-
S-19 & 20	SLO-1	-	Lab 7- Host parasite relationship- Sordariomycetes	-	-	-
	SLO-2	-				
S-21	SLO-1	-	Classification - Smut fungi	-	-	-
	SLO-2	-	Symptoms- Smut Fungi	-	-	-
S-22	SLO-1	-	Characters- Ganoderma, Agaricus, Pleurotus, and Volvariella	-	-	-
	SLO-2	-	Characters - Calocybe, Exobasidium and Athelia.	-	-	-
S-23 & 24	SLO-1	-	Lab 8 - Host parasite relationship- Basidiomycota	-	-	-
	SLO-2	-				

Learning Resources	1. Agrios, G.N. (2005). Plant Pathology (5 th Ed.). New York. Academic: Press. pp. 1-922.	2. Alice. D, and Jeyalakshmi. C (2014). Plant Pathology. Coimbatore: A.E Publications. pp.1-375.

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In semester (20%)	Practical (15%)		
Level 1	Remember	40 %	45 %	40 %	45 %
	Understand				
Level 2	Apply	40 %	30 %	30 %	30 %
	Analyze				
Level 3	Evaluate	20 %	25 %	20 %	25 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. A. Bharani deppan, Ph.D. E.I. DuPont India Pvt Ltd. The V-Ascendas, Atria Block, 12th Floor, Plot.17 SoftwareUnits Layout, Madhapur, Hyderabad, Telangana Ph: 936666899 Mail: bharani-deepan.a@corteva.com	Dr. A. Kamalakannan, Professor Department of Plant Pathology Tamil Nadu Agricultural University Coimbatore- 641003 Ph: 9790620313 E-Mail: kamals2k@yahoo.co.in	Dr. Rageshwari S (Assistant Professor) Plant Pathology Dr. VinodKumar S (Assistant Professor) Plant Pathology

THEORY

Unit I – Plant pathogenic organisms (5 Hour)

Plant Pathology - Definition - Objectives - Scope - History of Plant Pathology and Economic importance of plant diseases - Terms and concepts in Plant Pathology - Causes of Plant Diseases - Parasitic and Non parasitic causes - Classification of Plant Diseases – Parasitic/ Biotic causes – Plant Pathogens - Protozoa, Fungi, Bacteria, Candidatus Phytoplasma, Fastidious vascular bacteria, Spiroplasma, Viruses, Viroids, Algae and Phanerogamic parasitic plants - Koch's postulates – Non parasitic / Abiotic causes - Abiotic disorders- Types of parasitism - Infection process - Survival and dispersal. Role of toxins and enzymes in Pathogenesis. Classification of Plant diseases.

Unit II – Fungi and their classification (12 Hours)

General characters of fungi - Somatic structures - Types of mycelia - Resting structures - Asexual and Sexual reproduction - Classification of Kingdom: Protozoa - important taxonomic characters and symptoms and life cycle of *Plasmodiophorabraceae*, Classification of Kingdom: Chromista - important taxonomic characters - Classification of Phylum: Oomycota, Symptoms caused by *Pythium*, *Phytophthora*, *Albugo*, *Peronospora*, *Pseudoperonospora* and *Plasmopora*. Classification of Kingdom: Fungi - Classification of Phylum: Chytridiomycota and Zygomycota. Classification of Phylum: Ascomycota - Taxonomic characters and symptoms caused by *Taphrina*, *Capnodium*, *Mycosphaerella*, *Alternaria*, *Botryosphaeria* and *Venturia* - life cycle of *Venturia* - Taxonomic characters and symptoms of *Aspergillus*, *Penicillium*, *Erysiphe*, *Leveillula*, *Phyllactinia*, *Uncinula*, *Podosphaera* and *Sphaerotheca* - Taxonomic characters and symptoms caused by *Fusarium*, *Verticillium*, *Glomerella*, and *Macrophomina* - Classification of Phylum: Basidiomycota - Taxonomic characters and symptoms caused by rust fungi - Taxonomic characters and symptoms caused by smut fungi - Taxonomic characters of *Ganoderma*, *Exobasidium*, *Athelia*, *Agaricus*, *Pleurotus*, *Calocybe* and *Volvariella*.

Unit III - Bacteria, viruses, viroids, algae and phanerogamic parasites (4 Hours)

General characters of Bacteria - Taxonomy of bacteria – symptoms of Plant bacterial diseases – Infection process - Mode of entry - Survival and dispersal - General characters and symptoms caused by Candidatus Phytoplasma, Fastidious vascular bacteria, Spiroplasma, Viruses, Viroids, Algae and Phanerogamic parasitic diseases.

Unit IV – Plant disease epidemiology (3 Hours)

Epidemiology of crop diseases - Types of disease epidemics - Role of host, pathogen and weather factors in disease epidemics, boom and bust cycle, disease cycle of globally important horticulture crops (late blight, fusarium wilt, powdery mildew, and rust - Disease surveillance and assessment.

Unit V - Plant disease management (9 Hours)

Principles of plant disease management - Avoidance - Exclusion - Eradication – Resistance -Protection - Fungicides - classification - group of fungicides - contact and systemic fungicides common methods and special methods of application - Precautions and safety measures in handling of fungicides. - Biological control of crop diseases – Fungal and bacterial biocontrol agents and their mode of action - Plant extracts and Anti-Viral Principles in plant disease management - Integrated Crop Management.

Theory – Lecture Schedule

1. Definition, objectives and Scope of plant pathology, history of plant pathology, economic importance of plant diseases and socio-economic changes due to plant diseases.
2. Terms and concepts in Plant Pathology - Causes of plant disease – Parasitic and Non parasitic causes, Parasitic causes - Fungi, Bacteria, Candidatus Phytoplasma, Fastidious vascular bacteria, Spiroplasma, Virus, Viroids, Algae and Phanerogamic parasites, Non Parasitic causes – Abiotic disorders
3. Types of parasitism, infection process, survival and dispersal of plant pathogenic fungi.
4. Host- pathogen interaction and role of toxins and enzymes in pathogenesis
5. Classification of plant diseases
6. General characters of fungi - Types of mycelia, resting structures, asexual and sexual reproduction
7. Classification of Kingdom: Protozoa - Important taxonomic characters, life cycle and symptoms of *Plasmodiophora brassicae*.
8. Classification and important taxonomic characters of the Kingdom: *Chromista*. Life cycle and symptoms caused by *Pythium* and *Phytophthora*.
9. Taxonomic characters and symptoms caused by *Albugo*, *Peronospora*, *Pseudoperonospora* and *Plasmopara*.
10. Classification of Kingdom: Fungi. Important taxonomic characters and classification of Phylum: *Chytridiomycota* and *Zygomycota*.
11. Classification, symptoms and important taxonomic characters of Phylum: Ascomycota- *Taphrina*, *Capnodium*, *Mycosphaerella*, *Alternaria*, *Botryosphaeria* and *Venturia*.
12. Taxonomic characters and symptoms caused by *Eurotium*, *Talaromyces*, *Erysiphe*, *Leveillula*, *Phyllactinia*, *Uncinula*, *Podosphaera* and *Sphaerotheca*.
13. Taxonomic characters and symptoms produced by *Fusarium*, *Verticillium*, *Glomerella*, and *Macrophomina*.
14. Classification and important taxonomic characters of Phylum: *Basidiomycota*
15. Important taxonomic characters and symptoms caused by rust fungi.
16. Important taxonomic characters and symptoms caused by smut fungi.

17. **In semester Exam**
18. Important taxonomic characters of *Ganoderma*, *Agaricus*, *Pleurotus*, *Volvariella* and *Calocybe*, *Exobasidium* and *Athelia*.
19. Classification, general characters and symptoms of phytopathogenic bacteria.
20. Infection process, mode of entry, survival and dispersal of phytopathogenic bacteria.
21. General characters and symptoms caused by *Candidatus phytoplasma*, *Spiroplasma* and Fastidious vascular bacteria.
22. General characters and symptoms caused by virus, viroid, algae and phanerogamic parasitic plants
23. Epidemiology of crop diseases - Role of host, pathogen and weather factors in disease epidemics
24. Boom and bust cycle and disease cycle of globally important horticulture crops (late blight, fusarium wilt, powdery mildew, and rust)
25. Disease surveillance and assessment.
26. Avoidance, Exclusion: Crop inspection, Seed certification and Plant quarantine
27. Eradication: Mechanical, Physical and cultural methods
28. Resistance: Types and mechanism of resistance - Immunization
29. Protection: Chemical and Biological methods
30. Fungicides-groups of fungicides - contact fungicides, systemic fungicides and antibiotics.
31. Methods of application of fungicides - seed treatment, dry and wet, soil drenching, foliar spray, post-harvest treatment, corm injection, root feeding, capsule application and acid delinting and Precautions and safety measures in storage and handling of fungicides.
32. Biological control of plant disease – biocontrol agents, fungi, bacteria - Mechanisms - methods of application.
33. Plant extracts and anti-viral principles in plant disease management.
34. Integrated crop management.

Practical Schedule

1. Handling and care of microscopes and Preparation of temporary mounts
2. General characters of fungi - Types of mycelium, special somatic structures and resting structures.
3. Asexual and sexual reproduction.
4. Study of disease symptoms, systematic position, important taxonomic characters and host parasite relationship of *Plasmodiophora*, *Pythium*, *Phytophthora*, *Albugo*, *Peronospora*, *Pseudoperonospora*, and *Plasmopara*
5. Study of disease symptoms, systematic position, important taxonomic characters and host parasite relationship of *Rhizopus*, *Taphrina*, *Capnodium*, *Mycosphaerella*, *Lewia*, *Botryosphaeria* and *Venturia*
6. Study of disease symptoms, systematic position, important taxonomic characters and host parasite relationship of *Erysiphe*, *Leveillula*, *Phyllactinia*, *Uncinula*, *Podosphaera* and *Sphaerotheca*
7. Study of disease symptoms, systematic position, important taxonomic characters and host parasite relationship of *Fusarium*, *Verticillium*, *Glomerella*, *Pestalotia* and *Macrophoma*
8. Study of disease symptoms, systematic position, important taxonomic characters and host parasite relationship of *Puccinia*, *Uromyces*, *Hemileia*, *Urocystis*, *Ganoderma*, *Exobasidium* and *Athelia*.
9. Study of symptoms of bacterial, *Candidatus phytoplasma* and Fastidious vascular bacterial diseases
10. Study of symptoms caused by viruses, viroids, algae and phanerogamic parasitic plants.
11. Isolation of fungal and bacterial plant pathogens and proving Koch's postulates.
12. Study of various groups of fungicides.
13. Preparation of fungicidal solution and methods of application.
14. Mass production of *Trichoderma viride* and *Pseudomonas fluorescens*.
15. Cross protection – demonstration of production of immunized seedling against citrus tristeza.
16. Survey and assessment of plant diseases.
17. **University Practical Examination**

Note: Students should submit fifty well preserved disease specimens

Text Books

1. Agrios, G.N. (2005). *Plant Pathology* (5th Ed.). New York. Academic: Press. pp. 1-922.
2. Alice, D. and Jeyalakshmi, C. (2014). *Plant Pathology*. Coimbatore: A.E Publications. pp.1-375.
3. Dube, H.C. (2013). *An introduction to Fungi* (4th edition). Scientific publisher. India. pp. 1- 603.
4. Jagtap, G.P., Dhutraj, D.N. and Utpal Dey. (2014). *Principles of Plant Pathology*. India: Agrobios, Pai and Sons. pp. 1-309.
5. Singh, R.P. (2012). *Plant pathology*. India: Kalyani publishers. pp. 1- 724.

Web References

1. <http://www.biologydiscussion.com>
2. <https://www.microscopemaster.com/fungi>
3. <https://talk.ictvonline.org/taxonomy/>
4. www.apsnet.org/edcenter
5. Tolweb.org
6. <http://www.hillagric.ac.in/edu/coa/ppath/lectures.htm>
7. <http://ecoursesonline.iasri.res.in/course/view.php?id=143>
8. www.ucmp.berkeley.edu/fungi
9. www.ictv.org
10. www.vivo.library.cornell.edu
11. <https://www.youtube.com/c/MTutorEdu/search?query=plant+pathology>
12. <https://www.youtube.com/channel/UCsqovy3Llp-dB8pMxU2VZ7A>

Journals

1. Phytopathology
2. Plant Pathology
3. Australasian Plant Pathology
4. Indian Phytopathology
5. Studies in Mycology
6. Journal of Plant Pathology

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	CRH19303	Course Name	Growth and Development of Horticultural Crops	Course Category	S	Supportive Course	L	T	P	C
							1	0	1	2

Pre-requisite Courses	CRH19204	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Department of Crop Improvement	Data Book / Codes/Standards			Nil

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning			Program Learning Outcomes (PLO)														
CLR-1 :	Define the physiological pattern of horticultural crops and their management in relation to yield potential.	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	Explain the growth physiology of horticultural crops	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems	Ability to implement knowledge gained	Ability to understand social and ethical responsibilities
CLR-3 :	Describe the plant growth regulator applications				H	L	L	H	M	L	M	L	H	H	L	H	H	H	H
CLR-4 :	Summarize the knowledge on growth analytical parameters				H	M	L	H	M	M	H	M	H	H	L	H	H	H	H
CLR-5 :	Understand the modification of the canopy architecture				H	H	M	H	L	M	M	H	H	H	H	H	H	H	H
CLR-6 :	Outline the analytical parameters data with yield of horticultural crops				M	H	H	M	L	L	H	M	H	H	H	H	H	H	H
Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:				H	H	H	M	L	M	M	M	H	H	M	H	H	H	H
CLO-1 :	Predict the growth and development with physiological pattern of horticultural crops.	2	80	70															
CLO-2 :	Interpret the growth parameters data.	2	80	70															
CLO-3 :	Determine the usage of various natural and synthetic growth hormones in the regulation of growth and development	3	85	80															
CLO-4 :	Apply the technical skill to manipulate the various physiological processes	3	80	70															
CLO-5 :	Illustrate the preparation of suitable hormonal formulation and their application	2	85	70															
CLO-6 :	Explain the farmer by recommending best nutrient management practices	3	85	70															

Duration (hour)		Learning Unit / Module 1 15	Learning Unit / Module 2 11	Learning Unit / Module 3 6	Learning Unit / Module 4 9	Learning Unit / Module 5 7
S-1	SLO-1	Growth, development and components of horticultural crops	Seed germination	Pruning and training	Physiology of flowering	Physiology of fruit growth and development
	SLO-2	Canopy development of crops	Physiology of seed development and maturation	PGR in canopy management	Photoperiodism	Factors affecting fruit set and development
S 2-3	SLO-1	Lab-1: Estimation of photosynthetic pigments	Lab-6: Preparation of hormonal solutions	Lab-10: Estimation of ascorbic acid content in fruits	Lab-12: Identification of physiological and nutritional disorders	Lab-15: Preparation of suitable hormonal formulations for breaking dormancy
	SLO-2	Different stages of growth	Dormancy of seeds and buds	Source – Sink relationship	Phytochrome	Physiology of Abscission
S-4	SLO-1	Factors affecting growth	Artificial methods of breaking dormancy of seeds	Partitioning of assimilates	PGRs in flowering	Physiology of senescence
	SLO-2	Lab-2: Estimation of photosynthetic efficiency	Lab-7: Hormonal influence on induction of rooting of cuttings	Lab-11: Estimation of Lycopene content in fruit	Lab-13: Preparation of suitable hormonal formulations for the correction of physiological and nutritional disorders	Lab-16: Field visit
S-7	SLO-1	Basic functions of Auxin and GA	Physiology of root formation in cuttings and layering		Vernalization	Physiology of pre-harvest management
	SLO-2	Basic functions of Cytokinins	PGR in propagation		Mechanisms of vernalization	Physiology of post-harvest management
S 8-9	SLO-1	Lab-3: Measurement of leaf area				–

Duration (hour)	Learning Unit / Module 1		Learning Unit / Module 2		Learning Unit / Module 3		Learning Unit / Module 4		Learning Unit / Module 5	
	15		11		6		9		7	
	SLO-2		Lab-8: Hormonal influence on control of flower and fruit drop				Lab-14: Seed viability by tetrazolium test			
S 10	SLO-1	Basic functions of Ethylene and Absciscic acid	–						-	
	SLO-2	Basic functions of Brassinosteroids	–						-	
S 11-12	SLO-1	Lab-4: Growth analysis	Lab-9: Physiological changes during fruit ripening							
	SLO-2									
S 13	SLO-1	Growth inhibitors and retardants								
	SLO-2	Physiological role in crop regulations.								
S 14 - 15	SLO-1	Lab-5: Identification of synthetic plant hormones and growth retardants								
	SLO-2									

Learning Resources	1. Taiz, L. & Zeiger, E. (2014). <i>Plant Physiology</i> (6th ed.), Massachusetts, USA, Oxford University Press, Sinauer Associates, Inc. pp.1-761
	2. Ray Noggle, G. & Fritz, G. J., (1991). <i>Introductory Plant Physiology</i> (2nd ed.), New Delhi, Prentice Hall of India Pvt. Ltd. pp.1-704\

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember	40 %	30 %	35 %	30 %
	Understand				
Level 2	Apply	40 %	40 %	35 %	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	30 %	30 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr.Pandian, Bayer Crop Sciences, Kerala	Dr. C.N.Chandrasekhar, Dept.of Crop Physiology, TNAU, Coimbatore	Ms. P. Mohanasundari

THEORY

Unit I - Growth physiology

Growth and development – definitions, components, leaf area index (LAI) – optimum LAI in horticultural crops. Canopy development: Different stages of growth, growth curves, growth analysis in horticultural crops. Plant hormones - auxin, gibberellin, cytokinin, ethylene, ABA and retardants, basic functions, role in crop growth and development. New generation Plant Growth regulators

Unit II - Physiology of propagation

Seed germination - Physiology of seed development and maturation, seed dormancy and bud dormancy, causes and breaking methods in horticultural crops. Physiology of root formation in cuttings and layering and stock and scion relationship - PGR in propagation

Unit III - Physiology of canopy management

Pruning and training, physiological basis of training and pruning - canopy management - PGR in canopy management - source and sink relationship - translocation of assimilates – partitioning of assimilates

Unit IV - Physiology of flowering

Flowering - physiology of flowering - Photoperiodism - long day, short day and day neutral plants, Phytochrome – off-season flowering - PGRs in flowering - Factors affecting flowering, - vernalisation, factors affecting and its application in horticulture.

Unit V – Post harvest physiology

Physiology of fruit growth and development, fruit setting, fruit thinning, fruit drop - factors affecting fruit set and development, Ripening - physiology of fruit ripening – climacteric and non-climacteric fruits. Physiology of pre and post-harvest management of fruit vegetable and flower crops.

Theory - Lecture Schedule

1. Growth and development – definitions, components, leaf area index (LAI) – optimum LAI in horticultural crops. Canopy development
2. Different stages of growth, growth curves, growth analysis in horticultural crops. Factors affecting growth.
3. Growth hormones: Auxins, gibberellins, Cytokinins - Basic functions – role in crop growth.
4. Growth hormones: Ethylene, Absciscic acid and Brassinosteroids– Basic functions – role in crop growth.
5. Growth inhibitors and retardants – New generation Plant Growth Regulators -physiological role in crop regulations.
6. Seed germination - Physiology of seed development and maturation
7. Dormancy of seeds and buds – factors causing dormancy of seeds – Artificial methods of breaking dormancy of seeds – Advantages of dormancy of seeds.
8. Physiology of root formation in cuttings and layering and stock and scion relationship - PGR in propagation
9. **In-semester Examination**
10. Pruning and training - Physiological basis of training and pruning - Canopy management - PGR in canopy management
11. Source – Sink relationship – translocation of assimilates – partitioning of assimilates
12. Flowering - Physiology of flowering – photoperiodism- Photoperiodic induction
13. Phytochrome - Off- season flowering - PGRs in flowering - Factors affecting flowering
14. Vernalization: Perception of cold stimulus- presence of floral hormone – mechanisms of vernalization- factors affecting – devernalization – practical utility
15. Physiology of fruit growth and development, fruit setting, fruit thinning, fruit drop - factors affecting fruit set and development
16. Physiology of Abscission and senescence
17. Physiology of pre and post-harvest management of fruit, vegetable and flower crops

Practical Schedule

1. Estimation of photosynthetic pigments.
2. Estimation of photosynthetic efficiency in horticulture crops.
3. Measurement of leaf area following various methods.
4. Growth analysis.
5. Identification of synthetic plant hormones and growth retardants

6. Preparation of hormonal solutions.
7. Assessment of hormonal influence on induction of rooting of cuttings.
8. Assessment of hormonal influence on control of flower and fruit drop.
9. Assessment of physiological changes during fruit ripening.
10. Estimation of ascorbic acid content in fruits.
11. Estimation of Lycopene content in fruit
12. Identification of physiological and nutritional disorders in horticultural crops.
13. Preparation of suitable formulations for the correction of physiological and nutritional disorders
14. Seed viability by tetrazolium test
15. Preparation of suitable hormonal formulations for breaking dormancy
16. Field visit
17. **University Practical Examination**

Text Books

1. Hopkins, W.G. & Huner, N.P.A. (2008). Introduction to Plant Physiology (4th ed.,). USA, John Wiley & Sons. pp.1-523.
2. Jain, V.K. (2017). Fundamentals of Plant Physiology (19th ed.,), New Delhi, S. Chand & Company Ltd. pp.1-736.
3. Pandey, S. N. & B. K. Sinha, (2006). Plant Physiology. New Delhi, Vikas Publishing House Private Limited. pp.1-704.
4. Pessarakli, M. (2002). Handbook of Plant and Crop Physiology. New York, Marcel and Dekker Inc. pp. 1-997.
5. Purohit, S.S. (2005). Plant physiology., Jodhpur, Student edition. pp.1-837.
6. Salisbury, B., Frank & W.C. Ross. (1992). Plant Physiology (4th ed.,), CA, Wadsworth Publishing Co., Belmont. pp.1-682.
7. Taiz, L. & Zeiger, E. (2014). Plant Physiology (6th ed.,). Massachusetts, USA, Oxford University Press, Sinauer Associates, Inc. pp.1-761.

Reference Books

1. Basra, A. S. (2004). Plant Growth Regulators in Agriculture & Horticulture. New York, HAWARTH press. pp.1-264.
2. Delvin, R.M (1986). Plant Physiology (4th ed.,). New Delhi, CBS. pp.1-577
3. Edward E. Duma. (2014). Principles of Horticultural Physiology. UK, CABI. pp.1-416
4. Gardner, F.P., Pearce, R.B. & Mitchell, R.L. (1984). Physiology of Crop Plants (2nd ed.,). Jodhpur. Scientific Publishers. pp.1-327
5. Jacobs, W. P. (1979). Plant Hormones and Plant Development. Cambridge Univ. London. pp.1-339
6. Leopold, A.C. & P.E. Kriedemann, (1985). Plant growth and development. (3rd ed.,), New York, MC. Graw Hill. pp.1-545
7. Ray Noggle, G. & Fritz, G. J., (1991). Introductory Plant Physiology (2nd ed.,) New Delhi, Prentice Hall of India Pvt. Ltd. pp.1-704
8. Richard, N. Artea. (2004). Plant Growth Substances. New Delhi, CBS. pp. 1-332

Web Reference

1. <http://www.plantphys.org>
2. <http://6e.plantphys.net>
3. Grapevine Canopy Management. <https://www.youtube.com/watch?v=wH4HVU0CACw>
4. <https://plantscience.psu.edu/research/labs/roots/videos>
5. Pruning Peach Trees, Virginia Cooperative Extension publication 422-020, <http://pubs.ext.vt.edu/422-020/>
6. Richard P. Marini: Physiology of Pruning Fruit Trees. <http://pubs.ext.vt.edu/422/422-025/422-025.html#TOC>
7. Training and Pruning Apples Trees, Virginia Cooperative Extension publication 422-021, <http://pubs.ext.vt.edu/422-021/>
8. Training and Pruning Apple Trees in Intensive Orchards, Virginia Cooperative Extension publication 422-024, <http://pubs.ext.vt.edu/422-024/>

Journals

1. Horticulture Research
2. Indian Journal of Plant Physiology
3. Journal of Plant Biochemistry and Biotechnology
4. Journal of Plant Physiology
5. Plant Biochemistry and Physiology
6. Plant Physiology
7. Plant Physiology and Biochemistry

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	05	05	05	-	15
Grand Total							100

Course Code	GPB19302	Course Name	Principles of Plant Breeding	Course Category	C	Compulsory Core	L	T	P	C
							2	0	1	3

Pre-requisite Courses	GPB19201	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Genetics and Plant Breeding	Data Book / Codes/Standards			Nil

Course Learning Rationale (CLR):		The purpose of learning this course is to:			Learning			Program Learning Outcomes (PLO)														
CLR-1 :	Describe- the reproductive system of crop plants and their importance in plant breeding	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
CLR-2 :	Summarize the knowledge on breeding methods for crop plants according to the mode of pollination	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment	Agriculture	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team	Communication	Project Mgt. & Life Long Learning	Ability to solve scientific problems through Plant Breeding	Ability to implement knowledge gained in the applied field of Plant Breeding	Ability to understand social and ethical responsibilities of Plant Breeding				
CLR-3 :	Discuss the utilization of special breeding methods in crop plants																					
CLR-4 :	Describe the importance of maintenance breeding in crop improvement																					
CLR-5 :	Outline the trait-introgression protocols in crop breeding																					

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment	Agriculture	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team	Communication	Project Mgt. & Life Long Learning	Ability to solve scientific problems through Plant Breeding	Ability to implement knowledge gained in the applied field of Plant Breeding	Ability to understand social and ethical responsibilities of Plant Breeding
CLO-1 :	Demonstrate the Plant breeding methods	1	90	85	H			H			H		M	H		H	H	H
CLO-2 :	Illustrate the development of hybrids	2	95	85	H			H					L	H		H	H	H
CLO-3 :	Recall the breeding methodologies to develop new traits	2	80	70	M		M	M			H		L	H		H	H	H
CLO-4 :	Illustrate trait transfer to new genetic background	3	85	75	M			H					M	H		H	H	H
CLO-5 :	Outline the new trends in crop improvement	3	85	90	M								M	H		H	H	H

		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
Duration (hour)		9	7	6	6	5
S-1	SLO-1	Objectives and role of plant breeding	Basic biometrics for plant breeding	Genetic structure of a population in cross pollinated crop	Polyploidy breeding	Types of cultivars
	SLO-2	Historical perspective of Plant Breeding	Heritability and genetic advance	Hardy Weinberg law	Induction of polyploidy	Concept of seed certification and TC plants certification
S-2	SLO-1	Centres of origin for the crops	Plant introduction	Mass selection in cross pollinated crops	Wide hybridization	Transgenic crops and Concept of Plant Varietal protection,
	SLO-2	Contribution of Vavilov, Harlan, Zhukovsky for plant breeding and law of homologous series	Quarantine and acclimatization	Half sib and full sib	Overcoming barriers in wide hybridization	Geographical indications and DUS
S-3,4	SLO-1	Lab1: Pollination and reproduction in plants	Lab. 4. Emasculation and pollination techniques in horticultural crops	Lab. 7. Maintenance of A, B and R line and TGMS lines - Hybrid seed production techniques	Lab.10. Studies on different wild species in crop plants and wide hybridization	Lab.14. Layout of different yield trials - Observing the experimental plots - nucleus and breeder seed production plots
	SLO-2					
S-5	SLO-1	Plant genetic resources and their importances	Genetic basis of self pollinated crops	Breeding methods of cross pollinated crops involving artificial hybridization	Mutation breeding	-
	SLO-2	Gene Bank for crop breeding	Vilmorin principle of progeny selection and Johannsen's pure line theory.	Recurrent selection	Ideotype concept	-
S-6	SLO-1	Characterization and utilization of germplasm	Breeding methods for self pollinated crops without involving artificial hybridization	Heterosis breeding	Somaclonal variation	-
	SLO-2	Germplasm exchange and quarantine	Mass selection in self pollinated crops	Inbreeding depression	Concept of biotic and abiotic stress resistance Breeding	-

S-7,8	SLO-1	Lab 2: Mechanisms enforcing self and cross pollination in crops	Lab. 5. Studies on segregating generation and maintenance of records.	Lab. 8 Estimation of heterosis	Lab.11. procedure for irradiation of seeds and planting materials	Lab. 15. Screening methods – laboratory and field – for biotic and abiotic stresses
	SLO-2	Modes of reproduction crops	Breeding methods of self pollinated crops involving artificial hybridization	Heterosis breeding	Introduction to markers	-
S-9	SLO-1	Significance of pollination	Creating variability in self pollinated crops	Emasculation in hybrid seed production	Marker assisted selection	-
	SLO-2	Self incompatibility classifications and mechanisms	Hybridization and selection	Maintenance of parental lines	-	Lab. 16. Procedure for marker assisted selection
S-10	SLO-1	Applications of SI in crop breeding	Transgressive breeding	Hybrid variety	-	-
	SLO-2	Lab3: Breeder kit and its components for selfing and crossing techniques	Lab. 6. Maintenance of A, B and R line and TGMS lines - Hybrid seed production techniques	Lab. 9. Induction of polyploidy using colchicine	Lab.12. Germplasm preservation – conservation - records maintained in research stations	-
S - 11,12	SLO-1	Introduction to male sterility	Pedigree and mass pedigree breeding	Synthetics and composites	-	-
	SLO-2	Classification of male sterility	Bulk breeding	Achievements in synthetics and composites	-	-
S - 13	SLO-1	Environmentally influenced male sterility systems in crops	Comparison of pedigree and bulk breeding methods.	Genetic characters of asexual reproduction	-	-
	SLO-2	Transgenic Male sterility and applications	Single Seed Descent (SSD) method	Chimeras and its types	-	-
S-14,16	SLO-1	Emasculation and pollination techniques in field crops	-	-	Lab 13:Calculation of PCV, GCV, heritability, genetic advance	-
	SLO-2	Apomixis in crop improvement	Backcross breeding	-	-	-
S-17	SLO-1	Parthenocarp	Population improvement approach in self-pollinated crops	-	-	-
	SLO-2					

Learning Resources	1. Allard, R. (2010). <i>Principles of Plant breeding</i> (2nd ed.). India: Wiley India Pvt Ltd. pp. 1- 247.	3. Chahal, G.S. & Gosal, S. S. (2002). <i>Principles and Procedures of Plant Breeding: Biotechnological and Conventional Approaches</i> . India: Narosa Publishing House. pp. 1- 624.
	2. Bharadwaj, D. N. (2012). <i>Breeding Field Crops</i> . Jodhpur: Agrobios (India). pp. 1- 934.	

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember	40 %	30 %	35 %	30 %
	Understand				
Level 2	Apply	40 %	40 %	35 %	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	30 %	30 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. S M .Prabhu, Ph. D. Senior Breeder (Paddy Breeding and Transgenic) R&D centre, Rasi Seeds (P) Ltd., Attur, Salem – 636141.	Dr. T. Sabesan Associate rofessor Department of Genetics and Plant Breeding Faculty of Agriculture, Annamalai University, Annamalai nagar , Chidambaram - 608 002 sabavani@gmail.com	Dr. G. Selvakumar Dr. R. Mahendran Dr. J. Vanitha

THEORY

Unit I - Reproductive Systems in Plant Breeding

Objectives and role of plant breeding - historical perspective – activities in Plant Breeding. Centres of origin – contribution of Vavilov, Harlan, Zhukovsky – law of homologous series. Plant genetic resources – importance – germplasm – types – activities – gene erosion - gene bank – collection - conservation – types of conservation – agencies – quarantine. Germplasm: evaluation – use of descriptors, documentation, utilization; Agencies – national and international; germplasm exchange – quarantine. Modes of reproduction – sexual – asexual - self and cross fertilization – significance of pollination. Self incompatibility – classifications–mechanisms–application–measures to overcome and limitations. Sterility – male sterility – classification – CMS, GMS, CGMS - inheritance and applications. TGMS, PGMS, Gametocides, Transgenic Male sterility and applications. Apomixis – introduction – classification - applications; Parthenocarpy and its types.

Unit II - Breeding Methods of Self Pollinated Crops

Basic biometrics - nature and significance of qualitative and quantitative variation - phenotypic, genotypic and environmental variation - heritability and genetic advance. Plant introduction – types of introduction – objectives – quarantine - acclimatization – achievements - merits and demerits. Genetic basis of self pollinated crops – Vilmorin principle of progeny selection - Johannsen's pure line theory. Breeding methods for self pollinated crops without involving artificial hybridization: Pure line selection – merits and demerits – achievements; Mass selection in self pollinated crops – types – comparison of mass and pureline selection – achievements. Breeding methods of self pollinated crops involving artificial hybridization: Creating variability in self pollinated crops - Hybridization and selection — choice of parents – combining ability - combination breeding and transgressive breeding – kinds of emasculation. Pedigree breeding – mass pedigree – merits – demerits – achievements; Bulk breeding – merits – demerits – achievements. Comparison of pedigree and bulk breeding methods. Single Seed Descent (SSD) method – application – merits and demerits. Backcross breeding – prerequisites – procedures for transferring dominant and recessive genes – merits – demerits – multi lines and multi blends - population improvement approach in self-pollinated crops.

Unit III - Breeding Methods of Cross Pollinated Crops and Clonally Propagated Crops

Genetic structure of a population in cross pollinated crop – Hardy Weinberg law – gene frequencies in random mating population – principles in population improvement. Breeding methods of cross pollinated crops without involving artificial hybridization: Mass selection in cross pollinated crops – modified mass selection – unit selection – mass selection with progeny testing – half sib family selection – full sib family selection. Breeding methods of cross pollinated crops involving artificial hybridization: Recurrent selection principles – types merits and demerits. Heterosis breeding – theories - genetic basis – hybrid vigour – estimation of heterosis – inbreeding depression – development of inbreds. Heterosis breeding procedure – use of male-sterility systems and manual emasculation in hybrid seed production – maintenance of parental lines - types of hybrids – achievements – merits and demerits – hybrid variety–merits and demerits. Synthetics and composites-steps in development of synthetics and composites – achievements – merits and demerits. Genetic characters of asexual reproduction – breeding methods – clonal selection – hybridization and clonal selection – merits and demerits – achievements; Chimeras and its types; Tree breeding – clonal orchards.

Unit IV - Special Breeding Methods

Polyploidy breeding – classification – induction of polyploidy – diploid x tetraploid and diploid x hexaploid crosses - achievements – limitations. Wide hybridization - history – importance - barriers and techniques for overcoming barriers-utilization. Mutation breeding: mutation – types – mutagens – breeding procedure – applications – achievements – limitations. Ideotype concept. Somaclonal variation - utilization in crop improvement; *In vitro* selection techniques — Use of doubled haploids in crop improvement. Concept of biotic and abiotic stress resistance breeding. Introduction to markers – morphological – biochemical- DNA markers – uses of Marker Assisted Selection (MAS) - major genes – merits – demerits –achievements.

Unit V - Maintenance Breeding

Types of cultivars – procedure for release of new varieties – stages in seed multiplication – concept of seed certification and TC plants certification. Maintenance Breeding: General seed production techniques – steps in nucleus and breeder seed production – varietal rundown and renovation. Transgenic crops. Concept of Plant Varietal Protection and geographical indications and DUS.

Theory – Lecture Schedule

1. Objectives and role of plant breeding - historical perspective – activities in Plant Breeding
2. Centres of origin – contribution of Vavilov, Harlan, Zhukovsky – law of homologous series
3. Plant genetic resources – importance – germplasm – types – activities – gene erosion - gene bank – collection - conservation – types of conservation – agencies –quarantine
4. Germplasm: evaluation – use of descriptors, documentation, utilization; Agencies – national and international; germplasm exchange –quarantine
5. Modes of reproduction – sexual – asexual - self and cross fertilization – significance of pollination.
6. Self incompatibility – classifications – mechanisms – application – measures to overcome and limitations
7. Sterility – male sterility – introduction – classification – CMS, GMS, CGMS -inheritance andapplications
8. TGMS, PGMS, Gametocides, Transgenic Male sterility andapplications
9. Apomixis – introduction - classification-applications; Parthenocarpy and its types
10. Basic biometrics-nature and significance of qualitative and quantitative variation- phenotypic, genotypic and environmental-heritability and geneticadvance

11. Plant introduction- as a breeding method–types of introduction–objectives–quarantine acclimatization – achievements - merits and demerits
12. Genetic basis of self pollinated crops – Vilmorin principle of progeny selection - Johannsen's pure line theory
13. Breeding methods for self pollinated crops without involving artificial hybridization: Pure line selection – procedure – merits and demerits – achievements; Mass selection in self pollinated crops – procedure - types – comparison of mass and pureline selection – achievements
14. Breeding methods of self pollinated crops involving artificial hybridization: Creating variability in self pollinated crops
15. Hybridization and selection – objectives types – choice of parents – combining ability - combination breeding and transgressive breeding- steps in hybridization - kinds of emasculation
16. Pedigree breeding – procedure – mass pedigree – merits – demerits – achievements; Bulk breeding – procedure – merits – demerits –achievements.
17. **In Semester examination**
18. Comparison of pedigree and bulk breeding methods. Single Seed Descent(SSD) method procedure – application – merits and demerits
19. Backcross breeding – genetic principles – prerequisites – procedures for transferring dominant and recessive genes. Back cross breeding – merits – demerits – multi lines and multi blends - population improvement approach in self-pollinated crops
20. Genetic structure of a population in cross pollinated crop – Hardy Weinberg law – gene frequencies in random mating population – principles in population improvement
21. Breeding methods of cross pollinated crops without involving artificial hybridization: Mass selection in cross pollinated crops – modified mass selection – unit selection – mass selection with progeny testing – half sib family selection – full sib family selection
22. Breeding methods of cross pollinated crops involving artificial hybridization: Recurrent selection principles – types – merits and demerits
23. Heterosis breeding – theories - genetic basis – hybrid vigour – estimation of heterosis – inbreeding depression – development of inbreds
24. Heterosis breeding – procedure – use of male-sterility systems and manual emasculation in hybrid seed production
25. Maintenance of parental lines - types of hybrids – achievements – merits and demerits – hybrid variety – merits and demerits
26. Synthetics and composites - steps in development of synthetics and composites – achievements – merits and demerits
27. Genetic characters of asexual reproduction – breeding methods – clonal selection – hybridization and clonal selection – merits and demerits – achievements; Chimeras and its types; Tree breeding – clonal orchards
28. Polyploidy breeding – classification – induction of polyploidy – diploid x tetraploid and diploid x hexaploid crosses - achievements – limitations
29. Wide hybridization-history-importance-barriers and techniques for overcoming barriers- utilization
30. Mutation breeding: mutation – types – mutagens – breeding procedure – applications – achievements – limitations. Ideotype concept
31. Somaclonal variation - utilization in crop improvement; *In vitro* selection techniques — Use of doubled haploids in crop improvement. Concept of biotic and abiotic stress resistance Breeding
32. Introduction to markers – morphological – biochemical- DNA markers – uses of marker assisted selection - major genes – merits – demerits –achievements
33. Types of cultivars– procedure for release of new varieties–stages in seed multiplication concept of seed certification and TC plants certification
34. Transgenic crops. Concept of Plant Varietal protection, geographical indications and DUS

PracticalSchedule

1. Pollination and reproduction in plants
2. Description and drawing different pollination systems - Mechanisms enforcing self and cross pollination in crops; Pollen morphology - Exine structure of different crops. Fertility and sterility in A, B, R and TGMS lines
3. Breeder kit and its components – uses; Basic steps of selfing and crossing techniques
4. Emasculation and pollination techniques in field crops
5. Emasculation and pollination techniques in horticultural crops
6. Studies on segregating generation and maintenance of records
7. Maintenance of A, B and R line and TGMS lines - Hybrid seed production techniques
8. Estimation of heterosis
9. Induction of polyploidy using colchicine
10. Studies on different wild species in crop plants and wide hybridization
11. Irradiation - dosimetry - half life period - procedure for irradiation of seeds and planting materials Chemical mutagenesis - molar solution preparation - procedure for chemical mutagenesis of seeds and planting materials
12. Germplasm preservation – conservation - records maintained in research stations
13. Calculation of PCV, GCV, heritability, genetic advance
14. Layout of different yield trials - Observing the experimental plots - nucleus and breeder seed production plots
15. Screening methods – laboratory and field – for biotic and abiotic stresses
16. Procedure for marker assisted selection.

17. University Practical Examination

Text Books

1. Allard, R. (2010). *Principles of Plant breeding* (2nd ed.). India: Wiley India Pvt Ltd. pp. 1- 247.
2. Bharadwaj, D. N. (2012). *Breeding Field Crops*. Jodhpur: Agrobios (India). pp. 1- 934.
3. Chahal, G. S. & Gosal, S. S. (2002). *Principles and Procedures of Plant Breeding: Biotechnological and Conventional Approaches*. India: Narosa Publishing House. pp. 1- 624.
4. Singh, B.D. (2018). *Plant breeding - Principles and Methods*. India: Kalyani Publishers. pp. 1- 889.

Reference Books

1. Annaliese S. Mason. (2017). *Polyploidy and hybridization for crop improvement*. USA: CRC Press. pp. 1- 490.
2. Chaudhary, H. K. (1980). *Elementary Principles of plant breeding*. New Delhi: Oxford and IBH publication Co. pp. 1- 303.
3. Chopra, V. L. (1994). *Plant breeding theory and practice*. New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd. pp. 1- 490.
4. Daniel Sundararaj, Thulasidas, G. & Stephen Dorairaj, M. (1997). *Introduction to Cytogenetics and Plant Breeding*. Chennai : Popular Book Depot. pp. 1- 362.
5. George Acquaah. (2012). *Principles of Plant Genetics and Breeding* (2nd ed.). Blackwell, USA. pp 1- 739.
6. Sharma, J. R. (1994). *Principles and practice of plant breeding*. Tata McGraw-Hill publishing Co, New Delhi. pp. 1- 599.

Web-References

1. <https://www.britannica.com/science/plant-breeding>
2. <https://www.farm-europe.eu/travaux/new-plant-breeding-techniques-what-are-we-talking-about/>
3. <https://www.ag.ndsu.edu/plantsciences/research/durum/breeding-methods>
4. <https://www.toppr.com/guides/biology/strategies-for-enhancement-in-food-production/plant-breeding/http://www.edugreen.teri.res.in/explore/bio/breed.htm>
5. <http://cuke.hort.ncsu.edu/gpb/>
6. <http://www.stumbleupon.com/tag/plant-breeding>
7. <http://www.iaea.org/>
8. <https://www.youtube.com/watch?v=eZ0O0-tbhCs&list=PLMwQyDnbQLRUaJXwn0lgTREs3e3pmqYi>

Journals

1. Plant Breeding and Crop Science
2. Plant Breeding (Wiley)
3. Frontiers in Plant Science
4. Electronic Journal of Plant Breeding (EJPB)

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	05	05	05	-	15
Grand Total							100

Course Code	NRM19301	Course Name	Soil Fertility and Nutrient Management	Course Category	S	Supportive Course	L	T	P	C
							1	0	1	2

Pre-requisite Courses	NRM19101	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Soil Science and Agricultural Chemistry	Data Book / Codes/Standards			Nil

Course Learning Rationale (CLR):		Learning			Program Learning Outcomes (PLO)														
The purpose of learning this course is to:		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	Identify the nutrient deficiency symptoms on plants and soil	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems through Soil Fertility and Nutrient Management	Ability to implement knowledge gained in the applied field of Soil fertility and nutrient management	Ability to understand social and ethical responsibilities of Soil fertility and Nutrient Management
CLR-2 :	Define the chemistry of essential nutrient				H								M	H		H	H	H	H
CLR-3 :	Describe the chemical fertilizer manufacturing process and application methodology				H								L	H		H	H	H	H
CLR-4 :	Understand the importance of organic manures to maintain soil fertility				M		L	L					L	H		H	H	H	H
CLR-5 :	Perform soil health management practices in field level				M			L	L		M		M	H		H	H	H	H
Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:			L	L							M	H		H	H	H	H
CLO-1 :	Interpret the essential nutrients				1	95	80												
CLO-2 :	Outline the importance of nutrients in plant growth				1	90	85												
CLO-3 :	Explain the nutrient transformations in different soil conditions				2	70	70												
CLO-4 :	Paraphrase the fertilizer doses for individual plant				3	80	65												
CLO-5 :	Perform soil health management practices				3	75	60												

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		3	3	3	4	3
S-1	SLO-1	Soil fertility and productivity – introduction	N, P, K – sources and forms	Manures and fertilizers	Soil health: definition, principles	Soil fertility evaluation; DRIS approach
	SLO-2	Factors affecting	Transformations	Manufacturing processes	Productivity and fertility/quality index	Nutrient use efficiency and budgeting
S-2-3	SLO-1	Lab. 1. Sampling of organic manures and fertilizer for chemical analysis	Lab. 4. Estimation of available K	Lab. 7. Estimation of soil micronutrients	Lab. 10. Estimation of gypsum requirement in alkali soil	Lab. 14. Estimation of K in fertilizers/manures
	SLO-2					
S-4	SLO-1	Essential nutrients	Ca, Mg, S – sources and forms	Fertilizer application – rainfed	Soil physical properties	INM, STCR, IPNS, SSNM, RTNM
	SLO-2	Functions and deficiencies	Transformations	Fertilizer application - irrigated	Management	PME, LTFE
S-5-6	SLO-1	Lab.2. Estimation of available N	Lab.5. Estimation of Ca, Mg in soil	Lab.8. Estimation of soil organic carbon.	Lab. 11. Estimation of N in fertilizer/manures	Lab. 15. Soil test based fertilizer prescriptions
	SLO-2					
S-7	SLO-1	Criteria of essentiality	Micronutrients: Transformations	Biofertilizer-classification, manufacturing	Soil chemical properties	Fertilization recommendation models
	SLO-2	Critical level of different nutrients	Nutrient interactions	Fertilizer control order	Management	Crop growth models
S 8-9	SLO-1	Lab.3. Estimation of available P	Lab. 6. Estimation of S in soil	Lab.9. Estimation of lime requirement in acid soil	Lab. 12. Estimation of ammoniacal and nitrate N in ammonium nitrate	Lab. 16. Visit to STL
	SLO-2					
S-10	SLO-1				Soil biological properties	
	SLO-2				Management	

S-11-12	SLO-1				Lab. 13. Estimation of water soluble P in fertilizers/manures	
	SLO-2	-		-		

Learning Resources	1.	Brady, N.C and Raymond C.W. (2013). The nature and properties of soils (15 th ed.). Pearson Education.pp. 1 - 1035.				
	2.	Biswas, T.D and Mukherjee S.K. (2017). Textbook of soil science (2 nd ed.). New Delhi: Tata McGraw Hill Publishing Co.Ltd. pp. 1 - 433.				

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In semester (20%)	Practical (15%)		
Level 1	Remember	40 %	30 %	35 %	30 %
	Understand				
Level 2	Apply	40 %	40 %	35 %	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	30 %	30 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. JoshwaFenn Suresh Proprietor, Naruveli Ventures, MM nagar.	Dr. M.V. Sriramachandrasekharan Professor (SSAC), Annamalai University, Annamalai nagar – 608002.	Dr. R. Angelin Silviya Dr. S.N. Chikkaraju

THEORY

Unit I – Soil fertility and productivity

Introduction to soil fertility and productivity – factors affecting; Essential plant nutrients: importance, functions, deficiency symptoms, hidden hunger, luxury consumption and toxicity symptoms and remedies; Criteria of essentiality; Critical levels of different nutrients in soil. Effect of potential toxic elements in soil productivity.

Unit II - Nutrient dynamics

Nutrients: sources, forms, mobility, transformations, fixation, losses and availability of nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, iron, manganese, zinc, copper, boron, molybdenum, nickel, chloride in soils; Nutrient interactions.

Unit III – Manures and fertilizers

Manures and fertilizers: classification and manufacturing process; Fertilizer application methodology (rainfed and irrigated condition) – NPK, Secondary and micronutrient fertilizers; Biofertilizer – classification, importance and manufacturing process; Compost and composting; Fertilizer control order.

Unit IV – Soil health

Soil health: definition and principles; Soil health index (productivity and quality/fertility index): physical properties - soil texture, aggregate stability, infiltration rate; chemical properties – pH, CEC, buffering capacity, acid, calcareous and salt affected soils, its characteristics and management; biological properties – role of microorganisms in soil organic matter, decomposition, humus formation, C:N ratio.

Unit V - Nutrient management

Soil fertility evaluation; DRIS approach; Nutrient use efficiency and nutrient budgeting; Nutrient management concepts: INM, STCR, IPNS, SSNM and RTNM, PME and LTFE Fertilizer recommendation models and crop growth models.

Theory - Lecture Schedule

1. Introduction to soil fertility and productivity – factors affecting.
2. Essential plant nutrients: importance, functions, deficiency symptoms, hidden hunger, luxury consumption and toxicity symptoms and remedies.
3. Criteria of essentiality; Critical levels of different nutrients in soil. Effect of potential toxic elements in soil productivity.
4. Sources, forms, mobility, transformations, fixation, losses and availability of N, P, K
5. Sources, forms, mobility, transformations, fixation, losses and availability of Ca, Mg, S
6. Sources, forms, mobility, transformations, fixation, losses and availability of micronutrients and Nutrient interactions.
7. Manures and fertilizer classification; Manufacturing process of NPK fertilizers.
8. Fertilizer application methodology (rainfed and irrigated conditions)
9. **In-semester Examination**
10. Biofertilizer – classification, importance and manufacturing process; Compost and composting; Fertilizer control order
11. Soil health: definition and principles; Soil health index: productivity index and quality/fertility index.
12. Soil physical properties: Soil texture, aggregate stability, infiltration rate.
13. Soil chemical properties: pH, CEC, buffering capacity; Acid, calcareous, salt affected soils – its characteristics and management.
14. Soil biological properties: – role of microorganisms in soil organic matter, decomposition, humus formation, C:N ratio.
15. Soil fertility evaluation; DRIS approach; Nutrient use efficiency and nutrient budgeting.
16. Nutrient management concepts: INM, STCR, IPNS, SSNM, RTNM, PME and LTFE.
17. Fertilizer recommendation models; Crop growth models.

Practical schedule

1. Sampling of organic manures and fertilizer for chemical analysis.
2. Estimation of alkaline KMnO_4 N in soil (available N).
3. Estimation of Olsen P and Bray P in soil (available P).
4. Estimation of Neutral Normal NH_4OAc K in soil (available K).
5. Estimation of available Ca and Mg in soil.
6. Estimation of available S in soil.
7. Estimation of micronutrients in soil (DTPA extractable).
8. Estimation of soil organic carbon.

9. Estimation of lime requirement in acid soil.
10. Estimation of gypsum requirement in alkali soil.
11. Estimation of N in urea and FYM / Compost.
12. Estimation of ammoniacal and nitrate N in ammonium nitrate.
13. Estimation of water soluble P in SSP/FYM/compost.
14. Estimation of K in KCl and K₂SO₄/FYM/Compost.
15. Soil test based fertilizer prescriptions.
16. Visit to soil, plant, water and fertilizer testing laboratory.
17. **University Practical Examination**

Text books

1. Biswas, T.D. and Mukherjee S.K. (2017). TextBook of Soil Science (2nded.). New Delhi: Tata McGraw Hill Publishing Co. Ltd. pp. 1 - 433.
2. Chopra, S.C and Kanwar J.S. (2014). Analytical Agricultural Chemistry. Ludhiana: Kalyani publishers.
3. Das, D.K. (2015). Introductory Soil Science (4thed.). Ludhiana, India: Kalyani Publisher.
4. Indian Society of Soil Science. (2012). Fundamentals of Soil Science (2nded.). New Delhi: ISSS, IARI.
5. Brady, N.C. and Raymond, C. W. (2013). The Nature and Properties of Soils (15thed.). Pearson Education. pp. 1 - 1035.

Reference books

1. Epstein, E. and Bloom, A.J. (2005). Mineral Nutrition of Plants: Principles and perspectives (2nded.). Sunderland, MA: Sinauer Associates. pp. 1 - 380.
2. Jackson, M.L. (2012). Soil chemical analysis: Advanced course, Scientific Publisher.
3. John, L. H., Beaton J.D, Tisdale S.L and Nelson W.L. (2016). Soil Fertility and Fertilizers - An Introduction to Nutrient Management. (2nded.). New Delhi: PHL Learning Pvt. Ltd. pp. 1 - 433.
4. Tan K.H. (2018). Principles of Soil Chemistry, Special Indian edition (4thed.). Taylor & Francis.
5. Mengel, K and Kirkby, E.A. (2001). Principles of Plant Nutrition (5th ed.), Springer. pp. 1 - 849.

Web references

1. <https://www.usda.gov/>
2. <https://www.springer.com/gp/environmental-sciences/soil-science>
3. <https://www.soils.org.uk/students>
4. https://youtu.be/zrjL5J_U1iE
5. <https://youtu.be/OcEuG-NzmqQ>

Journals

1. Journal of the Indian Society of Soil Science (ISSS)
2. Soil Science and Plant Nutrition
3. International journal of Plant and Soil Sciences
4. Journal of soil and water conservation
5. Journal of soils and crops

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-	-	-	50	50
2	Theory-Internal	20	-	-	-	-	20
3	Practical-External	-	-	-	-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	AGE19303	Course Name	Introductory Agroforestry	Course Category	S	Supportive Course	L	T	P	C
							1	0	1	2

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Horticulture	Data Book / Codes/Standards			Nil

Course Learning Rationale (CLR):		The purpose of learning this course is to:			Learning			Program Learning Outcomes (PLO)															
CLR-1 :	Outline the forest cover of India and the role of forests in providing tangible and intangible benefits to human societies				1 Level of Thinking (Bloom)	2 Expected Proficiency (%)	3 Expected Attainment (%)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
CLR-2 :	Understand the concept of agroforestry along with the various agroforestry systems that prevail.							Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design,	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems	Ability to implement knowledge gained	Ability to understand social and ethical responsibilities	
CLR-3 :	Recall the information on important tree species in agroforestry systems							M								M	H		H	H	H	H	H
CLR-4 :	Discuss the techniques of various practices in agroforestry							H								L	H		H	H	H	H	H
CLR-5 :	Summarize the importance of social forestry and different social forestry schemes across India and Tamil Nadu							M			L	L				M	H		H	H	H	H	H
Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:						L	L							M	H		H	H	H	H	
CLO-1 :	Identify important trees species along with their seeds and seedlings				1	90	80																
CLO-2 :	Explain a nursery and produce saplings of important agroforestry trees such as Teak, Melia dubia etc				3	95	85																
CLO-3 :	Understand the constraints and on -field challenges of an agroforestry system				2	80	70																
CLO-4 :	Interpret the girth, height and volume of agroforestry trees using mensuration techniques				3	90	80																
CLO-5 :	Discuss agroforestrv models suitable for the local region				3	75	60																

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		8	9	9	12	9
S-1	SLO-1	Definitions, scope, classification of forests	Agroforestry: definition, objective and potential.	Management practices of Teak	Agroforestry practices for arid and semi-arid regions	Social forestry: Definition, objectives
	SLO-2	Forest types of Tamil Nadu	Planning for agroforestry	Management practices of Sandal	Agroforestry practices for salt affected soils, waterlogged areas.	History of social forestry
S-2,3	SLO-1	Identification of major farm grown tree species	Nursery technology of Casuarina equisetifolia	Studies on contract tree farming practices in Tamil Nadu	Visit to social forestry plantations: railway line plantations	Rapid assessment of farmers needs for green manure, fodder
	SLO-2	Identification of seeds and seedlings of multipurpose tree species	Nursery technology of Eucalyptus hybrid		Visit to social forestry plantations: canal plantations	Rapid assessment of farmers needs for fuel wood
S-4	SLO-1	Role of forests	Classification of agroforestry systems	Management practices of neem, eucalyptus	Soil and water conservation through agroforestry approaches.	Components of social forestry
	SLO-2	Forestry, Silvics and Silviculture	Shifting cultivation; taungya; alley cropping etc	Management practices casuarina	Carbon sequestration through agroforestry approaches	Benefits of social forestry
S-5,6	SLO-1	Design and Layout of Tree Nursery	Nursery technology of Azadirachta indica,	Visit to agro-forestry fields: silvipastoral, alley cropping	Visit to social forestry plantations: roadside plantations	Rapid assessment of farmers needs for green manure, fodder
	SLO-2		Nursery technology of Melia dubia and Ailanthus excelsa	Visit to agro-forestry fields: horti-silviculture	Visit to social forestry plantations: industrial plantations and shelterbelts	Rapid assessment of farmers needs for fuel wood
S-7	SLO-1		Agroforestry systems for different agro climatic zones of Tamil Nadu.	Management practices of rose wood, red sanders	Agroforestry projects: national, overseas	social forestry schemes

Duration (hour)	Learning Unit / Module 1		Learning Unit / Module 2		Learning Unit / Module 3		Learning Unit / Module 4		Learning Unit / Module 5	
	8		9		9		12		9	
	SLO-2				Management practices <i>Ailanthus</i> , <i>Melia dubia</i>		National Agroforestry policy.		JFM, TAP	
S-8,9	SLO-1	Nursery technology of <i>Tectona grandis</i>	Nursery technology of Red Sanders		Visit to agro-forestry fields: agro-silvipasture		Preparation of two agroforestry models for the region		Economics and marketing of products raised in agro-forestry systems	
	SLO-2	Nursery technology of <i>Santalum album</i>	Nursery technology of <i>Dalbergia sissoo</i> and <i>Acacia</i> species.		Visit to agro-forestry fields: fuel and fodder blocks					
S-10	SLO-1						Girth, height and volume measurement			
	SLO-2						Timber transit rules			
S-11,12	SLO-1						Estimation of girth, height			
	SLO-2						Estimation of volume			

Learning Resources	1.	<i>Alain Atangana, Damase Khasa, Scott Chang, Ann Degrande . Tropical Agroforestry 2014th Edition.</i>
	2.	<i>Divya, M.P., K.T. Parthiban, K. Srinivasan, K. Vanangamudi and M. Govinda Rao. 2008. A text book on Social Forestry and Agroforestry. Satish Publishers, Delhi.</i>

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In semester (20%)	Practical (15%)		
Level 1	Remember	40 %	30 %	35 %	30 %
	Understand				
Level 2	Apply	40 %	40 %	35 %	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	30 %	30 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr Mayavel, Contract farming Institute of Forest Genetics and tree breeding, Coimbatore 641002	Dr. Vennila, Assistant professor, Forest college and research institute , Tamil Nadu Agricultural University, Coimbatore 641003	Ms. T.S. Sri Ranjini

THEORY

Unit I - Introduction to forestry

Introduction to forests and forestry: Definitions, scope, classification of forests - Forest types of Tamil Nadu; Forest cover of India; Role of forests- Tangible and intangible benefits. Silvics and Silviculture. Branches in forestry

Unit II - Agroforestry

Agroforestry: definition, objective and potential. National Agroforestry policy. Planning for agroforestry – constraints, diagnosis and design methodology, selection of tree crop species for agro-forestry. Classification of agroforestry systems- agri-silviculture, silvipastoral, horti-silviculture, horti-silvipastora shifting cultivation; taungya; alley cropping, wind breaks and shelter belts; home gardens, energy plantation. Agroforestry systems for different agro climatic zones of Tamil Nadu. Agroforestry projects: national, overseas.

Unit III - Tree species in agroforestry

MPTS and management practices: Silvicultural characters; Regeneration techniques, Tending, Rotation, Yield and Uses and economics of cultivation of *Tectona grandis*, *Santalum album*, *Casuarina equisetifolia*, *Eucalyptus hybrid*, *Azadirachta indica*, *Melia dubia*, *Ailanthus excelsa*, *Dalbergia sissoo*, and *Pterocarpus santalinus*

Unit IV - Practices in agroforestry

Agroforestry practices for arid and semi-arid regions, salt affected soils, waterlogged areas, soil and water conservation, wasteland development and Carbon sequestration; Forest Mensuration - definition, objectives, diameter, girth and height measurement methods; standard rules governing breast height measurement; volume estimation in standing and felled trees; Timber transit rules for farm grown trees.

Unit V - Social forestry

Social forestry: Definition, history, objectives; Components - Farm forestry, Extension forestry, Community forestry, Recreation forestry, Urban forestry; Benefits of social forestry; Important social forestry schemes implemented in India; Interface forestry, Joint forest management (JFM); Tamil Nadu Afforestation Project (TAP)

Theory - Lecture Schedule

1. Definitions, scope, classification of forests - Forest types of Tamil Nadu; Forest cover of India.
2. Role of forests; Tangible and intangible benefits; Forestry, Silvics and Silviculture - definition and objectives, relation with other branches of forestry.
3. Agroforestry: definition, objective and potential. National Agroforestry policy.
4. Planning for agroforestry – constraints, diagnosis and design methodology, selection of tree crop species for agro-forestry.
5. Classification of agroforestry systems- shifting cultivation; taungya; alley cropping; Wind breaks and shelter belts; home gardens, energy plantation.
6. Agroforestry systems for different agro climatic zones of Tamil Nadu.
7. MPTS and management practices: Silvicultural characters; Regeneration techniques, Tending, Rotation, Yield and Uses of *Tectona grandis*, *Santalum album*.
8. Silvicultural characters; Regeneration techniques, Tending, Rotation, Yield and Uses of *Casuarina equisetifolia*, *Eucalyptus hybrid*, *Azadirachta indica*.
9. **In - Semester examination**
10. Silvicultural characters; Regeneration techniques, Tending, Rotation, Yield, Economics of cultivation and Uses of *Melia dubia*, *Ailanthus excelsa*, *Dalbergia sissoo*, and *Pterocarpus santalinus*.
11. Agroforestry practices for arid and semi-arid regions, salt affected soils, waterlogged areas.
12. Soil and water conservation, Carbon sequestration through agroforestry approaches.
13. Agroforestry projects: national, overseas; National Agroforestry policy.
14. Forest Mensuration - definition, objectives, diameter, girth and height measurement methods; standard rules governing breast height measurement. Volume estimation in standing and felled trees; Timber transit rules for farm grown trees.
15. Social forestry: Definition, history, objectives.
16. Components of social forestry- Farm forestry, Extension forestry, Community forestry, Recreation forestry, Urban forestry; Benefits of social forestry.
17. Important social forestry schemes implemented in India; Interface forestry, Joint forest management (JFM); Tamil Nadu Afforestation Project (TAP).

Practical schedule

1. Identification of major farm grown tree species, seeds and seedlings of multipurpose tree species
2. Design and Layout of Tree Nursery
3. Nursery technology of *Tectona grandis*, *Santalum album*

4. Nursery technology of *Casuarina equisetifolia* and *Eucalyptus hybrid*
5. Nursery technology of *Azadirachta indica*, *Melia dubia* and *Ailanthus excelsa*
6. Nursery technology of Red Sanders- *Pterocarpus santalinus*, *Dalbergia sissoo* and *Acacia species*.
7. Studies on contract tree farming practices in Tamil Nadu
8. Visit to agro-forestry fields to study the compatibility of MPTS with agricultural crops: silvipastoral, alley cropping, horti-silviculture, agro-silvipasture, fuel and fodder blocks.
9. Visit to agro-forestry fields to study the compatibility of MPTS with agricultural crops: silvipastoral, alley cropping, horti-silviculture, agro-silvipasture, fuel and fodder blocks.
10. Visit to social forestry plantations – railway line plantations, canal plantations, roadside plantations, industrial plantations and shelterbelts
11. Visit to social forestry plantations – railway line plantations, canal plantations, roadside plantations, industrial plantations and shelterbelts
12. Estimation of girth, height and volume of trees in agroforestry
13. Preparation of two agroforestry models for the region
14. Rapid assessment of farmers needs for green manure, fodder, fuel wood in selected villages
15. Rapid assessment of farmers needs for green manure, fodder, fuel wood in selected villages
16. Economics and marketing of products raised in agro-forestry systems
17. **University Practical Examination**

Text Books

1. Alain Atangana, Damase Khasa, Scott Chang, Ann Degrande. (2014th Edition). Tropical Agroforestry pp 1-380.
2. Antony Joseph Raj and S.B.Lal (2014). Agroforestry-Theory and Practices. Scientific Publishers (India), Jodhpur. Pp 1-356
3. Divya, M.P., K.T. Parthiban, K. Srinivasan, K. Vanangamudi and M. Govinda Rao (2008). A text book on Social Forestry and Agroforestry. Satish Publishers, Delhi. pp 1-315
4. Khanna, L.S (2010). Principles and Practices of Silviculture. Khanna Bavdhu Publishers, Dehra Dun. pp 1-56.
5. Louise E. Buck, James P. Lassoie, Erick C.M. Fernandes (1998). Agroforestry in Sustainable Agricultural Systems (Advances in Agroecology).
6. Nair, P.K.R (1993). An introduction to Agroforestry. Kluwer Academic Publishers, Dordrecht. pp 25-230.
7. Patra A.K (2013). Agroforestry - Principles and Practices, New India Publishing Agency, New Delhi. pp 1-78.
8. Ramesh Umrani and Jain C.K (2010). Agroforestry - Systems and Practices. Oxford Book Company, Jaipur.
9. Reddy, SR., C. Nagamani (2017). Introduction to Forestry. Kalyani publishers. pp 1-120.

Web Resources

1. www.agroforestry.net.au
2. www.fao.org/forestry/9469/en
3. www.fsi.org.in
4. www.global-saf.com
5. www.nac.unl.edu/documents/insideagroforestry/vol16issue2.pdf
6. www.silviculture.com
7. www.worldagroforestry.org

Journals

1. Agroforestry Systems
2. Annals of Forest Science
3. Applied Vegetation Science
4. Forest Science
5. International Journal of Agroforestry and Silviculture
6. World Agroforestry

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-	-	-	50	50
2	Theory-Internal	20	-	-	-	-	20
3	Practical-External	-	-	-	-	15	15
4	Practical-Internal	-	05	05	05	-	15
Grand Total							100

Course Code	SKE19301	Course Name	Information and Communication Technology	Course Category	S	Supportive Courses	L	T	P	C
							1	0	1	2

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Department of Basic and Applied Sciences	Data Book / Codes/Standards			Nil

Course Learning Rationale (CLR):	<i>The purpose of learning this course is to:</i>	Learning			Program Learning Outcomes (PLO)														
CLR-1 :	<i>Understand the operating and application software</i>	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	<i>Identify the programming language</i>	Thinking (Bloom)	Efficiency (%)	Mastery (%)	Knowledge	Analysis	Development	Design, Research	Usage	Culture & Values	Team Work	Communication	Finance & Management	Use scientific through ICT	Implement	Gained in the field of information technology	Understand social responsibilities		
CLR-3 :	<i>Define various computer technology for horticulture development</i>																		
CLR-4 :	<i>Discuss the ICT and smart phone apps in horticulture</i>																		
CLR-5 :	<i>Summarize crop simulation model</i>																		
CLR-6 :	<i>Describe ICT for rural development</i>																		

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Horticulture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems through ICT	Ability to implement knowledge gained in the applied field of information and communication technology	Ability to understand social and ethical responsibilities of ICT
CLO-1 :	Understand the application of information and technology	3	80	60	H														
CLO-2 :	Explain the digital framework used in horticulture	3	80	70				H	H							H	H	M	M
CLO-3 :	Interpret crop simulation model and IOT	2	80	70		M	M			M						L	H		
CLO-4 :	Paraphrase information and communication technology applying in rural areas	2	80	75	M					L	L								
CLO-5 :	Discuss the smart phone mobile app for horticulture	3	90	85	M	H	H							H	M	H	H		
CLO-6 :	Perform ICT for research purpose	2	90	70	H	H			H			M	H	H			H	M	M

Duration (hour)		Learning Unit / Module 1 3T+3P	Learning Unit / Module 2 2T+2P	Learning Unit / Module 3 3T+3P	Learning Unit / Module 4 4T+4P	Learning Unit / Module 5 4T+4P
S-1	SLO-1	Introduction to Computers - Basic anatomy of the computer system: Input devices, CPU, Output; devices	Microsoft Excel - Worksheet manipulation: insert, delete, move, copy and hide worksheet	Introduction to Computer Programming – Programming languages	Agricultural Informatics – Need and objectives,	Introduction to computer based agricultural models
	SLO-2	Memory: Primary and secondary	Cell manipulation: copy, edit and format cell data – Charts - Create Bar and Pie charts - PIVOT table	Translators: Compilers and Interpreters - Algorithm – Flowchart.	e-Agriculture: Concept, Meaning, Terminologies and Importance	Types: Mechanistic process models, Operational models, Statistical models and dynamic simulation models - List of agricultural models
S-2-3	SLO-1	LAB 1 - Study of computer anatomy, components and accessories	LAB 4 -Microsoft Excel - Entering a formula in a cell, Built-in functions	LAB 6 - Introduction of programming languages	LAB 9 -Agricultural informatics, e-Agriculture Concept, Meaning, Terminologies and Importance	LAB 13 - Computation of water and nutrient requirement of crops using CSM
	SLO-2					
S-4	SLO-1	Software – Types: System software, Application software and Utility software	Microsoft Access: Database terms: Data, Database, DBMS, RDBMS, Row, Column, Table	Introduction to C – Structure of C program - Data types, Variables, Constants, Operators: Arithmetic, Relational, Logical, Assignment - Input/Output: scanf(), printf()	ICT for Data collection, formation of development programmes, monitoring and evaluation of programmes.	Internet of Things (IoT) in horticulture
	SLO-2	Software terminologies: Firmware, Liveware, Freeware, Shareware, Commercial software, Proprietary software, Semi-free software	Database Architecture – Use of databases in horticulture, preparing queries and reports			

Duration (hour)		Learning Unit / Module 1 3T+3P	Learning Unit / Module 2 2T+2P	Learning Unit / Module 3 3T+3P	Learning Unit / Module 4 4T+4P	Learning Unit / Module 5 4T+4P
S-5-6	SLO-1	LAB 2 -Study of computer operation system and software packages	LAB 5 – Microsoft Access: Creating horticulture database – Entering, editing, deleting data – Creating Forms	LAB 7 - Familiarizing with the Integrated Development Environment of C Programs	LAB 10 - Decision support systems	LAB 14 - Application of Internet of things (IOT) in horticulture
	SLO-2					
S-7	SLO-1	Internet - World Wide Web – URL – Domain names - Protocols: HTTP, HTTPS		Control statements in C: if, if else – Loop: while, do while, for.	Decision support systems: Taxonomy, Components,	Cloud Computing for horticulture
	SLO-2	Internet Applications: Email, File sharing web apps, Social Networks, Online shopping, Video Conferencing, Mobile Apps			Framework, Classification and applications in Agriculture	
S-8-9	SLO-1	LAB 3 :Internet Applications: Email, File sharing web apps: Dropbox, Google drive - Social Networks, Online shopping, Video Conferencing		LAB 8 - Develop a C program to calculate Leaf Area Index (LAI), Crop Growth Rate (CGR) and analyze rain fall data	LAB 11 - Expert systems - Information systems for supporting farm decisions	LAB 15 - Application of Cloud computing in horticulture
	SLO-2					
S-10					Expert systems - Concepts and Importance – Components – User Interface – Knowledge Base – Inference Mechanism – Inference Rule -	Machine learning in horticulture
					Designing an Expert Systems - Advantages and disadvantages of Expert Systems - Information systems for supporting farm decisions.	
S-11-12					LAB 12 -Hands on crop simulation models (DSSAT/Crop-Info/CropSyst/Wofost)	LAB 16 - Machine learning application in Horticulture

Learning Resources	1.	Mahapatra S. K., Subrata K. M. Bhuiya J. & Pradhan J. (2019). Introductory Agri-Informatics (1 st Edn.), Jain Brothers, New Delhi, India. ISBN 9788183602969. pp 1-146
	2.	Panda C. K., Anil P. & Singh S. R. (2018). Advances in ICT in Agriculture (1 st Edn.), New Delhi Publisher, India. ISBN 9789386453341. pp 1- 283

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember Understand	60 %	50 %	50 %	60 %
Level 2	Apply Analyze	25 %	30 %	30 %	30 %
Level 3	Evaluate Create	15 %	20 %	20 %	10 %
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
S. Bharat	Dr. N.S. Chandel	Dr. Kamlesh Golhani
Vedmaya Software Technologies Pvt. Ltd., Chennai	Scientist, Central Institute of Agricultural Engineering, Bhopal	Dr. Sanjeev Gandhi

THEORY

Unit I – Information and communication technology (ICT)

Computer Fundamentals – computer generations, basic anatomy of the computer system: Input devices, CPU, Output devices, Memory: Primary and secondary - Software – types: System software, Application software and Utility software; Software terminologies: Firmware, Liveware, Freeware, Shareware, Commercial software, Proprietary software, Semi-free software; Internet - World Wide Web; Application of Smartphone apps

Unit II – Database management system (DBMS)

Microsoft Excel - Design worksheet: insert, delete, move, copy and hide worksheet; Cell manipulation: copy, edit and format cell data; Charts - Create Bar and Pie charts; PIVOT table; Microsoft Access: Tabular Data, Database, Database Architecture, DBMS, Preparing queries and reports

Unit III – C Programming

Introduction to Computer Programming – Programming languages; Translators: Compilers and Interpreters; Algorithm – Flowchart; Introduction to C – Structure of C program; Data types, variables, constants, operators: Arithmetic, Relational, Logical, Assignment; Input/Output: scanf(), printf(); Control statements: if, if else – Loop: while, do while, for.

Unit IV – Agricultural Informatics

Agricultural Informatics – Needs and objectives; e-Agriculture: Concept, Meaning, Terminologies and Importance - National and International scenario - ICT for Data collection, formation of development programmes, monitoring and evaluation of programmes; Decision support systems: Taxonomy, Components, Framework, Classification and applications in Agriculture -Expert systems - Concepts and Importance – Components – User Interface – Knowledge Base – Inference Mechanism – Inference Rule - Designing an Expert Systems - Advantages and disadvantages of Expert Systems, Information systems for supporting farm decisions.

Unit V – Computer Models and IoT

Introduction to computer based agricultural models: Model, Simulation, Systems analysis models, Subsystems, Types: Mechanistic process models, Operational models, Statistical models and dynamic simulation models - List of agricultural models; Internet of Things (IoT) and Cloud computing in horticulture, Machine learning in horticulture

Theory – Lecture Schedule

1. Introduction to computers – computer generations, Basic anatomy of the computer system, Input devices, CPU, Output devices; Memory- Primary and secondary.
2. Software - types of software - System software, Application software and Utility software; Software terminologies- Firmware, Liveware, Freeware, Shareware, Commercial software, Proprietary software, Semi-free software.
3. Internet - World Wide Web, URL - Domain names - Protocols: HTTP, HTTPS – Internet; Applications: Email, File sharing web apps, Social Networks, Online shopping, Video Conferencing, Application of smartphone apps
4. Microsoft Excel - worksheet manipulation: insert, delete, move, copy and hide worksheet; Cell manipulation: copy, edit and format cell data; Charts - create bar and pie charts, PIVOT table.
5. Microsoft Access - Database terms: Data, Database, DBMS, RDBMS, Row, Column, Table and Database Architecture; Use of databases in horticulture, preparing queries and reports
6. Introduction to Computer Programming - Programming languages; Translators: Compilers and Interpreters - Algorithm - Flowchart.
7. Introduction to C - Structure of C program - Data types, Variables, Constants, Operators: Arithmetic, Relational, Logical, Assignment - Input/Output: scanf(), printf().
8. Control statements in C programming: if, if else – Loop: while, do while, for.
9. **In – semester examination**
10. Agricultural Informatics – Need and objectives, e-Agriculture: Concept, Meaning, Terminologies and Importance, e-Agriculture – National and International scenario
11. ICT for Data collection, formation of development programmes, monitoring and evaluation of programmes
12. Decision support systems - Taxonomy, Components, Framework, Classification and applications in Agriculture.
13. Expert systems - Concepts and Importance - Components -User Interface - Knowledge Base - Inference Mechanism - Inference Rule - Designing an Expert Systems - Advantages and disadvantages of Expert Systems - Information systems for supporting farm decisions.
14. Introduction to computer based agricultural models: Model, Simulation, Systems analysis models, Subsystems, Types: Mechanistic process models, Operational models, Statistical models and dynamic simulation models - List of agricultural models.
15. Internet of Things (IoT) in horticulture
16. Cloud computing for horticulture
17. Machine learning in horticulture

Practical Schedule

1. Study of computer anatomy, components and accessories
2. Study of computer operation system and software packages
3. Internet Applications: Email, File sharing web apps: Dropbox, Google drive - Social Networks, Online shopping, Video Conferencing
4. Microsoft Excel - Entering a formula in a cell, Built-in functions
5. Microsoft Access: Creating horticulture database – Entering, editing, deleting data – Creating Forms
6. Introduction of programming languages
7. Familiarizing with the Integrated Development Environment of C Programs
8. Develop a C program to calculate Leaf Area Index (LAI), Crop Growth Rate (CGR) and analyze rain fall data
9. Agricultural informatics, e-Agriculture concept, meaning, terminologies and importance
10. Decision support systems
11. Expert systems - Information systems for supporting farm decisions.
12. Hands on crop simulation models (DSSAT/Crop-Info/CropSyst/Wofost)
13. Computation of water and nutrient requirement of crops using CSM
14. Application of Internet of things (IOT) in horticulture
15. Application of Cloud computing in horticulture
16. Machine learning application in horticulture
17. **University Practical Examination**

Text Books

1. Gurvinder S., Rachhpal S., & Saluja K. K. (2003). Fundamentals of Computer Programming and Information Technology (1st Edn). Kalyani Publishers. ISBN 9788127224363. pp 1-589.
2. Kumar A. (2015). Computer Basics with Office Automation (1st Edn). IK International Publishing House Pvt Ltd. ISBN 9789380578620. pp 1 -336.
3. Mahapatra S. K., Subrata K. M. Bhuiya J. & Pradhan J. (2019). Introductory Agri-Informatics (1st Edn.), Jain Brothers, New Delhi, India. ISBN 9788183602969. pp 1-146
4. Pearson (2013). Introduction to Information Technology (2nd Edn.), IITL Education Solutions Limited.
5. Rajaraman V. & Adabala N. (2015). Fundamentals of Computers. PHI. ISBN 9788131704363. pp 1-508.

Reference Books

1. Blackie M. J. (2012). Information Systems for Agriculture (1st Edn.). Springer Netherlands. ISBN 978-9401167390. pp 1- 188.
2. Panda C. K., Anil P. & Singh S. R. (2018). Advances in ICT in Agriculture (1st Edn.). New Delhi Publisher, India. ISBN 9789386453341. pp 1-283.
3. Saravanan, R., Kathiresan, C. & Indra Devi, T. (2011). Information & Communication Technology for Agriculture and Rural Development. New India Publishing Agency, ISBN 978-9380235882. pp 1-386.

Web References

1. <https://edu.gcfglobal.org/en/word2016/>
2. <https://edu.gcfglobal.org/en>
3. http://indiagovernance.gov.in/files/ict_in_agriculture.pdf
4. www.manage.gov.in/studymaterial/AKM-E.pdf
5. <https://www.youtube.com/watch?v=Jy9QDrFlyXE>

Journals

1. Computers and Electronics in Agriculture
2. Information Processing in Agriculture
3. International Journal of Information Technology

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-	-	-	50	50
2	Theory-Internal	20	-	-	-	-	20
3	Practical-External	-	-	-	-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	HOR19401	Course Name	Dry Land Horticulture	Course Category	C	Compulsory Core	L	T	P	C
							1	0	1	2

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Horticulture	Data Book / Codes/Standards			Nil

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning	Program Learning Outcomes (PLO)
CLR-1 :	Outline the scope and importance of dry land horticulture	1 2 3	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
CLR-2 :	Describe the production practices for dry land horticultural crops	Level of Thinking (Bloom)	Horticulture Knowledge
CLR-3 :	Define the various soil and water conservation measures	Expected Proficiency (%)	Problem Analysis
CLR-4 :	Explain the techniques involved in fruit cultivation for dry land fruit crops	Expected Attainment (%)	Design & Development
CLR-5 :	Summarize the horticultural crops adapted for dry land cultivation		Analysis, Design, Research
CLR-6 :	Interpret the post-harvest handling of arid zone fruit crops		Modern Tool Usage
			Society & Culture
			Environment & Sustainability
			Ethics
			Individual & Team Work
			Communication
			Project Mgt. & Finance
			Life Long Learning
			Ability to solve scientific problems through dry land horticulture
			Ability to implement knowledge gained in the applied field of dry land horticulture
			Ability to understand social and ethical responsibilities of dry land horticulture

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Horticulture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems through dry land horticulture	Ability to implement knowledge gained in the applied field of dry land horticulture	Ability to understand social and ethical responsibilities of dry land horticulture
CLO-1 :	Explain different cropping systems followed in dry land horticulture	1	75	70	M								L	H		H	H	H	H
CLO-2 :	Recall different crops that are suitable to dry land areas	1	80	70	L	H	H		H				M	H		H	H	H	H
CLO-3 :	Identify different dry land farming techniques	1	85	75	M	H	H		H				H	H		H	H	H	H
CLO-4 :	Understand the present status of dry land horticulture	2	90	85	H		H		H		H		L	H		H	H	H	H
CLO-5 :	Explain drought and erosion management problems	3	95	90	H				L				L	H		H	H	H	H
CLO6 :	Describe the latest watershed management techniques	2	85	80	M				H		H		M	H		H	H	H	H

Duration (hour)	Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
	4	3	3	3	3
S-1	SLO-1 Dry land horticulture: introduction and definition	Efficient cropping systems	Water harvesting and lifesaving irrigation.	Pomegranate: Production technology	Jamun and Bael: Production technology
	SLO-2 Scope and importance	Evapo-transpiration	Dry land horticultural crops based alternate land use systems		
S-2-3	SLO-1 Lab 1: Analysis of rainfall data and its interpretation	Lab 5: Study of mulches and antitranspirants	Lab 8: Fertilizer use in dry land horticultural crops, inorganic, organic and biofertilizers	Lab 11: Study of varieties and propagation techniques for pomegranate, fig and phalsa	Lab 14: Assessment of maturity standards for dry land fruit crops
S-4	SLO-1 Characteristics of dry land horticulture	Watershed management	Aonla: Production technology	Custard Apple and Fig: Production technology	Phalsa and West Indian cherry: Production technology
	SLO-2 Dry climates and their classification	Land use capability and classification			
S-5-6	SLO-1 Lab 2: Collection and interpretation of data on temperature and evaporation	Lab 6: Study of erosion problems in field	Lab 9: Collection of biometric data on crop and its interpretation	Lab 12: Study of varieties and propagation techniques for custard apple, Jamun, bael and West Indian cherry	Lab 15: Practices in harvesting and postharvest handling of dry land fruit crops
	SLO-2				
S-7	SLO-1 Problems of crop production in dry lands	Soil conservation measures in watershed areas	Ber: Production technology	Date palm and Carissa: Production technology	Manila tamarind and wood apple: Production technology
	SLO-2 Rainfall patterns in dry regions	Water conservation measures in watershed areas			
S-8-9	SLO-1				

Duration (hour)	Learning Unit / Module 1		Learning Unit / Module 2		Learning Unit / Module 3		Learning Unit / Module 4		Learning Unit / Module 5	
	4		3		3		3		3	
	SLO-2	Lab 3: Study of dry farming implements	Lab 7: Preparation of contingent crop planning for aberrant weather conditions		Lab 10: Study of varieties, propagation techniques, training and pruning for aonla and ber		Lab 13: Study of varieties and propagation techniques for Carissa and manila tamarind		Lab 16: Visit to watershed areas and dry land fruit crop fields	
S-10	SLO-1	Drought	-		-		-		-	
	SLO-2	Soil erosion	-		-		-		-	
S-11	SLO-1	Lab 4: Study of agronomic measures of soil and moisture conservation	-		-		-		-	
	SLO-2									

Learning Resources	1.	Kumar, N. 2020. <i>Introduction to Horticulture</i> (7 th revised edition). New Delhi: Oxford & I.B.H. Publishing. pp. 1 – 452.
	2.	Yellamanda Reddy, T. 2017. <i>Dry land Agriculture: Principles and practices</i> . New Delhi: Kalyani publishers.

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember	40 %	30 %	35 %	30 %
	Understand				
Level 2	Apply	40 %	40 %	35 %	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	30 %	30 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr.Amol Chaudhari Manager, R & D Farm, Jain Irrigation Systems Ltd., Udumalpet	Dr Vijay Rakesh Reddy, S. Scientist (Horticulture), ICAR-IIHR, Bengaluru	Dr. B. Gopu Dr. Akojam Ranjita Devi

THEORY

Unit I - Introduction to dry land horticulture

Dry land horticulture – introduction and definition - Scope and importance of dry land horticulture - Characteristics of dry land horticulture - Dry climates and their classification - Problems of crop production in dry lands. Rainfall patterns in dry regions.

Unit II - Resource management

Drought - definition, types and management - Soil erosion - types, factors affecting erosion - Efficient cropping systems, normal and contingency crop planning under aberrant weather conditions. Evapo-transpiration – measures to reduce evaporation and transpiration.

Unit III - Watershed management

Watershed management – objectives and approaches, steps in watershed planning. Land use capability and classification. Soil and water conservation measures in watershed areas. Water harvesting and lifesaving irrigation. Problems and prospects under watersheds. Dry land horticultural crops based alternate land use systems.

Unit IV - Dry land fruit crops (aonla, ber, pomegranate, date palm, fig, phalsa and custard apple)

Composition and uses - origin and distribution - climate and soil requirements – varieties -spacing and planting patterns - cropping systems - management of nutrients, water, weeds – special horticultural practices – use of plant growth regulators – harvest and yield-production constraints - post harvest handling.

Unit V - Dry land fruit crops (jamun, bael, wood apple, west indian cherry, carissa and manila tamarind)

Composition and uses - origin and distribution - climate and soil requirements – varieties -spacing and planting patterns - cropping systems - management of nutrients, water, weeds – special horticultural practices – use of plant growth regulators – harvest and yield-production constraints - post harvest handling.

Theory lecture schedule

1. Dry land horticulture – introduction and definition - Scope and importance of dry land horticulture
2. Characteristics of dry land horticulture - Dry climates and their classification.
3. Problems of crop production in dry lands. Rainfall patterns in dry regions.
4. Drought - definition, types and management - Soil erosion - types, factors affecting erosion
5. Efficient cropping systems, normal and contingency crop planning under aberrant weather conditions. Evapo-transpiration – measures to reduce evaporation and transpiration.
6. Watershed management – objectives and approaches, steps in watershed planning. Land use capability and classification.
7. Soil and water conservation measures in watershed areas.
8. Water harvesting and lifesaving irrigation. Dry land horticultural crops based alternate land use systems.
9. **In-Semester Examination**
10. Aonla - composition and uses - origin and distribution - climate and soil requirements – varieties -spacing and planting patterns - cropping systems - management of nutrients, water, weeds – special horticultural practices – use of plant growth regulators – harvest and yield-production constraints - post harvest handling.
11. Ber - composition and uses - origin and distribution - climate and soil requirements – varieties -spacing and planting patterns - cropping systems - management of nutrients, water, weeds – special horticultural practices – use of plant growth regulators – harvest and yield-production constraints - post harvest handling.
12. Pomegranate - composition and uses - origin and distribution - climate and soil requirements – varieties -spacing and planting patterns - cropping systems - management of nutrients, water, weeds – special horticultural practices – use of plant growth regulators – harvest and yield-production constraints - post harvest handling.
13. Custard apple and fig - composition and uses - origin and distribution - climate and soil requirements – varieties -spacing and planting patterns - cropping systems - management of nutrients, water, weeds – special horticultural practices – use of plant growth regulators – harvest and yield-production constraints - post harvest handling.
14. Date palm and Carissa - composition and uses - origin and distribution - climate and soil requirements – varieties -spacing and planting patterns - cropping systems - management of nutrients, water, weeds – special horticultural practices – use of plant growth regulators – harvest and yield-production constraints - post harvest handling.
15. Jamun and Bael – composition and uses - origin and distribution - climate and soil requirements – varieties -spacing and planting patterns - cropping systems - management of nutrients, water, weeds – special horticultural practices – use of plant growth regulators – harvest and yield-production constraints - post harvest handling.
16. Phalsa and West Indian cherry – composition and uses - origin and distribution - climate and soil requirements – varieties -spacing and planting patterns - cropping systems - management of nutrients, water, weeds – special horticultural practices – use of plant growth regulators – harvest and yield-production constraints - post harvest handling.

17. Manila tamarind and wood apple - composition and uses - origin and distribution - climate and soil requirements – varieties -spacing and planting patterns - cropping systems - management of nutrients, water, weeds – special horticultural practices – use of plant growth regulators – harvest and yield-production constraints - post harvest handling.

Practical schedule

1. Analysis of rainfall data and its interpretation.
2. Collection and interpretation of data on temperature and evaporation.
3. Study of dry farming implements.
4. Study of agronomic measures of soil and moisture conservation.
5. Study of mulches and antitranspirants.
6. Study of erosion problems in field.
7. Preparation of contingent crop planning for aberrant weather conditions.
8. Fertilizer use in dry land horticultural crops, inorganic, organic and biofertilizers.
9. Collection of biometric data on crop and its interpretation.
10. Study of varieties, propagation techniques, training and pruning for aonla and ber
11. Study of varieties and propagation techniques for pomegranate, fig and phalsa.
12. Study of varieties and propagation techniques for custard apple, Jamun, bael and West Indian cherry.
13. Study of varieties and propagation techniques for Carissa and manila tamarind.
14. Assessment of maturity standards for dry land fruit crops.
15. Practices in harvesting and postharvest handling of dry land fruit crops.
16. Visit to watershed areas and dry land fruit crop fields.
17. **University practical examination.**

Text Books

1. Chadha, K.L. (2019). Handbook of Horticulture. Vol. I (2nd revised edition). New Delhi: ICAR. pp 1 – 299.
2. Kumar, N. (2020). Introduction to Horticulture (7th revised edition). New Delhi: Oxford & I.B.H. Publishing. pp. 1 – 452.
3. Panda, S.C. (2010). Agrometeorology and contingent crop planning. Jodhpur: Agrobios. pp. 1 – 574.
4. Panda, S.C. (2014). Dry land agriculture. Jodhpur: Agrobios.
5. Pareek, O.P., Sharma, B.D. & S. Sharma. (1998). Wasteland Horticulture. New Delhi: Oscar Publications.
6. Yellamanda Reddy, T. (2017). Dry land Agriculture: Principles and practices. New Delhi: Kalyani publishers.

Reference Books

1. Panda, S.C. (2010). Soil water conservation and dry land farming. Jodhpur: Agrobios.
2. Peterson, G.A., Unger P.W. & W.A. Payne. (2006). Dry land Agriculture (2nd edition). Published by American Society of Agronomy-Crop Science Society of America. pp. 1-1026.
3. Saroj, P. L & O.P. Awasthi. (2008). Advances in Arid Horticulture (Vol. 2) Production technology of arid and semiarid fruits. Lucknow: International Book Distributing Co.,

Web Resources

1. http://agritech.tnau.ac.in/horticulture/horti_fruits.html
2. <http://ecourses.iasri.res.in>
3. <http://www.ishs.org>
4. <https://ciah.icar.gov.in/>
5. www.crida.org

Journals

1. *Acta Horticulturae*
2. *Annals of Arid zone Research*
3. *HortScience*

4. HortTechnology
5. Indian Horticulture
6. Indian Journal of Arid Horticulture
7. Indian Journal of Dry land Agriculture Research and Development
8. Indian Journal of Horticulture
9. Journal of Horticultural Sciences
10. Journal of the American Society for Horticultural Science

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-	-	-	50	50
2	Theory-Internal	20	-	-	-	-	20
3	Practical-External	-	-	-	-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	HOR19402	Course Name	Breeding of Fruit and Plantation Crops	Course Category	C	Compulsory Core	L	T	P	C
							2	0	1	3

Pre-requisite Courses	GPB19302	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Horticulture	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:			Learning			Program Learning Outcomes (PLO)														
CLR-1 :	Understand the scope and Importance of breeding fruit and plantation crops	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
CLR-2 :	Define the principles and methods of crop improvement programme	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems through breeding of Horticultural crops	Ability to implement knowledge gained in the applied field of breeding of Horticultural crops	Ability to understand social and ethical responsibilities of breeding of Horticultural crops	Plantation crops		
CLR-3 :	Describe the germplasm characterization of Fruit and Plantation Crops																					
CLR-4 :	Summarize the essential of plant genetic resources in development of hybrids																					
CLR-5 :	Interpret the various methods of mutagenesis for crop improvement																					
CLR-6 :	Outline the methods of polyploidy breeding																					
Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:																				
CLO-1 :	Understand the concepts of breeding and floral biology	2	90	80	M	M	M	M	M	M	H	M	M	H	M	H	H	H	M			
CLO-2 :	Utilize the genetic resources in crop improvement	2	95	85	H	M	M	M	M	H	H	H	H	H	H	H	H	H	H			
CLO-3 :	Perform selection and hybridization process for crop improvement	2	90	80	H	H	M	M	M	H	M	H	H	H	H	H	H	H	M			
CLO-4 :	Exploit crops to express hybrid vigor	2	85	75	M	M	M	M	M	M	M	M	M	H	M	H	H	H	M			
CLO-5 :	Explain polyploidy, mutation and biotechnological application for crop improvement	2	80	80	M	M	M	M	M	M	M	M	M	H	M	H	H	H	M			
CLO6 :	Interpret crop specific breeding objectives	2	85	75	M	M	M	M	M	M	M	M	M	H	M	H	H	H	M			

Duration (hour)		Learning Unit / Module 1 7T+4P	Learning Unit / Module 2 8T+3P	Learning Unit / Module 3 5T+3P	Learning Unit / Module 4 9T+3P	Learning Unit / Module 5 4T+3P
S-1	SLO-1	History and development of fruit breeding	Objectives of breeding in mango	Objectives of breeding in aonla	History of plantation crops	Objectives of breeding in cashew
	SLO-2	Importance of fruit breeding	Breeding methods and achievement in mango	Breeding methods and achievement in aonla	Importance of plantation crops	Breeding methods and achievement in cashew
S-2	SLO-1	Centers of diversity of fruit species	Objectives of breeding in banana	Objectives of breeding in pomegranate	Origin, distribution of plantation crops	Objectives of breeding in coffee
	SLO-2	Domestication of fruit species	Breeding methods and achievement in banana	Breeding methods and achievement in pomegranate	Domestication and adoption of plantation crops	Breeding methods and achievement in coffee
S-3	Practical-1	Study of floral biology, pollen viability; breeding techniques in mango	Study of floral biology in pomegranate and custard apple	Study of polyembryony in certain mango & citrus spp	Exposure to resistance breeding & screening techniques	Study of pollen viability, emasculation and pollination procedures in plantation crops
S-4						
S-5	SLO-1	Breeding approaches in fruit crops	Objectives of breeding in papaya	Objectives of breeding in pineapple	Breeding strategies, clonal selection, poly-clonal orchards, its application in crop improvement of plantation crops	Objectives of breeding in tea
	SLO-2	Breeding approaches in plantation crops	Breeding methods and achievement in papaya	Breeding methods and achievement in pineapple	Breeding strategies, bud mutation, mutagenesis and its application in crop improvement of plantation crops	Breeding methods and achievement in tea
S-6	SLO-1	Plant genetic resources - conservation	Objectives of breeding in sapota	Objectives of breeding in custard apple	Hybridization breeding in the improvement of plantation crops	Objectives of breeding in cocoa

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		7T+4P	8T+3P	5T+3P	9T+3P	4T+3P
	SLO-2	Plant genetic resources - utilization	Breeding methods and achievement in sapota	Breeding methods and achievement in custard apple	Haploid and ploidy breeding in the improvement of plantation crops	Breeding methods and achievement in cocoa
S-7	Practical-2	Study of floral biology and different cultivars of banana for their genome	Study of pollen fertility in major fruit crops	Study of different sex forms of papaya, their anthesis time	Preparation and uses of chemical and physical mutagens	Technique of selfing and crossing in plantation crops
S-8						
S-9	SLO-1	Resistance breeding - biotic stresses	Objectives of breeding in guava	Objectives of breeding in rosaceae crop	In vitro techniques in the improvement of plantation crops	
	SLO-2	Resistance breeding - abiotic stresses	Breeding methods and achievement in guava	Breeding methods and achievement in rosaceae crop	Application of In vitro techniques in the improvement of plantation crops	
S-10	SLO-1	Utilization of male sterility in fruit crops	Objectives of breeding in citrus		Objectives of breeding in coconut	
	SLO-2	Utilization of male sterility in plantation crops	Breeding methods and achievement in citrus		Breeding methods and achievement in coconut	
S-11	Practical-3	Study of floral biology in papaya, sapota and guava	Study and practice of crossing technique in major fruit crops	Visit to Biotechnology Lab & study of in-vitro breeding techniques	Botany, floral biology, selfing and crossing techniques for plantation crops	Visit to research institutes involved in Plantation crops Research
S-12						
S-13	SLO-1	Utilization of incompatibility in fruit crops	Objectives of breeding in grapes		Objectives of breeding in arecanut	
	SLO-2	Utilization of incompatibility in plantation crops	Breeding methods and achievement in grapes		Breeding methods and achievement in arecanut	
S-14	SLO-1		Objectives of breeding in strawberry		Objectives of breeding in oil palm	
	SLO-2		Breeding methods and achievement in strawberry		Breeding methods and achievement in oil palm	
S-15	Practical-4	Study of different species of citrus & morphological description				
S-16						
S-17	SLO-1				Objectives of breeding in rubber	
	SLO-2				Breeding methods and achievement in rubber	
S-18	SLO-1					
	SLO-2					

Learning Resources	1.	Kumar, N. 2018. Breeding of Horticultural Crops, Principles and Practices. New India Publishing Agency, New Delhi. pp.1-220
	2.	Shukla, A. K. 2004. Fruit breeding approaches & Achievements. International Book Distributing Co. New Delhi. pp.1-342

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember Understand	50 %	30 %	35 %	30 %
Level 2	Apply Analyze	30 %	40 %	35 %	40 %
Level 3	Evaluate Create	20 %	30 %	30 %	30 %
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Prakash M, Assistant breeder, TCI Research Private Limited, Bangalore, Karnataka	Dr. Vikram HC, Kerala Agricultural University, Thrissur, Kerala	Dr. Akoijam Ranjita Devi Dr. B. Gopu

THEORY

Unit I – Introduction to breeding in fruit and plantation crops

Fruits and Plantation breeding: Scope and importance, genetic diversity and acclimatization of commercially important horticulture crops; breeding approaches; plant genetic resources - conservation and utilization; resistance breeding - biotic and abiotic stresses; male sterility, incompatibility.

Unit II - Breeding of mango, banana, papaya, sapota, guava, citrus, grapes, strawberry

Floral biology, objectives, breeding methodology, biotechnological interventions, achievements and future thrusts

Unit III – Breeding of aonla, pomegranate, pineapple, custard apple, apple, pear, peach, apricot and plum

Floral biology, objectives, breeding methodology, biotechnological interventions, achievements and future thrusts

Unit IV – Breeding of coconut, arecanut, oilpalm and rubber

Floral biology, objectives, breeding methodology, biotechnological interventions, achievements and future thrusts

UNIT V – Breeding of tea, coffee, cocoa and cashew

Floral biology, objectives, breeding methodology, biotechnological interventions, achievements and future thrusts

Theory – Lecture Schedule

1. History and development, importance of fruit breeding
2. Centers of diversity distribution and domestication of fruit species
3. Breeding approaches in fruit and plantation crops
4. Plant genetic resources - conservation and utilization
5. Resistance breeding - biotic and abiotic stresses
6. Utilization of male sterility in fruit and plantation crops
7. Utilization of incompatibility in fruit and plantation crops
8. Genetic resources, objectives of breeding, principles and method of breeding and salient breeding achievements in mango
9. Genetic resources, objectives of breeding, principles and method of breeding and salient breeding achievements in banana
10. Genetic resources, objectives of breeding, principles and method of breeding and salient breeding achievements in papaya
11. Genetic resources, objectives of breeding, principles and method of breeding and salient breeding achievements in sapota
12. Genetic resources, objectives of breeding, principles and method of breeding and salient breeding achievements in guava
13. Genetic resources, objectives of breeding, principles and method of breeding and salient breeding achievements in citrus
14. Genetic resources, objectives of breeding, principles and method of breeding and salient breeding achievements in grapes
15. Genetic resources, objectives of breeding, principles and method of breeding and salient breeding achievements in strawberry
16. Genetic resources, objectives of breeding, principles and method of breeding and salient breeding achievements in aonla
17. **In-Semester Examination**
18. Genetic resources, objectives of breeding, principles and method of breeding and salient breeding achievements in pomegranate
19. Genetic resources, objectives of breeding, principles and method of breeding and salient breeding achievements in pineapple
20. Genetic resources, objectives of breeding, principles and method of breeding and salient breeding achievements in custard apple
21. Genetic resources, objectives of breeding, principles and method of breeding and salient breeding achievements in rosaceae crops
22. History and importance of plantation crops
23. Origin, distribution, domestication and adoption of plantation crops
24. Breeding strategies, clonal selection, poly-clonal orchards, bud mutation, mutagenesis and its application in crop improvement of plantation crops
25. Hybridization, haploid and ploidy breeding in the improvement of plantation crops
26. *In vitro* techniques in the improvement of plantation crops
27. Genetic resources, objectives of breeding, principles and method of breeding and salient breeding achievements in coconut

28. Genetic resources, objectives of breeding, principles and method of breeding and salient breeding achievements in arecanut
29. Genetic resources, objectives of breeding, principles and method of breeding and salient breeding achievements in oil palm
30. Genetic resources, objectives of breeding, principles and method of breeding and salient breeding achievements and rubber
31. Genetic resources, objectives of breeding, principles and method of breeding and salient breeding achievements in cashewnut
32. Genetic resources, objectives of breeding, principles and method of breeding and salient breeding achievements in coffee
33. Genetic resources, objectives of breeding, principles and method of breeding and salient breeding achievements in tea
34. Genetic resources, objectives of breeding, principles and method of breeding and salient breeding achievements in cocoa

Practical Schedule

1. Study of floral biology, pollen viability; breeding techniques in mango
2. Study of floral biology & different cultivars of banana for their genome
3. Study of floral biology in papaya, sapota and guava
4. Study of different species of citrus & morphological description
5. Study of floral biology in pomegranate and custard apple
6. Study of pollen fertility in major fruit crops
7. Study & practice of crossing technique in major fruit crops
8. Study of polyembryony in certain mango & citrus spp
9. Study of different sex forms of papaya, their anthesis time
10. Visit to Biotechnology Lab & study of in- vitro breeding techniques
11. Exposure to resistance breeding & screening techniques
12. Preparation and uses of chemical and physical mutagens
13. Botany, floral biology, selfing and crossing techniques for plantation crops
14. Study of pollen viability, emasculation and pollination procedures in plantation crops
15. Production of hybrids in plantation crops
16. Visit to research institutes involved in Plantation crops Research
17. **University Practical Examination**

Text Books

1. Kumar, N. (2018). Breeding of Horticultural Crops, Principles and Practices. New India Publishing Agency, New Delhi. pp.1- 220p
2. Parthasarathy, V.A., Chattopadhyay, P.K., and Bose, T. K. (2006). Plantation Crops. Vol I and II. Parthasankarbasu, NayaUdyog, Kolkata. pp.1-1050
3. Shukla, A. K. (2004). Fruit breeding approaches & Achievements. International Book Distributing Co. New Delhi. pp. 1-428

Reference Books

1. Nijar (1985). Fruit breeding in India, Oxford & IBH Publishing Co. New Delhi. pp.1-580
2. Singh, B. D. (2009). Plant Breeding: Principles and methods. Kalyani Publishers, New Delhi. pp.1-889
3. Janick, J. and Moore, J. N. (1996). Fruit Breeding. Vols.I-III. John Wiley & Sons. pp.1-632

Web References

1. <http://treephys.oxfordjournals.org/cgi/reprint/6/3/347.pdf>
2. [http://www.ilvo.vlaanderen.be/EN/Research/ResearchAppliedGeneticsandBreeding_new/ProductQualityImprovement/Breedingofagriculturalandhorticultu ralcrops/tabid/2314/Default.aspx](http://www.ilvo.vlaanderen.be/EN/Research/ResearchAppliedGeneticsandBreeding_new/ProductQualityImprovement/Breedingofagriculturalandhorticultu%20ralcrops/tabid/2314/Default.aspx).
3. <http://www.agricultureinformation.com/forums/jobs-resumes-projects/7081vegetable-breeding-research-job-required.html>
4. <http://www.agron.iastate.edu/faculty/fehr/BVC/00BVC.PDF>
5. https://ecourses.icar.gov.in/e-Learningdownload3_new.aspx?Degree_Id=07

Journals

1. J. of cytogenetics
2. Economic botany

3. Acta Horticulture

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-	-	-	50	50
2	Theory-Internal	20	-	-	-	-	20
3	Practical-External	-	-	-	-	15	15
4	Practical-Internal	-	5	05	05	-	15
Grand Total							100

Course Code	HOR19403	Course Name	Potato and Tuber Crops	Course Category	C	Compulsory Core	L	T	P	C
							1	0	1	2

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Horticulture	Data Book / Codes/Standards			Nil

Course Learning Rationale (CLR):	<i>The purpose of learning this course is to:</i>			Learning			Program Learning Outcomes (PLO)														
CLR-1 :	<i>Outline the significance of potato and tuber crops production</i>			1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	<i>Describe the importance of potato and tuber crop varieties and hybrids</i>			Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Knowledge	Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems through temperate vegetables	Ability to implement knowledge gained in the applied field of temperate vegetables	Ability to understand social and ethical responsibilities of temperate vegetables
CLR-3 :	<i>Define the essential of crop management practices in tuber crops and potato</i>																				
CLR-4 :	<i>Perform the potential of value chain in commercial crop production</i>																				
CLR-5 :	<i>Describe the managerial practices for nutrient and physiological disorders</i>																				

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:																		
CLO-1 :	Understand the scope and importance of potato and tuber crops in nutrition and economy	1	95	90	L								H	H		H	M	H	H
CLO-2 :	Summarize the commercial cultivation of potato	2	90	80	H				M		M		H	H		H	H	H	H
CLO-3 :	Explain disease free potato seed tubers using seed plot technique SPT	2	85	80	H								M	H		H	H	H	H
CLO-4 :	Interpret of producing true potato seeds (TPS)	2	75	65	H	M								H		H	H	H	H
CLO-5 :	Identify tuber crops to a nontraditional region of cultivation	3	85	70	H	L								H		H	H	H	H
CLO-6 :	Identify and control physiological disorders	2	70	65	H	H								H		H	H	H	H

Duration (hour)		Learning Unit / Module 1 2T+2P	Learning Unit / Module 2 5T+5P	Learning Unit / Module 3 3T+3P	Learning Unit / Module 4 4T+4P	Learning Unit / Module 5 2T+2P
S-1	SLO-1	Scope and importance	Potato - Economic importance and uses, classification of varieties	Arrow root – Introduction and importance	Xanthosoma – Introduction and importance	Jerusalem artichoke – Introduction and importance
	SLO-2	Area and production	Potato - description of varieties and hybrids Climate and soil requirements	Arrow root – Production technology	Xanthosoma – production technology	Jerusalem artichoke – production technology
S-2-3	SLO-1	LAB - Identification and description of varieties of potato	LAB - Identification and description of varieties of sub-tropical and temperate tuber crops	LAB - Use of herbicides and growth regulators	LAB -Post-harvest handling, storage and Marketing	LAB - Working out cost of cultivation
	SLO-2					
S-4	SLO-1	Export potential	Potato - Season/time of planting, seed rate and seed size, seed treatment, field preparation and planting, Method of planting	Cassava - Introduction and importance	Amorphophallus – Introduction and importance	Horse radish - production technology
	SLO-2	Institutions	Potato - spacing, cropping systems; water management, weed control, nutrient management; Special practices	Cassava – Production technology	Amorphophallus – production technology	Other under exploited tuber crop
S-5-6	SLO-1	LAB - Identification and description of varieties of tropical tuber crops	LAB - Planting systems and practices	LAB - Identification of nutrient deficiencies and physiological disorders	LAB - Seed collection	LAB - Project preparation of commercial cultivation
	SLO-2					
S-7	SLO-1		Potato - physiological disorders and production constraint, plant growth regulators, maturity indices, harvest and yield, post-harvest handling and storage	Colacasia – Introduction and importance	Dioscorea – Introduction and importance	

Duration (hour)	Learning Unit / Module 1 2T+2P		Learning Unit / Module 2 5T+5P		Learning Unit / Module 3 3T+3P		Learning Unit / Module 4 4T+4P		Learning Unit / Module 5 2T+2P	
S-8-9	SLO-2		Potato - Seed plot technique (SPT), True potato seed (TPS)		Colacasia – production technology		Dioscorea – production technology			
	SLO-1		LAB - Field preparation and sowing/planting		LAB - Maturity indices and harvesting		LAB - Visit to CTCRI, Thiruvananthapuram / research stations / markets			
	SLO-2									
S-10	SLO-1		Sweet potato - Introduction, economic importance, description of varieties and hybrids, Climate and soil requirement, season				Chinese potato (vegetable coleus) – Introduction and importance			
	SLO-2		Sweet potato - propagation, nursery management, seed rate, preparation of field, planting practices, spacing, water, nutrient management				Chinese potato (vegetable coleus) – production technology			
S-11-12	SLO-1		LAB - Top dressing of fertilizers				LAB - Visit to commercial farmers field			
	SLO-2									
S-13	SLO-1		Sweet potato - weed management, nutrient deficiencies and physiological disorders, PGR							
	SLO-2		Sweet potato - cropping systems, Harvesting practices, yield, Post- harvest handling and storage,							
S-14-15	SLO-1		LAB - Intercultural operations							
	SLO-2									

Learning Resources	1.	Thamburaj, S. and Narendra Singh. (2001). A text book of vegetable tubercrops and spices. ICAR. New Delhi. pp 1-469
	2.	Hazra, P., A. Chattopadhyay, K. Karmakar and S. Dutta. (2010). "Modern technology in vegetable production" New India Publishing Agency, New Delhi. pp 1-424

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember	50 %	50 %	50 %	60 %
	Understand				
Level 2	Apply	30 %	30 %	30 %	30 %
	Analyze				
Level 3	Evaluate	20 %	20 %	20 %	10 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
		Mr. Harish. A

THEORY

Unit I - Scope and importance of potato and tuber crops

Potato and tuber crops: scope and importance, area and production, global and national scenario, institutions involved in potato and tuber crops research, export potential of potato and tropical, sub-tropical and temperate tuber crops

Unit II – Potato and sweet potato

Introduction, economic importance, description of varieties and hybrids, Climate and soil requirement, season, propagation, nursery management, seed rate, preparation of field, planting practices, spacing, water, nutrient and weed management, nutrient deficiencies and physiological disorders, Use of chemicals and growth regulators, cropping systems, Harvesting practices, yield, post- harvest handling, storage and marketing.

Unit III - Arrow root, cassava, colocasia

Introduction, economic importance, description of varieties and hybrids, Climate and soil requirement, season, propagation, nursery management, seed rate, preparation of field, planting practices, spacing, water, nutrient and weed management, nutrient deficiencies and physiological disorders, Use of chemicals and growth regulators, cropping systems, Harvesting practices, yield, post- harvest handling, storage and marketing.

Unit IV – Xanthosoma, amorphophallus, dioscorea, chinese potato (vegetable coleus)

Introduction, economic importance, description of varieties and hybrids, Climate and soil requirement, season, propagation, nursery management, seed rate, preparation of field, planting practices, spacing, water, nutrient and weed management, nutrient deficiencies and physiological disorders, Use of chemicals and growth regulators, cropping systems, Harvesting practices, yield, post- harvest handling, storage and marketing.

Unit V – Jerusalem artichoke, horse radish and other under exploited tuber crops

Introduction, economic importance, description of varieties and hybrids, Climate and soil requirement, season, propagation, nursery management, seed rate, preparation of field, planting practices, spacing, water, nutrient and weed management, nutrient deficiencies and physiological disorders, Use of chemicals and growth regulators, cropping systems, Harvesting practices, yield, Post- harvest handling, storage and marketing.

Theory – Lecture Schedule

1. Potato and tuber crops: scope and importance, area and production, global and national scenario
2. Export potential and Institutions involved in potato and tuber crops research
3. Potato - Economic importance and uses; description of varieties and hybrids and their classification, Climate and soil requirements,
4. Potato - Season/time of planting, seed rate and seed size, seed treatment, field preparation and planting, Method of planting, spacing, cropping systems; water management, weed control, nutrient management; Special practices,
5. Potato - physiological disorders; plant growth regulators; maturity indices, harvest and yield, Seed plot technique (SPT), True potato seed (TPS); post- harvest handling, storage, marketing and value added products.
6. Sweet potato - Introduction, economic importance, description of varieties and hybrids, Climate and soil requirement, season, propagation, nursery management, seed rate, preparation of field, planting practices, spacing, water, nutrient management
7. Sweet potato - weed management, nutrient deficiencies and physiological disorders, Use of chemicals and growth regulators, cropping systems, Harvesting practices, yield, post- harvest handling, storage and marketing.
8. Arrow root - Introduction, economic importance, description of varieties and hybrids, Climate and soil requirement, season, propagation, nursery management, seed rate, preparation of field, planting practices, spacing, water, nutrient and weed management, nutrient deficiencies and physiological disorders, Use of chemicals and growth regulators, cropping systems, Harvesting practices, yield, post- harvest handling, storage and marketing.
9. **In-semester examination**
10. Cassava - Introduction, economic importance, description of varieties and hybrids, Climate and soil requirement, season, propagation, nursery management, seed rate, preparation of field, planting practices, spacing, water, nutrient and weed management, nutrient deficiencies and physiological disorders, Use of chemicals and growth regulators, cropping systems, Harvesting practices, yield, post- harvest handling, storage and marketing.
11. Colocasia - Introduction, economic importance, description of varieties and hybrids, Climate and soil requirement, season, propagation, nursery management, seed rate, preparation of field, planting practices, spacing, water, nutrient and weed management, nutrient deficiencies and physiological disorders, Use of chemicals and growth regulators, cropping systems, Harvesting practices, yield, post- harvest handling, storage and marketing.
12. Xanthosoma - Introduction, economic importance, description of varieties and hybrids, Climate and soil requirement, season, propagation, nursery management, seed rate, preparation of field, planting practices, spacing, water, nutrient and weed management, nutrient deficiencies and physiological disorders, Use of chemicals and growth regulators, cropping systems, Harvesting practices, yield, post- harvest handling, storage and marketing.
13. Amorphophallus - Introduction, economic importance, description of varieties and hybrids, Climate and soil requirement, season, propagation, nursery management, seed rate, preparation of field, planting practices, spacing, water, nutrient and weed management, nutrient deficiencies and physiological disorders, Use of chemicals and growth regulators, cropping systems, Harvesting practices, yield, post- harvest handling, storage and marketing.
14. Dioscorea - Introduction, economic importance, description of varieties and hybrids, Climate and soil requirement, season, propagation, nursery management, seed rate, preparation of field, planting practices, spacing, water, nutrient and weed management, nutrient deficiencies and physiological disorders, Use of chemicals and growth regulators, cropping systems, Harvesting practices, yield, post- harvest handling, storage and marketing.
15. Chinese potato (vegetable coleus) - Introduction, economic importance, description of varieties and hybrids, Climate and soil requirement, season, propagation, nursery management, seed rate, preparation of field, planting practices, spacing, water, nutrient and weed management, nutrient deficiencies and physiological disorders, Use of chemicals and growth regulators, cropping systems, Harvesting practices, yield, post- harvest handling, storage and marketing.

16. Jerusalem artichoke - Introduction, economic importance, description of varieties and hybrids, Climate and soil requirement, season, propagation, nursery management, seed rate, preparation of field, planting practices, spacing, water, nutrient and weed management, nutrient deficiencies and physiological disorders, Use of chemicals and growth regulators, cropping systems, Harvesting practices, yield, post- harvest handling, storage and marketing.
17. Horse radish and other under exploited tuber crop - Introduction, economic importance, description of varieties and hybrids, Climate and soil requirement, season, propagation, nursery management, seed rate, preparation of field, planting practices, spacing, water, nutrient and weed management, nutrient deficiencies and physiological disorders, Use of chemicals and growth regulators, cropping systems, Harvesting practices, yield, post- harvest handling, storage and marketing.

Practical Schedule

1. Identification and description of varieties of potato
2. Identification and description of varieties of tropical tuber crops
3. Identification and description of varieties of sub-tropical and temperate tuber crops
4. Planting systems and practices
5. Field preparation and sowing/planting
6. Top dressing of fertilizers
7. Intercultural operations
8. Use of herbicides and growth regulators
9. Identification of nutrient deficiencies and physiological disorders
10. Maturity indices and harvesting
11. Post-harvest handling, storage and Marketing
12. Seed collection
13. Visit to CTCRI, Thiruvananthapuram/research stations/markets
14. Visit to commercial farmers field
15. Working out cost of cultivation
16. Project preparation of commercial cultivation
17. **University Practical Examination**

Text Books

1. Choudhary, B.R. (2009). A Text book on production technology of vegetables. Kalyani Publishers. Ludhiana. pp 1-308
2. K S Yawalkar, (2004).Vegetable crops in India. Agri-Horticultural Pub. House. Nagpur. pp 1-350
3. M.S.Dhaliwal, (2008).Handbook of Vegetable Crops. Kalyani Publishers. Ludhiana. pp 1-389
4. Thamburaj, S. and Narendra Singh. (2001). A textbook of vegetable tuber crops and spices. ICAR. New Delhi. pp 1-469
5. Uma Shankar Singh, (2008). "Indian vegetables", Anmol publications Pvt., Ltd., New Delhi. pp 1-318

Reference Books

1. Hazra, P., A. Chattopadhyay, K. Karmakar and S. Dutta. (2010). "Modern technology in vegetable production" New India Publishing Agency, New Delhi. pp 1-424
2. Shanmugavelu, K.G. (1989). Production technology of vegetable crops. Oxford and IBH publishing Co. Pvt. Ltd, New Delhi. pp 1-930

Web References

1. <http://ecoursesonline.iasri.res.in/mod/page/view.php?id=13692>
2. <https://cpri.icar.gov.in/>
3. <https://cipotato.org/>
4. <https://www.ctcri.org/>
5. https://iims.icar.gov.in/Institute_Details.aspx?Inst=41
6. <https://www.iivr.org.in/>
7. <https://www.iihr.res.in/>
8. <https://icar.org.in/>

Journals

1. Indian Journal of Horticulture
2. Vegetable sciences
3. Indian Journal of Vegetable sciences
4. Indian Horticulture
5. International Journal of Vegetable Science
6. Scientia Horticulture
7. Acta Horticulturae
8. Progressive Horticulture

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	HOR19404	Course Name	Ornamental Horticulture	Course Category	C	Compulsory Core	L	T	P	C
							1	0	1	2

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	HOR19504					
Course Offering Department	Horticulture		Data Book / Codes/Standards		Nil					

Course Learning Rationale (CLR):	<i>The purpose of learning this course is to:</i>
CLR-1 :	<i>Understand the scope and importance of ornamental flower crops</i>
CLR-2 :	<i>Describe the plant and non plant components</i>
CLR-3 :	<i>Identify the flower crops</i>
CLR-4 :	<i>Perform flower arrangements</i>
CLR-5 :	<i>Perform the bonsai techniques</i>
CLR-6 :	<i>Summarize the special types of garden</i>

Course Learning Outcomes (CLO):	<i>At the end of this course, learners will be able to:</i>	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLO-1 :	<i>Identify the ornamental plants</i>	1	95	85
CLO-2 :	<i>Describe the plant and non plant components.</i>	1	80	75
CLO-3 :	<i>Describe the different use of plants in a garden</i>	1	75	65
CLO-4 :	<i>Interpret the bonsai techniques</i>	2	75	65
CLO-5 :	<i>Recall the flower arrangement techniques.</i>	2	90	80
CLO6 :	<i>Identify different styles of garden.</i>	3	95	90

Program Learning Outcomes (PLO)														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Horticulture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to become a entrepreneur in the field of Floriculture	Ability to Produce Bonsai.	Ability to produce value added products from the commercial flowers
H								H	M		H	H	H	H
H								L	H		H	H	H	H
M	L	L						L	H		H	H	H	H
M			L	L				M	H		H	H	H	H
L	L							M	H		H	H	H	H
L						H		M	H		H	H	H	H

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		2	6	2	4	2
S-1	SLO-1	History of Gardening	Study of annuals	Principles of plant components	Terrarium	Principle of flower arrangement
	SLO-2	Scope and Importance	Study of Herbaceous perennials	Designing of plant components	Bog garden	Methods of flower arrangement
S-2,3	SLO-1	Lab1:Identification and description of annuals, biennials and herbaceous perennials.	Lab 4:Identification of Palms, cycads, ferns and Selaginellas.	Lab 7: Planning and designing of Hedge, edge and rockery.	Lab 10:Planning and designing of vertical garden.	Lab 13:Preparation of floral Boquets.
	SLO-2					
S-4	SLO-1	Definition of Gardening	Study of trees	Principles of non-plant components	Roof gardening	Styles of Bonsai making
	SLO-2	Principles of Gardening	Study of shrubs	Designing of non-plant components	Vertical Gardening	Types of Bonsai making
S-5,6	SLO-1	Lab 2: Identification and description of trees and shrubs.	Lab 5:Identification of Cacti, Succulents and Indoor plants.	Lab 8: Planning and designing of water garden, carpet bedding, shade garden and roof garden	Lab 11:Planning and designing of Lawn.	Lab 14:Designing and practice of Bonsai.
	SLO-2					
S-7	SLO-1		Study of Climbers		Burlapping	
	SLO-2		Study of Ground covers		Tree transplanting	
S-8,9	SLO-1	Lab 3:Identification of climbers and ground covers.	Lab 6:Description and designing of garden components	Lab 9:Planning and designing of Terrariums.	Lab 12:Practice of different types of flower arrangement.	Lab 15:Preparation of floral rangoli and veni.
	SLO-2					
S-10	SLO-1		Study of palms and cycads		Lawn establishment	
	SLO-2		Study of Ferns and Sellaginellas		Lawn Maintenance	
S-11	SLO-1	Lab4:Visit to nurseries and floriculture units	Study of Cacti			
	SLO-2		Study of Succulents			

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		2	6	2	4	2
S-12	SLO-1		Study of Indoor plants			
	SLO-2		Study of Ornamental grasses			

Learning Resources	1.	Prasad, S. and Kumar, U. (2013). A hand book of Floriculture. Jodhpur, Agrobios.(pp.1-654)
	2.	Tiwari, A.K. (2012). Fundamentals of Ornamental Horticulture and Landscape Gardening. New Delhi, NIPA.(pp.1 – 588).

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember	40 %	30 %	35 %	30 %
	Understand				
Level 2	Apply	40 %	40 %	35 %	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	30 %	30 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Gorthi Nagarjuna Naidu General Manager(TANFLORA) naidugorthi@gmail.com	Dr Vijay Rakesh Reddy, S. Scientist (Horticulture) ICAR-IIHR Bengaluru	Mrs. C. Kanimozhi

Theory

Unit I - Importance and scope

Importance and scope of gardening – historical background - gardens in India – definition, principles and concepts of landscape gardening –aesthetic values- Floricultureindustry, Importance, area and production, industrial importance of ornamental plants and flowers.

Unit II – Garden plants for landscaping

Study of foliage and flowering plants and their design and values in landscaping –general cultivation- ornamental annuals - shrubs - trees – herbaceous perennials – climbers and creepers – palms and palmatum- ferns and fernery – cacti and succulents-Indoor plants- Ornamental grasses and bulbous plants.

Unit III- Garden designs

Garden components and adornments – importance and designing – plant components and non-plant components - rosary, topiary, trophy, rockery, pond, sunken garden, flower beds, arboretum, conservatory, roads, walks, paths, hedges, edges, carpet garden, arch, pergola, arbour, fountains, cascades, garden seats, statues, hanging baskets, trellies, ornamental vases, ornamental urns and window boxes.

Unit IV – Special types of garden and lawn making

Special types of gardens - principles and design – dish, terrarium, water and bog garden, traffic islands, terrace garden, rockery, vertical garden and tree transplanting- Lawn types- establishment and maintenance.

Unit V – Flower arrangement and bonsai making

Flower arrangement – principles, designs and styles –ikebana, moribana - bouquet making - bonsai - methods, styles and maintenance.

Theory - Lecture Schedule

1. History, development, scope and importance of gardening.
2. Definition and basic principles of gardening.
3. Study of annuals and herbaceous perennials in landscape gardening.
4. Study of trees, shrubs and their role in landscape Gardening.
5. Study of climbers and ground covers in landscape gardening.
6. Study of palms and cycad, ferns and selaginellas.
7. Study of cacti and succulents.
8. Study of indoor plants, ornamental grasses and bulbous plants.
9. **In- Semester Examination**
10. Study of principles and designing of plant components.
11. Study of principles and designing of non plant components.
12. Study of special types of gardens - dish, terrarium, water garden and bog gardens.
13. Study of special types of gardens – roof garden, rockery, vertical garden and traffic islands.
14. Principles and method of tree transplanting – Burlapping.
15. Lawn types, establishment and maintenance.
16. Study of principles and methods of flower arrangement.
17. Study of styles and types of bonsai making.

Practical Schedule

1. Identification and description of annuals, biennials and herbaceous perennials.
2. Identification and description of trees and shrubs.
3. Identification of climbers and ground covers.
4. Identification of palms, cycads, ferns and selaginellas.
5. Identification of cacti, succulents and Indoor plants.
6. Description and designing of garden components – arches, bowers, pergolas, paths, walks, bridges, fountains and statues.

7. Planning and designing of hedge, edge and rockery.
8. Planning and designing of water garden, carpet bedding, shade garden and roof garden.
9. Planning and designing of terrariums.
10. Planning and designing of vertical garden.
11. Planning and designing of lawn.
12. Practice of different types of flower arrangement.
13. Preparation of floral bouquets.
14. Designing and practice of bonsai.
15. Preparation of floral rangoli and veni.
16. Visit to nurseries and floriculture units
17. **University Practical examination.**

Text Books

1. Arora, J.S. (2006). Introductory Ornamental Horticulture. Ludhiana: Kalyani Publishers. (pp.1-188).
2. Bhattacharjee, S.K. (2004). Landscape Gardening and Design with plants. Jaipur : Aavishkar Publishers and Distributors.
3. Dharmendra Kaulani and Arati Joshi. (2018). A textbook of Ornamental Horticulture. Nepal, Heritage Publishers.
4. Peter, K. V. (2009). Ornamental plants. New Delhi: New India publishing agency.
5. Prasad, S. and Kumar, U. (2013). A handbook of Floriculture. Jodhpur: Agrobios. (pp.1-654)

Reference Books

1. Karuppaiah, P. and Manivannan, K. (2018). Ornamental Horticulture. Jodhpur: Agrobios. (pp.1-648).
2. Supriya Kumar Bhattacharjee. (2006). Ornamental Crop Production Technology Jaipur: Pointer Publisher. (pp.1-344).
3. Supriya Kumar Bhattacharjee. (2005). Flowering Shrubs and Seasonal Ornamentals. Jaipur: Pointer Publisher. (pp. 1-359).
4. Suresh K Malhotra Lallan Ram. (2017). Advances in Floriculture and Landscape Gardening. Nagaland: Central Institute of Horticulture. (pp.1 - 322).
5. Tiwari, A.K. (2012). Fundamentals of Ornamental Horticulture and Landscape Gardening. New Delhi: NIPA. (pp.1 – 588).

Web References

1. www.bestgarden.net
2. www.indiaagronet.com
3. www.intuxford.tripod.com
4. www.webct.uark.edu
5. www.personal.psu.edu
6. www.sunny.crk.umn.edu/courses
7. www.lawngrasses.com
8. www.mediatoday@vsnl.com
9. www.hsi1942.org

Journals

1. Journal of ornamental Horticulture.
2. Journal of Floriculture and Landscaping.
3. Indian Journal of Horticulture.
4. The American Journal of Horticulture and Floriculture Research.
5. International journal of Horticulture and Floriculture.

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	HOR19405	Course Name	Plantation Crops	Course Category	C	Compulsory Core	L	T	P	C
							2	0	1	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Horticulture	Data Book / Codes/Standards			Nil

Course Learning Rationale (CLR):		<i>The purpose of learning this course is to:</i>			Learning			Program Learning Outcomes (PLO)																
CLR-1 :	<i>Outline the scope and importance of plantation crops</i>	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
CLR-2 :	<i>Describe the production technology of important plantation crops</i>																							
CLR-3 :	<i>Define the nursery management and propagation techniques of plantation crops</i>																							
CLR-4 :	<i>Define the field management of plantation crops</i>																							
CLR-5 :	<i>Summarize the post-harvest technology and processing of plantation crops</i>																							
CLR-6 :	<i>Recognize the value addition of plantation crops</i>																							
Course Learning Outcomes (CLO):		<i>At the end of this course, learners will be able to:</i>																						
CLO-1 :	<i>Recall the commercial production techniques of plantation crops that can be adopted to specific geographical region</i>	2	90	80	M	M	M	M	M	M	H	M	M	H	M	H	M	H	H	H	M			
CLO-2 :	<i>Perform nursery management of various plantation crops</i>	2	95	85	H	M	M	M	M	H	H	H	H	H	H	H	H	H	H	H	H			
CLO-3 :	<i>Perform propagation techniques of various plantation crops</i>	2	90	80	H	H	M	M	M	H	M	H	H	H	H	H	H	H	H	H	M			
CLO-4 :	<i>Describe the management for package of practices for plantation field</i>	2	85	75	M	M	M	M	M	M	M	M	M	H	M	H	H	H	H	H	M			
CLO-5 :	<i>Perform harvest and post-harvest technique of various plantation crops</i>	2	80	80	M	M	M	M	M	M	M	M	M	H	M	H	H	H	H	H	M			
CLO6 :	<i>Explain the plantation field and work out the benefit of cost ratio of plantation crops</i>	2	85	75	M	M	M	M	M	M	M	M	M	H	M	H	H	H	H	H	M			

Duration (hour)		Learning Unit / Module 1 3T+4P	Learning Unit / Module 2 12T+3P	Learning Unit / Module 3 6T+3P	Learning Unit / Module 4 5T+4P	Learning Unit / Module 5 7T+3P
S-1	SLO-1	Scope and importance of plantation crops	Introduction to coffee	Introduction, propagation of rubber	Coconut-Introduction	Oil palm-Introduction and propagation
	SLO-2	Industrial importance and byproduct utilization	Differences in arabica and robusta coffee	Nursery management of rubber	Coconut-varieties	Oil palm- nursery management
S-2	SLO-1	Export and import potentials	Preparation of main field in coffee	Planting of rubber	Coconut-propagation	Oil palm- planting
	SLO-2	Role of commodity boards	Irrigation and manuring in coffee	Tapping and post-harvest of rubber	Coconut-nursery and field management	Oil palm- physiological disorder
S-3	Practical-1	Training and pruning in coffee.	Practice in grafting techniques, HDP and top working in Cashew	Preparation of nursery and nursery management of Coconut	Preparation of nursery and its management in Arecanut	Visit to Coffee board and Coffee Plantation / Tea board and Tea Plantation
S-4						
S-5	SLO-1	GAP for plantation crops	Training and pruning of coffee	Cashew-Introduction	Coconut-intercultural operation	Oil palm- Harvesting
	SLO-2	Organic production of plantation crops, Carbon sequestration potential	Inter cultural practices of coffee	Cashew- propagation	Coconut-harvest and post harvest	Oil palm- processing
S-6	SLO-1		Harvesting of coffee	Cashew-planting	Arecanut-Introduction	Palmyrah- Introduction
	SLO-2		Processing of coffee	Cashew- nutrient management	Arecanut-Nursery management	Palmyrah- nursery management
S-7	Practical-2	Preparation of cuttings and rooting under specialized structure in Tea	Tapping of latex and processing of rubber	Study of nutritional disorders and correction in Coconut	Working out cost economics of Coconut/Cashew/Rubber	Visit to Research station/ farmers field
S-8						

Duration (hour)		Learning Unit / Module 1 3T+4P	Learning Unit / Module 2 12T+3P	Learning Unit / Module 3 6T+3P	Learning Unit / Module 4 5T+4P	Learning Unit / Module 5 7T+3P
S-9	SLO-1		Introduction to tea	Cashew-Training and pruning	Arecanut-Establishment of plantation	Palmyrah- Cultural and intercultural operation
	SLO-2		Types of tea	Cashew-Harvesting	Arecanut-harvest and post-harvest management	Palmyrah- harvesting and processing
S-10	SLO-1		Propagation techniques of tea	Cashew-processing		Date palm- Introduction
	SLO-2		Methods of planting in tea	Cashew-CNSL extraction and grading		Date palm- nursery management
S-11	Practical-3	Training, centering, pruning, tipping in Tea	Description and identification of Coconut and Arecanut varieties	Root feeding of coconut tonic in Coconut	Harvest and processing of Palmyrah	Visit to Rubber plantation and processing unit
S-12						
S-13	SLO-1		Training and pruning of tea			Date palm- intercultural operation
	SLO-2		Intercultural operation in tea			Date palm- harvest and post-harvest
S-14	SLO-1		Plucking of tea			
	SLO-2		Processing of tea			
S-15	Practical-4	Harvesting and processing of Cocoa				
S-16						
S-17	SLO-1		Introduction to cocoa			
	SLO-2		Types of cocoa			
S-18	SLO-1		Propagation techniques of cocoa			
	SLO-2		Methods of planting in cocoa			
S-19	SLO-1		Training and pruning of cocoa			
	SLO-2		Intercultural operation in cocoa			
S-20	SLO-1		Harvesting of cocoa			
	SLO-2		Processing and storage of cocoa			

Learning Resources	1.	Kumar, N, Md. Abdul Khader, Rangasamy, P., and Irulappan, I. (2017). Spices, Plantation Crops, Medicinal and Aromatic plants, Rajalakshmi Publications, Nagercoil. pp. 1-351
	2.	Parthasarathy, V.A., Chattopadhyay, P. K., and Bose, T. K. (2006). Plantation Crops. Vol I and II. Parthasankarbasu, NayaUdyog, Kolkata. pp.1-1050

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember	50 %	30 %	35 %	30 %
	Understand				
Level 2	Apply	30 %	40 %	35 %	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	30 %	30 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. Subbiah, Retired professor TNAU, Consultant of Spices, Plantation, Medicinal and Aromatic crops, Theni, Tamil Nadu	Dr. J. Dinakara Adiga, Principal Scientist, ICAR, Directorate of Cashew Research station, Puttur, Karnataka.	Dr. Akoijam Ranjita Devi

THEORY

Unit I – Introduction to plantation crops

History, status, scope and importance of plantation crops – area and production - National and State scenario - export and import – Role in national economy – Role of commodity board and other organizations – Industrial importance and byproduct utilization – GAP – Organic production- Carbon sequestration potential.

Unit II – Production technology of coffee, tea and cocoa

Origin and distribution –area and production- composition and uses – soil and climate – varieties – propagation– seed and vegetative propagation and planting systems - methods – irrigation and nutrient management - weed control – training - pruning - mulching - shade regulation –application of growth regulators – soil management – liming - Special horticultural practices – handling –harvest and yield - post harvest handling - processing – value addition and storage.

Unit III - Production technology of rubber and cashew

Origin and distribution –area and production- composition and uses – soil and climate – varieties – propagation– seed and vegetative propagation and planting systems - methods –gap filling - irrigation and nutrient management - weed control – training - pruning - mulching - cover cropping - shade regulation –application of growth regulators - Special horticultural practices – top working – HDP in cashew - handling –harvest and yield - post harvest handling - processing – value addition and storage.

Unit IV - Production technology of coconut and arecanut

Origin and distribution –area and production- composition and uses – soil and climate – varieties – propagation– nursery management - planting systems and methods – multi-tier cropping systems - gap filling – irrigation, nutrient and micronutrient management - weed control – soil & water conservation measures - mulching - intercropping - application of growth regulators – harvest and yield - post harvest handling - processing – value addition and storage.

Unit V - Production technology of oil palm, palmyrah and date palm

Origin and distribution –area and production- composition and uses – soil and climate – varieties – propagation– seed and vegetative propagation - planting systems and methods –gap filling - irrigation and nutrient management - weed control – training - pruning - mulching -application of growth regulators –harvest and yield - post harvest handling - processing – value addition and storage.

Theory – Lecture Schedule

1. Plantation crops – history, scope and importance – state, national and global scenario of plantation crops - Area and production of plantation crops- Industrial importance and byproduct utilization.
2. Export and import potentials – role in national and state economy – institutions and commodity boards involved in research and development of plantation crops.
3. GAP for plantation crops, organic production of plantation crops, Carbon sequestration potential.
4. Coffee - Introduction, origin and distribution, area and production, soil, climate, species and climatological differences in arabica and robusta, varieties and propagation.
5. Coffee - Preparation of main field, planting, shade management, irrigation and manuring
6. Coffee - Training and pruning, inter cultural practices, digging, scuffling or soil stirring, trenching, mulching, weeding, liming, flowering- season of flowering, fruit set and control of premature fruit drop, bean disorders.
7. Coffee - Cropping pattern and harvest – types of harvest, processing – preparation of parchment coffee, cherry coffee, types of beans – elephant bean, pea berry, yield and storage.
8. Tea - Introduction, origin and distribution, area and production, types of tea- assam, china and cambod hybrid, soil, location, climate and varieties.
9. Tea - Propagation, method of planting, planting season, mulching, weeding, shade and its management.
10. Tea - Training and pruning, manuring, liming, application of zinc sulphate, irrigation
11. Tea - Leaf plucking, yield of leaves, processing, grading and packing.
12. Cocoa - Introduction, area and production, origin and distribution, uses, varieties, classification, climate, soil, propagation – seed and vegetative propagation.
13. Cocoa - Preparation of land, provision of shade, spacing, planting, shade regulation and inter cropping.
14. Cocoa - Irrigation, manuring, weeding, types of branching, pruning, top-working harvesting, and physiological disorder- cherelle wilt.
15. Cocoa - Processing - fermentation, drying- sun drying, artificial drying, storage of kernels, cocoa products/ byproducts.
16. Rubber - Introduction, origin and distribution, area and production, uses, climate and soil, varieties and types of clones, propagation- seeds, vegetative methods, bud wood nursery for stump planting, planting – season, spacing, manuring, cover crops, irrigation, weeding.
17. **In-Semester Examination**
18. Rubber - Types of planting material, improved clones and polyclonal seed garden, tapping, tapping systems, puncture tapping, slaughter tapping, use of growth regulators for latex flow, rain guarding, latex collection, yield of latex, processing and storage.
19. Cashew Nut - Introduction, area and production, origin and distribution, uses, climate, soils, varieties/ hybrids, propagation – seed, vegetative propagation, epicotyl and softwood grafting and cuttings.
20. Cashew Nut - Planting, HDP, irrigation, weeding, manuring and nutrient deficiency

21. Cashew Nut - Training and pruning, top-working, flowering – season, type of flowers, pollination, fruit and nut development, fruit drop, harvesting and yield.
22. Cashew Nut - Processing methods – CNSL extraction, grading and packing.
23. Coconut- Introduction, importance, area and production, origin and distribution, uses, varieties-tall x dwarf hybrids (TXD), dwarf x tall hybrids (DXT), tall x tall hybrids (T X T).
24. Coconut- Soil, climate, propagation – seed propagation, selection of seed nuts, selection of mother palm, collection of seed nuts, nursery site selection and preparation, sowing of seed nuts, management of nursery, selection of seedling for planting, preparation of pits, spacing and planting,
25. Coconut- planting systems, care of young palm, irrigation, soil moisture conservation, manuring and fertilization, methods of application of fertilizer application and weeding cropping system, physiological disorder, harvesting, yield, storage, deficiency disorders – crown choke and Products / by products.
26. Arecanut - Introduction, importance, area and production, origin and distribution, uses, varieties, soil, climate, nursery raising techniques- selection of mother palms, seed nut selection, primary and secondary nurseries and selection of nursery plant material.
27. Arecanut - Establishment of plantation – spacing, season of planting, plantation management- inter cultural operations- manuring, irrigation, weeding, cropping system, harvesting, processing- dried ripe nuts, chali and kalipak, scented supari, and products/byproducts
28. Oil Palm - Introduction, importance, area and production, origin and distribution, uses - varieties, classification based on fruit structure, seed propagation, nursery practices, raising nursery, climate – sunshine and temperature requirement – oil palm growing areas.
29. Oil Palm - Soil- types of soils for oil palm growing regions, spacing, planting, irrigation, manuring, weeding and mulching, pruning, flowering and pollination, ablation, physiological disorder.
30. Oil Palm - Harvesting, yield and processing – extraction of oil from mesocarp and kernel, products/ byproducts.
31. Palmyrah - Introduction, importance, area and production, origin and distribution, uses, varieties – black and red skin fruit, male and female palms differentiation, soil and climate, propagation – raising nursery-Pre-treatment of seeds, nursery practices – raising seedlings in situ, in mound nursery bed and in masonry bed, transplanting
32. Palmyrah - cultural practices – tending, irrigation, fertilization, tapping, harvesting, yield, processing and products / byproducts.
33. Date palm - climate and soil requirements - varietal wealth- propagation - nursery management- planting systems- cropping systems- after care- training and pruning-water
34. Date palm - nutrient and weed management- shade management and regulation- intercropping- mulching- maturity indices and harvest- post-harvest and processing.

Practical Schedule

1. Training and pruning in coffee.
2. Preparation of cuttings and rooting under specialized structure in Tea
3. Training, centering, pruning, tipping in Tea
4. Harvesting and processing of Cocoa
5. Practice in grafting techniques, HDP and top working in Cashew
6. Tapping of latex and processing of rubber
7. Description and identification of Coconut and Arecanut varieties
8. Preparation of nursery and nursery management of Coconut
9. Study of nutritional disorders and correction in Coconut
10. Root feeding of coconut tonic in Coconut
11. Preparation of nursery and its management in Arecanut
12. Working out cost economics of Coconut/Cashew/Rubber
13. Harvest and processing of Palmyrah
14. Visit to Coffee board and Coffee Plantation / Tea board and Tea Plantation
15. Visit to Research station/ farmers field
16. Visit to Rubber plantation and processing unit

Text Books

1. Kumar, N. (2018). Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants. CBS Publishers; 2nd edition. pp.1-351.
2. Parthasarathy, V.A., P.K. Chattopadhyay and T.K. Bose. (2006). Plantation Crops. Vol I and II. Parthasankarbasu, NayaUdyog, Kolkata. pp. 1-1050.
3. Ponnuswami, V., Kumar, M., Arumugom, V., Ramesh Kumar, S., and Krishnamoorthy, S. (2015). Text Book on Fruit & Plantation Crops. Narendra Publishing House. pp.1-302.

Reference Books

1. Jitendra, S. (2008). Spices and Plantation Crops. Aavishkar Publishers and Distributors, Jaipur. pp.1-466.
2. Kurian, A. and Peter, K. V. (2007). Commercial Crops Technology, Horticultural Sciences Series Vol-8. ed. by K.V. Peter, New India Publishing Agency, New Delhi. pp.1-492.

3. Shanmugavelu, K.G., Kumar, N., and Peter, K.V. (2005). Production Technology of Spices and Plantation Crops. Agrobios (India), Jodhpur. pp.1-456

Web References

1. www.kissankerala.net
2. www.coconutboard.nic.in
3. https://ecourses.icar.gov.in/e-Learningdownload3_new.aspx?Degree_Id=07
4. https://books.google.co.in/books/about/Plantation_Crops.html?id=89Pa0HsOzu0C&redir_esc=y

Journals

1. J. Plantation Crops
2. Indian Journal of Horticulture
3. Indian Journal of Agriculture Sciences

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	HOR19406	Course Name	Precision Farming and Protected Cultivation	Course Category	C	Compulsory Core	L	T	P	C
							2	0	1	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Horticulture	Data Book / Codes/Standards			Nil

Course Learning Rationale (CLR):		The purpose of learning this course is to:			Learning			Program Learning Outcomes (PLO)															
CLR-1 :		Understand the principles and concept of precision farming			Level of Thinking (Bloom)	1	2	3	Horticulture Knowledge	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :		Outline the GPS, GIS and sensor involving in precision horticulture																					
CLR-3 :		Define the knowledge on protected cultivation of horticultural crops																					
CLR-4 :		Interpret the NFT, hydroponics and aeroponics																					
CLR-5 :		Describe the hands on training to precision farming and protected cultivation of horticultural crops																					
CLR-6 :		Explain the construction of greenhouse																					
Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:			Level of Thinking (Bloom)	1	2	3	Horticulture Knowledge	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLO-1 :		Identify precision farming techniques in commercial cultivation																					
CLO-2 :		Describe the remote sensing and GIS in precision farming uses in protected cultivation																					
CLO-3 :		Interpret the application of drones and robots in precision farming of horticultural crops																					
CLO-4 :		Perform plan and design a greenhouse																					
CLO-5 :		Describe the establishment and maintain the commercial protected production units																					
CLO-6 :		Perform start an hydroponic unit																					

Duration (hour)		Learning Unit / Module 1 9T+4P	Learning Unit / Module 2 4T+2P	Learning Unit / Module 3 9T+4P	Learning Unit / Module 4 4T+2P	Learning Unit / Module 5 7T+4P
S-1	SLO-1	Definition, Scope and importance of precision horticulture	Precision farming techniques for mango	Introduction, Scope and importance - types of protected structures viz., green house, poly house, net house, poly tunnels,	strawberry - soil sterilization - growing media preparation - bed formation - special horticultural practices	Cut roses - - soil sterilization - growing media preparation - bed formation - special horticultural practices
	SLO-2	Principles and concepts	Precision farming techniques for banana	Classification of greenhouses	strawberry - drip and fertigation – mulching - plant growth regulators - harvest and yield - storage - postharvest management	Cut roses - drip and fertigation – mulching - plant growth regulators - harvest and yield - storage - postharvest management
S-2	SLO-1	Laser leveling, mechanized direct seed sowing	Precision farming techniques for grape	Plant response to Greenhouse environment	Tomato - soil sterilization - growing media preparation - bed formation - special horticultural practices	Cut chrysanthemum - soil sterilization - growing media preparation - bed formation - special horticultural practices
	SLO-2	Seedling and sapling transplanting	Precision farming techniques for grape	planning and design of greenhouse	Tomato - drip and fertigation – mulching - plant growth regulators - harvest and yield - storage - postharvest management	Cut chrysanthemum - drip and fertigation – mulching - plant growth regulators - harvest and yield - storage - postharvest management
S-3-4	SLO-1					

Duration (hour)	Learning Unit / Module 1		Learning Unit / Module 2		Learning Unit / Module 3		Learning Unit / Module 4		Learning Unit / Module 5	
	9T+4P		4T+2P		9T+4P		4T+2P		7T+4P	
	SLO-2	LAB - Precision farming equipments: Laser leveling, mechanized direct seed sowing - seedling and sapling transplanting	LAB - Precision farming techniques for vegetable and fruit crops (design and layout)		LAB - Precision farming techniques for flowers (design and layout)		LAB - Testing of soil and water to study the suitability for growing crops		LAB - Visit to protected cultivation units	
S-5	SLO-1	Soil mapping	Precision farming techniques for tomato		Materials of construction for traditional and low cost greenhouse		Capsicum - soil sterilization - growing media preparation - bed formation - special horticultural practices		Carnation - soil sterilization - growing media preparation - bed formation - special horticultural practices	
	SLO-2	plant attributes	Precision farming techniques for tomato		Heating and cooling systems		Capsicum - drip and fertigation – mulching - plant growth regulators - harvest and yield - storage - postharvest management		Carnation - drip and fertigation – mulching - plant growth regulators - harvest and yield - storage - postharvest management	
S-6	SLO-1	Remote sensing, Geographic Information Systems (GIS)	Precision farming techniques for chilli		Green house equipment, Passive solar greenhouse		Cucumber - soil sterilization - growing media preparation - bed formation - special horticultural practices		Gerbera - soil sterilization - growing media preparation - bed formation - special horticultural practices	
	SLO-2	Global Positioning Systems (GPS)	Precision farming techniques for bitter gourd		green house drying and CO ₂ enrichment		Cucumber - drip and fertigation – mulching - plant growth regulators - harvest and yield - storage - postharvest management		Gerbera - drip and fertigation – mulching - plant growth regulators - harvest and yield - storage - postharvest management	
S-7-8	SLO-1	LAB - Application of GPS for soil sampling	LAB - Precision farming techniques for medicinal crops and spices (design and layout)		LAB - Study of different kinds of greenhouses based on shape, construction and cladding materials		LAB -Estimation of drying rate of agricultural products inside greenhouse		LAB - Visit to commercial precision farming fields	
	SLO-2									
S-9	SLO-1	Thematic maps	Precision farming techniques for marigold		Growing media- different types, soil culture		Lettuce - soil sterilization - growing media preparation - bed formation - special horticultural practices		Protected cultivation techniques of anthurium	
	SLO-2	Spatial variability	Precision farming techniques for turmeric		Pasteurization of media		Lettuce - drip and fertigation – mulching - plant growth regulators - harvest and yield - storage - postharvest management		Protected cultivation techniques of orchids	
S-10	SLO-1	mobile mapping system			Drainage, flooding and leaching		LAB - Study the fertigation requirements for green house crops and estimation of EC in the fertigation solution		LAB - Working out economics for precision and protected cultivation of horticulture crops	
	SLO-2	Its application in precision farming			Irrigation and fertigation systems in green house					
S-11-12	SLO-1	LAB - Use of GIS software: Georeferencing, photometric correction, thematic maps, spatial variability, and mobile mapping			LAB - Calculation of air rate exchange in active summer, winter cooling system					
	SLO-1									
S-13	SLO-1	Georeferencing			Cost estimation					
	SLO-2	Photometric correction			economic analysis of a greenhouse					
S-14	SLO-1	Sensors for information gathering			Constraints of greenhouse cultivation					
	SLO-2	Use of drones and robotics in precision farming			future strategies of greenhouse cultivation					
S-15-16	SLO-1	LAB - Use of ground sensors and demonstration of use of drones and robotics in precision farming			LAB - Study of different growing media, pasteurization / sterilization methods for greenhouse					
	SLO-2									

Duration (hour)		Learning Unit / Module 1 9T+4P	Learning Unit / Module 2 4T+2P	Learning Unit / Module 3 9T+4P	Learning Unit / Module 4 4T+2P	Learning Unit / Module 5 7T+4P
S-17	SLO-1	Site Specific input application, weed management, insect pests		Nutrient film technique - hydroponics		
	SLO-2	Disease management, yield mapping in horticultural crops		aeroponic culture		

Learning Resources	1.	Balraj Singh. (2006). Protected cultivation of vegetable crops. Kalyani Publishers, Ludhiana. pp 1-168
	2.	Jitendra Singh, S.K. Jain, L.K. Dashora, B.S. Cundawat. (2013). Precision farming in Horticulture. New India Publishing Agency, New Delhi. pp 1-382

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember	30 %	30 %	40 %	35 %
	Understand				
Level 2	Apply	40 %	40 %	40 %	50 %
	Analyze				
Level 3	Evaluate	30 %	30 %	20 %	15 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
		Mr. Harish. A Dr. Kamlesh Golhani

THEORY

Unit I – Concepts and introduction to precision horticulture

Definition, scope and importance of precision horticulture - principles and concepts – laser leveling, mechanized direct seed sowing - seedling and sapling transplanting – Soil mapping and plant attributes, remote sensing, Geographic Information Systems (GIS), Global Positioning Systems (GPS), thematic maps, spatial variability, mobile mapping system and its application in precision farming, georeferencing and photometric correction – Sensors for information gathering – Use of drones and robotics in precision farming - Site specific input application, weed management, insect pests and disease management, yield mapping in horticultural crops

Unit II – Precision farming techniques for horticultural crops

Precision farming techniques – pro tray seedlings - field preparation - raised bed forming- row planting - drip irrigation - mulching- fertigation system - training systems – growth regulators – plant protection – harvesting – grading and packing system. **Crops:** Mango, banana, grapes, tomato, chilli, bitter gourd, marigold and turmeric.

Unit III – Introduction and methods of protected cultivation

Introduction, Scope and importance - types of protected structures viz., green house, poly house, net house, poly tunnels, classification of greenhouses - Plant response to greenhouse environment –planning and design of greenhouse, materials of construction for traditional and low cost greenhouse - Heating and cooling systems, Green house equipment, passive solar greenhouse, green house drying and CO₂ enrichment - Growing media- different types, soil culture, pasteurization of media, drainage, flooding and leaching - Irrigation and fertigation systems in green house - Cost estimation and economic analysis - Constraints of greenhouse cultivation and future strategies - Nutrient film technique - hydroponics and aeroponic culture.

Unit IV - Protected cultivation technology for fruit and vegetable crops

Protected cultivation techniques - soil sterilization - growing media preparation - bed formation - special horticultural practices - drip and fertigation – mulching - plant growth regulators - harvest and yield - storage - postharvest management. **Crops:** Strawberry, tomato, capsicum, cucumber and lettuce.

Unit V - Protected cultivation technology for flower crops

Hi-tech protected cultivation techniques - soil sterilization - growing media preparation - bed formation - special horticultural practices - drip and fertigation –mulching- plant growth regulators - harvest and yield - storage - post harvest management. **Crops:** Cut roses, cut chrysanthemum, carnation, gerbera, anthurium and orchids.

Theory – Lecture Schedule

1. Definition, scope and importance of precision horticulture - principles and concepts
2. Laser leveling, mechanized direct seed sowing - seedling and sapling transplanting
3. Soil mapping and plant attributes.
4. Remote sensing, Geographic Information Systems (GIS), Global Positioning Systems (GPS)
5. Thematic maps, spatial variability
6. Mobile mapping system and its application in precision farming
7. Georeferencing and photometric correction
8. Sensors for information gathering and use of drones and robotics in precision farming
9. Site Specific input application, weed management, insect pests and disease management, yield mapping in horticultural crops
10. Precision farming techniques for mango and banana
11. Precision farming techniques for grapes
12. Precision farming techniques for tomato
13. Precision farming techniques for chilli and bitter gourd
14. Precision farming techniques for marigold and turmeric
15. Introduction, scope and importance - types of protected structures viz., green house, poly house, net house, poly tunnels, classification of greenhouses
16. Plant response to greenhouse environment – planning and design of greenhouse
17. **In - Semester Examination**
18. Materials of construction for traditional and low cost greenhouse, Heating and cooling systems
19. Green house equipment, Passive solar greenhouse, green house drying and CO₂ enrichment
20. Growing media- different types, soil culture, pasteurization of media

21. Drainage, flooding and leaching - Irrigation and fertigation systems in green house
22. Cost estimation and economic analysis
23. Constraints of greenhouse cultivation and future strategies
24. Nutrient film technique – hydroponics and aeroponic culture
25. Protected cultivation techniques of strawberry
26. Protected cultivation techniques of tomato
27. Protected cultivation techniques of capsicum
28. Protected cultivation techniques of cucumber
29. Protected cultivation techniques of lettuce
30. Protected cultivation techniques of cut roses
31. Protected cultivation techniques of cut chrysanthemum
32. Protected cultivation techniques of carnation
33. Protected cultivation techniques of gerbera
34. Protected cultivation techniques of anthurium and orchids

Practical Schedule

1. Precision farming equipments: Laser leveling, mechanized direct seed sowing - seedling and sapling transplanting
2. Application of GPS for soil sampling
3. Use of GIS software: Georeferencing, photometric correction, thematic maps, spatial variability, and mobile mapping
4. Use of ground sensors and demonstration of use of drones and robotics in precision farming
5. Precision farming techniques for vegetable and fruit crops (design and layout)
6. Precision farming techniques for medicinal crops and spices (design and layout)
7. Precision farming techniques for flowers (design and layout)
8. Study of different kinds of greenhouses based on shape, construction and cladding materials.
9. Calculation of air rate exchange in active summer, winter cooling system
10. Study of different growing media, pasteurization / sterilization methods for greenhouse
11. Testing of soil and water to study the suitability for growing crops
12. Estimation of drying rate of agricultural products inside greenhouse
13. Study the fertigation requirements for green house crops and estimation of EC in the fertigation solution
14. Visit to protected cultivation units
15. Visit to commercial precision farming fields
16. Working out economics for precision and protected cultivation of horticulture crops
17. **University Practical Examination.**

Text Books

1. Aldrich RA & Bartok JW. (1994). NRAES, Riley, Robb Hall. Green House Engineering. Cornell University, Ithaca, New York. pp 1-210
2. Balraj Singh. (2006). Protected cultivation of vegetable crops. Kalyani Publishers, Ludhiana. pp 1-168
3. Brahma Singh, (2014). Advances in Protected Cultivation. New India Publishing Agency. New Delhi. pp 1-248
4. Jitendra Singh, S.K. Jain, L.K. Dashora, B.S. Cundawat. (2013). Precision farming in Horticulture. New India Publishing Agency, New Delhi. pp 1-382
5. Pant V Nelson. (1991). GreenHouse Operation and Management. Bali Publ. pp 1-512
6. Prasad S. (2005). Greenhouse Management for Horticultural Crops. Agrobios. Jodhpur. pp 1-500
7. Reddy, P. Parvatha. (2011). Sustainable crop protection under Protected Cultivation. Springer Publications. USA. pp 1-464
8. T. Pradeep Kumar, B. Suma, Jyothi Bhaskar and K.N. Satheson. (2008). Management of Horticultural crops. New India Publishing Agency, New Delhi. pp 1-996

Reference Books

1. David Reed. (1996). Water, media and nutrition for greenhouse crops. Ball publishing USA. pp 1-314.

2. Lyn. Malone, Anita M. Palmer, Christine L. VloghatJachDangeermond. (2002). Mapping out world: GIS lessons for Education. ESRI press. pp 1-564.
3. Peter A. B. and Rachael A. M. (2004) Principles of Geographical Information System, Oxford University Press Inc., New York. pp 1-432.
4. Rolf, A.de. (2001) Principles of Geographic Information Systems. ITC Educational Textbook Series. pp 1-536.
5. Roy, P.S., Dwivedi, R.S. and Vijayan, D. (2010) Remote Sensing Applications. NRSC Publication. pp 1-397.

Web References

1. www.icar.org.in/ciphet.html
2. www.jains.com
3. www.gisdevelopment.net
4. www.lasercladding.com
5. www.epa.gov
6. www.geospatialworld.net
7. <https://www.ucdavis.edu/minors/precision-agriculture>

Journals

1. Hort. Science
2. Horticultural Technology
3. Floriculture Today
4. Hi-tech Horticulture
5. Acta Horticulture
6. Journal of Indian Society of Remote Sensing
7. Precision Agriculture

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-	-	-	50	50
2	Theory-Internal	20	-	-	-	-	20
3	Practical-External	-	-	-	-	15	15
4	Practical-Internal	-	05	05	05	-	15
Grand Total							100

Course Code	Course Title	T	P	Credit
HOR19407	Study Tour – II	0	1	1
Course Orientation: Higher education, Competitive Examination and Entrepreneurship				

Practical

Students will be taken for ten day tour of Tamil Nadu to several study areas like Laboratories; Horticulture Nurseries; Seed Production Centers; Orchards; Vegetable Farms; Plantation Crop Areas; Gardens; Other Horticultural Institutes (State / Central), Organic Farms; Farm Machinery Companies; Forests; Cattle / Goat / Poultry Farms; Post-Harvest Processing and Value addition Centres for Horticultural Products; Sales and Marketing Companies for exposing themselves to learn the activities pertaining to the field of horticulture.

Practical Schedule

The following institutes may be visited based on the requirement.

1. HC & RI, Periyakulam
2. AC & RI, Madurai
3. Visit to SHF, Srivilliputhur.
4. Visit to SHF, Courtalam for sub-tropical fruits.
5. Visit to HRS, Pechiparai for high rainfall zone crops.
6. Visit to AC&RI, Killikulam for tropical fruits and vegetables.
7. Visit to ARS, Paramakudi and Ramnad for tropical fruits and vegetables.
8. Visit to RRS, Aruppukottai and AC&RI, Madurai for arid zone fruits.
9. Visit to HRS, Kodaikanal and Thadiyankudisai for sub-tropical and temperate fruits and vegetables.
10. Visit to Agricultural Research Station, Aliyarnagar – Coconut and coconut based intercrop systems.
11. Tamil Nadu Agricultural University, Coimbatore campus.
12. Visit to Thudiyalur- arecanut area- FC & RI, Mettupalayam – Encee Aromatics.
13. Visit to Ooty, Coonoor and Bhavanisagar.
14. Visit to mango orchards, Regional Research Station, Paiyur-processing unit.
15. Visit to Giant Orchards, Melchengam
16. Visit to Regional Research Station, Vridhachalam – Cashew.
17. Visit to Sugarcane Research Station, Sirugamani – Betelvine

Course Nature: Practical			
Total Marks (100)			
S. No.	Category	Assessment Tools	Marks
1	Practical-Internal	Purely internal based on the participation, involvement and contribution of students in the activities pertaining to the course and the assessment criteria be as follows,	
		Written Test	40
		Behaviour (Punctuality and Discipline)	20
		Observation Note Book	25
		Viva-Voce	10
		Attendance	05
Grand Total			100

Course Code	AGE19406	Course Name	Agro-meteorology and Climate Change	Course Category	S	Supportive Course	L	T	P	C
							1	0	1	2

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Agronomy	Data Book / Codes/Standards			Nil

Course Learning Rationale (CLR):		The purpose of learning this course is to:			Learning			Program Learning Outcomes (PLO)														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15								
CLR-1 :	Understand the science and use agro meteorology in agricultural production decisions				Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems	Ability to implement knowledge gained in the applied field	Ability to understand social and ethical responsibilities
CLR-2 :	Explain the relationships between different stages of crop growth and weather elements							H					H		M	H		H	L	M	M	
CLR-3 :	Define the weather hazards, weather forecasting and impact of climate change on agriculture							H				L	H					H	H	H	H	
CLR-4 :	Explain the adoptability of the farmers to apply this scientific knowledge and information in agrometeorological practices							H		H	M		L			H	M	L	H	M	H	M
CLR-5 :	Understand threats and opportunities of predicted climate changes will influence specific sectors at global and regional scale							H				L						H	M	M	M	
					2	75	80	H	M				L	H		H		H	H			
Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:																				
CLO-1 :	Summarize the knowledge relevant to meteorology				1	85	80	H						H		M	H		H	L	M	M
CLO-2 :	Recall the information of weather and climate which are considered as basic input in agricultural planning				2	80	85	H						L	H				H	H	H	H
CLO-3 :	Categorize the meteorological instruments and recording the observation from the agro meteorological observatory.				3	80	75	H		H	M		L			H	M	L	H	M	H	M
CLO-4 :	Impart the skills on application of agro meteorological information to extension service delivery to farming community				3	85	70	H					L						H	M	M	M
CLO-5 :	Analyse the weather hazards, weather forecasting and impact of climate change on agriculture				2	75	80	H	M					L	H		H		H	H	H	

Duration (hour)	Learning Unit / Module 1		Learning Unit / Module 2		Learning Unit / Module 3		Learning Unit / Module 4		Learning Unit / Module 5	
	3		4		4		2		3	
S-1	SLO-1	Importance of Agricultural meteorology	Solar radiation		Atmospheric pressure systems		Weather hazards		Climate change and global warning	
	SLO-2	Atmospheric weather variables	Light intensity, quality, direction, duration		Cyclones and storms		Modification of micro climate		Climate change impacts on agriculture	
S-2,3	SLO-1	Lab 1. Site selection and layout for Agromet Observatory	Lab 4. Humidity, wind direction and wind speed measurements		Lab 8. Heat Unit concept- GDD, HTU, PTU for fixing time of sowing		Lab 12. Estimation of length of growing periods using weekly rainfall data		Lab 14. Determine the soil moisture from water balance studies	
	SLO-2									
S-4	SLO-1	Composition of earth atmosphere	Air temperature on crop production		Wind systems of the world		Weather forecasting		Climate change impacts on forestry and livestock's	
	SLO-2	Structure of atmosphere	Soil temperature on crop production		Clouds - types and their classification		Remote sensing in agriculture		Climate change impacts on marine and coastal ecosystem	
S-5,6	SLO-1	Lab 2. Measurements of solar radiation	Lab 5. Measurement of atmospheric		Lab 9. Probability analysis of rainfall for crop planning		Lab 13. Working principle of automatic weather station (AWS)		Lab 15. Identification of efficient cropping zone- RYI, RSI	
	SLO-1	Differentiate climate and weather	Relative Humidity and its importance		Forms of precipitation		-		Carbon trading and sequestration	
S-7	SLO-2	Agricultural seasons in India	Wind and its effect on crops		Monsoons in India		-		UNFCCC and IPCC	
	SLO-1									
S-8,9	SLO-2	Lab 3. Measurement of air and soil temperature	Lab 6. Measurement of rainfall and dew gauge		Lab 10. Preparation of synoptic charts, crop weather calendars & forecast based agro advisories		-		Lab 16. Mapping of Agro climatic Zones of India and Tamil Nadu	
S-10	SLO-1	-	Energy balance of earth		Cloud seeding		-		-	
	SLO-2	-	Heat unit and its importance		Potential evapotranspiration		-		-	

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		3	4	4	2	3
S-11	SLO-1	-	Lab 7. Measurement of Evaporation	Lab 11. Preparation of pest weather calendar and pest forewarning	-	-
	SLO-2	-			-	-

Learning Resources	1.	John Warren Smith. (2007). <i>Agricultural Meteorology: The Effect of Weather on Crops</i> . Macmillan publishers, UK. pp. 1-383.	3.	Mahi, G.S. and Kingra, P.K. (2015). <i>Fundamentals of Agrometeorology</i> . Kalyani Publishers, New Delhi. pp. 1-383.
	2.	Latief, A., Kanth, R.H., Parvaze, S. and Mahdi, S.S. (2017). <i>Experimental Agrometeorology: A Practical Manual</i> . Springer International Publishing AG. pp. 1-159.	4.	Srivastava, A.K. and Tyagi, P. K. (2011). <i>Practical Agricultural Meteorology</i> . New India Publishing Agency, New Delhi. pp. 1-266.

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In semester (20%)	Practical (15%)		
Level 1	Remember	40 %	35 %	35 %	30 %
	Understand				
Level 2	Apply	35 %	35 %	40 %	40 %
	Analyze				
Level 3	Evaluate	25 %	30 %	25 %	30 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Umesh Nandgaokar. M/s. Ramkala Manufacturers, Sr no 50/12, Near Deshpande Carden, Narhe Road, Dhayari Phata, and Pune - 41.	Dr. V. Geethalakshmi, Director, Directorate of Crop Management, Tamil Nadu Agricultural University, Coimbatore - 3	Dr. S. Marimuthu Dr. N. Krishnaprabu

THEORY

Unit I - Introduction

Agricultural meteorology: Importance and scope in crop production; Atmosphere: composition and structure; Atmospheric weather variables; Climate: weather, factors affecting climate and weather, climatic types, different agricultural seasons of India.

Unit II - Weather Parameters

Atmospheric phenomena: solar radiation, solar constant; Light: intensity, quality, direction and duration; Air and soil temperature: Diurnal variation - importance in crop production - Relative Humidity and its importance - vapor pressure deficit and its importance - Wind and its effect on crops - Energy balance of earth; Heat unit and its importance in agriculture.

Unit III - Atmospheric Circulations

Atmospheric pressure - Pressure systems - cyclones, anticyclones, tornado, hurricane and storms - Wind systems of the world - land breeze and sea breeze; Intertropical Convergence Zone. Clouds - types and their classification. Precipitation - forms - monsoon - Seasons of India- Cloud seeding, artificial rain making- Evaporation - transpiration - Evapotranspiration - PET.

Unit IV - Weather Hazards and Analysis

Weather hazards: drought, floods, frost, tropical cyclones and extreme weather conditions, heat-wave and cold-wave; Modifications of crop microclimate; Weather forecasting: Types and their uses; Synoptic chart; Crop weather calendar; Remote sensing and its application.

Unit V - Impacts of Climate Change

Climate change: variability, global warming, causes and impact: Crop production, Pest and diseases, Forestry, Marine and Coastal ecosystem; Clean Development Mechanism; Carbon Trading; Carbon sequestration; Montreal Protocol: UNFCCC and IPCC.

Theory- Lecture Schedule

1. Agricultural meteorology: Importance and scope in crop production; Atmospheric weather variables.
2. Earth atmosphere - composition, extent and structure.
3. Climate - weather, factors affecting climate and weather, climatic types, different agricultural seasons of India.
4. Atmospheric phenomena: Solar radiation, solar constant; Light - intensity, quality, direction and duration; short wave, long wave and thermal radiation; net radiation; albedo.
5. Air and soil temperature; Diurnal variation - importance in crop production
6. Relative Humidity and its importance - vapor pressure deficit and its importance - Wind and its effect on crops
7. Energy balance of earth; Heat unit and its importance in agriculture.
8. Atmospheric pressure - Pressure systems - cyclones, anticyclones, tornado, hurricane and storms
9. **In - semester examination**
10. Wind systems of the world - land breeze and sea breeze; Intertropical Convergence Zone. Clouds - types and their classification
11. Precipitation- forms; Monsoons: North East and South West Monsoon; Mechanism and importance in Indian agriculture.
12. Cloud seeding, artificial rainmaking; Evaporation; Transpiration, Evapotranspiration, PET.
13. Weather hazards: drought, floods, frost, tropical cyclones and extreme weather conditions, heat-wave and cold-wave; Modifications of crop microclimate
14. Weather forecasting: Types and their uses; Synoptic chart; Crop weather calendar; remote sensing and its application.
15. Climate change: variability, global warming, causes and impact - Crop production, Pest and diseases
16. Climate change impact on Livestock, Forestry, Marine and Coastal ecosystems.
17. Clean Development Mechanism; Carbon Trading; Carbon sequestration; Montreal Protocol: UNFCCC and IPCC.

Practical Schedule

1. Site selection and layout for Agromet Observatory - Calculation of local time - Time of observation of different weather elements - Reviewing agromet registers
2. Measurements of solar radiation (pyranometers), sunshine hours (sunshine recorder) - working out weekly and monthly mean for graphical representation
3. Measurement of air and soil temperature and grass minimum thermometers and thermographs - drawing isolines
4. Humidity measurements - use of wet and dry bulb thermometers- Hygrograph - Measurement of wind direction and wind speed and conversion - Beaufort's scale

5. Measurement of atmospheric pressure - barograph - Fortin-s barometer - Isobars based on past data for different seasons
6. Measurement of rainfall - Ordinary and self-recording rain gauges - Measurement of Dew - dew gauge
7. Measurement of Evaporation - Open pan evaporimeter- application of evaporation data
8. Heat Unit concept- GDD, HTU, PTU for fixing time of sowing
9. Probability analysis of rainfall for crop planning
10. Preparation of synoptic charts, crop weather calendars & forecast based agro advisories
11. Preparation of pest weather calendar and pest forewarning
12. Estimation of length of growing periods using weekly rainfall data
13. Working principle of automatic weather station (AWS)
14. Determine the soil moisture from water balance studies
15. Identification of efficient cropping zone- RYI, RSI
16. Mapping of Agro climatic Zones of India and Tamil Nadu and its characterization
17. **University Practical Examination**

Text Books

1. John Warren Smith. (2007). *Agricultural Meteorology: The Effect of Weather on Crops*. Macmillan publishers, UK. pp. 1-383.
2. Mahi, G.S. and Kingra, P.K. (2015). *Fundamentals of Agrometeorology*. Kalyani Publishers, New Delhi. pp. 1-383.
3. Mavi, H.S. and Tupper, G.J. (2004). *Agrometeorology: Principles and Application of Climate Studies in Agriculture*. Haworth Press. pp. 1- 351.
4. Reddy, S.R. and Reddy, D.S. (2014). *Agrometeorology*. Kalyani Publishers New Delhi. pp. 1-381.
5. Sahu, D.D. (2007). *Agrometeorology and Remote Sensing: Principles and Practices*. Agrobios, Jodhpur. pp. 1-245.
6. Varshneya, M.C. and P. Balakrishana Pillai. (2003). *Textbook of Agricultural Meteorology*, ICAR. pp. 1-217.

Reference Books

1. Latief, A., Kanth, R.H., Parvaze, S and Mahdi, S.S. (2017). *Experimental Agrometeorology: A Practical Manual*. Springer International Publishing AG. pp. 1-159.
2. Mote, B.M. and Sahu, D.D. (2014). *Principles of Agricultural Meteorology*. Scientific Publishers, Jodhpur. pp. 1-197.
3. Srivastava, A.K. and Tyagi, P. K. (2011). *Practical Agricultural Meteorology*. New India Publishing Agency, New Delhi. pp. 1- 266.
4. Adaptation and mitigation of climate - Scientific Technical Analysis. (2006). Cambridge University Press, Cambridge. pp. 1-851.
5. Prasad Rao, G.S.L.H.V. (2005). *Agricultural Meteorology*. Kerala Agricultural University, Press, Thrissur. pp. 1-326.
6. Variraju, R and Krishnamurty. (1995). *Practical Manual on Agricultural Meteorology*. Kalyani publications, New Delhi. pp. 1-198.

Web References

1. www.tawn.tnau.ac.in
2. <http://www.fao.org/docrep/x5672e/x5672e09.htm>
3. www.imd.gov.in
4. <https://public.wmo.int/en>
5. <https://library.wmo.int>
6. www.usbr.gov/pn/agri.met

Journals

1. Journal of Agrometeorology
2. Advances in Meteorology
3. Agricultural Meteorology
4. Meteorological Applications
5. Journal of Applied Meteorology and Climatology
6. Advances in Agronomy

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	NRM19402	Course Name	Soil, Water and Plant Analysis	Course Category	S	Supportive Course	L	T	P	C
							1	0	1	2

Pre-requisite Courses	NRM19301	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Soil Science and Agricultural Chemistry	Data Book / Codes/Standards			Nil

Course Learning Rationale (CLR):		The purpose of learning this course is to:			Learning			Program Learning Outcomes (PLO)																	
CLR-1 :	Outline the sampling techniques involved in soil water and plant samples				1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
CLR-2 :	Identify the problematic soils and its reclamation.				Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems through Soil, water and plant analysis	Ability to implement knowledge gained in the applied field of Soil, water and plant analysis	Ability to understand social and ethical responsibilities of Soil, water and plant analysis			
CLR-3 :	Identify the plant nutritional deficiencies.							H										M	H		H	H	H	H	
CLR-4 :	Describe the quality and standards of irrigation water.							M							L				L	H		H	H	H	H
CLR-5 :	Perform the soil and water health management practices.							M	M		H								M	H		H	H	H	H
Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:			1	90	80	H									M	H		H	H	H	H		
CLO-1 :	Describe the common analytical reagents used for the analysis of soil, plant and water				2	95	85	M									L	H		H	H	H	H		
CLO-2 :	Define the analytical procedures followed in the laboratory.				3	75	70	M	M		H		L				L	H		H	H	H	H		
CLO-3 :	Calculate the analytical data based on analytical procedures.				3	75	65	M									M	H		H	H	H	H		
CLO-4 :	Interpret the analytical data for prescribing the fertilizers				3	75	60	H						H			M	H		H	H	H	H		
CLO-5 :	Apply the technology to maintain the irrigation water quality				3	75	60	H							H		M	H		H	H	H	H		

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		3	5	2	1	5
S-1	SLO-1	Objective of soil plant water analysis	Diffusion	Chemical composition of horticultural crops	Criteria evaluation of irrigation water	Radioactivity detection
	SLO-2	Instrumentation principles	Mass flow	Mineral composition of horticultural crops	Guidelines and standards of water quality	Radioactivity measurement
S-2,3	SLO-1	Lab1: Introduction to laboratory safety measures and reagent preparations	Lab 4: Determination of Soil CEC	Lab 9: Estimation of Ca, Mg in soil/water	Lab11: Estimation of nitrogen in plant samples	Lab 12: Estimation of P in plant samples
	SLO-2	Soil sample collection and processing	Renewal of gases in soils	Leaf analysis values		Stable isotopes and importance
S-4	SLO-1	Soil sample storage techniques	Oxygen diffusion rate and redox potential estimation	Rapid soil and water test	-	Soil fertility evaluation
	SLO-2	Lab 2: Soil, water and plant sample collection	Lab 5: Estimation of soil nitrogen	Lab10: Determination of carbonates and bicarbonates in soil/water	-	Lab 13: Estimation of K in plant samples
S-7	SLO-1	Water and plant sample collection	Management of saline and alkali soils	-	-	Soil pollution causes
	SLO-2	Processing and storage techniques	Management of acidic soils	-	-	Soil pollution management
S - 8,9	SLO-1	Lab 3: Determination of pH, EC and OC in soil	Lab 6: Estimation of soil Phosphorous	-	-	Lab 14: Estimation of micronutrients in soil/water/plant.
	SLO-2	-	Management of waterlogged soils	-	-	Water pollution causes
S 10	SLO-1	-	Management of sandy soils	-	-	Water pollution management
	SLO-2	-	Lab7: Estimation of K, Na in soil/water	-	-	Lab 15: Rapid plant and soil test

Duration (hour)	Learning Unit / Module 1		Learning Unit / Module 2		Learning Unit / Module 3		Learning Unit / Module 4		Learning Unit / Module 5	
	3		5		2		1		5	
S 13	SLO-2									
	SLO-1	-	Description of soil micro organisms		-		-		Soil clinic	
	SLO-2	-	Importance of soil micro organisms		-		-		Soil health card	
S – 14,15		-	Lab 8: Estimation of S in soil		-		-		Lab 16: Soil/plant/water test based fertilizer prescriptions	

Learning Resources	1.	Durai, M.V. (2014). Handbook of soil, plant, water, fertilizer and manure analysis. New India publishing Agency.pp. 1 - 245.
	2.	Piper, C.S. (2014). Soil and Plant analysis. Scientific Publishers, India.pp. 1 - 368.

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In semester (20%)	Practical (15%)		
Level 1	Remember	40 %	30 %	35 %	30 %
	Understand				
Level 2	Apply	40 %	40 %	35 %	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	30 %	30 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. S.Suresh, Senior Agricultural Officer STL, Kanchipuram.	Dr. M.V. Sriramachandrasekharan Professor (SSAC), Annamalai University, Annamalai Nagar – 608002.	Dr. R. Angelin Silviya Dr. S.N. Chikkaraju

THEORY

Unit I – Sampling techniques

Soil, water and plant analysis – importance, objectives and instrumentation principles; Soil sample collection – surface soil and profile soil - processing and storage techniques. Plant sample – collection, processing, storage and digestion techniques. Water sampling and processing techniques for analysis.

Unit II - Soil analysis

Characterization of hydraulic mobility – diffusion and mass flow. Renewal of gases in soil and their abundance. Methods of estimation of oxygen diffusion rate and redox potential. Saline, alkali, acid, waterlogged and sandy soils - their appraisal and management. Soil microorganisms and their importance.

Unit III – Plant analysis

Chemical and mineral composition of horticultural crops. Leaf analysis standards, index tissue, interpretation of leaf analysis values. Rapid soil and plant test.

Unit IV – Water analysis

Criteria for evaluation of irrigation water – Salinity hazard, sodium hazard, Salt index, Bicarbonate hazard, Boron concentration, Chloride concentration, Soluble sodium percentage, Magnesium hazard. Guidelines for irrigation water quality established by standard organizations.

Unit V - Management practices

Radioactivity – detection and measurement, Stable isotopes and their application in horticultural research and soil fertility evaluation; Soil pollution- causes and management; Water pollution - causes and management; Soil clinic and soil health card, its role and importance.

Theory - Lecture schedule

1. Soil, water and plant analysis – importance, objectives and instrumentation principles.
2. Soil sample collection – surface and profile soil sample collection, processing and storage techniques.
3. Water and plant sample collection, processing and storage techniques.
4. Characterization of hydraulic mobility – diffusion and mass flow.
5. Renewal of gases in soil and their abundance. Methods of estimation of oxygen diffusion rate and redox potential.
6. Saline, Alkali, Acid soils – their appraisal and management.
7. Waterlogged and Sandy soils - their appraisal and management.
8. Soil microorganisms and their importance.
9. **In – Semester Examination.**
10. Chemical and mineral composition of horticultural crops.
11. Leaf analysis standards, index tissue, interpretation of leaf analysis values. Rapid soil and plant test.
12. Criteria for evaluation of irrigation water – Salinity hazard, sodium hazard, Salt index, Bicarbonate hazard, Boron concentration, Chloride concentration, Soluble sodium percentage, Magnesium hazard. Guidelines for irrigation water quality established by standard organizations.
13. Radioactivity – detection and measurement.
14. Stable isotopes and their application in horticultural research and soil fertility evaluation.
15. Soil pollution - causes and management.
16. Water pollution - causes and management.
17. Soil clinic and soil health card, its role and importance.

Practical schedule

1. Introduction to laboratory safety measures and preparation of reagents.
2. Farm visit – collection of soil, water and plant samples
3. Determination of pH, EC in soil/water and OC in soil.
4. Determination of soil CEC.

5. Estimation of Nitrogen in soil.
6. Estimation of Phosphorus in soil.
7. Estimation of Potassium and Sodium in soil/water.
8. Estimation of Sulphur in soil.
9. Determination of Ca, Mg in soil/water.
10. Determination of carbonates, bicarbonates in soil/water.
11. Estimation of Nitrogen in plant samples.
12. Estimation of Phosphorus in plant samples.
13. Estimation of Potassium in plant samples.
14. Determination of micronutrients in soil, water and plant samples.
15. Rapid soil test (probes/sensors/soil testing kit) and rapid plant test.
16. Soil/Plant/Water test based fertilizer prescriptions.
17. **University Practical Examination**

Text Books

1. Durai, M.V. (2014). Handbook of soil, plant, water, fertilizer and manure analysis. New India publishing Agency. pp. 1 - 245.
2. Hesse, P.R. (2002). A textbook of soil chemical analysis. CBS Publishers and Distributors. pp. 1 - 520.
3. Jaiswal, P.C. (2006). Soil, Plant and Water Analysis (2nd ed.). Ludhiana: Kalyani Publishers. pp. 1 - 450.
4. Manikandan K., Thiyageswari, S and Prabhakaran, J. (2016). Beginner's guide to Analytical Chemistry (1st ed.). New Delhi: Jain Brothers. pp. 1 - 223.
5. Motsara, M.R and Roy, R.N. (2008). Guide to laboratory establishment for plant nutrient analysis. FAO fertilizer and plant nutrition bulletin, FAO. pp. 1 - 203.

Reference Books

1. Jackson, M.L. (1967). Soil Chemical Analysis. New Delhi: Oxford and IBH Publishing Co. pp. 1 - 498.
2. Piper, C.S. (2014). Soil and Plant analysis. India: Scientific Publishers. pp. 1 - 368.
3. Singh, K.K., Asha, J, Singh, A.K and Alka, T. (2007). Air, water and soil pollution. Kalyani Publishers. pp. 1 - 445.
4. Tandon, H.L.S. (2013). Methods of analysis of soil, plant, water and fertilizers. New Delhi: FDCO. pp. 1 - 143.
5. Umkovich, M.J., Pate, J.S and Neil, A.M. (2010). Stable isotope techniques in the study of biological processes and functioning of Ecosystem. Springer. pp. 1 - 293.

Web References

1. <http://ecoursesonline.iasri.res.in/course/view.php?id=584>
2. <https://www.intechopen.com/books/metals-in-soil-contamination-andremediation/radioactive-isotopes-in-soils-and-their-impact-on-plant-growth>
3. https://aq.umass.edu/cafe/nifa-planned-extension-initiatives/soil-fertility-nutrient_management
4. <https://youtu.be/Al1v-iARhLM>
5. <tps://youtu.be/qoSvbbd1d18o>

Journals

1. Soil Science and Plant Nutrition
2. International journal of Plant and Soil Sciences
3. Communications in Soil Sciences and plant analysis
4. Journal of environmental radioactivity
5. Water, Air and Soil pollution

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	05	05	05	-	15
Grand Total							100

Course Code	CRH19402	Course Name	Diseases of Fruit, Plantation, Medicinal and Aromatic Crops	Course Category	S	Supportive Course	L	T	P	C
							2	0	1	3

Pre-requisite Courses	CRH19302	Co-requisite Courses	Nil	Progressive Courses	CRH19504
Course Offering Department	Plant Pathology	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning	Program Learning Outcomes (PLO)
CLR-1 :	Understand the symptoms of different diseases	1	1
CLR-2 :	Describe the host pathogen interaction	2	2
CLR-3 :	Define the role of environmental factors in disease development	3	3
CLR-4 :	Summarize the survival and mode of spread of the pathogen		4
CLR-5 :	Explain the integrated disease management		5
CLR-6 :	-		6

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Program Learning Outcomes (PLO)
CLO-1 :	Perform and interpret different crop related issues	2	90	75	M
CLO-2 :	Summarize the correlation of host parasite relationship for different crops	2	85	70	M
CLO-3 :	Identify the causal organisms of the disease	1	95	70	M
CLO-4 :	Correlate epidemiological parameters for disease development	2	80	65	L
CLO-5 :	Execute different approaches for plant disease management	1	85	70	M
CLO6 :	Potential for business entrepreneur	3	75	65	L

Duration (hour)	Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
	11	15	12	14	13
S-1	SLO-1 Fungal disease - Mango	Diseases Symptoms- Guava	Diseases Symptoms - Apple	Diseases Symptoms - Coconut	Fungal diseases- Medicinal crops
	SLO-2 Bacterial disease - Mango	IDM - Guava	IDM - Apple	IDM - Coconut	IDM - Medicinal crops
S-2	SLO-1 Viral disease- Mango	Diseases Symptoms - Grapes	Diseases Symptoms - Peach	Diseases Symptoms - Arecanut	Bacterial diseases - Medicinal crops
	SLO-2 Post-harvest disease-Mango	IDM Grapes	IDM - Peach	IDM - Arecanut	IDM - Medicinal crops
S-3 & 4	SLO-1 Lab 1- Host pathogen interaction- Mango	Lab 4- Host pathogen interaction - Guava and Grapes	Lab 8 Host pathogen interaction – Apple and Peach	Lab 11- Host pathogen interaction - Coconut, Arecanut, Betel vine and Oil palm	Lab 14- Host pathogen interaction - medicinal plants
	SLO-2				
S-5	SLO-1 Fungal disease - Banana	Diseases Symptoms - Sapota	Diseases Symptoms - Pear and Plum	Diseases Symptoms - OilPalm	Fungal diseases- Aromatic crops
	SLO-2 Bacterial disease - Banana	IDM - Sapota	IDM - Pear and Plum	IDM - OilPalm	IDM - Aromatic crops
S-6	SLO-1 Viral disease- Banana	Diseases Symptoms - Pomegranate	Diseases Symptoms - Almond and Walnut.	Diseases Symptoms - Betelvine	Bacterial diseases - Aromatic crops
	SLO-2 Post-harvest disease-Banana	IDM - Pomegranate	IDM - Almond and Walnut.	IDM - Betelvine	IDM - Aromatic crops
S-7& 8	SLO-1 Lab 2- Host pathogen interaction - Banana	Lab 5 – Host pathogen interaction - Sapota	Lab 9 – Host pathogen interaction - Pear, Plum, Almond and Walnut	Lab 12- Host pathogen interaction - Coffee and Tea	Lab 15- Host pathogen interaction - aromatic plants
	SLO-2				
S-9	SLO-1 Fungal disease - Citrus	Diseases Symptoms - Papaya	Diseases Symptoms - Pineapple	Diseases Symptoms - Coffee	Nematode complex

Duration (hour)	Learning Unit / Module 1		Learning Unit / Module 2		Learning Unit / Module 3		Learning Unit / Module 4		Learning Unit / Module 5	
	11		15		12		14		13	
	SLO-2	Bacterial, viral and Viroid disease - Citrus	IDM - Papaya		IDM - Pineapple		IDM - Coffee		Integrated nematode management	
S-10	SLO-1	-	Diseases Symptoms - Aonla and Ber		Diseases Symptoms - Strawberry		Diseases Symptoms - Tea		Post-harvest diseases- Fungal	
	SLO-2	-	IDM - Aonla and Ber		IDM - strawberry		IDM - Tea		Post-harvest diseases- bacterial	
S-11&12	SLO-1	Lab 3- Host pathogen interaction - Citrus	Lab 6- Host pathogen interaction - Pomegranate and Papaya		Lab 10 - Host pathogen interaction - Pineapple and Strawberry		Lab 13- Host pathogen interaction - Rubber and Cocoa		Lab 16- Survey, assessment - plant diseases	
	SLO-2	-	Diseases Symptoms - Annona and Jackfruit		-		Diseases Symptoms - Rubber		Post-harvest disease- abiotic stress	
S-13	SLO-1	-	IDM - Annona and Jackfruit		-		IDM - Rubber		Management- Post harvest diseases	
	SLO-2	-	-		-		Diseases Symptoms - Cocoa		-	
S-14	SLO-1	-	-		-		IDM - Cocoa		-	
	SLO-2	-	-		-		-		-	
S-15& 16	SLO-1	-	Lab 7- Host pathogen interaction -Aonla, Ber, Annona, and Jackfruit		-		-		-	
	SLO-2	-	-		-		-		-	

Learning Resources	1.	Gupta, V.K. and Paul, Y S. (2005). Diseases of Plantation Crops. Kalyani Publishers. pp. 1-197
	2.	Sanjeev Kumar. (2015). Diseases of Horticultural crops, Identification and Management. New India Publishing Agency. Pai & Sons. pp. 1-296

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In semester (20%)	Practical (15%)		
Level 1	Remember	40 %	45 %	40 %	45 %
	Understand				
Level 2	Apply	40 %	30 %	30 %	30 %
	Analyze				
Level 3	Evaluate	20 %	25 %	20 %	25 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. A. Bharani deppan, Ph.D. E.I. DuPont India Pvt Ltd. The V-Ascendas, Atria Block, 12 th Floor, Plot.17 SoftwareUnits Layout, Madhapur, Hyderabad, Telangana Ph: 936666899 Mail: bharani-deepan.a@corteva.com	Dr. A. Kamalakannan, Professor Department of Plant Pathology Tamil Nadu Agricultural University Coimbatore- 641003 Ph: 9790620313 E-Mail: kamals2k@yahoo.co.in	Dr. Rageshwari S (Assistant Professor) Plant Pathology Dr. VinodKumar S (Assistant Professor) Plant Pathology

THEORY

Symptoms, etiology, mode of spread, survival, epidemiology and integrated management of diseases and nematode disease complex.

Unit I - Diseases of tropical fruit crops – part 1 (5 hours)

Diseases of Mango- mango malformation, powdery mildew, anthracnose, black tip of mango, algal leaf spot, gray blight, sooty mold, die back, gummosis, root rot; Banana- Panama wilt, Moko wilt, anthracnose, sigatoka leaf spot, freckle leaf spot, cordana leaf spot, tip over disease, banana bunchy top disease, banana streak virus, banana mosaic virus, infectious chlorosis, bract mosaic, nematode diseases; Citrus- citrus canker, citrus tristeza disease, citrus greening, citrus stubborn, citrus die back, citrus wilt, exocortis, root rot.

Unit II - Diseases of tropical fruit crops – part 2 (7 hours)

Guava- wilt, root rot, gray blight, leaf spot, algal leaf spot, sooty mold; Grapes- anthracnose, rust, powdery mildew, downy mildew, pierce disease, grape fan leaf virus; Pomegranate- bacterial leaf spot, fungal blight, fruit cracking, anthracnose; Papaya- foot rot, fruit rot, papaya ring spot, papaya mosaic, Sapota – gray blight, leaf spot, sooty mold, flat stem; Aonla - powdery mildew, leaf spot, fruit rot; Ber- powdery mildew, Annona- leaf spot, fruit rot, gray blight, and sooty mold; Jackfruit- fruit rot.

Unit III - Diseases of temperate fruit crops (6 hours)

Apple - fire blight of apple, apple canker, anthracnose, apple scab, root rot, etc; Peach – leaf curl, powdery mildew; diseases of Pear, Plum, Almond, Walnut; Pineapple- butt rot, heart rot, wilt; Strawberry – leaf spot, rust, fruit blight, powdery mildew.

Unit IV - Diseases of plantation crops (8 hours)

Coconut -bud rot, stem bleeding, root wilt, leaf blight, Thanjavur wilt, coconut yellows; Arecanut - koleroga/mahali disease, foot rot, stem bleeding, leaf spot, leaf blight; Betelvine – foot rot, wilt, powdery mildew, anthracnose, leaf spot. Oil palm – bud rot, leaf blight, Coffee - anthracnose, rust, root rot, leaf spot, sooty mould; Tea - blister blight, algal leaf spot, gray blight, leaf spot, root rot; Rubber - stem rot, powdery mildew, leaf spot, root rot; Cocoa - black pod rot, charcoal pod rot, gray blight, wilt, root rot, and swollen shoot.

Unit V: Diseases of medicinal and aromatic crops, nematode disease complex, post - harvest diseases (7 hours)

Diseases of Aloe vera, Basil, Coleus, Ashwagandha, Periwinkle, Citronella, etc.

Post-harvest diseases of fruits.

Theory – Lecture Schedule

Symptomatology, etiology, mode of spread, survival, epidemiology and integrated management of

1. Diseases of Mango
2. Diseases of Mango
3. Diseases of Banana
4. Diseases of Banana
5. Diseases of Citrus
6. Diseases of Guava
7. Diseases of Grapes
8. Diseases of Sapota
9. Diseases of Pomegranate
10. Diseases of Papaya
11. Diseases of Aonla and Ber.
12. Diseases of Annona and Jack fruit
13. Diseases of Apple
14. Diseases of Peach
15. Diseases of Pear and Plum
16. Diseases of Almond and Walnut.
17. Diseases of Pineapple
18. **In-semester examination**

19. Diseases of Strawberry
20. Diseases of Coconut
21. Diseases of Arecanut
22. Diseases of Oil palm
23. Diseases of Betel vine
24. Diseases of Coffee
25. Diseases of Tea
26. Diseases of Rubber
27. Diseases of Cocoa
28. Diseases of Medicinal plants
29. Diseases of Medicinal plants
30. Diseases of Aromatic plants
31. Diseases of Aromatic plants
32. Nematode disease complex
33. Post-harvest disease of fruits - I
34. Post-harvest disease of fruits - II

Practical Schedule

Symptomatology, host parasite relationship and management of

1. Diseases of Mango
2. Diseases of Banana
3. Diseases of Citrus
4. Diseases of Guava and Grapes
5. Diseases of Sapota
6. Diseases of Pomegranate and Papaya
7. Diseases of Aonla, Ber, Annona, and Jackfruit
8. Diseases of Apple and Peach
9. Diseases of Pear, Plum, Almond and Walnut
10. Diseases of Pineapple and Strawberry
11. Diseases of Coconut, Arecanut, Betel vine and Oil palm
12. Diseases of Coffee and Tea
13. Diseases of Rubber and Cocoa
14. Diseases of Medicinal plants
15. Diseases of Aromatic plants
16. Post-harvest disease of fruits

17. University Practical Examination

Note: Students should submit 50 well preserved herbarium of diseased specimens

Text Books

1. Agrios, G.N. (2005). *Plant Pathology* (5th ed.) New York: Academic Press. pp.1-922.
2. Girish Chand and Santhosh Kumar. (2016). *Crop Diseases and Their Management*. CRC press. pp. 1-295. Gupta, V.K. (2008). *Diseases of Fruit Crops*. Kalyani Publishers. pp. 1-344.
3. Gupta, V.K. and Paul, Y S. (2005). *Diseases of Plantation Crops*. Kalyani Publishers. pp. 1-197.
4. Rangaswami, G and Mahadevan, A. (2004). *Diseases of Crop Plants in India*. New Delhi: Prentice Hall of India Pvt. Ltd. pp. 1-548.
5. Sanjeev Kumar. (2015). *Diseases of Horticultural crops, Identification and Management*. New India Publishing Agency. Pai & Sons. pp. 1-296.

Reference Books

1. Alfred Stefferud. (2005). *Diseases of Plantation Crops*. Delhi: Biotech Books. pp. 1-317.
2. Madhu Meeta. (2005). *Diseases of Ornamental Plants in India: Reference Book Cum Bibliography*. pp. 1-320.
3. Sonia Ahuja (2005). *Plant Diseases*. New Delhi: Vishvabharti. pp. 1-268.
4. Srikant Kulkarni and Yashoda R. Hegde. (2002). *Diseases of Plantation Crops and Their Management*. Udaipur: Agrotech. pp. 1-176

Web References

1. <http://www.biologydiscussion.com>
2. <https://www.microscopemaster.com/fungi>
3. www.apsnet.org/edcenter
4. Tolweb.org
5. <http://www.hillagric.ac.in/edu/coa/ppath/lectures.htm>
6. <http://ecoursesonline.iasri.res.in/course/view.php?id=143>
7. www.ucmp.berkeley.edu/fungi
8. www.ictv.org
9. www.vivo.library.cornell.edu
10. <https://www.youtube.com/c/MTutorEdu/search?query=plant+pathology>
11. <https://www.youtube.com/channel/UCsqovy3Llp-dB8pMxU2VZ7A>
12. <https://www.youtube.com/user/uwipm/search?query=diseases>

Journals

1. Phytopathology
2. Plant Pathology
3. Australasian Plant Pathology
4. Indian Phytopathology
5. Studies in Mycology
6. Journal of Plant Pathology

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	CRH19403	Course Name	Nematode Pests of Horticultural Crops and their Management	Course Category	S	Supportive Course	L	T	P	C
							1	0	1	2

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Crop protection	Data Book / Codes/Standards			Nil

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Learning			Program Learning Outcomes (PLO)															
CLR-1 :	Understand the history and importance of nematology			Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
CLR-2 :	Describe the nematode classification						Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems	Ability to implement knowledge gained in the applied field	Ability to understand social and ethical responsibilities	
CLR-3 :	Understand the difference in structure of different nematodes						M		M						L	H		H	H	H	H	H
CLR-4 :	Define plant nematode interaction						H								H	H		H	H	H	H	H
CLR-5 :	Summarize different approaches in nematode management						M	M							M	H		H	H	H	H	H
CLR-6 :	Explain important nematode diseases in crop plants						L								L	H		H	H	H	H	H
Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:																				
CLO-1 :	Determine and interpret different crop related issues			4	90	75																
CLO-2 :	Perform the survey and document the disease incidence.			3	85	70																
CLO-3 :	Identify the type of nematode pest based on symptoms and microscopic observation			2	95	70																
CLO-4 :	Understand the factors influencing nematode population			4	80	65																
CLO-5 :	Determine the plant stress phenomenon, and recommend the best cultural, chemical, and biological control methods towards management			4	75	60																
CLO6 :	Discuss the potential benefit for an entrepreneur			5	75	65							H		L	H		H	H	H	H	

Duration (hour)		Learning Unit / Module 1 9	Learning Unit / Module 2 12	Learning Unit / Module 3 9	Learning Unit / Module 4 8	Learning Unit / Module 5 9
S-1	SLO-1	History of nematology	Nematode digestive system	Life cycle of Meloidogyne, Globodera, and Rotylenchulus	Nematode management- legislative, cultural and physical methods	Nematode diseases of Fruit crops
	SLO-2	Introduction to nematology	Nematode excretory nematode	Life cycle of Tylenchulus, Radopholus and Pratylenchus	Nematode management- Chemical and biological control agents	Nematode diseases of Vegetables crops
S-2 & S-3	SLO-1	Lab 1- Nematode sampling techniques	Lab 4- Nematode extraction- Plant sample	Lab 8- Microscopic observation – Meloidogyne sp and Globodera sp	Lab 11 - Identification – Hemicriconemoides, Tylenchulus and Aphelenchoides.	Lab 14- Nematode damage- Fruits and vegetables
	SLO-2					
S-4	SLO-1	Economic importance of plant parasitic nematodes	Nematode nervous system	Symptoms of nematode damage- Soil borne nematodes	Nematode management- Host plant resistance	Nematode diseases of Spice and Flower crops
	SLO-2	List of economically important nematodes	Nematode reproductive system	Symptoms of nematode damage-Foliar nematodes	Nematode management- Improved management techniques	Nematode diseases of Plantation crops
S-5&6	SLO-1	Lab 2- Cobbs' s technique- processing soil	Lab 5- Nematode staining and examination	Lab 9- Identification - Helicotylenchus, Tylenchorhynchus, Hoplolaimus.-	Lab 12- Life stage- Meloidogyne and Globodera	Lab 15- Nematode damage- spices, flower crops and medicinal plants
	SLO-2					
S-7	SLO-1	Predatory nematodes	Nematode taxonomy	Nematode interaction with other nematodes	-	Nematode management in mushroom and medicinal crops

Duration (hour)	Learning Unit / Module 1		Learning Unit / Module 2		Learning Unit / Module 3		Learning Unit / Module 4		Learning Unit / Module 5	
	9		12		9		8		9	
	SLO-2	Entomo-pathogenic nematodes	Classification of nematode - parasitism		Important antagonists nematode		-		Nematode management in aromatic crops and protected cultivation	
S-8 & 9	SLO-1	Lab 3- Nematode extraction-centrifugal floatation	Lab 6- Killing, fixing, preservation and counting of nematodes		Lab 10- Identification - Pratylenchus, Longidorus, and Xiphinema.		Lab 13 - Life stages of Rotylenchulus and Radopholus		Lab 16-Nematicides and biocontrol agents	
	SLO-2		Nematode identification- biochemical method. Nematode identification- molecular tools						SLO-1 EPN as a biological control agent for insect pests and their mode of action	
S- 10	SLO-1								SLO-2	
	SLO-2									
S-11 & 12	SLO-1		Lab 7- Nematode processing and mounting							
	SLO-2									

Learning Resources	1.	Jonathan, E.I. (2010). Fundamentals of Plant Nematology. Tiruchirapalli: Devi Publications. pp. 1- 232.
	2.	Walia, R. K., and Bajaj, H. K. (2014). Textbook of Introductory Nematology. New Delhi: ICAR. pp. 1-240.

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In semester (20%)	Practical (15%)		
Level 1	Remember	40 %	45 %	40 %	45 %
	Understand				
Level 2	Apply	40 %	30 %	30 %	30 %
	Analyze				
Level 3	Evaluate	20 %	25 %	30 %	25 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. N. Muralitharan Regional Manager, NACL Industries limited. Ph- 9677780714	Dr. A. Shanthi, Professor Centre for plant protection studies TamilNadu Agricultural University, Coimbatore- 641003. E-mail: shanthigovardhan@yahoo.co.in	Dr.Rageshwari S (Assistant Professor) Plant Pathology Dr.Vinodkumar S (Assistant Professor) Plant Pathology Dr.N.Ashokkumar (Assistant Professor) Plant Nematology

THEORY

Unit I– Introduction to nematology (3 hours)

Introduction and economic importance Introduction to nematology – economic importance of nematodes – beneficial nematodes

Unit II – General characters of nematode and their classification (4 hours)

Morphology of nematodes. Anatomy of nematodes – digestive, excretory, nervous and reproductive system of nematodes. Biochemical/molecular tools for nematode identification - Taxonomy of nematodes upto super family and classification of nematodes based on parasitism.

Unit III – Nematode plant interaction (3 hours)

Lifecycle, symptom and interaction of important nematodes – *Meloidogyne*, *Globodera*, *Rotylenchulus*, *Tylenchulus*, *Radopholus* and *Pratylenchus*. Symptoms of nematode damage – interaction of nematodes with other microorganisms

Unit IV – Integrated nematode management (2 hours)

Nematode management Principles of nematode management - legislative (plant quarantine); physical methods (soil solarisation, hot water treatment, seed cleaning); cultural methods (deep ploughing, fallowing, crop rotation, antinemic plants, other land management practices); host plant resistance to nematodes; Improved techniques for nematode resistance breeding; biological control (nematode trapping fungi, egg parasitic fungi, obligate parasites, PGPR bacteria and predators); chemical control. Integrated nematode management.

Unit V – Diseases caused by nematodes (4 hours)

Nematode diseases of fruits (Banana, Citrus, Grapevine, Papaya) – vegetables (Tomato, Brinjal, Okra, Chilli, Potato) - spices (Turmeric, Pepper, Cardamom) flowers (Crossandra, Rose, Jasmine, Tuberose) plantation crops (Tea, Coffee, Betelvine) - mushroom, medicinal and aromatic plants and nematode problem in protected cultivation.

Theory – Lecture Schedule

1. Introduction and History of Nematology
2. Economic importance of plant parasitic nematodes
3. Beneficial nematodes – predatory, entomopathogenic nematodes etc.
4. Morphology and anatomy of nematodes – digestive and excretory system of nematodes.
5. Morphology and anatomy of nematodes (Contd.) – nervous and reproductive system of nematodes.
6. Taxonomy of nematodes up to genus and classification of nematodes based on parasitism.
7. Biochemical/molecular tools for nematode identification.
8. Life cycle of important nematodes –*Meloidogyne*, *Globodera*, *Rotylenchulus*, *Tylenchulus*, *Radopholus* and *Pratylenchus*.
9. **In – semester examination.**
10. Symptoms of nematode damage.
11. Interaction of nematodes with other microorganisms.
12. Principles and methods of nematode management (legislative, cultural, physical, chemical, and biological control)
13. Host plant resistance to nematodes, improved techniques for nematode resistance breeding.
14. Nematode diseases of fruit crops (Banana, Citrus, Grapevine, Papaya) and vegetable crops (Tomato, Brinjal, Okra, Chillies, Potato).
15. Nematode diseases of spices (Turmeric, Pepper, Cardamom) flower (Crossandra, Jasmine, Tuberose) and plantation crops (Tea, Coffee, Betelvine)
16. Nematode diseases of mushroom and medicinal crops
17. Nematode diseases of aromatic plants and nematode problems in protected cultivation.

Practical Schedule

1. Sampling techniques for nematode assay.
2. Processing of soil samples for extraction of active nematodes by Cobb's method
3. Extraction of nematodes by centrifugal floatation and extraction of cyst nematodes.
4. Extraction of nematodes from plant samples.

5. Staining techniques, direct examination and Blender technique.
6. Killing, fixing, preservation and counting of nematodes.
7. Processing and mounting of nematodes.
8. Observation of morphological characters of *Meloidogyne* sp and *Globodera* sp
9. Identification of nematodes *Helicotylenchus*, *Tylenchorhynchus*, and *Hoplolaimus*.
10. Identification of nematodes *Pratylenchus*, *Longidorus*, and *Xiphinema*.
11. Identification of nematodes *Hemicriconemoides/Hemicycliophora* and *Aphelenchoides*.
12. Study of life stages of *Meloidogyne* and *Globodera*
13. Study of life stages of *Rotylenchulus* and *Radopholus*
14. Nematode disease symptoms in fruit and Vegetables
15. Nematode disease symptoms in spices, flower crops and medicinal plants.
16. Nematicides, bio-control agents, application methods and calculation of dosages.
17. **University Practical examination**

Text Books

1. Agrios, G.N. (2005). *Plant Pathology* (5th ed.). New York: Academic Press. pp. 1-922.
2. Jonathan, E.I. (2010). *Fundamentals of Plant Nematology*. Tiruchirapalli: Devi Publications. pp. 1- 232.
3. Mohammad Manjur Shah and Mohammad Mahamood. (2017). *Nematology: Concepts, Diagnosis and Control*. UK: Intech Open
4. Ravichandra, N. G. (2014). *Horticultural Nematology*. Springer Publication. pp. 1-412
5. Walia, R. K., and Bajaj, H. K. (2014). *Textbook of Introductory Nematology*. New Delhi: ICAR. pp. 1-240

Reference Books

1. Bhatti, D.S. and R.K.Walia. 1992. *Nematode pests of crops*. Delhi: CBS Publishers and Distributors. pp.1-381.
2. Roland N Perry and Maurice Moens. 2013. *Plant Nematology* (2nd ed.) CABI. pp. 1-568

Web References

1. <https://www.youtube.com/watch?v=hWdmL8sGCB4>
2. <https://www.youtube.com/watch?v=14zmmbXsyuM>
3. <https://www.youtube.com/watch?v=baNDHY7JzTk>

Journals

1. Indian journal of nematology
2. Annals of Plant protection sciences
3. Nematology
4. Journal of entomology and nematology
5. Journal of Nematology
6. Russian Journal of Nematology

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-		-	-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	05	05	05	-	15
Grand Total							100

Course Code	GPB19402	Course Name	Elementary Plant Biotechnology	Course Category	S	Supportive Course	L	T	P	C
							1	0	1	2

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Agricultural Biotechnology		Data Book / Codes/Standards	Nil	

Course Learning Rationale (CLR):		<i>The purpose of learning this course is to:</i>		
CLR-1 :	<i>Understand the basic techniques in tissue culture</i>			
CLR-2 :	<i>Define the basics of molecular biology</i>			
CLR-3 :	<i>Summarize the different strategies of transgenesis of biotechnology in agriculture</i>			
CLR-4 :	<i>Describe the molecular markers</i>			
CLR-5 :	<i>Outline the DNA sequences</i>			

Learning			
1	2	3	
Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	

Program Learning Outcomes (PLO)														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems through Agricultural Microbiology	Ability to implement knowledge gained in the applied field of biotechnology	Ability to understand social and ethical responsibilities of Agricultural biotechnology

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning	Program Learning Outcomes (PLO)																
CLO-1 :	Perform tissue culture in crop plants	3	90	80	M								M	H		H	H	H	H
CLO-2 :	Discuss virus free plants	1	95	85	H								L	H		H	H	H	H
CLO-3 :	Utilize the genetic transformation in crops	2	80	70	M		L	L					L	H		H	H	H	H
CLO-4 :	Determine the DNA markers of plant breeding	3	75	65	M			L	L				M	H		H	H	H	H
CLO-5 :	Perform DNA extraction to sequencing	2	75	60	L	L							M	H		H	H	H	H
CLO 6 :	Identify the DNA fingerprinting of plants	2	75	65	L						H		M	H		H	H	H	H

Duration (hour)		Learning Unit / Module 1 9	Learning Unit / Module 2 7	Learning Unit / Module 3 12	Learning Unit / Module 4 15	Learning Unit / Module 5 6
S-1	SLO-1	Plant tissue culture: Concepts, history and scope	Micropropagation - banana and ornamental plants	Genome organization- prokaryotes vs eukaryotes.	DNA manipulation enzymes: Polymerases, restriction endonucleases and ligases.	Hybridization based markers and PCR based markers
	SLO-2	Media and Culture Conditions and Sterilization techniques	Meristem tip culture (virus free plants) and anther culture (doubled haploids)	Central dogma of life - Structure of nucleicacids. DNA replication	Different types of vectors: plasmids, phagemids, cosmids and BAC	DNA fingerprinting of crop varieties
S-2, 3	SLO-1	Lab 1. Biotech Laboratory organization, safety regulations	Lab 4. Meristem culture (tapioca)	Lab 6. Callus culture	Lab 10. Competent cell preparation and Bacterial transformation	Lab 15. NTSys- analysis of diversity in crop plants
	SLO-2					
S-4	SLO-1	Regeneration methods	Protoplast isolation and fusion-somaclonal variation-synthetic seeds	Aminoacids and their classification and genetic codes,transcription.	Construction of recombinant DNA molecules- Bacterial transformation.	Development of mapping populations, Linkage and QTL analysis.
	SLO-2	Culture types	Secondary metabolite production, invitro germplasm conservation.	Translation and protein synthesis	Direct and indirect gene transfer methods in plants	Marker Assisted Selection and genome databases
S-5, 6	SLO-1	Lab 2. Basics of reagents and solution preparation	Lab 5. Micro propagation of banana	Lab 7. Culturing of E.coli and determination of growth curve	Lab 11. Confirmation of transformation through colony screening	Lab 16. Visit to tissue culture units /biotech lab in seed industry/Bt cotton field/tissue culture banana field
	SLO-2					
S-7	SLO-1	Anther and pollen culture		Fine structure of a gene	Tissue specific promoters, selectable and scorable markers, reporter genes.	
	SLO-2	Ovule and embryo culture.		Gene components	Molecular analysis of transgenic plants	

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		9	7	12	15	6
S-8, 9	SLO-1	Lab 3. Plant tissue culture media preparation- shoot tip culture (rose)		Lab 8. Isolation of bacterial plasmid DNA	Lab 12. DNA extraction from plants	
	SLO-2					
S-10	SLO-1			Regulation of gene expression, Operon concept. Blotting techniques and Polymerase chain reaction.	Transgenic plants: herbicide, pest and disease resistant	
	SLO-2					
S-11, 12	SLO-1			Lab 9. Restriction Digestion and Ligation	Lab 13. Quantification of DNA and quality check through Agarose gelelectrophoresis	
	SLO-2					
S-13	SLO-1				Transgenic plants: nutritional enhancement and traits for improved quality.	
	SLO-2					
S-14, 15	SLO-1				Lab 14. DNA fingerprinting using RAPD/SSR markers	
	SLO-2					

Learning Resources	1.	Chawla, H.S. (2009). Introduction to Plant Biotechnology (3 rd ed.). London : CRC Press. pp. 1 - 698.
	2.	George, E.F, Hall M. A. & Geert-Jan De Klerk. (2009). Plant Propagation by Tissue Culture (3 rd ed.). The Netherlands: Springer. pp. 1 - 504.
	3.	Neal Stewart, Jr. C. (2008). Plant Biotechnology and Genetics: Principles, Techniques and Applications. New Jersey: John Wiley & Sons, Inc. pp. 1 - 432.

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember	40 %	30 %	35 %	30 %
	Understand				
Level 2	Apply	40 %	40 %	35 %	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	30 %	30 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. N. Jagadeeshselvam Scientist – I, MBL – I – LAB Rasi Seeds (P) Ltd., Athur, Salem – 636 141.	Dr. T. Sabesan Associate professor Department of Genetics and Plant Breeding Faculty of Agriculture, Annamalai University, Annamalai nagar , Chidambaram - 608 002 sabavani@gmail.com	Dr. G. Selvakumar , Assistant Professor (GPB) Dr. R. Mahendran, Assistant Professor (GPB) Dr. J. Vanitha, Tutor (GPB)

THEORY

Unit I - Basics of plant tissue culture

Plant tissue culture: Concepts, history and scope - Media and Culture Conditions - Sterilization techniques- Regeneration methods - morphogenesis, organogenesis and embryogenesis - culture types - callus culture and cell suspension culture; shoot tip and meristem tip culture; anther and pollen culture; ovule and embryo culture.

Unit II - Applied plant tissue culture

Micropropagation - banana and ornamental plants; National certification and Quality management of TC plants- Applications of organ culture - Meristem tip culture (virus free plants) and anther culture (doubled haploids)- Protoplast isolation and fusion- somaclonal variation- synthetic seeds - secondary metabolite production- invitro germplasm conservation.

Unit III - Basic molecular biology

Genome organization- prokaryotes vs eukaryotes - Central dogma of life - Structure of nucleic acids - DNA replication, aminoacids and their classification- genetic codes- transcription, translation and protein synthesis- Structure of a gene, regulation of gene expression, Operon concept- basic techniques in molecular biology- Blotting techniques- Polymerase chain reaction- DNA sequencing methods.

Unit IV - Recombinant dna technology and genetic transformation

DNA manipulation enzymes: Polymerases, restriction endonucleases and ligases - Different types of vectors: plasmids, phagemids, cosmids, BAC - Construction of recombinant DNA molecules- Bacterial transformation - Direct and indirect gene transfer methods in plants: microinjection, electroporation, particle bombardment, Agrobacterium mediated method - Tissue specific promoters, selectable and scorable markers, reporter genes- Molecular analysis of transgenic plants – Transgenic plants: herbicide, pest and disease resistant, abiotic stress resistant, nutritional enhancement and traits for improved quality- Detection of GMOs regulations and biosafety.

Unit V- Molecular marker technology and molecular breeding

DNA markers - hybridization based markers (RFLP) - PCR based markers: RAPD, SSR, AFLP, and SNPs - DNA fingerprinting of crop varieties – Development of mapping populations- linkage and QTL analysis- principles, methods and applications of Marker Assisted Selection in crop improvement- Applications of Plant Genomics and genome databases

Theory – Lecture Schedule

1. Plant tissue culture: Concepts, history and scope. Media and Culture Conditions and Sterilization techniques
2. Regeneration methods - morphogenesis, organogenesis and embryogenesis. Culture types - callus culture and cell suspension culture; shoot tip and meristem tip culture
3. Anther and pollen culture; ovule and embryo culture.
4. Micropropagation - banana and ornamental plants. National certification and Quality management of TC plants. Meristem tip culture (virus free plants) and anther culture (doubled haploids).
5. Protoplast isolation and fusion- somaclonal variation-synthetic seeds. Secondary metabolite production, *invitro* germplasm conservation.
6. Genome organization- prokaryotes vs eukaryotes. Central dogma of life - Structure of nucleic acids. DNA replication
7. Aminoacids and their classification and genetic codes, transcription. Translation and protein synthesis
8. Fine structure of a gene
9. **In - semester Examination**
10. Regulation of gene expression, Operon concept Blotting techniques and Polymerase chain reaction. DNA sequencing methods
11. DNA manipulation enzymes: Polymerases, restriction endonucleases and ligases. Different types of vectors: plasmids, phagemids, cosmids and BAC
12. Construction of recombinant DNA molecules- Bacterial transformation. Direct and indirect gene transfer methods in plants: microinjection, electroporation, particle bombardment, *Agrobacterium* mediated method
13. Tissue specific promoters, selectable and scorable markers, reporter genes. Molecular analysis of transgenic plants
14. Transgenic plants: herbicide, pest and disease resistant and abiotic stress resistant.
15. Transgenic plants: nutritional enhancement and traits for improved quality. Detection of GMOs – regulations and biosafety.
16. DNA markers - hybridization based markers (RFLP), PCR based markers: RAPD, SSR, AFLP, and SNPs. DNA fingerprinting of crop varieties
17. Development of mapping populations, Linkage and QTL analysis. Principles, methods and applications of Marker Assisted Selection in crop improvement. Applications of Plant Genomics and genome databases

Practical Schedule

1. Biotech Laboratory organization, safety regulations
2. Basics of reagents and solution preparation
3. Plant tissue culture media preparation- shoot tip culture (rose)
4. Meristem culture (tapioca)
5. Micro propagation of banana
6. Callus culture

7. Culturing of *E.coli* and determination of growth curve
8. Isolation of bacterial plasmid DNA
9. Restriction Digestion and Ligation
10. Competent cell preparation and Bacterial transformation
11. Confirmation of transformation through colony screening
12. DNA extraction from plants
13. Quantification of DNA and quality check through Agarose gelelectrophoresis
14. DNA fingerprinting using RAPD/SSR markers
15. NTSys- analysis of diversity in crop plants
16. Visit to tissue culture units /biotech lab in seed industry/Bt cotton field/tissue culture banana field
17. **University Practical Examination**

Text Books

1. Chawla, H S. (2009). *Introduction to Plant Biotechnology* (3rd ed.). London: CRC Press. pp. 1 - 698.
2. George, E.F, Hall M. A. & Geert-Jan De Klerk. (2009). *Plant Propagation by Tissue Culture* (3rd ed.). The Netherlands: Springer. pp. 1 - 504.
3. Neal Stewart, Jr. C. (2008). *Plant Biotechnology and Genetics: Principles, Techniques and Applications*. New Jersey: John Wiley & Sons, Inc. pp. 1 - 432.
4. Nelson, D.S. & Cox, M.M. (2012). *Lehninger's Principles of Biochemistry* (6th ed.). New York: W.H. Freeman and Company. pp. 1 – 1336.
5. Xu ,Y. (2010). *Molecular Plant Breeding. International Maize and Wheat Improvement Centre (CIMMYT)*. pp 1 - 338.

Reference Books

1. Colin Ratledge & Bjorn Kristiansen. (2006). *Basic Biotechnology*. England: Cambridge University Press. pp. 1 – 573.
2. Denis Murphy. (2007). *Plant Breeding and Biotechnology*. England: Cambridge University Press. pp. 1 – 453.
3. John E. Smith. (2004). *Biotechnology*. England: Cambridge University Press. pp. 1 – 207.
4. Singh H.P., Uma, S., Selvarajan, R. & Karihaloo, J.L.. (2011). *Micropropagation for Production of Quality Banana Planting Material in Asia-Pacific*. New Delhi: Asia-Pacific Consortium on Agricultural Biotechnology. pp. 1 – 79.

Web References

1. <https://www.usda.gov/topics/biotechnology/biotechnology-frequently-asked-questions-faqs>
2. <https://www.greenfacts.org/en/gmo/3-genetically-engineered-food/1-agricultural-biotechnology.htm>
3. <https://www.fda.gov/food/consumers/agricultural-biotechnology>
4. <https://science.howstuffworks.com/life/genetic/agricultural-biotechnology.htm>
5. <https://www.nature.com/scitable/knowledge/library/history-of-agricultural-biotechnology-how-crop-development-25885295/>

Journals

1. Agricultural Biotechnology
2. Chinese Journal of Agricultural Biotechnology
3. Journal of Crop Science and Biotechnology
4. Biocatalysis and Agricultural Biotechnology
5. Agricultural biotechnology (Nature)

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	HOR19501	Course Name	Orchard and Estate Management	Course Category	C	Compulsory Core	L	T	P	C
							1	0	1	2

Pre-requisite Courses	HOR19101	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Horticulture	Data Book / Codes/Standards			

Course Learning Rationale (CLR):		The purpose of learning this course is to:			Learning			Program Learning Outcomes (PLO)														
CLR-1 :	Outline the orchard and estate management	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
CLR-2 :	Recall practical experience on mulching, nutrient and cropping systems	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Orchard Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems through Orchard Management	Ability to implement knowledge gained in the applied field of Orchard management	Ability to understand social and ethical responsibilities of Orchard and estate management			
CLR-3 :	Understand the irrigation and soil management practices																					
CLR-4 :	Describe the rejuvenation techniques																					
CLR-5 :	Explain the crop regulation and crop model																					
CLR-6 :	Summarize the fruitfulness and unfruitfulness in fruit crops																					
Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:																				
CLO-1 :	Paraphrase the objectives and importance of orchard and estate management	1	80	70	L								L	H		H	H	H	H			
CLO-2 :	Discuss the cropping systems	2	90	85	H		H		H				M	H		H	H	H	H			
CLO-3 :	Demonstrate the irrigation and soil management	3	95	85	H	H	H						M	H		H	H	H	H			
CLO-4 :	Describe the resource utilization methods	2	75	80	M		M		H		H		L	H		H	H	H	H			
CLO-5 :	Determine the crop models and crop regulation	3	80	70	L								L	H		H	H	H	H			
CLO6 :	Recognize the orchard management	3	85	80	H						H		H	H		H	H	H	H			

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		4	3	3	3	3
S-1	SLO-1	Definition of orchard and estate	Definition of mulch and mulching	Soil Management	Sub surface systems	Pollination and fruit set problems
	SLO-2	Objectives and importance	Organic and Inorganic mulching	Fertilizers and manures	Over Head System	Causes of unfruitfulness
S-2-3	SLO-1 SLO-2	Lab 1: Planning and layout of orchard	Lab 5: Study of cover cropping	Lab 8: Visit to different local fruit orchards	Lab 11: Surface irrigation system	Lab 14: moisture conservation methods
S-4	SLO-1	Layout of orchard	Cropping Systems	Nutrient uptake	Integrated Nutrient Management	Crop regulations
	SLO-2	Planting methods	HDP	Inter cultivation	Fertigation	Climate aberration and mitigation
S-5-6	SLO-1	Lab 2: Planting systems	Lab 6: Study of mixed cropping	Lab 9: Study of use of organic mulches	Lab 12: sub-surface irrigation system	Lab 15: Observations on weed growth
	SLO-2					
S-7	SLO-1	Clean cultivation	Plant Interaction	Surface systems.	Rejuvenation of old orchard	Crop models in horticulture crops
	SLO-2	Characteristics of ideal sod	Allelopathy	Merits and Demerits	top working and frame working	canopy management
S-8-9	SLO-1 SLO-2	Lab 3: Study of clean cultivation	Lab 7: Study of filler crops	Lab 10: Study of use of inorganic mulches	Lab 13: Overhead irrigation system	Lab 16: Use of different weedicides
S-10	SLO-1	Weed management	-	-	-	-
	SLO-2	Herbicides	-	-	-	-
S-11	SLO-1	Lab 4: Study of Inter cropping	-	-	-	-
	SLO-2					

Learning Resources	1. Kumar, N. (2020). <i>Introduction to Horticulture (7th revised edition)</i> . New Delhi: Oxford & I.B.H. Publishing. pp. 1 – 452.
	2. Mazumdar, B.C. (2004). <i>Principles and Methods of Orchard Establishment</i> . New Delhi: Daya Publishing House. pp. 1 – 310.

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember Understand	40 %	30 %	35 %	30 %
Level 2	Apply Analyze	40 %	40 %	35 %	40 %
Level 3	Evaluate Create	20 %	30 %	30 %	30 %
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr.Amol Chaudhari Manager R & D Farm Jain Irrigation Systems Ltd. Udumalpet	Dr. A. Rameshkumar Associate Professor (Horticulture) Central University of Tamil Nadu Thiruvavur	Dr. B. Gopu

THEORY

Unit I Introduction to orchard and estate management

Orchard and estate management, Importance and objectives; cultivation methods and their merits and demerits

Unit II Mulching and cropping systems

Orchard and estate management, importance, objectives, merits and demerits, clean cultivation, sod culture, Sod mulch, herbicides and inorganic and organic mulches. Tropical, subtropical and temperate horticultural systems, competitive and complimentary effect of root and shoot systems.

Unit III Irrigation and soil management

Biological efficiency of cropping systems in horticulture, systems of irrigation. Soil management in relation to nutrient and water uptake and their effect on soil environment, moisture, organisms and soil properties.

Unit IV Unfruitfulness, rejuvenation of orchards and resource utilisation

Factors influencing the fruitfulness and unfruitfulness. Rejuvenation of old orchards, top working, frame working, Integrated nutrient and pest management. Utilization of resources, constraints in existing systems.

Unit V Crop model and crop regulation

Crop model and crop regulation in relation to cropping systems. Climate aberrations and mitigation measures of Horticultural crops.

Theory - Lecture Schedule

1. Definition of orchard and estate – Objectives and importance of orchard and estate management.
2. Planning - Layout of orchard- Planting methods - Vertical Row planting- Alternate row planting- Planting distance- Planting season.
3. Clean cultivation –Sod culture – Characteristics of ideal sod – Methods of growing – Types of sod culture – Sod pasture method – Sod mulch method –Temporary sod – Merits and Demerits.
4. Weed management in orchard – Cultural (mechanical) methods – Biological methods - Chemical methods – Guidelines for using herbicides in orchard – Herbicides used for weed control.
5. Mulching in orchard – Definition of mulch and mulching – Objectives of mulching –Types of mulches – Organic mulches - Inorganic mulches - Merits and Demerits of Mulching.
6. Cropping Systems – Tropical and subtropical Horticultural Systems – Mono cropping – Multiple cropping – Inter cropping – Factors determining choice of inter crop – Mixed cropping – Ratoon cropping – Multi storey or Multi-tier cropping –Temperate Horticultural Systems – Medium High density planting – Optimum high density planting viz., - Tatura trellis – Pyramid system Cordon system – Curtain system – Hedge row system – Ultra High Density planting viz., Meadow orchard – Mechanized system – Intensive system.
7. Plant Interaction – Types of Interactions in cropping systems – Competitive interaction – above ground and below ground – Complimentary Interactions– Annidation in space and time Allelopathy and its effects.
8. Soil Management in relation to soil organisms – Ploughing and tillage – Continuous cultivation – crop rotation – Irrigation – Liming – Gypsum – Fertilizers and manures– Oil cakes – Soil Aggregation.
9. **In - semester examination**
10. Soil management in relation to Nutrient uptake – Soil physical conditions – Soil Fertility – Soil reaction – Climatic factors – Crop factors – Soil management in relation to water uptake – Soil water – Factors influencing infiltration – Soil properties –Tillage – Inter cultivation – Soil management on soil environment – Soil temperature and plant growth.
11. Systems of Irrigation – Surface systems. Merits and Demerits.
12. Sub surface systems – Merits and Demerits Over Head System – Sprinkler system of irrigation – Different types and mechanism- Merits and Demerits.
13. Integrated Nutrient Management (INM) – Concept – Need for INM – Components of INM – Mineral fertilizer – Organic sources – Biological sources – Merits of INM -Method of application of fertilizers in orchards – Surface application – Trench application – Foliar application – Fertigation and integrated pest management.
14. Rejuvenation of old orchard, top working and frame working – Utilization of resources constraints in existing systems.
15. Pollination and fruit set problems –Self and Cross pollination – Definitions of fruit setting – Fruit fullness – Fertility – Self fertility – Self sterile – Cross unfruitful – Pollinator – Pollinizer – Causes of unfruitfulness – Internal factors- External factors.
16. Climate aberration and mitigation measures of horticultural crops – Crop regulations in relation to cropping systems – Crop regulation in Pine apple, Fig, Aonla, Bahar treatment, Citrus, Guava, Pomegranate.
17. Crop models in horticulture crops and canopy management in Mango, Guava, Apple, Plum, Pear, Peach.

Practical Schedule

1. Planning and layout of orchard - Orchard components- Records maintenance in orchard
2. Planting and lay out of different planting systems of orchard
3. Study of clean cultivation

4. Study of Inter cropping systems in orchards
5. Study of cover cropping with suitable examples
6. Study of mixed cropping with suitable examples
7. Study of filler crops in orchards-characteristics of a filler plant
8. Visit to different local fruit orchards
9. Study of use of organic mulches in fruit orchard
10. Study of use of inorganic mulches in fruit orchard
11. Study on layout of surface irrigation system
12. Study on layout of sub-surface irrigation system
13. Study on layout of overhead irrigation system
14. Study of moisture conservation methods and observations on soil moisture content under mulches
15. Observations on weed growth under different systems of management
16. Use of different weedicides in orchards
17. **University Practical Examination**

Text Books

1. Dhillon, W.S. (2013). Fruit production in India. New Delhi: Narendra Publishing House. pp. 1 – 704.
2. Kumar, N. (2020). Introduction to Horticulture (7th revised edition). New Delhi: Oxford & I.B.H. Publishing. pp. 1 – 452.
3. Mazumdar, B.C. (2004). Principles and Methods of Orchard Establishment. New Delhi: Daya Publishing House. pp. 1 – 310.
4. Sharma, R. R. (2006). Fruit production, problems and solutions. Lucknow: IBDC.

Reference Books

1. Dhillon, W.S & Z. A. Bhatt. (2011). Fruit Tree Physiology. New Delhi: Narendra Publishing House.
2. Srivastava, A. K & Chengxiao Hu. (2019). Fruit Crops (1st edition). Diagnosis and Management of Nutrient Constraints. Published by Elsevier. pp. 1 – 776.

Web References

1. http://agritech.tnau.ac.in/horticulture/horti_orchard%20management.html
2. <http://ecoursesonline.iasri.res.in/course/view.php?id=151>
3. <http://treefruit.wsu.edu/orchard-management>
4. <https://www.iaritoppers.com/2019/06/orchard-management-icar-e-course-pdf-download-e-krisi-shiksha.html>
5. <https://www.youtube.com/watch?v=JutHZeoigI8>
6. <https://www.youtube.com/watch?v=QISvYXF4sG8>
7. <https://www.youtube.com/watch?v=uYIclJP4ME>

Journals

1. *ActaHorticulturae*
2. *HortScience*
3. *HortTechnology*
4. *Indian Horticulture*
5. *Indian J. Horticulture*
6. *Journal of Horticultural Sciences*
7. *Journal of the American Society for Horticultural Science*

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	HOR19502	Course Name	Temperate Vegetable Crops	Course Category	C	Compulsory Core	L	T	P	C
							1	0	1	2

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Horticulture	Data Book / Codes/Standards			

Course Learning Rationale (CLR):		The purpose of learning this course is to:		
CLR-1 :	Explain vegetable crop production in temperate regions			
CLR-2 :	Perform the importance of vegetable varieties and hybrids			
CLR-3 :	Summarize the essential of crop management practices in vegetables			
CLR-4 :	Paraphrase the potential of value chain in commercial crop production			
CLR-5 :	Describe the managerial practices for nutrient and physiological disorders			
CLR-6 :	Discuss the nutritional importance of temperate vegetables			

Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:		
CLO-1 :	Understand the scope and importance of temperate vegetables in nutrition and economy			
CLO-2 :	Outline the commercial cultivation of temperate vegetables			
CLO-3 :	Discuss a plan of suitable vegetable cultivation technology for a particular region			
CLO-4 :	Describe the temperate vegetable varieties to grow in tropical climates or in accordance with seasons			
CLO-5 :	Paraphrase new vegetable crops to a nontraditional region of cultivation			
CLO6 :	Identify and control physiological disorders			

Learning			Program Learning Outcomes (PLO)															
1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Horticulture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems through temperate vegetables	Ability to implement knowledge gained in the applied field of temperate vegetables	Ability to understand social and ethical responsibilities of temperate vegetables	
			L									H		H	M	H	H	
			H				M		M		H	H		H	H	H	H	H
			H								M	H		H	H	H	H	H
			H	M								H		H	H	H	H	H
			H	L								H		H	H	H	H	H
2	70	65	H	H							H		H	H	H	H	H	

Duration (hour)		Learning Unit / Module 1 2T+2P	Learning Unit / Module 2 4T+4P	Learning Unit / Module 3 3T+3P	Learning Unit / Module 4 3T+3P	Learning Unit / Module 5 4T+4P
S-1	SLO-1	Scope and importance	Cabbage – importance, varieties, climate, soil, nursery, transplanting, field preparation	Onion – Introduction and importance	Carrot – Introduction and importance	Chinese cabbage – production technology
	SLO-2	Area and production	Cabbage – cultural practices, physiological disorders, harvesting, storage and marketing	Onion – Production technology	Carrot – production technology	Celery – production technology
S-2-3	SLO-1	LAB - Identification of subtropical and temperate vegetables and seeds	LAB - Botany, identification and description of varieties and hybrids of Bulb crops, Peas, Broad beans	LAB - Field preparation, seed rate, spacing for temperate vegetables	LAB - Preparation and application of plant growth regulators in temperate vegetable crops	LAB - Nutrient deficiencies and physiological disorders in temperate vegetable crops
	SLO-2					
S-4	SLO-1	Export potential	Cauliflower – importance, varieties, climate, soil, nursery, transplanting, field preparation	Garlic - Introduction and importance	Radish – Introduction and importance	Rhubarb – production technology
	SLO-2	Institutions	Cauliflower – cultural practices, physiological disorders, harvesting, storage and marketing	Garlic – Production technology	Radish – production technology	Asparagus – production technology
S-5-6	SLO-1	LAB - Botany, identification and description of varieties and hybrids of Cole crops	LAB - Botany, identification and description of varieties and hybrids of Root crops	LAB - Inter cultivation and Nutrient requirement and its management in temperate vegetable crops	LAB - Maturity indices, harvesting and yield of temperate vegetables	LAB - Visit to commercial farms in Plains and hills
	SLO-2					
S-7	SLO-1		Brussels sprouts – production technology	Peas – production technology	Beetroot – production technology	Globe artichoke – production technology
	SLO-2		Sprouting broccoli – production technology	Broad beans – production technology	Turnip – production technology	Leek – production technology
S-8-9	SLO-1					

Duration (hour)	Learning Unit / Module 1		Learning Unit / Module 2		Learning Unit / Module 3		Learning Unit / Module 4		Learning Unit / Module 5	
	2T+2P		4T+4P		3T+3P		3T+3P		4T+4P	
	SLO-2		LAB - Botany, identification and description of varieties and hybrids of Leafy and salad vegetables		LAB - Weed management practices		LAB - Post-harvest handling, storage and marketing of temperate vegetables		LAB - Visit to cold storage / markets / processing centres	
S-10	SLO-1		Knolkhol – production technology						Lettuce – production technology	
	SLO-2		kale – production technology						Palak and spinach – production technology	
S-11-12	SLO-1		LAB - Nursery preparation and sowing of						LAB - Project preparation and working	
	SLO-2		transplanted temperate vegetables						out economics	

Learning Resources	1.	Thamburaj, S. and Narendra Singh. (2001). A textbook of vegetable tuber crops and spices. ICAR. New Delhi. pp 1-469
	2.	Hazra, P., A. Chattopadhyay, K. Karmakar and S. Dutta. (2010). "Modern technology in vegetable production" New India Publishing Agency, New Delhi. pp 1-424

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember	60 %	50 %	50 %	60 %
	Understand				
Level 2	Apply	25 %	30 %	30 %	30 %
	Analyze				
Level 3	Evaluate	15 %	20 %	20 %	10 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
		Mr. Harish. A

THEORY

Unit I - Scope and importance of temperate vegetables

Temperate vegetables: scope and importance, area and production - global and national scenario, export potential, institutions involved in temperate vegetable crops research

Unit II - Cruciferous crops

Cabbage, cauliflower, brussels sprouts, sprouting broccoli, knol-khol and Kale: Economic importance and Uses; Description of varieties and hybrids, Climate and soil, season, seed rate, sowing, nursery practices, field preparation, direct sowing/transplanting, spacing, planting/cropping systems; Irrigation, weed and nutrient management; physiological disorders and nutrient deficiencies; plant growth regulators; maturity indices, harvest and yield; post-harvest handling, packaging, storage and marketing.

Unit III - Bulb crops, peas and broad beans

Onion, garlic, peas and broad beans: Economic importance and uses; description of varieties and hybrids, Climate and soil requirements, season/time of planting, seed rate, seed treatment, seed inoculation, nursery practices, field preparation, direct sowing/transplanting, spacing, planting/cropping systems, method of planting, water, weed and nutrient management; special practices; physiological disorders and nutrient deficiencies; plant growth regulators; maturity indices, harvest and yield, post-harvest handling, packaging, storage and marketing.

Unit IV – Root crops

Carrot, radish, beet root, and turnip : Economic importance and uses; description of varieties and hybrids, climate and soil requirements, season, seed rate, field preparation, direct sowing/transplanting, spacing, planting/cropping systems; water, weed and nutrient management; intercultural operations/special practices; physiological disorders and nutrient deficiencies; maturity indices, harvest and yield; post-harvest handling, packaging, storage and marketing.

Unit V – Salad and leafy vegetables

Chinese cabbage, celery, rhubarb, asparagus, Globe artichoke, leek, lettuce, Palak and spinach: Economic importance and uses; description of varieties and hybrids, climate and soil requirements, propagation/seed rate, nursery practices, field preparation, direct sowing/transplanting, spacing; water, weed and nutrient management; special practices/Intercultural operations; physiological disorders and nutrient deficiencies; maturity indices, harvest and yield: post-harvest handling, packaging, storage and marketing.

Theory – Lecture Schedule

1. Temperate vegetables: scope and importance, area and production, global and national scenario
2. Export potential, Institutions involved in vegetable crops research
3. Cabbage: Economic importance and uses, Classification of varieties, description of varieties and hybrids, Climate and soil, seed rate, nursery practices, field preparation, transplanting, spacing, Irrigation, weed control, nutrient management; Cropping system, plant growth regulators; physiological disorders and nutrient deficiencies; maturity indices, harvest and yield; post-harvest handling, packaging, storage and marketing.
4. Cauliflower: Economic importance and uses; description of varieties and hybrids, classification of varieties, Climate and soil, season, seed rate and sowing, nursery practices, field preparation, transplanting, spacing, planting/cropping systems; Irrigation, weed and nutrient management; physiological disorders and nutrient deficiencies; plant growth regulators; Blanching, maturity indices, harvest and yield; post-harvest handling, packaging, storage and marketing.
5. Brussels sprouts and Sprouting Broccoli: Economic importance and uses; description of varieties and hybrids, climate and soil, seed rate, nursery practices, field preparation, transplanting, spacing; irrigation, weed and nutrient management; maturity indices, harvest and yield; post-harvest handling, packaging, storage and marketing.
6. Knol-khol and kale: Economic importance and uses; description of varieties and hybrids, climate and soil, seed rate, nursery practices, field preparation, transplanting, spacing; Irrigation, weed and nutrient management; physiological disorders and nutrient deficiencies; maturity indices, harvest and yield; post-harvest handling, packaging, storage and marketing.
7. Onion: Economic importance and uses; description of varieties and hybrids, classification of varieties, climate and soil requirements, season, seed rate, field preparation, seed treatment and method of sowing, spacing; Irrigation management, weed control and nutrient management; Special practices; growth regulators, physiological disorders; maturity indices, harvest and yield, post-harvest handling, packaging, storage and marketing.
8. Garlic: Economic importance and uses; description of varieties and hybrids, classification of varieties, climate and soil requirements, season, seed rate, field preparation, seed treatment and method of sowing, spacing; Irrigation management, weed control and nutrient management; Special practices; growth regulators, physiological disorders; maturity indices, harvest and yield, post-harvest handling, packaging, storage and marketing.
9. **In - Semester Examination**
10. Peas and broad beans: Economic importance and uses; description of varieties and hybrids, classification of varieties, climate and soil requirements, season, seed rate, field preparation, seed treatment and method of sowing, spacing; Irrigation management, weed control and nutrient management; Special practices; growth regulators, physiological disorders; maturity indices, harvest and yield, post-harvest handling, packaging, storage and marketing.
11. Carrot: Economic importance and uses; description of varieties and hybrids, climate and soil requirements, seed rate, field preparation, spacing, planting; water management, weed and nutrient management; special practices; physiological disorders and nutrient deficiencies; plant growth regulators; maturity indices, harvest and yield, post-harvest handling, packaging, storage and marketing.
12. Radish: Economic importance and uses; description of varieties and hybrids, climate and soil requirements, seed rate, field preparation, spacing, planting; water management, weed and nutrient management; special practices; physiological disorders and nutrient deficiencies; plant growth regulators; maturity indices, harvest and yield, post-harvest handling, packaging, storage and marketing.

13. Beet root and Turnip: Economic importance and uses, description of varieties and hybrids, Soil and climatic requirements, seed rate, field preparation, sowing, spacing; water management, weed control and nutrient management; Intercultural operations; physiological disorders, maturity indices, harvest and yield; post-harvest handling, packaging, storage and marketing.
14. Chinese cabbage and celery: Economic importance and uses; description of varieties and hybrids, climate and soil requirements, propagation, nursery practices, field preparation, direct sowing/transplanting, spacing; water management, weed and nutrient management; special practices/Intercultural operations; physiological disorders; maturity indices, harvest and yield; post-harvest handling, packaging, storage and marketing.
15. Rhubarb and Asparagus: Economic importance and uses; description of varieties and hybrids, climate and soil requirements, propagation, nursery practices, field preparation, direct sowing/transplanting, spacing; water management, weed and nutrient management; special practices/Intercultural operations; physiological disorders; maturity indices, harvest and yield; post-harvest handling, packaging, storage and marketing.
16. Globe Artichoke and Leek: Economic importance and uses; description of varieties and hybrids, climate and soil requirements, propagation, nursery practices, field preparation, direct sowing/transplanting, spacing; water management, weed and nutrient management; special practices/Intercultural operations; physiological disorders; maturity indices, harvest and yield; post-harvest handling, packaging, storage and marketing.
17. Lettuce, Palak and spinach: Economic importance and uses; description of varieties and hybrids, climate and soil requirements, propagation, nursery practices, field preparation, direct sowing/transplanting, spacing; water management, weed and nutrient management; special practices/Intercultural operations; physiological disorders; maturity indices, harvest and yield; post-harvest handling, packaging, storage and marketing.

Practical Schedule

1. Identification of temperate vegetables and seeds
2. Botany, identification and description of varieties and hybrids of Cole crops
3. Botany, identification and description of varieties and hybrids of Bulb crops, Peas and Broad beans
4. Botany, identification and description of varieties and hybrids of Root crops
5. Botany, identification and description of varieties and hybrids of Leafy and salad vegetables
6. Nursery preparation and sowing of transplanted temperate vegetables
7. Field preparation, seed rate, spacing for temperate vegetables
8. Inter cultivation and Nutrient requirement and its management in temperate vegetable crops
9. Weed management practices
10. Preparation and application of plant growth regulators in temperate vegetable crops
11. Maturity indices, harvesting and yield of temperate vegetables
12. Post-harvest handling, storage and marketing of temperate vegetables
13. Nutrient deficiencies and physiological disorders in temperate vegetable crops
14. Visit to commercial farms in Plains and hills
15. Visit to cold storage / markets / processing centres
16. Project preparation and working out economics
17. **University Practical Examination**

Text Books

1. Choudhary, B.R. (2009). A Text book on production technology of vegetables. Kalyani Publishers. Ludhiana. pp 1-308
2. K S Yawalkar, (2004).Vegetable crops in India. Agri-Horticultural Pub. House. Nagpur. pp 1-350
3. M.S.Dhaliwal, (2008).Handbook of Vegetable Crops. Kalyani Publishers. Ludhiana. pp 1-389
4. Thamburaj, S. and Narendra Singh. (2001). A textbook of vegetable tuber crops and spices. ICAR. New Delhi. pp 1-469
5. Uma Shankar Singh, (2008). "Indian vegetables", Anmol publications Pvt., Ltd., New Delhi. pp 1-318

Reference Books

1. Hazra, P., A. Chattopadhyay, K. Karmakar and S. Dutta. (2010). "Modern technology in vegetable production" New India Publishing Agency, New Delhi. pp 1-424
2. Shanmugavelu, K.G. (1989). Production technology of vegetable crops. Oxford and IBH publishing Co. Pvt. Ltd, New Delhi. pp 1-930

Web References

1. <http://ecoursesonline.iasri.res.in/course/view.php?id=145>
2. <http://ecoursesonline.iasri.res.in/course/view.php?id=154>
3. <https://cpri.icar.gov.in/>
4. <https://cipotato.org/>
5. <https://www.ctcri.org/>
6. https://iims.icar.gov.in/Institute_Details.aspx?Inst=41
7. <https://www.iivr.org.in/>
8. <https://www.iihr.res.in/>
9. <https://icar.org.in/>

Journals

1. Indian Journal of Horticulture
2. Vegetable sciences
3. Indian Journal of Vegetable sciences
4. Indian Horticulture
5. International Journal of Vegetable Science
6. Scientia Horticulture
7. ActaHorticulturae
8. Progressive Horticulture

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-		-	-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	HOR19503	Course Name	Breeding of Vegetable, Tuber and Spice Crops	Course Category	C	Compulsory Core	L	T	P	C
							2	0	1	3

Pre-requisite Courses	GPB19302	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Horticulture	Data Book / Codes/Standards			

Course Learning Rationale (CLR):		The purpose of learning this course is to:			Learning			Program Learning Outcomes (PLO)														
CLR-1 :	Paraphrase the scope and Importance of breeding Vegetable, Tuber and Spice Crops				1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	Interpret the principles and methods of crop improvement programme				Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems through breeding of Horticultural crops	Ability to implement knowledge gained in the applied field of breeding of Horticultural crops	Ability to understand social and ethical responsibilities of breeding of Horticultural crops
CLR-3 :	Describe the germplasm characterization of vegetable, tuber and spice crops strategies in crop improvement programme																					
CLR-4 :	Explain the essential of plant genetic resources in development of hybrids																					
CLR-5 :	Summarize various methods of mutagenesis for crop improvement																					
CLR-6 :	Identify the methods of polyploidy breeding																					
Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:			2	90	80	M	M	M	M	M	M	H	M	M	H	M	H	H	H	M
CLO-1 :	Understand the concepts of breeding and floral biology				2	95	85	H	M	M	M	M	H	H	H	H	H	H	H	H	H	H
CLO-2 :	Discuss on genetic resources and utilize it in crop improvement				2	90	80	H	H	M	M	M	H	M	H	H	H	H	H	H	H	M
CLO-3 :	Perform the selection and hybridization for crop improvement				2	85	75	M	M	M	M	M	M	M	M	M	H	M	H	H	H	M
CLO-4 :	Utilize crops to express hybrid vigor				2	80	80	M	M	M	M	M	M	M	M	M	H	M	H	H	H	M
CLO-5 :	Explain the polyploidy, mutation and biotechnological application for crop improvement				2	85	75	M	M	M	M	M	M	M	M	M	H	M	H	H	H	M
CLO6 :	Gain knowledge on crop specific breeding				2	85	75	M	M	M	M	M	M	M	M	M	H	M	H	H	H	M

Duration (hour)		Learning Unit / Module 1 8T+4T	Learning Unit / Module 2 7T+3P	Learning Unit / Module 3 4T+3P	Learning Unit / Module 4 8T+3P	Learning Unit / Module 5 6T+3P
S-1	SLO-1	Different centres of origin of important tuber and spice crops	Objective and methods of breeding in Tomato	Objective and methods of breeding in cabbage	Objective and methods of breeding in onion	Objective and methods of breeding in black pepper
	SLO-2	Different centres of origin of important tuber and spice crops	Achievement of breeding in Tomato	Achievement of breeding in cabbage	Achievement of breeding in onion	Achievement of breeding in black pepper
S-2	SLO-1	In situ and Ex situ germplasm-conservation	Objective and methods of breeding in Brinjal	Objective and methods of breeding in cauliflower	Objective and methods of breeding in garlic	Objective and methods of breeding in cardamom
	SLO-2	Plant quarantine	Achievement of breeding in Brinjal	Achievement of breeding in cauliflower	Achievement of breeding in garlic	Achievement of breeding in cardamom
S-3	PRACTICAL-1	Selfing, emasculation and hybridization techniques	Breeding objectives, Floral biology, selfing, emasculation and crossing technique in Chilli	Breeding objectives, Floral biology, selfing, emasculation and crossing technique in Cucurbits-3	Breeding objectives, Floral biology, selfing, emasculation and crossing technique in seed spices	Techniques of F1 hybrid seed production
S-4						
S-5	SLO-1	Self and cross pollination	Objective and methods of breeding in capsicum	Objective and methods of breeding in carrot	Objective and methods of breeding in potato	Objective and methods of breeding in ginger
	SLO-2	Mechanism of pollination in plants	Achievement of breeding in capsicum	Achievement of breeding in carrot	Achievement of breeding in potato	Achievement of breeding in ginger
S-6	SLO-1	Methods of pollination in vegetable	Objective and methods of breeding in Chilli	Objective and methods of breeding in radish	Objective and methods of breeding in tuber crops	Objective and methods of breeding in turmeric
	SLO-2	Methods of pollination in tuber, spice crops	Achievement of breeding in Chilli	Achievement of breeding in radish	Achievement of breeding in tuber crops	Achievement of breeding in turmeric

S-7	PRACTICAL-2	Breeding objectives, Floral biology, selfing, emasculation and crossing technique in Tomato	Breeding objectives, Floral biology, selfing, emasculation and crossing technique in Cucurbit-1	Breeding objectives, Floral biology, selfing, emasculation and crossing technique in Potato	Breeding objectives, Floral biology, selfing, emasculation and crossing technique in tree spices	Maintenance of breeding records
S-8						
S-9	SLO-1	Principles of breeding of cross pollinated crops	Objective and methods of breeding in okra		Objective and methods of breeding in leafy vegetable-1	Objective and methods of breeding in tree spices
	SLO-2	Systems of mating	Achievement of breeding in okra		Achievement of breeding in leafy vegetable-1	Achievement of breeding in tree spices
S-10	SLO-1	Exploitation of Heterosis: Single cross	Objective and methods of breeding in cucurbits-1		Objective and methods of breeding in leafy vegetable-2	Objective and methods of breeding in seed spices
	SLO-2	Exploitation of Heterosis: double cross, poly cross	Achievement of breeding in cucurbits-1		Achievement of breeding in cauliflower leafy vegetable-2	Achievement of breeding in seed spices
S-11	PRACTICAL-3	Breeding objectives, Floral biology, selfing, emasculation and crossing technique in Brinjal	Breeding objectives, Floral biology, selfing, emasculation and crossing technique in Cucurbits-1	Breeding objectives, Floral biology in Turmeric & Ginger	Preparation and uses of chemical and physical mutagens	Working out phenotypic and genotypic variability, heritability, genetic advance, genotypic and phenotypic correlation coefficient, hybrid vigour
S-12						
S-13	SLO-1	Scope and importance of Biotechnology in crop improvement	Objective and methods of breeding in cucurbits -2		Objective and methods of breeding in cowpea	
	SLO-2	Bio-safety, Intellectual property issue	Achievement of breeding in cucurbits-2		Achievement of breeding in cowpea	
S-14	SLO-1	Molecular markers – Methods employed in crop improvement			Objective and methods of breeding in French beans	
	SLO-2	Molecular markers- Achievements			Achievement of breeding in French beans	
S-15	Practical-4	Breeding objectives, Floral biology, selfing, emasculation and crossing technique in Bhendi				
S-16						

Learning Resources	1. Kumar, N. (2018). Breeding of Horticultural Crops, Principles and Practices. New India Publishing Agency, New Delhi. pp.1-220 2. Hari Hara Ram. (2013). Vegetable Breeding: Principle and Practices. Kalyani Publishers. Ludhiana.

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember Understand	50 %	30 %	35 %	30 %
Level 2	Apply Analyze	30 %	40 %	35 %	40 %
Level 3	Evaluate Create	20 %	30 %	30 %	30 %
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Prakash M, Assistant breeder, TCI Research Private Limited, Bangalore, Karnataka	Dr. Vikram HC, Kerala Agricultural University, Thrissur, Kerala	Dr. Akoijam Ranjita Devi Mr. Harish A

THEORY

Unit I – Introduction

Breeding objectives and important concepts of breeding self-pollinated, cross pollinated and Vegetatively propagated crops. Plant genetic resources, their conservation and utilization in crop improvement. Breeding for insect resistance, breeding for disease resistance, breeding for abiotic resistance, male sterility and incompatibility and their utilization in development of hybrids. Genetic basis of adoptability and stability.

Unit II – Crop improvement in vegetable crops-I

Origin, distribution of species, wild relatives, floral biology, objectives, breeding methodology, biotechnological interventions, achievements and future thrusts of Tomato, Brinjal, Bhendi, Capsicum, Chilli, Cucurbits.

Unit III - Crop improvement in vegetable crops-II

Origin, distribution of species, wild relatives floral biology, objectives, breeding methodology, biotechnological interventions, achievements and future thrusts of Cabbage, Cauliflower, Carrot, Radish.

Unit IV – Crop improvement in tuber crops and other vegetables

Origin, distribution of species, wild relatives, floral biology, objectives, breeding methodology, biotechnological interventions, achievements and future thrusts of Tuber crops and Potato.

Unit V - Crop improvement in spices

Origin, distribution of species, wild relatives, floral biology, objectives, breeding methodology, biotechnological interventions, achievements and future thrusts of Black pepper, cardamom, ginger, turmeric, nutmeg, clove, coriander, cumin.

Theory – Lecture Schedule

1. Centres of origin – different centres of origin – origin of important vegetable, tuber and spice crops
2. Germplasm conservation-In situ and Ex situ germplasm-conservation, plant quarantine
3. Pollination – self and cross pollination – Mechanism of pollination in plants
4. Methods of pollination in vegetable, tuber, spice crops
5. Principles of breeding of cross pollinated crops – Hardy – Weinberg law – factors affecting equilibrium in population – systems of mating
6. Exploitation of Heterosis: Single cross, double cross, polycross
7. Scope and importance of Biotechnology in crop improvement – genetic engineering in plants - Bio-safety -Intellectual property issue
8. Molecular markers – Methods employed in crop improvement – Achievements and future prospects in breeding of vegetable, tuber and spice crops
9. Centre of origin – Ploidy level – objective and methods of breeding – Achievements of Tomato
10. Centre of origin – Ploidy level – objective and methods of breeding – Achievements of Brinjal
11. Centre of origin – Ploidy level – objective and methods of breeding – Achievements of Capsicum
12. Centre of origin – Ploidy level – objective and methods of breeding – Achievements of Chilli
13. Centre of origin – Ploidy level – objective and methods of breeding – Achievements of Okra
14. Centre of origin – Ploidy level – objective and methods of breeding – Achievements of Cucurbits-1
15. Centre of origin – Ploidy level – objective and methods of breeding – Achievements of Cucurbits-2
16. Centre of origin – Ploidy level – objective and methods of breeding – Achievements of Cabbage
17. In – Semester Examination
18. Centre of origin – Ploidy level – objective and methods of breeding – Achievements of Cauliflower
19. Centre of origin – Ploidy level – objective and methods of breeding – Achievements of Carrot
20. Centre of origin – Ploidy level – objective and methods of breeding – Achievements of Radish
21. Centre of origin – ploidy level – objectives and methods of breeding – Achievements of Onion
22. Centre of origin – ploidy level – objectives and methods of breeding – Achievements of Garlic
23. Centre of origin – ploidy level – objectives and methods of breeding – Achievements of Potato
24. Centre of origin – ploidy level – objectives and methods of breeding – Achievements of Tuber crops
25. Centre of origin – Ploidy level – objectives and methods of breeding – Achievements of Leafy vegetables-1
26. Centre of origin – Ploidy level – objectives and methods of breeding – Achievements of Leafy vegetables-2
27. Centre of origin – Ploidy level – objectives and methods of breeding – Achievements of Cowpea

28. Centre of origin – Ploidy level – objectives and methods of breeding – Achievements of French beans
29. Centre of origin – Ploidy level - objective and methods of breeding – Achievements of Black pepper
30. Centre of origin – Ploidy level - objective and methods of breeding – Achievements of Cardamom
31. Centre of origin – Ploidy level - objective and methods of breeding – Achievements of Ginger
32. Centre of origin – Ploidy level - objective and methods of breeding – Achievements of Turmeric
33. Centre of origin – Ploidy level - objective and methods of breeding – Achievements of Tree spices
34. Centre of origin – Ploidy level - objective and methods of breeding – Achievements of Seed spices

Practical– Schedule

1. Selfing, emasculation and hybridization techniques.
2. Breeding objectives, Floral biology, selfing, emasculation and crossing technique in Tomato
3. Breeding objectives, Floral biology, selfing, emasculation and crossing technique in Brinjal
4. Breeding objectives, Floral biology, selfing, emasculation and crossing technique in Bhendi
5. Breeding objectives, Floral biology, selfing, emasculation and crossing technique in Chilli
6. Breeding objectives, Floral biology, selfing, emasculation and crossing technique in Cucurbits
7. Breeding objectives, Floral biology, selfing, emasculation and crossing technique in Cucurbits
8. Breeding objectives, Floral biology, selfing, emasculation and crossing technique in Cucurbits
9. Breeding objectives, Floral biology, selfing, emasculation and crossing technique in Potato
10. Breeding objectives, Floral biology in Turmeric and Ginger
11. Breeding objectives, Floral biology, selfing, emasculation and crossing technique in Seed spices
12. Breeding objectives, Floral biology, selfing, emasculation and crossing technique in Tree spices
13. Preparation and uses of chemical and physical mutagens
14. Techniques of F1 hybrid seed production
15. Maintenance of breeding records
16. Working out phenotypic and genotypic variability, heritability, genetic advance, genotypic and phenotypic correlation coefficient, hybrid vigour

Text Books

1. Aswath, C., NirmalBabu, N., Senthil Kumar, R., Parthasarathy, V. A. (2017). Breeding of Horticultural Crops. Volume, Part A-B set [Spices and Plantation crops]. Today and Tomorrow Printers and Publishers. pp. 1-334
2. Kumar, N. (2018). Breeding of Horticultural Crops, Principles and Practices. New India Publishing Agency, New Delhi. pp. 1-220
3. Singh, B.D. (2009). Plant Breeding: Principles and methods. Kalyani Publishers, New Delhi. pp 1-889
4. Ramachandra, R. K, Maheshwari, D. L., Shobha, N., and Maruthi Prasad, P. N. (2016). Breeding of Spices & Plantation Crops. Narendra Publishing House.

Reference Books

1. Allard, R. W. (1999). Principles of Plant Breeding. John Wiley & Sons, Inc., New York. pp 1-131
2. HariHar Ram, (2013). Vegetable Breeding: Principle and Practices. Kalyani Publishers. Ludhiana.

Web References

1. http://www.ilvo.vlaanderen.be/EN/Research/ResearchAppliedGeneticsandBreeding_new/ProductQualityImprovement/Breedingofagriculturalandhorticulturalcrops/tabid/2314/Default.aspx
2. <http://www.agricultureinformation.com/forums/jobs-resumes-projects/7081vegetable-breeding-research-job-required.html>
3. <http://www.agron.iastate.edu/faculty/fehr/BVC/00BVC.PDF>

Journals

1. J. of cytogenetics
2. Economic botany
3. Acta Horticulture

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	HOR19504	Course Name	Principles of Landscape Architecture	Course Category	C	Compulsory Core	L	T	P	C
							1	0	1	2

Pre-requisite Courses	HOR19404	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Horticulture	Data Book / Codes/Standards			

Course Learning Rationale (CLR):		The purpose of learning this course is to:			Learning			Program Learning Outcomes (PLO)														
CLR-1 :	Paraphrase the gardening scenario				1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	Understand the Principles and elements of Landscaping				Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Horticulture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to become a entrepreneur in the field of Floriculture	Ability to create a garden style	Ability to apply software for designing a garden
CLR-3 :	Identify the plant and non plant components																					
CLR-4 :	Explain the design and software's for landscaping																					
CLR-5 :	Summarize the layout of different styles of Garden.																					
CLR-6 :	Describe bio-aesthetic planning and xeriscaping																					
Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:																				
CLO-1 :	Identify the different styles of garden				1	95	85	H								H	M		H	H	H	H
CLO-2 :	Describe the different types of garden tools				1	80	75	H								L	H		H	H	H	H
CLO-3 :	Describe the importance of plants in garden for landscape				1	75	65	M		L	L					L	H		H	H	H	H
CLO-4 :	Analyze the application of GIS in landscaping				2	75	65	M			L	L				M	H		H	H	H	H
CLO-5 :	Determine the different gardens for rural and public places				2	90	80	L	L							M	H		H	H	H	H
CLO6 :	Discuss the different styles of garden				3	95	90	L						H		M	H		H	H	H	H

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		3	3	3	3	4
S-1	SLO-1	Gardening scenario	Study of Hindu Garden	Principles of Landscape architecture	Steps in Preparation of Garden Design	Study of roadside planting
	SLO-2	History of Gardening	Study of Persian Garden	Principles of Landscape architecture	Steps in Preparation of Garden Design	Study of avenue planting
S-2,3	SLO-1	Lab1:Study of Garden equipments, Graphic Language and use of Drawing equipments.	Lab5:Study and designing of different styles of gardens and designing of gardens based on different themes.	Lab 8:Layout and designing of landscape gardens for corporate buildings and malls.	Lab 11:Designing Garden for Publics Places- Railway stations and airports	Lab 14:Lay out of Traffic islands.
	SLO-2					
S-4	SLO-1	Famous garden of India	Study of English Garden	Tangible elements	Application of softwares	Study of public garden
	SLO-2	Famous garden of abroad	Study of Japanese Garden	Intangible elements	Application of GIS	Study of rural garden
S-5,6	SLO-1	Lab2:Study of graphic symbols and notations in landscape designing.	Lab6:Layout and designing of gardens using Computer software's.	Lab 9:Study of indoor plants and Interiorscaping.	Lab 12:Designing Garden for religious places- Temples, Mosque and Churches.	Lab 15: Designing of English Garden, Mughal Garden and Japanese Garden
	SLO-2					
S-7	SLO-1	Styles of Garden	Xeriscaping- Definitions	Bio-aesthetic planning- Definition	Factors affecting landscape design	Gardens of religious places
	SLO-2	Themes of Garden	Xeriscaping- Principles	Bio-aesthetic planning-need	Factors affecting landscape design	Gardens of religious places
S-8,9	SLO-1	Lab3:Study of Plant components in Landscape designing.	Lab7:Layout and designing of gardens using GIS.	Lab10:Layout and designing garden for Institutions.	Lab 13:Avenue planting for state and National Highways.	Lab16:Visit to large-scale gardens /dam sites.
	SLO-2					
S-10	SLO-1					Study of Corporate landscaping
	SLO-2					Study of Interiorscaping
S-11	SLO-1	Lab 4:Study of Non Plant components in Landscape designing.				
	SLO-2					

Learning Resources	1. Prasad, S. and Kumar, U. (2013). <i>A hand book of Floriculture</i> . Jodhpur: Agrobios.(pp.1-654).
	2. Tiwari, A.K. (2012). <i>Fundamentals of Ornamental Horticulture and Landscape Gardening</i> . New Delhi: NIPA. (pp.1 – 588).

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember	40 %	30 %	35 %	30 %
	Understand				
Level 2	Apply	40 %	40 %	35 %	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	30 %	30 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Gorthi Nagarjuna Naidu General Manager (TANFLORA) naidugorthi@gmail.com	Dr. T. Arumugam Dean (Horticulture) HC & RI, Periyakulam	Mrs. C. Kanimozhi

THEORY

Unit I – Gardening scenario

Landscape gardening: Scope and importance; Historical Importance of Indian gardens, Gardens of ancient world, Definitions, Famous gardens of India and abroad, formal, informal, free style and wild gardens, basic themes of gardens viz. circular, rectangular and diagonal themes

Unit II- Importance and features of various garden

Importance, features and establishment of English garden, Japanese gardens, Mughal gardens, French and Persian garden, Italian gardens, Hindu gardens and Buddhist gardens. Xeriscaping, definition, principles and practice.

Unit III- Principle and elements of landscape gardening

Principles of Landscape gardens viz. Axis, rhythm, balance, time and light, space, texture, form, mass effect, focal point, mobility, emphasis, unity and harmony etc.. Elements of landscape gardens viz. tangible and intangible elements; Bio-aesthetic planning, definition, objectives

Unit IV- Application of software in landscaping

Steps in preparation of garden design; Use of Auto CAD and Arch CAD in designing gardens.; Factors affecting landscape design viz. initial approach, view, human choice, simplicity, topography etc.,

Unit V – Landscaping for different situations

Landscape architecture – design, planning and management of natural and built environments; Development of institutional gardens- planning and planting of avenues, -beautifying schools, railway lines, railway stations, factories, bus stands, air ports corporate buildings, dams, hydro electric stations, river banks, play grounds, Gardens for places of religious importance viz. temples, churches, mosques, tombs.

Theory - Lecture Schedule

1. History, development, scope and importance of landscape gardening.
2. Famous Gardens of India and abroad.
3. Study of themes and styles of garden.
4. Study of types of garden – Hindu garden, Persian garden and Moghul garden.
5. Study of types of garden – English garden, Japanese garden and Italian garden.
6. Xeriscaping, definition, principles and practice.
7. Definition and basic principles of landscape architecture.
8. Tangible and intangible elements in Landscape gardening
9. **In-semester examination**
10. Bio aesthetic planning – definition and need.
11. Steps in preparation of Garden Design.
12. Study of softwares in landscape designing.
13. Factors affecting landscape design.
14. Study of roadside and avenue planting.
15. Designing public, urban and industrial gardens.
16. Gardens for places of religious importance viz. temples, churches, mosques and tombs.
17. Designing of corporate landscape and Interiorscaping.

Practical - Schedule

1. Study of Garden equipments, Graphic Language and use of Drawing equipments.
2. Study of graphic symbols and notations in landscape designing.
3. Study of Plant components in Landscape designing.
4. Study of Non Plant components in Landscape designing.
5. Study and designing of different styles of gardens and designing of gardens based on different themes.
6. Layout and designing of gardens using Computer software's.

7. Layout and designing of gardens using GIS.
8. Layout and designing of landscape gardens for corporate buildings and malls.
9. Study of indoor plants and Interiorscaping.
10. Layout and designing garden for Institutions.
11. Designing Garden for Public Places- Railway stations and airports
12. Designing Garden for religious places- Temples, Mosque and Churches.
13. Avenue planting for state and National Highways.
14. Lay out of Traffic islands.
15. Designing of English Garden, Mughal Garden and Japanese Garden.
16. Visit to large-scale gardens /dam sites.
17. **University Practical Examination**

Text Books

1. Arora, J.S. (2006). Introductory Ornamental Horticulture. Ludhiana: Kalyani Publishers. (pp.1-188).
2. Auto CAD – 2010 Edition
3. Bhattacharjee, S.K. (2004). Landscape Gardening and Design with plants. Jaipur, Aavishkar Publishers and Distributors.
4. DharmendraKaulani and Arati Joshi. (2018). A textbook of Ornamental Horticulture. Nepal, Heritage Publishers.
5. Prasad, S. and Kumar, U. (2013). A hand book of Floriculture. Jodhpur: Agrobios.(pp.1-654).

Reference Books

1. Bhattacharjee, S.K. (2004). Landscape Gardening and Design with plants. Jaipur, Aavishkar Publishers and Distributors.
2. Grant, W. Reid Asia. (2002). Landscape Graphics. Colorado: Watson Guptil Publisher. (2nd ed. pp.1 – 208).
3. Suresh K Malhotra Lallan Ram . (2017). Advances in Floriculture and Landscape Gardening. Nagaland: Central Institute of Horticulture.(pp.1 - 322).
4. Thompson Ian, H. (2014). Landscape Architecture. Oxford University Press.(pp.1 -152).
5. Tiwari, A.K. (2012). Fundamentals of Ornamental Horticulture and Landscape Gardening. New Delhi: NIPA.(pp.1 – 588).

Web References

1. www.bestgarden.net
2. www.indiaagronet.com
3. www.intuxford.tripod.com
4. www.webct.uark.edu
5. www.personal.psu.edu
6. www.sunny.crk.umn.edu/courses
7. www.lawngrasses.com
8. www.mediatoday@vsnl.com
9. www.hsi1942.org

Journals

1. Journal of ornamental Horticulture.
2. Journal of Floriculture and Landscaping.
3. Indian Journal of Horticulture.
4. The American Journal of Horticulture and Floriculture Research.
5. International journal of Horticulture and Floriculture.

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	HOR19505	Course Name	Medicinal and Aromatic Crops	Course Category	C	Compulsory Core	L	T	P	C
							2	0	1	3

Pre-requisite Courses	HOR19101	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Horticulture	Data Book / Codes/Standards			

Course Learning Rationale (CLR):		The purpose of learning this course is to:			Learning			Program Learning Outcomes (PLO)														
CLR-1 :	Understand the scope and importance of medicinal and aromatic crops				1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	Discuss the production technology and importance of medicinal and aromatic crops				Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems through Horticultural techniques	Ability to implement knowledge gained in the applied field of production technology of MAP crops	Ability to understand social and ethical responsibilities of Production Technology of MAP Technology Plantation
CLR-3 :	Describe the nursery management and propagation techniques of medicinal and aromatic crops																					
CLR-4 :	Summarize the field management of medicinal and aromatic crops																					
CLR-5 :	Explain the post-harvest technology and processing of medicinal and aromatic crops																					
CLR-6 :	Identify the extraction methods and value addition of medicinal and aromatic crops																					
Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:			2	90	80	M	M	M	M	M	M	H	M	M	H	M	H	H	H	M
CLO-1 :	Outline the commercial production techniques of medicinal and aromatic crops that can be adopted to specific geographical region				2	90	80	H	M	M	M	M	H	H	H	H	H	H	H	H	H	M
CLO-2 :	Perform nursery management of various medicinal and aromatic crops				2	95	85	H	M	M	M	M	H	H	H	H	H	H	H	H	H	H
CLO-3 :	Perform propagation techniques of various medicinal and aromatic crops				2	90	80	H	H	M	M	M	H	M	H	H	H	H	H	H	H	M
CLO-4 :	Recognize the management of medicinal and aromatic crops for field adopting specific package of practices				2	85	75	M	M	M	M	M	M	M	M	M	H	M	H	H	H	M
CLO-5 :	Perform harvest and post-harvest technique of various medicinal and aromatic crops				2	80	80	M	M	M	M	M	M	M	M	M	H	M	H	H	H	M
CLO6 :	Identify a field for medicinal and aromatic crops and work out the benefit of cost ratio				2	85	75	M	M	M	M	M	M	M	M	M	H	M	H	H	H	M

Duration (hour)		Learning Unit / Module 1 2T+4P	Learning Unit / Module 2 8T+3P	Learning Unit / Module 3 9T+3P	Learning Unit / Module 4 2T+3P	Learning Unit / Module 5 12T+3P
S-1	SLO-1	History and background of MAP	Senna-introduction, propagation, nursery techniques	Medicinal solanum-introduction, propagation, nursery techniques	Importance aromatic plant wealth of India	Lemon grass -introduction, propagation, nursery techniques
	SLO-2	MAP wealth of India and Tamil Nadu	Senna-intercultural operation, harvest and post-harvest	Medicinal solanum-intercultural operation, harvest and post-harvest	Scope- aromatic plant wealth of India	Lemon grass -intercultural operation, harvest and post-harvest
S-2	SLO-1	Classification of MAP	Periwinkle-introduction, propagation, nursery techniques	Stevia-introduction, propagation, nursery techniques	Methods of distillation of essential oil	Citronella -introduction, propagation, nursery techniques
	SLO-2	GAP and GMP of MAP	Periwinkle-intercultural operation, harvest and post-harvest	Stevia-intercultural operation, harvest and post-harvest	Aromatherapy	Citronella -intercultural operation, harvest and post-harvest
S-3	PRACTICAL-1	Identification of major medicinal crops	Study of propagation techniques of medicinal coleus and aloe	Study of propagation techniques, growth regulators for rooting of long pepper	Study of species, propagation techniques of ocimum and davana	Distillation of essential oil from aromatic crops using Clevenger apparatus
S-4						
S-5	SLO-1		Glory lily-introduction, propagation, nursery techniques	Medicinal dioscorea--introduction, propagation, nursery techniques		Palmarosa --introduction, propagation, nursery techniques
	SLO-2		Glory lily-intercultural operation, harvest and post-harvest	Medicinal dioscorea -intercultural operation, harvest and post-harvest		Palmarosa -intercultural operation, harvest and post-harvest
S-6	SLO-1		Medicinal coleus-introduction, propagation, nursery techniques	Sarpagantha -introduction, propagation, nursery techniques		Vetiver -introduction, propagation, nursery techniques

Duration (hour)	Learning Unit / Module 1		Learning Unit / Module 2		Learning Unit / Module 3		Learning Unit / Module 4		Learning Unit / Module 5	
	2T+4P		8T+3P		9T+3P		2T+3P		12T+3P	
	SLO-2		Medicinal coleus-intercultural operation, harvest and post-harvest		Sarpagantha-intercultural operation, harvest and post-harvest				Vetiver -intercultural operation, harvest and post-harvest	
S-7	PRACTICAL-2	Identification of major aromatic crops	Study of varieties, propagation techniques of ashwagandha		Study of seed treatment techniques for enhancing germination of noni		Study of species, propagation techniques of Mint and Rosemary		Working out the benefit cost ratio for Medicinal crops	
S-8										
S-9	SLO-1		Aswagandha-introduction, propagation, nursery techniques		Phyllanthusamaraus -introduction, propagation, nursery techniques				Mint- Introduction, nursery management	
	SLO-2		Aswagandha-intercultural operation, harvest and post-harvest		Phyllanthusamaraus -intercultural operation, harvest and post-harvest				Mint- Planting method	
S-10	SLO-1		Aloe-introduction, propagation, nursery techniques		Acorus-introduction, propagation, nursery techniques				Mint-Intercultural operation	
	SLO-2		Aloe-intercultural operation, harvest and post-harvest		Acorus-intercultural operation, harvest and post-harvest				Mint- harvest and post harvest	
S-11	PRACTICAL-3	Study of varieties, propagation techniques of Senna and Periwinkle	Study of varieties, propagation techniques of centella		Study of species, propagation techniques of Lemon grass, Citronella and Palmarosa		Extraction of medicinal products using Soxhlet apparatus		Visit to commercial medicinal and aromatic plantation	
S-12										
S-13	SLO-1		Isabgol-introduction, propagation, nursery techniques		Centella-introduction, propagation, nursery techniques				Geranium-introduction, propagation, nursery techniques	
	SLO-2		Isabgol-intercultural operation, harvest and post-harvest		Centella-intercultural operation, harvest and post-harvest				Geranium-intercultural operation, harvest and post-harvest	
S-14	SLO-1		Opium poppy-introduction, propagation, nursery techniques		Noni-introduction, propagation, nursery techniques				Ocimum-introduction, propagation, nursery techniques	
	SLO-2		Senna-intercultural operation, harvest and post-harvest		Noni-intercultural operation, harvest and post-harvest				Ocimum-intercultural operation, harvest and post-harvest	
S-15	PRACTICAL-4	Study on propagation, pollination in glory lily								
S-16										
S-17	SLO-1				Long pepper-introduction, propagation, nursery techniques				Rosemary-introduction, propagation, nursery techniques	
	SLO-2				Long pepper-intercultural operation, harvest and post-harvest				Rosemary-intercultural operation, harvest and post-harvest	
S-18	SLO-1								Thyme-introduction, propagation, nursery techniques	
	SLO-2								Thyme-intercultural operation, harvest and post-harvest	
S-19	SLO-1								Artemisia-introduction, propagation, nursery techniques	
	SLO-2								Artemisia-intercultural operation, harvest and post-harvest	
S-20	SLO-1								Patchouli-introduction, propagation, nursery techniques	
	SLO-2								Patchouli-intercultural operation, harvest and post-harvest	

Learning Resources	1. Farooqi, M.M., Khan and Vasundhara, m. (2004). <i>Production technology of medicinal and aromatic crops</i> . Publ. Natural Remedies Pvt. Ltd. pp. 176
	2. Kumar, N, Md. Abdul Khader, Rangasamy, P. and Irulappan, I. (2017). <i>Spices, Plantation Crops, Medicinal and Aromatic plants</i> , Rajalakshmi Publications. pp. 313

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In semester (20%)	Practical (15%)		
Level 1	Remember	50 %	30 %	35 %	30 %
	Understand				
Level 2	Apply	30 %	40 %	35 %	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	30 %	30 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr.Subbiah, Retired professor TNAU, Consultant of Spices, Plantation, Medicinal and Aromatic crops, Theni, Tamil Nadu	Dr. N. Mini Raj, Professor, Department of Plantation crops & Spices, Kerala Agricultural University, Thrissur, Kerala	Dr. Akojam Ranjita Devi

THEORY

Unit I - Introduction to medicinal crops and aromatic crops

History - Scope and importance – global and national scenario - area and production - imports and exports - conservation strategies - classification of MAPs - GAP, GMP guidelines - contract farming - institutions for promotion of MAPs- constraints and challenges.

Unit II - Medicinal crops

Importance, origin, distribution, area, production, climatic and soil requirements, propagation and nursery techniques, planting and after care, cultural practices, training and pruning, nutritional and water requirements. Plant protection, harvesting and processing of under mentioned important medicinal and aromatic plants. Study of chemical composition of a few important medicinal and aromatic plants, extraction, use and economics of drugs and essential oils in medicinal and aromatic plants. Therapeutic and pharmaceutical uses of important species. Storage techniques of essential oils of Senna, Periwinkle, Glory lily, Medicinal Coleus, Ashwagandha, Aloe, Isabgol and Opium poppy.

Unit III - Medicinal crops

Importance, origin, distribution, area, production, climatic and soil requirements, propagation and nursery techniques, planting and after care, cultural practices, training and pruning, nutritional and water requirements. Plant protection, harvesting and processing of under mentioned important medicinal and aromatic plants. Study of chemical composition of a few important medicinal and aromatic plants, extraction, use and economics of drugs and essential oils in medicinal and aromatic plants. Therapeutic and pharmaceutical uses of important species. Storage techniques of essential oils of Medicinal solanum, Stevia, Medicinal dioscorea, Sarpagantha, Phyllanthusamarus, Acorus, Centella, and Noni, Long pepper.

Unit IV - Importance and scope of aromatic crops

Importance and scope- aromatic plant wealth of India- area and production - exports and imports of essential oil – Demand of aromatic crops in perfumery and cosmetic industries - International standards for perfumes – Classification of essential oils-Methods of distillation of essential oil – Fractional distillation-Aromatherapy.

Unit V - Aromatic crops

Importance, origin, distribution, area, production, climatic and soil requirements, propagation and nursery techniques, planting and after care, cultural practices, training and pruning, nutritional and water requirements. Plant protection, harvesting and processing of under mentioned important medicinal and aromatic plants. Study of chemical composition of a few important medicinal and aromatic plants, extraction, use and economics of drugs and essential oils in medicinal and aromatic plants. Therapeutic and pharmaceutical uses of important species. Storage techniques of essential oils of Lemon grass, Citronella, Palmarosa, Vetiver, Ocimum, Mint, Geranium, Rosemary, Thyme, Artemisia and Patchouli.

Theory – Lecture Schedule

1. History and background – scope and importance – uses and demands of phyto chemicals and AYUSH – Medicinal and aromatic plants wealth of India and Tamil Nadu – Area and production – Export and imports.
2. Conservation strategies – exsitu and insitu– Classification – based on family, habit, climate, soil and ecological factors – Organized production – GAP, GMP guide lines and contract farming – constraints and challenges in production and maintenance – Institutions for promotion of medicinal and aromatic crops.
3. Senna - Soil and climate – varieties – propagation – nursery practices – planting methods – nutrient management- irrigation and intercropping – plant protection – harvest and yield.
4. Periwinkle - Soil and climate – varieties – propagation – nursery practices – planting methods – nutrient management- irrigation and intercropping – plant protection – harvest and yield.
5. Glory lily - Soil and climate – varieties – propagation – nursery practices – planting methods – manuring, irrigation and intercropping – plant protection – harvest and yield.
6. Medicinal coleus-soil and climate-varieties-propagation-nursery practices-planting method-manuring-irrigation and intercropping-plant protection-harvest and yield
7. Aswagandha - Soil and climate – varieties – propagation – nursery practices – planting methods – manuring, irrigation and intercropping – plant protection – harvest and yield.
8. Aloe - Soil and climate – varieties – propagation – nursery practices – planting methods – manuring, irrigation and intercropping – plant protection – harvest and yield.
9. Isabgol - Soil and climate –varieties – propagation – nursery practices – planting methods – manuring, irrigation and intercropping – plant protection – harvest and yield.
10. Opium poppy - Soil and climate –varieties – propagation – nursery practices – planting methods – manuring, irrigation and intercropping – plant protection – harvest and yield.
11. Medicinal Dioscorea- Soil and climate –varieties – propagation – nursery practices – planting methods – manuring, irrigation and intercropping – plant protection – harvest and yield.
12. Medicinal solanum - Soil and climate –varieties – propagation – nursery practices – planting methods – manuring, irrigation and intercropping – plant protection – harvest and yield.
13. Sarpagantha- Soil and climate –varieties – propagation – nursery practices – planting methods– manuring, irrigation and intercropping – plant protection – harvest and yield.
14. Stevia- Soil and climate –varieties – propagation – nursery practices – planting methods– manuring, irrigation and intercropping – plant protection – harvest and yield.
15. Long pepper - Soil and climate –varieties – propagation – nursery practices – planting methods– manuring, irrigation and intercropping – plant protection – harvest and yield.
16. Phyllanthusamarus - Soil and climate –varieties – propagation – nursery practices – planting methods– manuring, irrigation and intercropping – plant protection – harvest and yield.
17. **In-Semester Examination**
18. Acorus - Soil and climate –varieties – propagation – nursery practices – planting methods – manuring, irrigation and intercropping – plant protection – harvest and yield.

19. Noni - Soil and climate –varieties – propagation – nursery practices – planting methods – manuring, irrigation and intercropping – plant protection – harvest and yield.
20. Centella - Soil and climate –varieties – propagation – nursery practices – planting methods – manuring, irrigation and intercropping – plant protection – harvest and yield.
21. Importance and scope- aromatic plant wealth of India
22. Classification of essential oils-Methods of distillation of essential oil – Fractional distillation-Aromatherapy.
23. Lemon grass- Soil and climate –varieties – propagation – nursery practices – planting methods– manuring, irrigation and intercropping – plant protection – harvest and yield.
24. Citronella - Soil and climate –varieties – propagation – nursery practices – planting methods– manuring, irrigation and intercropping – plant protection – harvest and yield.
25. Palmarosa - Soil and climate –varieties – propagation – nursery practices – planting methods– manuring, irrigation and intercropping – plant protection – harvest and yield.
26. Vetiver - Soil and climate –varieties – propagation – nursery practices – planting methods– manuring, irrigation and intercropping – plant protection – harvest and yield.
27. Mint - Soil and climate –varieties – propagation – nursery practices – planting methods
28. Mint - Manuring, irrigation and intercropping – plant protection – harvest and yield.
29. Geranium - Soil and climate –varieties – propagation – nursery practices – planting methods – manuring, irrigation and intercropping – plant protection – harvest and yield.
30. Ocimum- Soil and climate –varieties – propagation – nursery practices – planting methods – manuring, irrigation and intercropping – plant protection – harvest and yield.
31. Rosemary - Soil and climate –varieties – propagation – nursery practices – planting methods – manuring, irrigation and intercropping – plant protection – harvest and yield.
32. Thyme - Soil and climate –varieties – propagation – nursery practices – planting methods – manuring, irrigation and intercropping – plant protection – harvest and yield.
33. Artemisia- Soil and climate –varieties – propagation – nursery practices – planting methods – manuring, irrigation and intercropping – plant protection – harvest and yield.
34. Patchouli - Soil and climate –varieties – propagation – nursery practices – planting methods – manuring, irrigation and intercropping – plant protection – harvest and yield.

Practical– Schedule

1. Identification of major medicinal crops – parts used and their products
2. Identification of major aromatic crops- essential oil content
3. Study of varieties, propagation techniques of Senna and Periwinkle
4. Study on propagation, pollination in glory lily
5. Study of propagation techniques of medicinal coleus and aloe
6. Study of varieties, propagation techniques of ashwagandha
7. Study of varieties, propagation techniques of centella
8. Study of propagation techniques, growth regulators for rooting of long pepper.
9. Study of seed treatment techniques for enhancing germination of noni
10. Study of species, propagation techniques of Lemon grass, Citronella and Palmarosa
11. Study of species, propagation techniques of ocimum and davana
12. Study of species, propagation techniques of Mint and Rosemary
13. Extraction of medicinal products using Soxhlet apparatus
14. Distillation of essential oil from aromatic crops using Clevenger apparatus
15. Working out the benefit cost ratio for Medicinal crops
16. Visit to commercial medicinal and aromatic plantation
17. **University Practical Examination**

Text Books

1. AkosMáthé. (2015). Medicinal and Aromatic Plants of the World. Springer Netherlands. pp.1- 450
2. Atal, C. K. and Kapur, B. M. (1992). Cultivation and utilization of medicinal plants RRL. CSIR, Jammu Tawi, pp1-778
3. Baby P. S. (2007). Aromatic plants. New India Publishing. pp 1-290
4. Chadha, K.L. (1994). Advances in Horticulture, Vol.10.Melhotra Publishing house, New Delhi. pp1-941
5. Farooqi, M.M., Khan and M. Vasundhara. (2004). Production technology of medicinal and aromatic crops. Publ. Natural Remedies Pvt. Ltd., Bangalore. pp. 1- 176
6. Ravindra, S. (2004). Agrotechniques of medicinal plants. Daya pub. House. N. Dehi, pp. 1-275

Reference Books

1. Abdul Kareem, M. (2002). Plants in Ayurveda, FRLHT, Bangalore, Business Press, New Delhi. pp.1-243
2. Bose, T. K., Yadav, L.P., Pal. P., Das. P. and Parthasarathy, V.A. (2002). Commercial Flowers. Vol.1, Naya Prakash, Calcutta. pp. 1-653
3. Kumar, N. Md. Abdul Khader, J. B.M., Rangasamy, P. and Irulappan, I. (1998). Introduction to Spices, Plantation crops, Medicinal and Aromatic Plants. Oxford IBH Publishers, New Delhi. pp.1- 313

Web References

1. https://ecourses.icar.gov.in/e-Leaarningdownload3_new.aspx?Degree_Id=07
2. <https://www.cimap.res.in/english/index.php/plant-varieties>
3. <https://www.nmpb.nic.in/>
4. <https://nmpb.nic.in/states/tamil-nadu>

Journals

1. Indian J. Arecanut, Spices and Medicinal Plants
2. Journal of Spices and Aromatic Crops.

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	HOR19506	Course Name	Fundamentals of Food Technology	Course Category	C	Compulsory Core	L	T	P	C
							1	0	1	2

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Horticulture	Data Book / Codes/Standards			

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning			Program Learning Outcomes (PLO)														
CLR-1 :	Understand the basic knowledge of food technology	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	Describe the importance food components	Thinking (Bloom)	Proficiency (%)	Attainment (%)	Knowledge	Analysis	Development	Design, Research	Usage	Culture	Sustainability		Team Work	Communication	Finance	Learning	scientific high food	Implementation in the food	Understand social responsibilities of food technology
CLR-3 :	Recognize the nutrition in human health																		
CLR-4 :	Explain the techniques of food analysis																		
CLR-5 :	Summarize the importance of therapeutic diet																		
CLR-6 :	Outline the formulation of diet for various age group																		

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLO-1 :	Outline the food in human health	3	90	80	H								M	H		H	H	H	H
CLO-2 :	Discuss the food digestion and absorption	2	95	85	H		M	H					L	H		H	H	H	H
CLO-3 :	Recall the concept of food nutrition	2	80	70	H		L	L					L	H		H	H	H	H
CLO-4 :	Describe the nutritional disorders	3	75	65	L			L	L				M	H		H	H	H	H
CLO-5 :	Determine the energy metabolism	3	75	60	L	L					L		M	H		H	H	H	H
CLO6 :	Identify the equipments and machineries used in the fruit and vegetable processing unit	2	90	80	M	M			H				M	H		H	H	H	H

Duration (hour)	Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
	2	5	3	3	3
S-1	SLO-1 Scope of Food science	Classification, function, digestion and absorption of carbohydrate	Mineral nutrition	Nutrition to human health	Food packaging materials
	SLO-2 Classification of food group		Functions and utilization	Malnutrition	Labeling
S-2	SLO-1 Methods of cooking	Classification, function, digestion and absorption of protein	Fat soluble vitamins	Energy relation to health	Food adulteration
	SLO-2 Merits and demerits		Functions and sources	Total energy requirements	Detection method
S-3	SLO-1 -	Classification, function, digestion and absorption of fat	Water soluble vitamins	Balanced diet	Food laws
	SLO-2 -		Coenzyme derivatives	Diet for various age group	HACCP principle
S-3	SLO-1 -	Classification, function, digestion and absorption of fibre	-	-	-
	SLO-2 -		-	-	-
S-3	SLO-1 -	Nutraceutical and therapeutic properties	-	-	-
	SLO-2 -		-	-	-

Learning Resources	1. Devendra, K. B and Priyanka, T. 2006. An Introduction to Food Science and Technology and Quality Management. Kalyani publishers.
	2. Srivastava, R.P and Sanjeev Kumar. 2002. Fruit and vegetable Preservation: Principles and Practices. International Book Distribution Company.

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember Understand	40 %	30 %	35 %	30 %
Level 2	Apply Analyze	40 %	40 %	35 %	40 %
Level 3	Evaluate Create	20 %	30 %	30 %	30 %
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Elangovan, Avvai Foods Enterprise, No.92, Puliyankudi, Kokkeri vai, Papanasam Taluk, Ammapet, Thanjavur - 614402	Dr. Kanchana S, Professor and Head, Department of Human development and Family studies, Community Science College and Research Institute, TNAU, Madurai- 625104	Dr. P. Sheela, Assistant Professor (Food Science and Nutrition)

THEORY

Unit I - Concept of food technology

Food science – definition need scope of food science. Classification of food group. Physic-chemical properties of foods. Methods of cooking – moist heat, dry heat, microwave and combination methods of cooking – merits and demerits.

Unit II - Food components

Classification, functions, digestion and absorption of carbohydrate, protein, fat and fibre. Nutraceutical and therapeutic properties of food.

Unit III - Minerals and vitamins

Mineral nutrition – macro and micro minerals – function, utilization, requirements, sources, effects of deficiency. Vitamins – definition, classification, functions, sources, metabolic functions and deficiency disorder. Co enzyme derivatives of vitamins.

Unit IV - Food nutrition

Nutrition – definition, relation of nutrition to health. Over and under nutrition. Characteristic of well and malnourished population. Energy – definition, determination of gross energy, value of foods, total energy requirement of the body. Balanced diet – definition, recommended nutrient and dietary allowances for various age groups

Unit IV – Food quality control

Food packaging materials – requirements, methods – labelling. Food adulterations and their detection method. Food laws and regulations at national and international standards (FSSAI, ISO, EU and FDA), GHP, GMP and HACCP principle.

Theory - Lecture Schedule

1. Food science – definition need scope of food science. Classification of food group. Physico-chemical properties of foods
2. Methods of cooking – moist heat, dry heat, microwave and combination methods of cooking – merits and demerits.
3. Classification, functions, digestion and absorption of carbohydrate
4. Classification, functions, digestion and absorption of protein
5. Classification, functions, digestion and absorption of fat
6. Classification, functions, digestion and absorption of fibre
7. Nutraceutical and therapeutic properties of foods
8. Mineral nutrition – macro and micro minerals – function, utilization, requirements, sources, effects of deficiency.
9. **In – Semester Examination**
10. Water soluble vitamins – definition, classification, functions, sources, metabolic functions and deficiency disorder.
11. Fat soluble vitamins – definition, classification, functions, sources, metabolic functions and deficiency disorder and Co enzyme derivatives of vitamins.
12. Nutrition – definition, relation of nutrition to health. Over and under nutrition. Characteristic of well and malnourished population.
13. Energy – definition, determination of gross energy, value of foods, total energy requirement of the body.
14. Balanced diet – definition, recommended nutrient and dietary allowances for various age group
15. Food packaging materials – requirements, methods – labelling
16. Food adulterations and their detection method.
17. Food laws and regulations at national and international standards (FSSAI, ISO, EU and FDA, GHP, GMP and HACCP principle.

Practical– Schedule

1. Identification of equipments and machineries used in fruits and vegetable processing industry
2. Perishable and non perishable foods – demonstration of degree of spoilage
3. Experimental methods for prevention of browning in fruits
4. Experimental methods for prevention of browning in vegetables
5. Cooking quality test for cereals and pulses
6. Effect of cooking on volume and weight
7. Determination of percentage of edible portion

8. Estimation of moisture
9. Estimation of protein
10. Estimation of fat
11. Estimation of crude fibre
12. Estimation of reducing and total sugar
13. Estimation of ascorbic acid
14. Estimation of pH, acidity and TSS
15. Planning diet for various age group
16. Visit to fruit and vegetable processing unit
17. **University Practical Examination**

Text Books

1. Giridharilal, Sidappa.G.S and Tandon.G..L. (1979). Preservation of fruits and vegetables. ICAR. New Delhi.
2. ShaifurRehman. M. (2007). Handbook of food preservation. (2nd Edition). CRC, Press. London
3. Srilakshmi .B. (2015). Nutrition Science. New Age International Pvt. Ltd. New Delhi, PP: 1-508.
4. Srilakshmi, B. (2005). Food Science. New Age International (P) Ltd., Publishers, New Delhi.
5. Srivastava, R.P and Sanjeev Kumar. (2002). Fruit and vegetable Preservation: Principles and Practices. International Book Distribution Company.
6. Srivastava, R.P., and Sanjeevkumar. S. (2013). Fruit and Vegetable preservation. International Book Distributing Co. Lucknow.

Reference Books

1. Singh N P. (2007). Fruits and vegetable preservation. Oxford Book publisher, Jaipur, India
2. Srilakshmi, B. (2005). Dietetics. New age International Pvt. Ltd. New Delhi.
3. Srilakshmi. (2018). Food Science. (7th Edition), New age international publisher, New Delhi

Web-References

1. www.foodnetbase.com
2. www.cellinteractive.com
3. www.fnrc.nal.usda.gov
4. www.myfooddiary.com
5. www.nutrition.org.uk

Journals

1. Advances in Nutrition
2. Annual Reviews of Food Science and Technology
3. Comprehensive reviews in Food Science and Food Safety
4. Food Research International
5. Nutrients
6. Trends in Foods Science and Technology

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	CRH19503	Course Name	Insect Pests of Fruit, Plantation, Medicinal and Aromatic Crops	Course Category	S	Supportive Course	L	T	P	C
							2	0	1	3

Pre-requisite Courses	<i>Fundamentals of Entomology</i>	Co-requisite Courses	<i>Nil</i>	Progressive Courses	<i>Nil</i>
Course Offering Department	<i>Crop Protection</i>	Data Book / Codes/Standards			<i>Nil</i>

Course Learning Rationale (CLR):		The purpose of learning this course is to:			Learning			Program Learning Outcomes (PLO)																	
					1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
CLR-1 :	Outline of insect ecology, pests category and cause of pest outbreak				Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems through Horticultural Entomology	Ability to implement knowledge gained in the applied field of Horticultural Entomology	Ability to understand social and ethical responsibilities of Horticultural Entomology			
CLR-2 :	Describe the economic threshold level (ETL) and economic injury level (EIL), IPM components							M									M	H	H	H	H	H	H		
CLR-3 :	Discuss on cultural, physical, mechanical, legal methods biological and chemical methods of pest control							H									H	H	H	H	H	H	H		
CLR-4 :	Identify the pests of fruit crops, plantation and aromatic crops and their management							M			L						M	H	H	H	H	H	H	H	
CLR-5 :	Obtain basic information on major medicinal crop pest and their management							L	L		L						L	L	H	H	H	H	H	H	H
CLR-6 :	Interpret the pest control measures							L								H		M	H	H	H	H	H	H	H
Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:																							
CLO-1 :	Recall the skills on management of fruit crops				3	90	80	M								M	H	H	H	H	H	H			
CLO-2 :	Summarize the biorational pest management				2	95	85	H								L	H	H	H	H	H	H			
CLO-3 :	Understand the biotechnological pest management methods				1	75	70	M			L					M	H	H	H	H	H	H			
CLO-4 :	Identify the pests fruit crops, plantation and aromatic crops and their management				3	80	65	M		L		L				L	H	H	H	H	H	H			
CLO-5 :	Describe the techniques of major medicinal crop pest and their management				2	75	60	L	L		L					M	H	H	H	H	H	H			
CLO6 :	Explain the Insecticide residue problem in fruits, plantations, medicinal and aromatic crops and their tolerance limits.				2	75	65	L						H		M	H	H	H	H	H	H			

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		5	13	8	31	7
S-1	SLO-1	<i>Insect Ecology- Effect of abiotic and biotic factors on insect population. Pest – definition, categories of pests, factors governing pest outbreaks.</i>	<i>IPM -Cultural, physical, mechanical and legal methods of pest control</i>	<i>Lab: 5 Pests of pomegranate</i>	<i>Lab: 7 Pests of apple, pear, peach and plum</i>	<i>Storage insects, distribution, host range, bioecology, injury, integrated management of important insect pests attacking stored fruits, plantation, medicinal and aromatic crops and their processed products.</i>
	SLO-2	<i>Concept of economic threshold level- pest of mango, citrus, sapota and banana, coconut coffee and cashewnut and economic injury level.</i>	<i>Lab: 2 Pests of citrus</i>	<i>Distribution, bionomics, symptoms of damage and management strategies of insect and non insect pests of Mango, Sapota, Guava.</i>	<i>Pests of Apple, Pear, Peach and Plum-</i>	<i>Lab: 15 Pests of neem and eucalyptus</i>
S-2	SLO-1	<i>Lab:1 Pests of mango</i>	<i>Biological control–parasitoids, predators, viruses, bacteria, fungi and nematodes and their role in insect management.</i>	<i>Pests of Citrus</i>	<i>Pests of coconut, arecanut and oil palm</i>	<i>Insecticide residue problem in fruits, plantations, medicinal and aromatic crops and their</i>
	SLO-2	<i>Principles and components of pest management.</i>	<i>Host plant resistance – Types and mechanisms of resistance</i>	<i>Lab: 6 Pests of anola, ber, pineapple and papaya</i>	<i>Lab: 8 Pests of coconut, arecanut and oil palm</i>	<i>Pesticide residue tolerance limits in fruits, plantation , medicinal and aromatic crops Lab:16 Pests of dry fruits, nuts and other horticultural products</i>

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		5	13	8	31	7
S-3	SLO-1		Lab: 3 Pests of guava and sapota	Pests of Citrus Banana, Grapevine, Jack, Jamun and Aonla,	pests of coffee and cinchona,	
	SLO-2		Chemical control – Classification of pesticides, role of insecticides in pest management.	Pests of Pomegranate, Papaya, Ber and Pineapple	Pests of tea,	
S-4	SLO-1	-	Biorational pest management - Semiochemicals – pheromones, allomones, kairomones and synomones - role of pheromones in pest management.		Lab: 9 Pest of coffee and tea	-
	SLO-2	-	Lab: 4 Pests of banana, grapevine and jamun		Pests of cashew	-
S-5	SLO-1		Insect growth regulators – moult inhibitors, JH mimics, insect antifeedants, repellants and botanicals in pest management.		Pests of rubber	
	SLO-2		Biotechnology in pest management		Lab: 10 Pests of cashew, rubber and cocoa	
S-6					Pests of cocoa,	
					Pests of cardamom,	
S-7					Lab: 11 Pests of aswagantha and senna	
					Pests of pepper,	
S-8					Pests of betelvine,	
					Lab:12 Pests of cardamom, pepper and betelvine	
S-9					pests of aswagantha, senna,	
					Pests of hemp, belladonna,	
S-10					Lab: 13 Pests of pyrethrum and camphor	
					Pests of pyrethrum, camphor, costus and crotonaria,	
S-11					Pests of datura, dioscorea, mint, and opium	
					Lab:14 Pests of mint and opium	
S-12					Pests of Solanum viarum, Tephrosia, neem, teak, subabul, eucalyptus	

Learning Resources	1. David, B.V. and Ramamurthy, V.V.(2011). Elements of Economic Entomology, Namrutha Publications, Chennai.pp1- 386.
	2. Manisegaran, S. and Soundararajan,R.P. (2010).Pest Management in Field Crops-Principles and Practices. Agrobios, Jodhpur, India. pp1-316.

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember Understand	40 %	40 %	35 %	30 %
Level 2	Apply Analyze	40 %	40 %	30 %	40 %
Level 3	Evaluate Create	20 %	20 %	35 %	30 %
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. K. Ramesh Ph.D Principal Biologist –Rice Insecticide and Nematicide, South Asia Co-chair for insecticide resistance action committee(IRAC), India Corteva Agrisciences (Dow Dupont) Madhapur, Hyderabad, India e- mail :ramesh.kaliaperumal@corteva.com mobile : 9952885708	Dr. M. Kandibane , Associate professor, Department of Agricultural Entomology, PAJANCOA&RI, Karaikal-609603	Dr. L. Ramazeame Ph.D (Assistant Professor) Agricultural Entomology

THEORY

Unit I: Insect ecology and components of pest management

Insect Ecology- Effect of abiotic and biotic factors on insect population. Pest – definition, categories of pests, factors governing pest outbreaks. Concept of economic threshold level and economic injury level. Principles and components of pest management

Unit II: Methods of pest control

Cultural, physical, mechanical and legal methods of pest control. Biological control–parasitoids, predators, viruses, bacteria, fungi and nematodes and their role in insect management. Host plant resistance – Types and mechanisms of resistance. Chemical control – Classification of pesticides, role of insecticides in pest management. Biorational pest management - Semiochemicals – pheromones, allomones, kairomones and synomones - role of pheromones in pest management. Insect growth regulators – moult inhibitors, JH mimics, insect antifeedants, repellants and botanicals in pest management. Biotechnology in pest management.

Unit III: Pests of fruits

Distribution, bionomics, symptoms of damage and management strategies of insect and non insect pests of Mango, Guava, Sapota, Citrus, Banana, Grapevine, Jack, Jamun, Aonla, Pomegranate, Papaya, Ber, Apple, Pear, Peach and Plum, Pineapple.

Unit IV: Pests of plantation crops, medicinal and aromatic plants

Distribution, bionomics, symptoms of damage and management strategies of insect and non insect pests of coconut, arecanut, oilpalm, cinchona, coffee, tea, cashew, rubber, cocoa, cardamom, pepper, betelvine, aswagantha, senna, hemp, belladonna, pyrethrum, camphor, costus, crotolaria, datura, dioscorea, mint, opium, *Solanum viarum*, Tephrosia, neem, teak, subabul, eucalyptus.

Unit V: Stored product pests

Storage insects, distribution, host range, bioecology, injury, integrated management of important insect pests attacking stored fruits, plantation, medicinal and aromatic crops and their processed products. Insecticide residue problem in fruits, plantations, medicinal and aromatic crops and their tolerance limits.

Assignment

1. Collection and submission of 50 pests of fruits and plantation and aromatic crops.
2. Rearing a minimum of 20 insect pests and preparation of two riker mounts

Theory - Lecture Schedule

1. Insect Ecology- Effect of abiotic and biotic factors on insect population. Pest – definition, categories of pests, factors governing pest outbreaks.
2. Concept of economic threshold level and economic injury level.
3. Principles and components of pest management.
4. IPM -Cultural, physical, mechanical and legal methods of pest control.
5. Biological control–parasitoids, predators, viruses, bacteria, fungi and nematodes and their role in insect management.
6. Host plant resistance – Types and mechanisms of resistance
7. Chemical control – Classification of pesticides, role of insecticides in pest management.
8. Biorational pest management - Semiochemicals – pheromones, allomones, kairomones and synomones - role of pheromones in pest management.
9. Insect growth regulators – moult inhibitors, JH mimics, insect antifeedants, repellants and botanicals in pest management.
10. Biotechnology in pest management.
11. Distribution, bionomics, symptoms of damage and management strategies of insect and non insect pests of Mango, Sapota, Guava
12. Pests of Citrus
13. Pests of Banana, Grapevine, Jack, Jamun and Aonla
14. Pests of Pomegranate, Papaya, Ber and Pineapple
15. Pests of Apple, Pear, Peach and Plum
16. Pests of Coconut, Arecanut, Oilpalm
17. **In- semester examination**
18. Pests of Coffee and Cinchona

19. Pests of Tea
20. Pests of Cashew
21. Pests of Rubber
22. Pests of Cocoa
23. Pests of Cardamom
24. Pests of Pepper
25. Pests of Betelvine
26. Pests of Aswagantha and senna
27. Pests of Hemp and Belladonna
28. Pests of Pyrethrum, Camphor, Costus and Croton
29. Pests of Datura, Dioscorea, Mint and Opium
30. Pests of Solanum *varium* and Tephrosia
31. Pests of Neem, Teak, Subabul and Eucalyptus.
32. Storage insects, distribution, host range, bioecology, injury, integrated management of important insect pests attacking stored fruits, plantation, medicinal and aromatic crops and their processed products.
33. Insecticide residue problem in fruits, plantations, medicinal and aromatic crops
34. Insecticide residue tolerance limits in fruits, plantations, medicinal and aromatic crops

Practical Schedule

1. Pests of mango
2. Pests of citrus
3. Pests of guava and sapota
4. Pests of banana, grapevine and jamun
5. Pests of pomegranate
6. Pests of anola, ber, pineapple and papaya
7. Pests of apple, pear, peach and plum
8. Pests of coconut, arecanut and oil palm
9. Pest of coffee and tea
10. Pests of cashew, rubber and cocoa
11. Pests of aswagantha and senna
12. Pests of cardamom, pepper and betelvine
13. Pests of pyrethrum and camphor
14. Pests of mint and opium
15. Pests of neem and eucalyptus
16. Pests of dry fruits, nuts and other horticultural products
17. **University Practical Examination**

Text Books

1. Ayyar, T.V.R. (1963). Hand Book of Economics Entomology for South India. Govt. Press Madras.pp1-516.
2. David, B.V. (2006). Elements of Economic Entomology. Popular Book Depot, Chennai.pp1-562.
3. Butani, D.K. (2009). Insects and Fruits. Periodical Expert Book Agency, New Delhi.pp1-415.
4. Butani, D.K. and Jotwani, M.G. (1984). Insects of Vegetables. Periodical Expert Book Agency, New Delhi. pp1-365.
5. Srivastava, K.P. and D.K.Butani, (1998). Pest Management in Vegetables (Part I & II) Research Periodicals and Book Publishing House, India. Pp1-637.

Reference Books

1. Shravan M Haldhar and Sushil K Maheshwari. (2018). Insect-Pests Management in Arid and Semi-arid Horticultural crops published by ICAR-Central Institute for Arid Horticulture, Bikaner (Rajasthan).pp1-345
2. Rangaswamy Muniappan, Merle Shepard,B and Gerald Carner . (2012). Arthropod pest of horticultural crops in tropical Asia, CABI publication. Pp1-356.

Web References

1. http://agritech.tnau.ac.in/pdf/2013/cpg_horti_2013.pdf
2. http://agritech.tnau.ac.in/crop_protection/crop_prot_crop_insect_horti_pest.html
3. <https://youtu.be/HrQx7RQA5vs>
4. <https://youtu.be/lfuNAgN9OH0>
5. <https://youtu.be/lhfBCWGYSQQ>

Journals

1. Arthropod Pests of Horticultural Crops in Tropical Asia
2. International Journal of Pest Management
3. Journal of Integrated Pest Management
4. Pest Management in Horticultural Ecosystems

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	CRH19504	Course Name	Diseases of Vegetable, Ornamental and Spice Crops	Course Category	S	Supportive Course	L	T	P	C
							2	0	1	3

Pre-requisite Courses	CRH19402	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Plant Pathology	Data Book / Codes/Standards			

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Describe the symptoms of diseases
CLR-2 :	Understand the host pathogen interaction
CLR-3 :	Discuss the role of environmental factors in disease development
CLR-4 :	Understand the survival and mode of spread of the pathogen
CLR-5 :	Learn the Integrated disease management
CLR-6 :	Understand the pathogen detection measures

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:
CLO-1 :	Distinguish and interpret different crop related issues
CLO-2 :	Correlate host parasite relationship for different crops
CLO-3 :	Identify the causal organisms of the disease
CLO-4 :	Interpret different approaches for management of plant disease
CLO-5 :	Gain knowledge in mushroom cultivation
CLO6 :	Potential for business entrepreneur

Learning	1	2	3
Level of Thinking (Bloom)			
Expected Proficiency (%)			
Expected Attainment (%)			

Program Learning Outcomes (PLO)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Agriculture Knowledge															
Problem Analysis															
Design & Development															
Analysis, Design, Research															
Modern Tool Usage															
Society & Culture															
Environment & Sustainability															
Ethics															
Individual & Team Work															
Communication															
Project Mgt. & Finance															
Life Long Learning															
Ability to solve scientific problems															
Ability to implement knowledge gained in the applied field															
Ability to understand social and ethical responsibilities															

Duration (hour)	Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
	16	11	7	12	19
S-1	SLO-1 Disease Symptoms- Tomato	Disease Symptoms - Potato	Disease Symptoms - Cabbage	Disease Symptoms - Jasmine	Disease Symptoms - Turmeric
	SLO-2 IDM -Tomato	IDM -Potato	IDM - Cabbage	IDM - Jasmine	IDM - Turmeric
S-2	SLO-1 Disease Symptoms - Brinjal	Disease Symptoms - Beet root	Disease Symptoms - Cauliflower	Disease Symptoms - Rose and Chrysanthemum	Disease Symptoms - Ginger
	SLO-2 IDM - Brinjal	IDM - Beet root	IDM - Cauliflower	IDM - Rose and Chrysanthemum	IDM - Ginger
S-3 & S-4	SLO-1 Lab 1- Host Parasite relationship - Tomato and Brinjal	Lab 5- Host Parasite relationship - Peas, Potato, and Beet root	Lab 8 Host Parasite relationship – Cabbage and Cauliflower	Lab 10- Host Parasite relationship - Jasmine, Rose and Chrysanthemum	Lab 13- Host Parasite relationship - Turmeric and Ginger
	SLO-2				
S-5	SLO-1 Disease Symptoms - Chilli	Disease Symptoms - Carrot	Disease Symptoms - Leafy Vegetables	Disease Symptoms - Tuberose and Marigold	Disease Symptoms - Pepper
	SLO-2 IDM - Chilli	IDM - Carrot	IDM - Leafy Vegetables	IDM - Tuberose and Marigold	IDM - Pepper
S-6	SLO-1 Disease Symptoms - Okra	Disease Symptoms - Radish	-	Disease Symptoms - Carnation and liliun	Disease Symptoms - Cardamom
	SLO-2 IDM - Okra	IDM - Radish	-	IDM - Carnation and liliun	IDM - Cardamom
S-7& S-8	SLO-1 Lab 2- Host Parasite relationship - Chilli and Okra	Lab 6 – Host Parasite relationship - Carrot and Radish	Lab 9 – Host Parasite relationship – Leafy vegetables	Lab 11- Host Parasite relationship - Tuberose, Marigold, Carnation and Lilium	Lab 14- Host Parasite relationship - Pepper and Cardamom
	SLO-2				
S-9	SLO-1 Disease Symptoms - Cucurbits and Annual moringa	Disease Symptoms - Cassava and Sugar Beet	-	Disease Symptoms - Gloriosa and Gerbera	Disease Symptoms -Cumin, Fennel, and Fenugreek
	SLO-2 IDM - Cucurbits and Annual moringa	IDM - Cassava and Sugar Beet	-	IDM - Gloriosa and Gerbera	IDM - Cumin, Fennel, and Fenugreek
S-10	SLO-1 Disease Symptoms - Onion	-	-	Disease Symptoms - Orchids and Nerium	Disease Symptoms - Vanilla, Clove, and Cinnamon
	SLO-2 IDM - Onion	-	-	IDM - Orchids and Nerium	IDM - Vanilla, Clove, and Cinnamon

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		16	11	7	12	19
S-11& S-12	SLO-1	Lab 3- Host Parasite relationship	Lab 7 – Host Parasite relationship -		Lab 12- Host Parasite relationship- Gloriosa, Gerbera, Orchids and Nerium	Lab 15- Host Parasite relationship -Spices and Condiments
	SLO-2	- Cucurbits and Annual moringa	Cassava and Sugarbeet			
S-13	SLO-1	Disease Symptoms - Garlic	-	-	-	Disease Symptoms -Nutmeg, All spice and Saffron
	SLO-2	IDM - Garlic	-	-	-	IDM - Nutmeg, All spice and Saffron
S-14	SLO-1	Disease Symptoms – Beans and Peas	-	-	-	Cultivation of oyster mushroom
	SLO-2	IDM - Beans and Peas	-	-	-	Pest and Diseases of oyster mushroom
S-15&16	SLO-1	Lab 4- Host Parasite relationship	-	-	-	Lab 16- Mushroom Cultivation
	SLO-2	- Onion, Garlic and Beans	-	-	-	
S-17	SLO-1	-	-	-	-	Cultivation of milky mushroom
	SLO-2	-	-	-	-	Pest and Diseases of milky mushroom
S-18	SLO-1	-	-	-	-	Cultivation of button mushroom
	SLO-2	-	-	-	-	Pest and Diseases of button mushroom
S-19 &20	SLO-1	-	-	-	-	-
	SLO-2	-	-	-	-	-
S-21	SLO-1	-	-	-	-	Cultivation of paddy straw mushroom
	SLO-2	-	-	-	-	Pest and Diseases of paddy straw mushroom

Learning Resources	1. Girish Chand and Santhosh Kumar. (2016). Crop Diseases and Their Management. CRC press. pp. 1-295.
	2. Krishnamoorthy, A.S., Marimuthu, T., and S. Nakkeeran. (2005). Mushroom Biotechnology. Sivakasi, India: Vijay Books.

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember	40 %	40%	40 %	45 %
	Understand				
Level 2	Apply	40 %	35%	30 %	30 %
	Analyze				
Level 3	Evaluate	20 %	25%	20 %	25 %
	Create				
	Total	100 %	100%	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. A. Bharani deppan, Ph.D. E.I. DuPont India Pvt Ltd. The V-Ascendas, Atria Block, 12 th Floor, Plot.17 Software Units Layout, Madhapur, Hyderabad, Telangana Ph: 936666899 Mail: bharani-deepan.a@corteva.com	Dr. A. Kamalakannan, Professor Department of Plant Pathology Tamil Nadu Agricultural University Coimbatore- 641003 Ph: 9790620313 E-Mail: kamals2k@yahoo.co.in	Dr. Rageshwari S (Assistant Professor) Plant Pathology Dr. VinodKumar S (Assistant Professor) Plant Pathology

THEORY

Symptoms, etiology, mode of spread, survival, epidemiology and integrated management of diseases and nematode disease complex.

Unit I: Diseases of vegetable crops – fruit vegetables, cucurbits, bulb crops, and legumes (8 hours)

Tomato - early blight, late blight, damping off, root rot, wilt, bacterial wilt, canker, spotted wilt, big bud; Brinjal - damping off, leaf spot, rust, fruit rot, wilt, root rot, little leaf; Chilli- damping off, leaf spot, anthracnose, powdery mildew, wilt, root rot; Okra - powdery mildew, leaf spot, vein clearing; Cucurbits - powdery mildew, leaf spot, downy mildew, root rot, wilt, bacterial leaf spot, mosaic disease; Moringa – fruit rot, stem rot, root rot, stem canker; Onion - blight, smut, smudge, purple blotch blast rust, root rot; Garlic – basal rot, white rot, downy mildew, botrytis rot, penicillium rot; Beans- anthracnose, root rot, rust, mosaic disease, bacterial blight; Peas – powdery mildew, fusarium wilt and rust.

Unit II: Diseases of vegetable crops – root crops, tubers and rhizomes (5 hours)

Potato - late blight, early blight, ring rot, leaf roll, mosaic, leaf spot, black scurf, silvery scurf, powdery scab, black leg, bacterial soft rot, viral diseases and golden cyst nematode; Beetroot - leaf spot, curly top; Carrot - leaf spot, leaf blight, powdery mildew, bacterial soft rot; Radish – black rot, blight, white rust; Cassava - leaf spot, mosaic disease, root rot; Sugar Beet - leaf spot, blight, and wilt.

Unit III: Diseases of vegetable crops – cole crops and leafy vegetables (3 hours)

Cabbage - damping off, black rot, club root, leaf spot, white blister, head rot; Cauliflower- leaf spot, leaf blight, white blister, downy mildew; diseases of leafy vegetables – Amaranthus, Curry leaf and Celery.

Unit IV: Diseases of flower crops (6 hours)

Jasmine - leaf spot, collar rot, phyllody, root rot; Rose - black spot, powdery mildew, flower blight, rust, gray blight, die back; Chrysanthemum - leaf spot, white rust, wilt, root rot, stunt viroid; Marigold - leaf spot, wilt, root rot; Tube rose - stem rot, flower bud rot, botrytis spot and blight, sclerotial wilt, leaf spot; Carnation - wilt, root rot, wilt, rust, fairy ring spot, stem rot, Lilium - leaf spot, blight, root rot; Gloriosa - leaf spot, leaf blight, wilt, tuber rot; diseases of Gerbera, Orchids and Nerium.

Unit V: Diseases of spices and condiments crops. mushroom cultivation (11 hours)

Turmeric– rhizome rot, leaf blotch, leaf spot, root rot, blast, bacterial wilt; Ginger – soft rot, bacterial wilt, leaf spot, storage rot, yellows, dry rot; Black pepper - quick wilt, slow wilt, pollu disease, charcoal rot, root rot; Cardamom - Katte/marble mosaic disease, azhukal disease, rhizome rot, leaf spot; Coriander - stem gall, powdery mildew; diseases of Cumin, Fennel, Fenugreek, Vanilla, Clove, Cinnamon, Nutmeg, All spice and Saffron. Cultivation of oyster mushroom, milky mushroom, button mushroom and paddy straw mushroom.

Theory – Lecture Schedule

Symptomatology, etiology, mode of spread, survival, epidemiology and integrated management of

1. Diseases of Tomato
2. Diseases of Brinjal
3. Diseases of Chilli
4. Diseases of Okra.
5. Diseases of Cucurbits and Annual moringa
6. Diseases of Onion
7. Diseases of Garlic
8. Diseases of Beans and peas
9. Diseases of Potato
10. Diseases of Beetroot
11. Diseases of Carrot
12. Diseases of Radish
13. Diseases of Cassava and Sugarbeet.
14. Diseases of Cabbage
15. Diseases of Cauliflower
16. Diseases of Leafy vegetables
17. **In-Semester Examination**
18. Diseases of Jasmine.

19. Diseases of Rose and Chrysanthemum
20. Diseases of Tuberose and Marigold
21. Diseases of Carnation and Lilium
22. Diseases of Gloriosa and Gerbera
23. Diseases of Orchids and Nerium
24. Diseases of Turmeric
25. Diseases of Ginger
26. Diseases of Pepper
27. Diseases of Cardamom
28. Diseases of Cumin, Fennel, and Fenugreek
29. Diseases of Vanilla, Clove, and Cinnamon
30. Diseases of Nutmeg, All spice and Saffron
31. Cultivation of Oyster mushroom
32. Cultivation of Milky mushroom
33. Cultivation of Button mushroom
34. Cultivation of Paddy straw mushroom

Practical Schedule

Symptomatology, host parasite relationship and management of

1. Diseases of Tomato and Brinjal
2. Diseases of Chilli and Okra
3. Diseases of Cucurbits and Annual moringa
4. Diseases of Onion, Garlic and Beans
5. Diseases of Peas, Cassava and Sugar beet
6. Diseases of Potato and Beetroot
7. Diseases of Carrot and Radish
8. Diseases of Cabbage and Cauliflower
9. Diseases of leafy vegetables
10. Diseases of Jasmine, Rose and Chrysanthemum
11. Diseases of Tuberose, Marigold, Carnation and Lilium
12. Diseases of Gloriosa, Gerbera, Orchids and Nerium
13. Diseases of Turmeric and Ginger
14. Diseases of Pepper and Cardamom
15. Diseases of Cumin, Fennel, Fenugreek, Vanilla, Clove, Cinnamon, Nutmeg, All spice and Saffron
16. Cultivation of Oyster mushroom, Milky mushroom, button mushroom and Paddy straw mushroom.
17. **University Practical Examination**

Note: Students should submit 50 well preserved herbarium of diseased specimens

Text Books

1. Girish Chand and Santhosh Kumar. (2016). *Crop Diseases and Their Management*. CRC press. pp. 1-295.
2. Krishnamoorthy, A.S., Marimuthu, T., and S. Nakkeeran. (2005). *Mushroom Biotechnology*, Sivakasi, India: Vijay Books.
3. Rangasami, G and Mahadevan, A. (2004). *Diseases of Crop Plants in India*. New Delhi: Prentice Hall of India Pvt. Ltd. pp. 1-548.
4. Sanjeev Kumar. (2015). *Diseases of Horticultural crops, Identification and Management*. New India Publishing Agency, Pai & Sons. pp. 1-296.
5. Trivedi, P.C. (2016). *Diseases of Vegetables and Their Management*. Jaipur: Pointer publishers. pp. 1-270.

Reference Books

1. Agrios, G.N. (2005). *Plant Pathology* (5th ed). New York : Academic Press. pp. 1-922.
2. Alfred Stefferud. (2005). *Diseases of Vegetable Crops*. New Delhi: Biotech Books. pp. 1-210
3. Sonia Ahuja. (2005). *Plant Diseases*. New Delhi : Vishvabharti. pp. 1-268
4. Suresh G Borkar and Rupert A. Y. (2017). *Bacterial diseases of crop plants*. CRC Press. pp. 1-594.

Web References

1. <http://www.biologydiscussion.com>
2. <https://www.microscopemaster.com/fungi>
3. www.apsnet.org/edcenter
4. Tolweb.org
5. <http://www.hillagric.ac.in/edu/coa/ppath/lectures.htm>
6. <http://ecoursesonline.iasri.res.in/course/view.php?id=143>
7. www.ucmp.berkeley.edu/fungi
8. www.ictv.org
9. www.vivo.library.cornell.edu
10. <https://www.youtube.com/c/MTutorEdu/search?query=plant+pathology>
11. <https://www.youtube.com/channel/UCsqovy3Llp-dB8pMxU2VZ7A>
12. <https://www.youtube.com/user/uwipm/search?query=diseases>

Journals

1. Phytopathology
2. Plant Pathology
3. Australasian Plant Pathology
4. Indian Phytopathology
5. Studies in Mycology
6. Journal of Plant Pathology

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	AGE19502	Course Name	Water Management in Horticultural Crops	Course Category	S	Supportive Course	L	T	P	C
							1	0	1	2

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Agronomy	Data Book / Codes/Standards			

Course Learning Rationale (CLR):		The purpose of learning this course is to:		
CLR-1 :	Understand different irrigation water resources and its role on agriculture			
CLR-2 :	Identify the factors influence of soil water plant relationship			
CLR-3 :	Explain the requirements of irrigation and various irrigation techniques			
CLR-4 :	Determine the total water volume needs per unit of time and irrigation delivery			
CLR-5 :	Outline the importance of drainage in crop production and the need to control water logging and salinization			
CLR-6 :	Summarize the water resource within the environment			

Learning			Program Learning Outcomes (PLO)															
1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Thinking (Bloom)	Proficiency (%)	Attainment (%)	Knowledge	Analysis	Development	Design,	Tool Usage	Culture	Environment &	Sustainability	Individual & Team Work	Communication	Management & Finance	Learning	Solve scientific	Implement	gained in the field	Understand ethical responsibilities

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLO-1 :	Define the scientific and critical thinking by creating conceptual irrigation water management in crop production	1	75	80	M								M	H		H	H	H	H
CLO-2 :	Understand the challenges for future water professionals	2	80	85	H						H		M	H		H	H	H	H
CLO-3 :	Analyse the irrigation structures for effective water productivity	2	80	70	M		H		L	L	M		H	H		H	H	H	H
CLO-4 :	Perform the water budgets used to develop irrigation schedules	3	85	80	M			M					M	H		H	H	H	H
CLO-5 :	Determine water requirements of crops and the irrigation schedule for different crops	2	90	85	H	L		L					M	H		H	H	H	H
CLO6 :	Understand the factors related to drainage, essential to design, and manage a drainage system	3	85	80	H		H	H	M		H		H	H	L	H	H	H	H

Duration (hour)	Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
	2	4	3	4	3
S-1	SLO-1 History and water resources	Concept of Soil-Water-Plant Continuum	Water requirement of major crops	Concept of irrigation scheduling	Quality of irrigation water
	SLO-2 Water availability and demand	Kinds of soil water	Consumptive water use (CU)	Irrigation scheduling approaches	Management of poor quality water
S-2,3	SLO-1 Lab 1.Observation of irrigation structures in wetlands and irrigated drylands	Lab 3.Assessment of irrigation water quality parameters	Lab 7. Scheduling of irrigation based on indicator plants, soil-sand mini plot technique	Lab 10. Layout and operation of different surface irrigation systems	Lab 14. Determining the irrigation efficiency parameters
	SLO-2				
S-4	SLO-1 Role of water in crop growth	Soil water movement	Definition of crop water requirement	Surface methods of irrigation	Irrigation management in major horticultural crops
	SLO-2 Role of Govt. for promotion of irrigation and virtual water	Soil moisture extraction pattern	Crop water requirement methods		
S-5,6	SLO-1 Lab 2.Estimation of soil moisture by gravimetric methods	Lab 4.Estimation of ET – Empirical formula	Lab 8. Scheduling of irrigation based on depletion of available soil moisture and IW/CPE ratio	Lab 11. Layout, operation and maintenance of drip irrigation systems	Lab 15. Working out cost economics of irrigation systems
	SLO-2				
S-7	SLO-1 -	Estimation of evapotranspiration	Water flow measuring device	Drip irrigation	Scope and importance of drainage
	SLO-2 -	Crop co –efficient (Kc)	Critical stages of irrigation for major horticultural crops	Sprinkler irrigation	Methods of drainage
S-8,9	SLO-1	Lab 5.Estimation of effective Rainfall – Soil moisture balance	Lab 9. Measurement of water flow: flumes ,weirs and water meter	Lab 12. Layout, operation and maintenance of sprinkler irrigation systems	Lab 16. Observation on irrigation and drainage structures during on/off campus field visits
	SLO-2				
S-10	SLO-1 -	Plant water stress	-	Irrigation efficiency	-

Duration (hour)	Learning Unit / Module 1		Learning Unit / Module 2		Learning Unit / Module 3		Learning Unit / Module 4		Learning Unit / Module 5	
	2		4		3		4		3	
SLO-2	-		Overcome the plant water stress		-		Water budgeting		-	
S-11,12	SLO-1		Lab 6. Estimation of water and irrigation requirement for major crops				Lab 13. Fertigation systems & scheduling of fertilizers to major horticultural crops			
	SLO-2									

Learning Resources	1.	Dilip Kumar Mujmdar. (2004). Irrigation Water Management: Principles and Practices. Prentice Hall of India Pvt. Ltd. pp. 1-577.
	2.	Michael, A.M. (2015). Irrigation Theory and Practices. Vikas publishing house Pvt., Ltd. pp. 1-768.
	3.	Suresh, R. (2010). Micro Irrigation: Theory and practices. Standard Publishers, New Delhi. pp. 1-704.

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember	40 %	30 %	30 %	40 %
	Understand				
Level 2	Apply	40 %	40 %	35 %	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	35 %	20 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Krishnan The Green Turf Irrigation PVT LTD #23/6, first main road, Jawahar Nagar, Chennai-600 082.	Dr. M.V. Rangaswami, Dean & Head, Department of Agriculture Engineering, Saveetha Engineering College, Saveetha Nagar, Thandalam, Chennai-602 105	Dr. S. Marimuthu Dr. N. Krishnaprabu Dr. D. Selvakumar

THEORY

Unit I - Water resources

Water resources in World, India and Tamil Nadu; History and development of irrigation in India Importance of water; Water availability and demand; Role of water in plant growth; Role of Govt. for the promotion of micro-irrigation in India.

Unit II - Soil- water -plant- relationship

Soil - Plant - Atmospheric - Continuum (SPAC); Kinds of soil water; Soil water potential; Hydrological cycle; Soil Water Movement; Soil moisture constants; Distribution of soil moisture; moisture extraction pattern - Absorption of water; Evapotranspiration - Crop Co-efficient; Plant water stress and its effect.

Unit III - Crop water requirement

Water requirement for major horticultural crops - Factors affecting water requirement - Potential Evapotranspiration (PET) and consumptive use (CU) - Determining Crop Water requirement; Transpiration Ratio method, depth interval yield method, Water balance method, lysimeter studies - Effective rainfall - Water flow measuring devices - Critical stages of irrigation for major horticultural crops.

Unit IV - Scheduling of irrigation and methods of irrigation

Concepts of irrigation scheduling; different approaches; Soil moisture regime, climatological and plant indices - Methods of irrigation; surface, sub-surface and pressurized irrigation, their suitability, merits and limitations; Fertigation: Merits and Demerits; Water Use Efficiency (WUE); Conjunctive use of water; Irrigation efficiency; Water budgeting; Virtual water.

Unit V - Irrigation management and drainage

Deficit irrigation; Quality of irrigation water; Management practices for use of poor-quality irrigation water; Water management for major horticultural crops; Drainage: definition, scope, importance and various methods.

Theory - Lecture Schedule

1. Water resources in World, India and Tamil Nadu - History and development of irrigation in India; Water availability and demand
2. Role of water in plant growth- importance of irrigation - Role of Govt. for the promotion of micro-irrigation in India
3. Soil- plant- water relations, Soil-Water-Plant Continuum (SPAC); hydrological cycle, Kinds of soil water - Soil water potential
4. Soil water movement- saturated and unsaturated flow and vapour movement, Soil moisture constants - Distribution of soil moisture; moisture extraction pattern.
5. Evapotranspiration - Crop Co-efficient; various methods
6. Plant water stress- plant response and adaptations and its effect and methods to overcome plant water stress
7. Water requirement for major crops - Factors affecting water requirement - Potential Evapotranspiration (PET) and consumptive use (CU).
8. Crop Water requirement; Transpiration ratio method, depth interval yield method, Water balance method, Lysimeter studies - Effective rainfall.
9. **In- Semester Examination**
10. Water flow measuring devices - Critical stages of irrigation for major horticultural crops
11. Irrigation scheduling: different approaches; Soil moisture regime, climatological and plant indices.
12. Methods of irrigation; surface and sub-surface and pressurized irrigation methods.
13. Drip and sprinkler irrigation; their suitability, merits and limitations - Fertigation: advantages.
14. Water Use Efficiency (WUE): Irrigation efficiency -Water budgeting - Virtual water; Deficit irrigation
15. Quality of irrigation water - Management practices for use of poor quality water (saline, effluent and sewage water) for irrigation;
16. Irrigation water management in major horticultural crops.
17. Drainage: definition, scope, importance and various methods.

Practical Schedule

1. Observation of irrigation structures in wetlands and irrigated drylands
2. Estimation of soil moisture by gravimetric methods
3. Assessment of irrigation water quality parameters
4. Estimation of ET – Empirical formula
5. Estimation of effective Rainfall – Soil moisture balance
6. Estimation of water and irrigation requirement for major crops

7. Scheduling of irrigation based on indicator plants, soil-sand mini plot technique.
8. Scheduling of irrigation based on depletion of available soil moisture and IW/CPE ratio
9. Measurement of water flow: flumes ,weirs and water meters
10. Layout and operation of different surface irrigation systems
11. Layout, operation and maintenance of drip irrigation systems
12. Layout, operation and maintenance of sprinkler irrigation systems
13. Fertigation systems & scheduling of fertilizers to major horticultural crops
14. Determining the irrigation efficiency parameters
15. Working out cost economics of irrigation systems
16. Observation on irrigation and drainage structures during on/off campus field visits
17. **University Practical Examination**

Text Books

1. Patil, S.V. and Rajakumar, G.R. (2016). *Water Management in Agriculture and Horticultural Crops*. Satish serial publishing House, Delhi. pp. 1- 110.
2. Burton, M. (2010). *Irrigation Management, Principles and Practices*. CABI. pp. 1-375.
3. Suresh, R. (2010). *Micro Irrigation: Theory and practices*. Standard publishers, New Delhi.pp. 1-704.
4. Panda, S.C. (2009). *Principles and Practices of Water Management*. Agrobios (India), Rajasthan. pp. 1-345.
5. Rao, Y.P. and Bhaskar, S.R. (2008). *Irrigation Technology. Theory and practices*. Agrotech publishing Academy, Udaipur. pp.1-472.
6. Dilip Kumar Mujmdar. (2004). *Irrigation Water Management: Principles and Practices*. Prentice Hall of India Pvt. Ltd.pp.1- 486.

Reference Books

1. Davis Twomey. (2016). *Sustainable irrigation Management*. Callisto Reference, USA. pp.1-228.
2. Michael, A.M. (2015). *Irrigation Theory and Practices*. Vikas publishing house Pvt., Ltd. New Delhi. pp. 1-768.
3. Carr, M.K.V. and Elias Fereres. (2012). *Advances in Irrigation Agronomy (fruits, vegetables)* Cambridge University Press. Pp. 1-453.
4. Goyal, M.R. (2015). *Sustainable micro irrigation design systems for agricultural crops*. Taylor and Francis. pp. 1-356.
5. Ali, M.H. (2011). *Practices of Irrigation & On-farm Water Management (volume 1 & 2)* Springer-Verlag New York. pp 1- 556 & 1-518.
6. FAO. Series of Publications on *Irrigation and Water Management*.

Web References

1. agritech.tnau.ac.in/agriculture/agri_irrigationmgt.html
2. <http://agriinfo.in/default.aspx?page=topiclist&superid=1&catid=67>
3. <https://www.iwmi.cgiar.org/>
4. www.dripirrigation.org
5. www.jains.com
6. www.springerlink.com/content/u35k21u5548x7320
7. www.wcc.nrcs.sda.gov/irrig.info.html
8. www.croinfo.net/irrigschedule.htm

Journals

1. Agricultural water management
2. International Journal of Water Resources Development
3. Journal of Indian Water Resources Society
4. Journal of Soil and Water Conservation
5. Irrigation science
6. Irrigation and Drainage Systems Engineering

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	AGS19502	Course Name	Horti-Business Management	Course Category	S	Supportive Course	L	T	P	C
							2	0	0	2

Pre-requisite Courses	AGS19202	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Agricultural Economics	Data Book / Codes/Standards			

Course Learning Rationale (CLR):		The purpose of learning this course is to:		
CLR-1 :	Understand the basic concepts in farm economic managements			
CLR-2 :	Summarize the economics of scale and cost of cultivation			
CLR-3 :	Perform the farm planning and budgeting			
CLR-4 :	Explain the basic concepts in market and its role in agriculture			
CLR-5 :	Outline the managerial aspects of farm planning and organizing			
CLR-6 :	Interpret different types of business strategies and entrepreneurship concepts for define the learning methods and goals.			

Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:		
CLO-1 :	Expose the students to production economics principles and their applications.			
CLO-2 :	Perform the analysis of cost of cultivation			
CLO-3 :	Perform agricultural decision making process in farm management			
CLO-4 :	Expose the student for agribusiness and its applications for decision making			
CLO-5 :	Outline the guideline for preparation of project proposals			
CLO6 :	Explain marketing management and financial management			

Learning		
1	2	3
Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
3	90	80
1	90	85
2	75	70
3	80	75
2	85	80
2	85	80

Program Learning Outcomes (PLO)														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design,	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems	Ability to implement knowledge gained in the applied field of Horticulture Business Management	Ability to understand social and ethical responsibilities
M	M	L	M	M	M	H	H	M	H	H	H	H	H	H
H	M	M	H	M	H	M	M	L	H	H	H	H	H	H
M	H	L	M	M	H	M	M	H	H	H	H	H	H	H
M	H	M	H	L	M	L	M	M	H	H	H	H	H	H
M	M	L	M	M	M	M	M	M	H	H	H	H	H	H
M	H	M	M	M	L	H	L	M	H	H	H	H	H	H

Duration (hour)	Learning Unit / Module 1		Learning Unit / Module 2		Learning Unit / Module 3		Learning Unit / Module 4		Learning Unit / Module 5	
	4		5		6		12		7	
S-1	SLO-1	Meaning and concept of farm management	costs, cost curves		Farm business analysis		Marketing Process		Managerial functions	
	SLO-2	Principles of farm management	shut down and break even points		Technical and economic efficiency measures		Role of marketing		Methods of controlling	
S-2	SLO-1	Types of farming	Cost in managing farm business		Importance of farm records		Producer surplus of agricultural commodities		Organizing – Principles and Departmentation	
	SLO-2	Systems of farming	Estimation of gross farm income		Farm inventory		Marketable and Marketed surplus		Staffing – Job Analysis	
S-3	SLO-1	Principles of farm management	Factor – Factor relationship:		Farm budgeting		Marketing functions		Directing – Principles, Techniques and Supervision.	
	SLO-2	Concept of production function	Economies of Scale		Farm planning		Price Determination		Controlling – Process and Types	
S-4	SLO-1	Factor - Product relationship	Economies of Size		Linear programming		Market Finance		Supply Chain Management	
	SLO-2	Laws of Returns: Classical production function and its characteristics.	Equi-marginal returns and comparative advantages		Appraisal of farm resources		Storage and Warehousing		Marketing Management	
S-5	SLO-1	-	Principles of opportunity cost		Characteristics of ideal plans.,		Market Structure		Financial Management	
	SLO-2	-	Risk and uncertainty		Organizations – forms of business organizations		Marketing Channels		Inventory costs	
S-6	SLO-1	-	-		Unity of command		Marketing Efficiency		Functional areas of management	
	SLO-2	-	-		Span of control responsibility		Market Integration		Operations management	

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		4	5	6	12	7
S-7	SLO-1	-	-	-	Market intelligence	Marketing mix
	SLO-2	-	-	-	Price determination and Role of CACP	Financial management
S-8	SLO-1	-	-	-	Agricultural Finance	-
	SLO-2	-	-	-	Role of institutional and non - institutional agencies	-
S-9	SLO-1	-	-	-	Agricultural Finance	-
	SLO-2	-	-	-	Agricultural credit	-
S-10	SLO-1	-	-	-	Preparation and Appraisal of Bankable Projects / Farm Credit Proposals	-
	SLO-2	-	-	-	Farm Financial Analysis	-
S-11	SLO-1	-	-	-	Crisis management in Farm Management	-
	SLO-2	-	-	-	Crop Insurance	-
S-12	SLO-1	-	-	-	Estimation of Crop Yields	-
	SLO-2	-	-	-	Livestock Insurance Schemes	-

Learning Resources	1. Johl, S.S. and T.R. Kapoor. (2009). <i>Fundamentals of Farm Business Management</i> , Kalyani Publishers, New Delhi. pp.1-255.	3. Panda, S.C. (2007). <i>Farm Management and Agricultural Marketing</i> . Kalyani Publishers. Ludhiana. India. pp.10-150.
	2. Mohanty S K. (2007). <i>Fundamentals of Entrepreneurship</i> . Prentice Hall India Ltd. , New Delhi. pp. 1-272.	4. Raju VT and Rao. (2017). <i>Economics of Farm Production and Management</i> . Oxford & IBH Publishing. New Delhi. pp.1-207.

	Level of Thinking	Continuous Learning Assessment (50% weightage)		Final theory Examination (50%)
		In Semester (40%)	Record and Assignment (10%)	
Level 1	Remember	40 %	30 %	30 %
	Understand			
Level 2	Apply	40 %	40 %	40 %
	Analyze			
Level 3	Evaluate	20 %	30 %	30 %
	Create			
	Total	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. K.Arun, Business Manager, EDII Periyakulam Horti Business Incubation Forum, Periyakulam	Dr. Venkatesa Palanisamy, Professor and Head, Centre for Agricultural and Rural Development Studies Department of Agricultural Rural Management, TNAU, Coimbatore	Dr. Anbarasan A Dr. Periasami N

THEORY

Unit I – Scope of farm management

Farm management and Agricultural production economics - definition, basic concepts, nature, characteristics and scope. Farm management principles and decision making, production function, elasticity of production, technical relationships, cost concepts, curves and functions – factors and product relationship – factors relationship, product relationship, optimum conditions.

Unit II – Economics of scale and cost of cultivation

Principles of opportunity cost, equi-marginal returns and comparative advantages, time value of money, economies of scale, returns to scale, cost of cultivation and production, break even analysis, decision making under risk and uncertainty.

Unit III – Farm planning and budgeting

Farming systems and types. Budgeting as a tool for planning and control. Record keeping as a tool of control. Planning – meaning, steps and methods of planning, types of plan, characteristics of ideal plans. Organizations – forms of business organizations, organizational principles, division of labour. Unity of command, scalar pattern, job design, span of control responsibility, power, authority and accountability.

Unit IV – Marketing management

Marketing- definition – Marketing Process – Need for marketing – Role of marketing. Marketing functions – Classification of markets – Marketing of various channels – Price spread – Marketing Efficiency – Integration – Constraints in marketing of agricultural produce. Market intelligence – Basic guidelines for preparation of project reports- Bank norms – Insurance SWOT analysis – Crisis management. Direction – guiding, leading, motivating, supervising, coordination – meaning, types and methods of controlling – evaluation, control systems and devices. Budgeting as a tool for planning and control.

Unit V – Managerial functions – planning and organizing

Record keeping as a tool of control. Functional areas of management – operations management – physical facilities, implementing the plan, scheduling the work, controlling production in terms of quantity and quality. Materials management – types of inventories, inventory costs, managing the inventories, economic order quantity (EOQ). Personnel management – recruitment, selection and training, job specialization. Marketing management – definitions, planning the marketing programmes, marketing mix and four P's. Financial management – financial statements and ratios, capital budgeting. Project management – project preparation evaluation measures.

Theory - Lecture Schedule

1. Meaning and concept of farm management, objectives and relationship with other sciences. Meaning and definition of farms, its types and characteristics, factors determining types and size of farms.
2. Types of farming: Specialized, Diversified, and Mixed farming – Systems of farming: Peasant Farming, State Farming, Capitalistic, Collective and Co – operative Farming.
3. Principles of farm management: concept of production function and its characteristics and its type, use of production function in decision-making on a farm.
4. Factor - Product relationship: Meaning, Definition – Laws of Returns: Classical production function and its characteristics.
5. Meaning and concept of cost, types of costs, cost curves - and their inter-relationship - shut down and break even points, importance of cost in managing farm business and estimation of gross farm income, net farm income, family labor income and farm business income.
6. Economies of Scale – Economies of Size - Determination of Optimum Input and Output – Physical and Economic Optimum.
7. Factor – Factor relationship: Least Cost Combination of inputs. Product – Product relationship: Optimum Combination of Products – Principle of Equi –Marginal Returns – Principle of Opportunity Cost and Minimum Loss Principle. Law of Comparative Advantage.
8. Farm business analysis: meaning and concept of farm income and profitability, technical and economic efficiency measures in crop and livestock enterprises.
9. Importance of farm records and accounts in managing a farm, various types of farm records needed to maintain on farm, farm inventory, balance sheet, profit and loss accounts.
10. Meaning and importance of farm planning and budgeting, partial and complete budgeting, steps in farm planning and budgeting - linear programming, appraisal of farm resources, selection of crops and livestock's enterprises.
11. Planning – meaning, steps and methods of planning, types of plan, characteristics of ideal plans. Organizations – forms of business organizations, organizational principles, division of labour.
12. Unity of command, scalar pattern, job design, span of control responsibility, power, authority and accountability
13. Exchange: Market and Marketing: Definition, Components and Dimensions - Agricultural Marketing: Definition, Scope and Subject matter – Marketing Process – Need for marketing - Role of marketing - Classification of market and Approaches to the study of marketing - Functional, Institutional, Commodity and Behavioral system.
14. Producer surplus of agricultural commodities: Definition and Types of producer surplus - Marketable and Marketed surplus: Importance and Relationship and Factors affecting marketable surplus.
15. Marketing functions: Market Functionaries and Market Forces - Market equilibrium - Price Determination - Marketing of agricultural versus manufactured goods. Characteristics of agricultural and horticultural commodities in relation to marketing.
16. Marketing Functions: Buying and Selling, Packaging and Transportation, Grading and Standardization, Market Finance, Storage and Warehousing, Processing and Value Addition and Risk Taking.
17. **In-semester examination**
18. Market structure: SCP paradigm: Market Structure, Conduct and Performance – Definitions and Components.

19. Marketing Channels: Definition - Channels for different agriculture/horticulture/forest products - Marketing costs, Margins and Prices. Price spread – Factors affecting cost of marketing.
20. Marketing Efficiency: Types: Operational and Pricing - Market Integration - Vertical, Horizontal and Conglomeration - Market Research and Steps in market research.
21. Market intelligence. Price determination and forecasting under various market structures. Agricultural Prices: Function and Scope - Price characteristics of agricultural products – Price Policy and Price Stabilization – Role of CACP - Role of administered prices – MSP, SMP and SAP - Procurement of food grains - Buffer Stock.
22. Agricultural Finance and Agricultural credit: Definition, Importance, Nature and Scope – Need and Classification. Role of institutional and non - institutional agencies: Types, Roles, Advantages and Disadvantages - Rural indebtedness: Consequences and Control measures of rural indebtedness
23. Principles of Credit - 3R's, 5C's, and 7 P's of Credit - Preparation and Appraisal of Bankable Projects / Farm Credit Proposals – Basic guidelines for preparation of Feasibility Report of Project. Bank norms and Farm Financial Analysis – SWOT analysis.
24. Crisis management in Farm Management. Assessment of crop losses, Determination of compensation - Crop Insurance: Schemes, Coverage, Advantages and Limitations in Implementation
25. Estimation of Crop Yields - Livestock Insurance Schemes - Agricultural Insurance Company of India Ltd (AIC): Objectives and functions.
26. Direction – guiding, leading, motivating, supervising, coordination – meaning, types and methods of controlling – evaluation, control systems and devices. Budgeting as a tool for planning and control.
27. Organizing – Principles and Departmentation
28. Staffing – Job Analysis, Human Resource Planning Process, Recruitment and Selection
29. Directing – Principles, Techniques and Supervision. Controlling – Process and Types, Record keeping as a tool of control.
30. Supply Chain Management – Importance, Drivers and flows and Total Quality Management – Meaning and Principles
31. Marketing Management – Market Segmentation and Marketing Mix Financial Management –Meaning, Objectives and Scope Materials management – types of inventories, inventory costs, managing the inventories, economic order quantity (EOQ)
32. Functional areas of management – operations management – physical facilities, implementing the plan, scheduling the work, controlling production in terms of quantity and quality.
33. Marketing mix and four P's. Financial management – financial statements and ratios, capital budgeting. Project management – project preparation evaluation measures.
34. Marketing of products and its value with compounding and discounting.

Text Books

1. Johl, S.S. and T.R. Kapoor. (2009). Fundamentals of Farm Business Management, Kalyani Publishers, New Delhi. . pp;1-255.
2. Mohanty S K. (2007). Fundamentals of Entrepreneurship. Prentice Hall India Ltd. , New Delhi. pp;1-272
3. Panda, S.C. (2007). Farm Management and Agricultural Marketing. Kalyani Publishers. Ludhiana. India. . pp;10-150.
4. Raju VT. (2017). Economics of Farm Production And Management. Oxford & Ibh Publishing. New Delhi. pp;1-207

Reference Books

1. Chandrasekaran N. and G. Raghuram. (2014). Agribusiness Supply Chain Management. CRC Press, Taylor & Francis Group, Brooklyn. pp. 1-125.
2. Debertin, D.L. (2012). Agricultural Production Economics. Macmillan. New York. pp.1-98.
3. Joseph, L. Massie. (1995). Essentials of Management. Prentice Hall of India Pvt. Ltd., New Delhi. pp. 1-196.
4. Sankayan, P.L. (1983). Introduction to Farm Management. Tata McGraw Hill Publishing Company Ltd. New Delhi. pp. 1-86.

Web Sources

1. www.msme.gov.in
2. www.nabard.org
3. www.niesbudtraining.org
4. www.nimsme.org
5. www.nsic.co.in
6. www.youtube.com/watch?v=qAs42y_oAYE

Journals

1. Journal of Farm Management
2. International Journal of Agricultural Management.
3. The International Journal of Production Economics

Course Nature: Theory only							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-	-	-	50	50
2	Theory-Internal	40	5	-	5	-	50
Grand Total							100

Course Code	SUP19503	Course Name	Farm Power and Machinery	Course Category	S	Supplementary Course	L	T	P	C
							1	0	1	2

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Agricultural Engineering	Data Book / Codes/Standards			

Course Learning Rationale (CLR):		The purpose of learning this course is to:			Learning			Program Learning Outcomes (PLO)														
CLR-1 :	Outline the scientists involved in the development of field of farm machinery				1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	Understand different implements and their role in agricultural operations				Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design,	Modern Tool Usage	Society & Culture	Environment & Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems through Agricultural Microbiology	Ability to implement knowledge gained in the applied field of farm power and machinery	Ability to understand social and ethical responsibilities of farm power and machinery	
CLR-3 :	Explain the different implements and their uses																					
CLR-4 :	Identify the engines, tillage tools and different implements used for harvesting and planting																					
CLR-5 :	Describe the technologies present in farm machinery and power side																					
CLR-6 :	Discuss the technologies used in farm machinery																					
Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:																				
CLO-1 :	Identify and differentiate between two stroke and four stroke I.C engines				3	90	80	M							M	H		H	H	H	H	H
CLO-2 :	Determine the different components and systems of IC engines				1	95	85	H							L	H		H	H	H	H	H
CLO-3 :	Identify the different tillage implements used for various agricultural purposes				2	80	70	M		L	L				L	H		H	H	H	H	H
CLO-4 :	Classify various farm implements and comprehend its calibration methods				3	75	65	M			L	L			M	H		H	H	H	H	H
CLO-5 :	Summarize the cost benefit economics of various farm implements				2	75	60	L	L						M	H		H	H	H	H	H
CLO6 :	Describe the techniques of equipment used in agricultural fields from planting to harvesting				2	75	65	L						H	M	H		H	H	H	H	H

Duration (hour)	Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
	3	3	3	4	3
S-1	SLO-1 Energy: Basics SLO-2 Types of Energy	Practical 3: Primary and secondary tillage implemets	Tillage- Objectives Tillage types	Practical 8: Practice in driving tractor	Practical 11: Power tiller handling
S-2	SLO-1 Practical 1:Calculation on force power and energy SLO-2	IC Engines Operations- 2 and 4 stroke	Practical 6: Study of tractors	Seedling equipment Metering mechanism devices	Intercultural equipment's Crop harvest equipment
S-3	SLO-1 Units of Energy SLO-2 Dimensions of Energy	Practical 4: Spraying equipment calibration	Construction tillage implements Function tillage implements	Practical 9: Mounted implement- tractor	Practical 12:Paddy transplanter handling
S-4	SLO-1 Practical 2: IC Engines SLO-2	Air cooling Lubrication system	Practical7: Learning to driver tractor	Seed Drill Planters	Fruit pluckers Farm machinery cost analysis
S5	SLO-1 Energy Loss SLO-2 Energy efficiency	Practical 5: Handling plant protection equipment's	Hill agriculture Implements	Practical 10: Tools for hill agriculture	Practical 13: Threshing machinery
S6		Tractors types Performance		Drill calibration Sprayers	Tractor Implement selection
S7				Particle Size	Practical 14: Harvester root crops
S8				Dusters	Practical15: Problems on cost operation
S9					Practical 16: Industrial Visit

Learning Resources	1. Surendra Singh- Farm machinery – Principles and applications, ICAR, New Delhi
	2. Jagadishwar Sahay, 2010. Elements of Agricultural Engineering. Standard Publishers Distributors, Delhi.

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember	40 %	30 %	35 %	30 %
	Understand				
Level 2	Apply	40 %	40 %	35 %	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	30 %	30 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts

THEORY

Unit I - Basic concepts energy and power

Energy: Basics and forms: Radiation, Solar, Chemical, Potential, Kinetic, Thermal, Mechanical and Electrical, farm power status in India; Units of energy and dimensions: Basic SI, Derived SI, conversion of non-SI, SI prefixes; Energy losses and efficiency; Equivalence and replacement of energy forms; Process energy requirements and gross energy requirements;

Unit II - Principles of IC engines

IC Engines: Basic principles, operations, compression, ignition and spark ignition engines, two stroke and four stroke engines; air, cooling and lubrication system; Fuel supply and hydraulic system; power transmission system: clutch, gear box, differential and final drive of a tractors; Tractor types, Electric motors: types, construction and performance comparison.

Unit III – Basics of tillage and its types

Tillage: Objectives, types; method of ploughing; Construction and function of primary tillage implements and Secondary tillage implements; Implements for hill agriculture.

Unit IV - Sowing and fertilizer application equipments

Seeding equipment: Devices for metering mechanism of seeds, furrow openers, Types of seed drills and planters; potato planters, seedling transplanter; Tools for horticultural crop propagation; Drill calibration: application of fertilizers, metering devices; seed come fertilizer drill; application of liquid fertilizers; Sprayers: classification, accessories; determination of particle size and distribution; dusters: types;

Unit V - Inter cultural and harvesting equipments

Inter-culture equipment: blade harrow, dry land weeders, sweeps, junior hoe, power operated weeders, long handle weeders; Crop harvesting equipments: diggers for potato, groundnut and other tubers; combined harvester for rice and sugarcane; cotton pickers and corn harvester; fruit pluckers. Cost analysis of farm machinery: Tractor and implement selection

Theory- Lecture Schedule

1. Energy: Basics and forms: Radiation, Solar, Chemical, Potential, Kinetic, Thermal, Mechanical and Electrical; farm power status in India.
2. Units of energy and dimensions: Basic SI, Derived SI, conversion of non-SI, SI prefixes;
3. Energy losses and efficiency; Equivalence and replacement of energy forms; Energy balance, Process energy requirements and gross energy requirements;
4. IC Engines: Basic principles, operations, compression, ignition and spark ignition engines, two stroke and four stroke engines;
5. Air, cooling and lubrication system; Fuel supply and hydraulic system: clutch, gear box, differential and final drive of a tractors
6. Tractors types; Electric motors: types, construction and performance comparison.
7. Tillage: objectives, Types of ploughing, Method of ploughing;
8. Construction and function of Primary tillage implements;
9. **In-Semester Examination**
10. Construction and function of Secondary tillage implements; Implement for hill agriculture.
11. Seeding Machines: devices in metering seeds, furrow openers, furrow closers, Types of seed drills and planters; potato planters, seedling transplanter;
12. Tools for horticultural crop propagation; Drill calibration: application of fertilizers, metering devices; seed come fertilizer drill;
13. Application of liquid fertilizers; Sprayers: classification, accessories; determination of particle size and distribution; dusters: types;
14. Inter-culture equipment: blade harrow, dry land weeders, sweeps, junior hoe, power operated weeders, long handle weeders;
15. Crop harvesting equipments: diggers for potato, groundnut and other tubers; combined harvester for rice and sugarcane;
16. Cotton pickers and corn harvester; fruit pluckers. Cost of operation of farm machinery: Tractor and implement selection

Practical – Schedule

1. Calculation on force, power and energy
2. IC engines – showing the components of dismantled engines and motors
3. Handling primary and secondary tillage implements, hitching, adjustments and operations
4. Handling spraying equipment, calibration and operation
5. Handling plant protection equipment, calculation of dilution ratio and operation
6. Study of tractors - their operation and maintenance

7. Learning to drive the tractor
8. Practice in driving tractor
9. Learning to operate tractor with mounted implement
10. Study of tools for Hill agriculture and horticultural crops – propagation tools, vegetable transplanter, harvesting tools -lawn mower, hole diggers, tree climber, shredders for crop residue.
11. Handling power tiller and observing their operation and maintenance
12. Handling paddy transplanter - allied machinery for raising mat nursery
13. Threshing machinery for paddy and identification of its components- different threshing drums - calculation of efficiency and losses.
14. Study of harvesters for root crops - turmeric and tapioca and groundnut diggers
15. Problems on cost of operation of tractor operated machinery.
16. Visit to Industry.
17. **University Practical Examination**

Text Books

1. Senthilkumar, T., R. Kavitha and V.M.Duraisamy 2015. A Text Book of Farm Machinery, Thannambikkai Publications, Coimbatore. ISBN: 978-9381102305
2. Jagadishwar Sahay, 2010. Elements of Agricultural Engineering. Standard Publishers Distributors, Delhi. ISBN: 978-8180140440

Reference Books

1. Ojha, T.P and A.M. Michael. 2005. Principles of Agricultural Engineering Vol-I. Jain Brothers, New Delhi. ISBN: 978-8186321638.
2. Nakra C.P 1970. Farm Machinery and Equipment: Dhanpat Rai Publishing Company Ltd, New Delhi ISBN: 978-8187433231.
3. Jain, S.C. and C.R.Rai. Farm Tractor and maintenance and repair. Standard Publishers, 1705-B, Naisarak., Delhi- 110006
4. Surendra Singh- Farm machinery –Principles and applications, ICAR, New Delhi
5. S.C. Jain & Grace Philip, Farm Machinery- An approach, Standard publishers Delhi

Web References

1. <https://www.agroengineering.org>
2. <https://www.sciencedirect.com › journal › journal-of-agricultural-engineering>.
3. <https://publons.com › journal › journal-of-agricultural-engineering-and-technology>
4. <https://www.agriculturejournals.cz>
5. <https://ecourses.icar.gov.in/>
6. <https://nptel.ac.in/courses>
7. <https://ciae.nic.in>
8. <https://cmeri.res.in>

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	05	05	05	-	15
Grand Total							100

Course Code	HOR19601	Course Name	Breeding and Seed Production of Flower and Ornamental Plants	Course Category	C	Compulsory Core	L	T	P	C
							2	0	1	3

Pre-requisite Courses	GPB19302	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Horticulture	Data Book / Codes/Standards			

Course Learning Rationale (CLR):	<i>The purpose of learning this course is to:</i>	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	<i>Outline the scope and importance of breeding flower and ornamental plants</i>	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems through breeding of Horticultural crops	Ability to implement knowledge gained in the applied field of breeding of Horticultural crops	Ability to understand social and ethical responsibilities of breeding of Horticultural crops
CLR-2 :	<i>Describe the principles and methods of crop improvement programme</i>				M	M	M	M	M	M	H	M	M	H	M	H	H	H	M
CLR-3 :	<i>Understand the germplasm characterization of flower and ornamental plants</i>				H	M	M	M	M	H	H	H	H	H	H	H	H	H	H
CLR-4 :	<i>Identify the seeds and hybrid seed production of flower and ornamental plants</i>				H	H	M	M	M	H	M	H	H	H	H	H	H	H	M
CLR-5 :	<i>Determine the methods of mutagenesis for crop improvement</i>				M	M	M	M	M	M	M	M	M	H	M	H	H	H	M
CLR-6 :	<i>Discuss the methods of polyploidy breeding</i>				M	M	M	M	M	M	M	M	M	H	M	H	H	H	M

Course Learning Outcomes (CLO):	<i>At the end of this course, learners will be able to:</i>	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLO-1 :	<i>Paraphrase the concepts of breeding and floral biology</i>	2	90	80	M	M	M	M	M	M	H	M	M	H	M	H	H	H	M
CLO-2 :	<i>Determine the genetic resources and utilize it in crop improvement</i>	2	95	85	H	M	M	M	M	H	H	H	H	H	H	H	H	H	H
CLO-3 :	<i>Perform the selection and hybridization for crop improvement</i>	2	90	80	H	H	M	M	M	H	M	H	H	H	H	H	H	H	M
CLO-4 :	<i>Utilize crops to express hybrid vigor</i>	2	85	75	M	M	M	M	M	M	M	M	M	H	M	H	H	H	M
CLO-5 :	<i>Identify the polyploidy, mutation and biotechnological application for crop improvement</i>	2	80	80	M	M	M	M	M	M	M	M	M	H	M	H	H	H	M
CLO6 :	<i>Perform entrepreneurial skill for seed production of flower and ornamental crops</i>	2	85	75	M	M	M	M	M	M	M	M	M	H	M	H	H	H	M

Duration (hour)		Learning Unit / Module 1 4T+4P	Learning Unit / Module 2 4T+3P	Learning Unit / Module 3 5T+3P	Learning Unit / Module 4 3T+3P	Learning Unit / Module 5 17T+3P
S-1	SLO-1	<i>History and development of hybrids</i>	<i>Breeding for disease resistance in ornamental plants</i>	<i>Breeding objectives, breeding methods in rose</i>	<i>Breeding objectives, breeding methods and achievements in liliun</i>	<i>Breeding objectives, breeding methods and achievements in Marigold</i>
	SLO-2	<i>Centre of origin of flower crops and ornamental crops</i>	<i>Breeding for disease resistance in flower crops</i>	<i>Breeding achievements in rose</i>	<i>Breeding objectives, breeding methods and achievements in Gaillaidia and Petunia</i>	<i>Breeding objectives, breeding methods and achievements in Geranium</i>
S-2	SLO-1	<i>Objectives in ornamental plant breeding</i>	<i>Role of heterosis and its exploitation</i>	<i>Breeding objectives, breeding methods in jasmine</i>	<i>Breeding objectives, breeding methods and achievements in Hibiscus</i>	<i>Breeding objectives, breeding methods and achievements in Antirrhinum</i>
	SLO-2	<i>Techniques in ornamental plant breeding</i>	<i>Production of F1 hybrids</i>	<i>Breeding achievements in jasmine</i>	<i>Breeding objectives, breeding methods and achievements in Bougainvillea, Zinnia</i>	<i>Breeding objectives, breeding methods and achievements in China aster</i>
S-3	Practical-1	<i>Selfing, emasculation and crossing techniques in ornamentals</i>	<i>Floral biology, selfing, emasculation and crossing technique in Rose, Jasmine, Marigold and Anthurium</i>	<i>Floral biology, selfing, emasculation and crossing technique in Zinnia, Ageratum, Alyssum, Aster and Calendula</i>	<i>Identification of seed and seed structure of ornamental plants</i>	<i>Seed germination, test evaluation and seed enhancement techniques (Seed Priming, Pregermination, Pelleting and Coating) in ornamental plants</i>
S-4						
S-5	SLO-1	<i>Introduction, selection for improvement of ornamental and flower crops</i>	<i>Utilization of male sterility</i>	<i>Breeding objectives, breeding methods and achievements in chrysanthemum</i>	<i>Breeding objectives, breeding methods and achievements in Dianthus, Snapdragon</i>	<i>Breeding objectives, breeding methods and achievements in Orchids</i>
	SLO-2	<i>Hybridization, mutation for improvement of ornamental and flower crops</i>	<i>Production of open pollinated seed</i>	<i>Breeding objectives, breeding methods and achievements in tuberos</i>	<i>Breeding objectives, breeding methods and achievements in Pansy, crossandra.</i>	<i>Breeding objectives, breeding methods and achievements in anthurium</i>

Duration (hour)		Learning Unit / Module 1 4T+4P	Learning Unit / Module 2 4T+3P	Learning Unit / Module 3 5T+3P	Learning Unit / Module 4 3T+3P	Learning Unit / Module 5 17T+3P
S-6	SLO-1	Biotechnological technique for improvement of ornamental	Harvesting, processing	Breeding objectives, breeding methods and achievements in gerbera		Breeding objectives, breeding methods in Carnation
	SLO-2	Biotechnological technique for improvement of flower crops	Storage of seeds, seed certification	Breeding objectives, breeding methods and achievements in gladiolus		Breeding achievements in Carnation
S-7	Practical-2	Introduction, selection, hybridization - technique for improvement of ornamental plants	Floral biology, selfing, emasculation and crossing technique in Gladiolus and Orchids	Seed collection in ornamental plants (annuals, perennials and tree crops)	Seed germination and viability testing in ornamental plants	Study of seed storage, seed package and packaging materials in ornamental plants
S-8						
S-9	SLO-1			Breeding objectives, breeding methods and achievements in dahlia		Introduction to Commercial Flower Seed Production
	SLO-2			Breeding objectives, breeding methods and achievements in heliconia		Introduction to Flower Seeds and Flower Seed Industry
S-10	SLO-1					Scope and Importance of Commercial Floriculture
	SLO-2					Scope and Importance Seed Production techniques of ornamental plant
S-11	Practical-3	Mutation and Polyploidy breeding - technique for improvement of ornamental plants	Floral biology, selfing, emasculation and crossing technique in Gaillardia and Gerbera	Methods of seed extraction in ornamental plants	Seed Dormancy & Methods of breaking of seed dormancy in ornamental plants	Visit to ornamental seed production plots and Commercial flower seed production Industries
S-12						
S-13	SLO-1					Factors considered for efficient seed programme in Ornamental seed production methods of seed production in marigold
	SLO-2					Factors considered for efficient seed programme in Ornamental seed production methods of seed production in Zinnia
S-14	SLO-1					Methods of Seed production techniques in marigold
	SLO-2					Methods of Seed production techniques in zinnia and Chrysanthemum
S-15	Practical-4	Biotechnological breeding - technique for improvement of ornamental plants				
S-16						
S-17	SLO-1					Methods of Seed production techniques in Dahlia
	SLO-2					Methods of Seed production techniques in Petunia and Phalsam
S-18	SLO-1					Methods of Seed production techniques in Cockscomb
	SLO-2					Methods of Seed production techniques in Cosmos and Hollyhock
S-19	SLO-1					Methods of Seed production techniques in Gaillardia
	SLO-2					Methods of Seed production techniques in Gomphrena

Duration (hour)		Learning Unit / Module 1 4T+4P	Learning Unit / Module 2 4T+3P	Learning Unit / Module 3 5T+3P	Learning Unit / Module 4 3T+3P	Learning Unit / Module 5 17T+3P
S-20	SLO-1					Methods of seed / vegetative plant production technique in rose
	SLO-2					Methods of seed / vegetative plant production technique in jasmine
S-21	SLO-1					Methods of Seed / vegetative plant production technique in hibiscus and Bougainvillea
	SLO-2					Methods of Seed / vegetative plant production technique in hibiscus and Orchids
S-22	SLO-1					Methods of Seed / vegetative plant production technique in Gerbera
	SLO-2					Methods of Seed / vegetative plant production technique in Anthurium
S-23	SLO-1					Methods of Seed / vegetative plant production technique in Gladiolus
	SLO-2					Methods of Seed / vegetative plant production technique in Carnation
S-24	SLO-1					Classification of Seeds based on longevity
	SLO-2					Storage conditions for some flower crops
S-35	SLO-1					Conserving the Germplasm of Herbaceous Ornamental Plants
	SLO-2					Conserving the Germplasm of Herbaceous Ornamental Plants

Learning Resources	1. Bhattacharjee, S. K., and De, L.C. (2003). Advanced Commercial Floriculture. Aavishkar Publishers, Distributors, Jaipur (Rajasthan). pp.1-330	3. Kumar, N. (2018). Breeding of Horticultural Crops, Principles and Practices. New India Publishing Agency, New Delhi. pp.1-220
	2. Callaway, D. J. and Callaway, M. B. (2000). Breeding Ornamental Plants. Timber Press. pp. 1-360	

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember	50 %	30 %	35 %	30 %
	Understand				
Level 2	Apply	30 %	40 %	35 %	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	30 %	30 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Prakash M, Assistant breeder, TCI Research Private Limited, Bangalore, Karnataka	Dr. Vikram H.C, Kerala Agricultural University, Thrissur, Kerala	Dr. Akoijam Ranjita Devi Mrs. Kanimozhi C Dr. N. Vinothini, Assistant Professor (SST)

THEORY

Unit 1 – Introduction and breeding approaches of flower and ornamentals

History of improvements of ornamental plants, Centre of origin of flower crops and ornamental crops, objectives and techniques in ornamental plant breeding. Introduction, selection, hybridization, mutation and biotechnological technique for improvement of ornamental and flower crops

Unit 2 – Production of hybrid seeds of flower and ornamentals

Breeding for disease resistance. Development of promising cultivars of important ornamentals and flower crops. Role of heterosis and its exploitation, production of F1 hybrids and utilization of male sterility, production of open pollinated seed. Harvesting, processing and storage of seeds, seed certification.

Unit 3 – Breeding and production of seeds in ornamental crops

Breeding of Rose, Jasmine, Chrysanthemum, Tuberose, Gerbera, Gladiolus, dahlia, Heliconia. Objectives, techniques and released varieties.

Unit 4 – Breeding and production of seeds in ornamental crops

Breeding of Lilium, Gaillardia, Petunia, Hibiscus, Bougainvillea, Zinnia, Cosmos, Dianthus, Snapdragon, Pansy, crossandra. Objectives, techniques and released varieties.

Unit 5 – Breeding and production of seeds in ornamental crops

Breeding of marigold, geranium, antirrhinum, china aster, orchids, anthurium, carnation. Objectives, techniques and released varieties.

Theory – Lecture Schedule

1. History of improvements of ornamental plants, Centre of origin of flower crops and ornamental crops
2. Objectives and techniques in ornamental plant breeding
3. Introduction, selection, hybridization, mutation for improvement of ornamental and flower crops
4. Biotechnological technique for improvement of ornamental and flower crops
5. Breeding for disease resistance
6. Role of heterosis and its exploitation, production of F1 hybrids
7. Utilization of male sterility, production of open pollinated seed
8. Harvesting, processing and storage of seeds, seed certification
9. Breeding objectives, breeding methods and achievements in rose
10. Breeding objectives, breeding methods and achievements in jasmine
11. Breeding objectives, breeding methods and achievements in Chrysanthemum and Tuberose
12. Breeding objectives, breeding methods and achievements in Gerbera and Gladiolus
13. Breeding objectives, breeding methods and achievements in Dahlia and Heliconia
14. Breeding objectives, breeding methods and achievements in Lilium, Gaillardia and Petunia
15. Breeding objectives, breeding methods and achievements in Hibiscus and Bougainvillea, Zinnia
16. Breeding objectives, breeding methods and achievements in Dianthus, Snapdragon, Pansy, crossandra.
17. **In - semester examination**
18. Breeding objectives, breeding methods and achievements in Marigold and Geranium
19. Breeding objectives, breeding methods and achievements in Antirrhinum and China aster
20. Breeding objectives, breeding methods and achievements in Orchids and anthurium
21. Breeding objectives, breeding methods and achievements in Carnation
22. Introduction to Commercial Flower Seed Production – Flower Seeds and Flower Seed Industry
23. Scope and Importance of Commercial Floriculture and Seed Production techniques of ornamental plant
24. Factors considered for efficient seed programme in Ornamental seed production methods of seed production in marigold and Zinnia.
25. Methods of Seed production techniques in marigold, zinnia and Chrysanthemum (including processing, storage and seed certification)
26. Methods of Seed production techniques in Dahlia, Petunia and Phalsam (including processing, storage and seed certification)

27. Methods of Seed production techniques in Cockscomb, Cosmos and Hollyhock (including processing, storage and seed certification).
28. Methods of Seed production techniques in Gaillardia and Gomphrena (including processing, storage and seed certification).
29. Methods of seed / vegetative plant production technique in rose and jasmine (including processing, storage and seed certification).
30. Methods of Seed / vegetative plant production technique in hibiscus and Bougainvillea, Orchids (including processing, storage and seed certification).
31. Methods of Seed / vegetative plant production technique in Gerbera and Anthurium (including processing, storage and seed certification).
32. Methods of Seed / vegetative plant production technique in Gladiolus and Carnation (including processing, storage and seed certification).
33. Classification of Seeds based on longevity – Seed storage and Storage conditions for some flower crops.
34. Conserving the Germplasm of Herbaceous Ornamental Plants.

Practical Schedule

1. Selfing, emasculation and crossing techniques in ornamentals
2. Introduction, selection, hybridization - technique for improvement of ornamental plants
3. Mutation and Polyploidy breeding - technique for improvement of ornamental plants
4. Biotechnological breeding - technique for improvement of ornamental plants
5. Floral biology, selfing, emasculation and crossing technique in Rose, Jasmine, Marigold and Anthurium
6. Floral biology, selfing, emasculation and crossing technique in Gladiolus and Orchids
7. Floral biology, selfing, emasculation and crossing technique in Gaillardia and Gerbera
8. Floral biology, selfing, emasculation and crossing technique in Zinnia, Ageratum, Alyssum, Aster and Calendula
9. Seed collection in ornamental plants (annuals, perennials and tree crops)
10. Methods of seed extraction in ornamental plants
11. Identification of seed and seed structure of ornamental plants
12. Seed germination and viability testing in ornamental plants
13. Seed Dormancy & Methods of breaking of seed dormancy in ornamental plants
14. Seed germination, test evaluation and seed enhancement techniques (Seed Priming, Pregermination, Pelleting and Coating) in ornamental plants
15. Study of seed storage, seed package and packaging materials in ornamental plants
16. Visit to ornamental seed production plots and Commercial flower seed production industries
17. **University Practical Examination**

Text Books

1. Bhattacharjee, S. K. and De, L. C. (2003). Advanced Commercial Floriculture. Aavishkar Publishers, Distributors, Jaipur (Rajasthan) India. pp. 1-330
2. Bose, T. K., Yadav, L. P., Patil, P., Das, P., and Parthasarthy, V. A. (2003). Commercial flowers. Partha Sankar Basu, Nayaudyog, 206, Bidhan Sarani, Kolkata. pp. 1-660
3. Callaway, D. J. and Callaway, M. B. (2000). Breeding Ornamental Plants. Timber Press. pp. 1-360
4. Vainstein, A. (2002). Breeding for Ornamental: Classical and Molecular Approaches. Springer Publishers.

Reference Books

1. Agarwal, R. L. (2017). Seed Technology. Oxford & IBH Publishers, New Delhi. pp. 1-848
2. Singh, B.D. (2009). Plant Breeding: Principles and methods. Kalyani Publishers, New Delhi. pp. 1-889

Web-References

1. http://www.ilvo.vlaanderen.be/EN/Research/ResearchAppliedGeneticsandBreeding_new/ProductQualityImprovement/Breedingofagriculturalandhorticulturalcrops/tabid/2314/Default.aspx
2. <https://www.youtube.com/watch?v=H-EugWBcPhM>
3. <https://www.youtube.com/watch?v=2y7eGHEAZdc>

Journals

1. J of cytogenetics
2. Economic botany
3. Acta Horticulture

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	HOR19602	Course Name	Postharvest Management of Horticultural Crops	Course Category	C	Compulsory Core	L	T	P	C
							2	0	1	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Horticulture	Data Book / Codes/Standards			

Course Learning Rationale (CLR):		The purpose of learning this course is to:		
CLR-1	Understand the postharvest technology of horticultural crops.			
CLR-2	Outline the shelf life of horticultural crops.			
CLR-3	Describe the pre and post harvest treatments of horticultural crops			
CLR-4	Recognize the postharvest scenario of horticultural crops			
CLR-5	Determine the scope and importance of postharvest technology			
CLR-6	Summarize the role of ethylene and ethylene management in postharvest technology			

Learning			Program Learning Outcomes (PLO)														
1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Culture	n Analysis	t & layout	s, varietal selection	Tool Usage	practices	nment problem		al & Team	unication	Mgt. &	ng Learning	o manage the post harvest loss.	o implement knowledge gained in Horticulture	o understand processing

Course Learning Outcomes (CLO)		Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLO-1	Outline the principles and importance of Post-harvest technology.	1	90	80	M								M	H		H	H	H	H
CLO-2	Describe the post harvest operations	2	95	85	H								L	H		H	H	H	H
CLO-3	Explain the packaging and storing processes	2	80	70	M		L	L					L	H		H	H	H	H
CLO-4	Discuss the storage disorders	2	75	65	M			L	L				M	H		H	H	H	H
CLO-5	Paraphrase the export standards	2	75	60	L	L							M	H		H	H	H	H
CLO-6	Explain the knowledge of food safety measures	3	75	65	L						H		M	H		H	H	H	H

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		6	6	7	7	7
S-1	SLO-1	Importance of postharvest technology for fruits	Harvesting and handling of plantation crops	Ripening changes – related enzymes for fruits	Types of packaging materials for fruit and vegetables	Methods of storage for local markets
	SLO-2	Scope of postharvest technology for fruits	Grading of plantation crops	Ripening changes – related enzymes for vegetables	Types of packaging materials for flowers, spices and plantation crops	Methods of storage for distant markets
S 2	SLO-1	Importance of postharvest technology for vegetables, spices	Harvesting and handling of spices	Physiological changes in spices during storage	Types of cushioning materials for fruit and vegetables	Postharvest pests, diseases and disorders in fruits
	SLO-2	Importance of postharvest technology for plantation crops and cut flowers	Grading of spices	Physiological changes in plantation crops during storage	Types of cushioning materials for flowers, spices and plantation crops	Constraints in postharvest management and thrust areas – fruits
S 3-4	SLO-1	Lab: 1 Assessment of maturity indices and methods of harvest	Lab 4: Determination of physiological loss in weight and quality	Lab 7: Packaging of fruits and vegetables	Lab 10: Packaging of medicinal and aromatic plants using different packing materials	Lab 14: Postharvest disorders
	SLO-2					
S 5	SLO-1	Maturity indices for tropical fruits crops	Harvesting and handling of cut flowers	Physiological changes in cut flowers during storage	Preparation for market, pre-cooling	Postharvest pests, diseases and disorders in vegetables
	SLO-2	Maturity indices for subtropical and temperate fruits crops	Grading of cut flowers	Physiological changes in cut flowers during storage	Cooling, storage	Constraints in postharvest management and thrust areas vegetables
S 6	SLO-1	Maturity indices for vegetables crops	Pre-harvest factors affecting postharvest life of fruit and vegetables	Hastening of ripening	Packaging technology for export by air for fruits	Postharvest pests, diseases and disorders in flowers
	SLO-2	Maturity indices for vegetables crops	Pre-harvest factors affecting postharvest life of flowers, spices and plantation crops	Delaying of ripening	Packaging technology for export by road and sea for fruits	Constraints in postharvest management and thrust areas flowers
S 7-8	SLO-1				Lab 11: Waxing	

Duration (hour)	Learning Unit / Module 1		Learning Unit / Module 2		Learning Unit / Module 3		Learning Unit / Module 4		Learning Unit / Module 5	
	6		6		7		7		7	
	SLO-2	Lab 2: Pre-harvest treatments to enhance the postharvest life	Lab 5: Sorting, grading and washing of horticultural produce	Lab 8: Packaging of cut flowers and dry flowers using different packing materials					Lab 15: Identification of storage pest and diseases.	
S-9	SLO-1	Harvesting and handling of fruits	Physical, physiological and biochemical changes during ripening of fruits	Pre harvest treatments and shelf life of horticultural crops	Packaging technology for export by air for vegetables	Postharvest pests, diseases and disorders, constraints in postharvest management and thrust areas – spices.				
	SLO-2	Grading of fruits	Physical, physiological and biochemical changes during storage of fruits	Postharvest treatments and shelf life of horticultural crops	Packaging technology for export by road and sea for vegetables	Postharvest pests, diseases and disorders, constraints in postharvest management and thrust areas - plantation crops				
S-10	SLO-1	Harvesting and handling of vegetables	Physical, physiological and biochemical changes during ripening of vegetables	Waxing	Packaging technology for export by air for plantation crops	WTO guidelines for export of horticultural produce -				
	SLO-2	Grading of vegetables	Physical, physiological and biochemical changes during storage of vegetables	effect of wax coating on shelf life of produce	Packaging technology for export by road and sea for plantation crops	Export standards for major fruits and vegetables - food safety practices				
S-11-12	SLO-1	Lab 3: Assessment of physical, physiological and biochemical changes during ripening	Lab 6: Postharvest treatments enhance the postharvest life	Lab 9: Vase life of cut flowers	Lab 12: Methods of storage	Lab 16: Visit to cold storage, processing units and markets				
	SLO-2									
S-13	SLO-1				Methods of storage of horticultural produce					
	SLO-2				Small scale and large scale storage					
S 14-15	SLO-1				Lab 13: Drying technology of medicinal plants					
	SLO-2									

Learning Resources	1. Jacob John, P. (2008). A Handbook on postharvest management of fruits and vegetables New Delhi: Daya publishing House. pp. 1 - 147.
	2. Saraswathy, S., Preethi, T.L., Balasubramanyan, S., Suresh, J., Revathy, N. & Natarajan, S. (2007). Postharvest management of Horticultural Crops. Jodhpur: Agrobios Publishers. pp. 1 - 546.

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember	40 %	30 %	35 %	30 %
	Understand				
Level 2	Apply	40 %	40 %	35 %	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	30 %	30 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Mohan, Horticulture Officer, Fruit preservation Unit, SIMS Park, Coonoor	Dr Vijay Rakesh Reddy, S. Scientist (Horticulture) ICAR-IIHR Bengaluru	Dr. B. Gopu

THEORY

Unit I Principles of postharvest technology

Importance and scope of postharvest technology in horticultural crops, edible parts of horticultural produce, composition of fruits and vegetables, pre and post-harvest factors influencing postharvest life, pre-harvest treatments to enhance the shelf life; post harvest treatments on post-harvest life of horticultural produce, waxing, hot water treatment, vapour heat treatment, irradiation, astringency removal, harvest indices, harvesting methods, manual and mechanical harvesting.

Unit II Cooling, packing and pack house operations

Pre-cooling, cooling methods, curing, cold chain, pack house operations, cleaning, washing, disinfection, sorting, grading, machineries used in pack house operations, ripening, methods regulation of ripening. Role of ethylene in postharvest technology of fruits, vegetables and flowers, physical, physiological and biochemical changes during ripening of fruits and vegetables

Unit III Packaging and storage

Packaging, types of containers and cushioning materials, packaging methods, map. Methods of storage, low cost and high cost storage technologies, refrigerated storage, cold storage, controlled atmosphere (C.A.) storage. Compatibility of horticultural produce for storage, pre-storage treatments. Physiological changes in fruits, vegetables, flowers, spices and plantation crops during storage.

Unit IV Transport, post harvest and storage disorders

Modes of transportation, constraints, transit hazards, postharvest disorders, pest and diseases and their management in major horticultural crops.

Unit V Export and food safety

WTO guidelines for export of horticultural produces, CODEX standards and export standards for major fruits, vegetables and cut flowers. Food safety practices, HACCP.

Theory - Lecture Schedule

1. Importance of postharvest technology for fruits
2. Importance of postharvest technology for vegetables, spices, plantation crops and cut flowers.
3. Maturity indices for fruits crops
4. Maturity indices for vegetables crops
5. Harvesting, handling and grading of fruits
6. Harvesting, handling and grading of vegetables
7. Harvesting, handling and grading of plantation crops
8. Harvesting, handling and grading of spices
9. Harvesting, handling and grading of cut flowers
10. Pre-harvest factors affecting postharvest life
11. Physical, physiological and biochemical changes during ripening and storage of fruits
12. Physical, physiological and biochemical changes during ripening and storage of vegetables
13. Ripening changes – related enzymes
14. Physiological changes in spices and plantation crops during storage
15. Physiological changes in cut flowers during storage
16. Hastening and delaying ripening
17. **In- semester examination**
18. Pre harvest and postharvest treatments and shelf life of horticultural crops
19. Waxing - effect of wax coating on shelf life of produce
20. Types of packaging materials
21. Types of cushioning materials
22. Preparation for market, pre-cooling, cooling, storage
23. Packaging technology for export by air, road and sea for fruits
24. Packaging technology for export by air, road and sea for vegetables
25. Packaging technology for export by air, road and sea for plantation crops

26. Packaging technology for export by air, road and sea for spices
27. Packaging technology for export by air, road and sea for cut flowers
28. Methods of storage of horticultural produce, small scale and large scale storage
29. Methods of storage for local and distant markets
30. Postharvest pests, diseases and disorders, constraints in postharvest management and thrust areas – fruits
31. Postharvest pests, diseases and disorders, constraints in postharvest management and thrust areas - vegetables
32. Postharvest pests, diseases and disorders, constraints in postharvest management and thrust areas - flowers
33. Postharvest pests, diseases and disorders, constraints in postharvest management and thrust areas - spices and plantation crops
34. WTO guidelines for export of horticultural produce - export standards for major fruits and vegetables - food safety practices

Practicals Schedule

1. Assessment of maturity indices and methods of harvest
2. Pre-harvest treatments to enhance the postharvest life
3. Assessment of physical, physiological and biochemical changes during ripening
4. Determination of physiological loss in weight and quality
5. Sorting, grading and washing of horticultural produce
6. Postharvest treatments enhance the postharvest life
7. Packaging of fruits and vegetables
8. Packaging of cut flowers and dry flowers using different packing materials
9. Vase life of cut flowers
10. Packaging of medicinal and aromatic plants using different packing materials
11. Waxing
12. Methods of storage
13. Drying technology of medicinal plants
14. Postharvest disorders
15. Identification of storage pest and diseases.
16. Visit to cold storage, processing units and markets.
17. **University Practical examination**

Text Books

1. Jacob John, P. (2008). A Handbook on postharvest management of fruits and vegetables New Delhi: Daya publishing House. pp. 1 - 147.
2. Saraswathy, S., Preethi, T.L., Balasubramanyan, S., Suresh, J., Revathy, N. & Natarajan, S. (2007). Postharvest management of Horticultural Crops. Jodhpur: Agrobios Publishers. pp. 1 - 546.

Reference Books

1. Sasikumar, R. (2016). Postharvest technology of fruits and vegetables (1st edition). Published by Biotech Books. pp. 1 – 506.
2. Srivastava, R.P. & S. Kumar. (2019). Fruit and vegetable preservation principles and practices (3rd edition). CBS publishers and distributors Pvt Ltd. pp. 1 – 504.
3. Thomson, A.K. (2014). Fruit and vegetables: Harvesting, Handling and Storage. Published by John Wiley & Sons, Ltd. pp. 1 – 1008.

Web References

1. <http://postharvest.ucdavis.edu/Produce/ProduceFacts/Fruit/mango.shtml>
2. <http://www.fao.org/inpho/>
3. <http://www.horticultureworld.net/hort-india>
4. <http://www.iari.res.in>
5. <http://www.india.exports.com>
6. <http://www.postharvest.org>
7. <http://www.sus-veg-thai.de/>

8. www.ars.usda.gov/ba/bhnrc/nd/

Journals

1. ActaHorticulturae
2. Floriculture today
3. Indian Horticulture
4. Indian Journal of Horticulture
5. Journal of American Society of Horticulture Sciences
6. Journal of vegetable crop production

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	HOR19603	Course Name	Processing of Horticultural Crops	Course Category	C	Compulsory Core	L	T	P	C
							1	0	2	3

Pre-requisite Courses	HOR 19506	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Horticulture	Data Book / Codes/Standards			

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning	Program Learning Outcomes (PLO)
CLR-1 :	Outline the knowledge on fruit and vegetable preservation	1 2 3	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
CLR-2 :	Understand the importance of food additives and deterioration	Level of Thinking (Bloom)	Agriculture Knowledge
CLR-3 :	Describe fruit and vegetables processing techniques	Expected Proficiency (%)	Problem Analysis
CLR-4 :	Explain the technical knowledge on value addition	Expected Attainment (%)	Design & Development
CLR-5 :	Summarize the plantation crop products		Analysis, Design, Modern Tool Usage
CLR-6 :	Perform the formulation of horticultural value added products		Society & Culture
			Environment & Ethics
			Individual & Team Work
			Communication
			Project Mgt. & Finance
			Life Long Learning
			Ability to solve scientific problems through food technology
			Ability to implement knowledge field of food technology
			Ability to understand social and ethical responsibilities of food

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning	Program Learning Outcomes (PLO)
CLO-1 :	Outline the skills on preservation of fruits and vegetables	3 90 80	H
CLO-2 :	Apply different processing methods for horticultural produces	2 95 85	H
CLO-3 :	Understand the concept of drying techniques of horticultural produces	2 80 70	H
CLO-4 :	Recall the concept of freezing method of horticultural produces	3 75 65	L
CLO-5 :	Perform the knowledge on fermented beverages of horticultural produces	3 75 60	L
CLO6 :	Determine the equipments and machineries used in the fruit and vegetable processing unit	2 90 80	M

Duration (hour)	Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
	3	4	3	4	3
S-1	SLO-1 Importance of fruits and vegetables	Role of food additives	Food preservation	Freezing preservation	Government policy APEDA
	SLO-2 Food industry	Food fortification	Thermal and non thermal processing	Principles and methods	Import and export policy
S-2	SLO-1 Food pipeline	Food deterioration	Preservation by sugar	Processing of coffee and tea	Quality control and safety
	SLO-2 Unit operation	Factors involved	Preservation by salt and chemical	Cocoa processing	HACCP principles
S-3	SLO-1 Guidelines for setting up of food processing industry	Reducing deterioration	Preparation of fermented beverages	Role of ingredient in chocolate manufacturing	Role of horticultural waste
	SLO-2 -	Types of food spoilage	Preparation of non fermented beverages	Food additives	Waste in food industry
S-3	SLO-1 -	Drying and dehydration	-	-	-
	SLO-2 -	Types of driers	-	-	-

Learning Resources	1. Shaifur Rehman. M. 2007. Handbook of food preservation. Second Edition. CRC, Press. London
	2. Srivastava, R.P and Sanjeev Kumar. 2002. Fruit and vegetable Preservation: Principles and Practices. International Book Distribution Company.

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember Understand	40 %	30 %	35 %	30 %
Level 2	Apply Analyze	40 %	40 %	35 %	40 %
Level 3	Evaluate Create	20 %	30 %	30 %	30 %
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Elangovan, Avvai Foods Enterprise, No.92, Puliyankudi, Kokkeri vai, Papanasam Taluk, Ammapet, Thanjavur - 614402	Dr. Selvi J, Assistant Professor, Department of Food Science and Nutrition, Community Science College and Research Institute, TNAU, Madurai- 625104	Dr. P. Sheela, Assistant Professor (Food Science and Nutrition)

THEORY

Unit I – Scope of fruit and vegetables preservation

Importance and scope of fruits and vegetable preservation industry – Principles and guidelines for location of units and setting up of processing units – Canning and dehydration industries. Food pipe line, losses in post harvest operations, unit operations in food processing.

Unit II – Food additives and deterioration

Food additives – classification and role of preservatives. Technical methods of reducing food deterioration – principles and procedure in reduction of moisture – drying and dehydration, methods and types of driers. Reduction of moisture by concentration – principles and equipments required

Unit III - Principles and methods of food preservation

Traditional and novel methods of food preservation and its importance – thermal processing and non thermal processing. Preservation by using sugar, salt and chemical. Methods of preparation of beverages – fermentation – lactic acid fermentation. Non-fermented beverages – syrups and cordials.

Unit IV – Preservation by freezing and processing of plantation crops

Freezing preservation – frozen orange slices and peas. Freeze drying of horticultural crops. Individual Quick Freezing. Processing of coffee and tea. Cocoa processing and chocolate manufacture process. Role of ingredient used in chocolate manufacturing – honey, molasses, cream, milk product, egg, additives, starches, fruits and nuts

Unit V – Quality control and food laws

Quality control in processed products – government policy on import and export of processed fruits. Food laws and quality control. Role of fruit and vegetable waste in food industry.

Theory – Lecture Schedule

1. Importance and scope of fruit and vegetable in global agriculture and preservation industry
2. Food pipeline loss of fruit and vegetables from farm to fork – losses in post harvest operations, unit operation in fruit and vegetable processing industry
3. Principles and guidelines for setting up of fruit and vegetable processing units
4. Role of food additives in food preservation – antioxidants, chelating agent, artificial sweeteners, flavours, colours, stabilizers, emulsifiers, firming, leavening, clarifying agents, food fortification and enrichment – application in foods
5. Deterioration factors and their control – enzymatic, chemical, physical and biological causes and types of food spoilage
6. Technical methods of reducing food deterioration
7. Principles and procedure by reduction of moisture – drying and dehydration, methods and types of driers
8. Traditional and novel methods of food preservation and its importance – thermal processing (pasteurization, sterilization, blanching and canning) and non thermal processing (HPP, PEF, COLD PLASMA)
9. **In – Semester Examination**
10. Preservation by using sugar, salt and chemical
11. Methods of preparation of beverages – fermented beverages (wine) and non fermented beverages (syrup and cordial)
12. Freezing preservation of horticultural produces- principles and methods
13. Processing of coffee and tea. Cocoa processing and chocolate manufacture process
14. Role of ingredient used in chocolate manufacturing – honey, molasses, cream, milk product, egg, additives, starches, fruits and nuts
15. Government policy on import and export of processed fruits and vegetables – APEDA
16. Quality control and safety of processed products – FSSAI, HACCP, Food safety and standards act
17. Role of horticultural waste in food industry

Practical Schedule

1. Identification of equipments used in food processing units
2. Market survey of fruit and vegetable based processed product
3. Physico-chemical analysis of fruits and vegetables
4. Shelf life studies of fruits and vegetables at different temperature and atmospheric conditions
5. Canning of fruits – mango, pineapple, guava

6. Canning of vegetables – peas, amla, gherkins
7. Preparation of RTS
8. Preparation of squash
9. Preparation of syrup
10. Preparation of cordial
11. Preparation of jam
12. Preparation of jelly
13. Preparation of marmalade
14. Preservation of candies
15. Preparation of fruit bar
16. Preparation of pickles
17. Preparation of tomato ketchup
18. Wine fermentation
19. Preparation of sauerkraut
20. Dehydration of fruits – sapota, mango and banana fig
21. Dehydration of vegetables – brinjal, cluster bean and bitter gourd
22. Refrigeration and freezing
23. Preparation of baby food using fruits and vegetables
24. Preparation of hot chocolates
25. Preparation of chocolate bars
26. Processing of plantation crops – cashew and coconut
27. Preparation of spice based masala product
28. Cut out analysis of processed food – TSS and Acidity
29. Cut out analysis of processed food – vitamin C and carotene
30. Cut out analysis of processed food – reducing and total sugar
31. Selection of containers used for processing of fruits and vegetables
32. Visit to processing unit
33. **University Practical Examination**

Text Books

1. Giridharilal, Sidappa.G.S and Tandon.G.L. (1979). Preservation of fruits and vegetables. ICAR. New Delhi.
2. ShaifurRehman. M. (2007). Handbook of food preservation. (2nd Edition). CRC, Press. London, PP: 1-1088.
3. Srivastava, R.P and Sanjeev Kumar. (2002). Fruit and vegetable Preservation: Principles and Practices. International Book Distribution Company.
4. Srivastava, R.P., and Sanjeevkumar. S. (2002). Fruit and Vegetable preservation: Principles and Practices. International Book Distributing Co. Lucknow.
5. Verma, L.R and V.K. Joshi. (2000). Post Harvest Technology of Fruits and Vegetables. Technical publishers of India, Allahabad.

Reference Books

1. Mircae Enachesu Deuby. (2004). Fruit and Vegetable processing. FAO, Agricultural service Bulletin, Rome
2. Singh N P. (2007). Fruits and vegetable preservation. Oxford Book publisher, Jaipur, India

Web References

1. www.ecourses.iasri.res.in/
2. www.fao.org/infood/index.en.stm
3. www.fnic.nal.usda.gov
4. www.fssai.org
5. www.myfooddiary.com

6. www.nutrition.org.uk
7. www.postharvest.com.au

Journals

1. Annual Reviews of Food Science and Technology
2. Comprehensive reviews in Food Science and Food Safety
3. Food Research International
4. Nutrients
5. Trends in Foods Science and Technology

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	HOR19604	Course Name	Seed Production of Vegetable, Tuber and Spice Crops	Course Category	C	Compulsory Core	L	T	P	C
							2	0	1	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Horticulture	Data Book / Codes/Standards			

Course Learning Rationale (CLR):		The purpose of learning this course is to:	Learning			Program Learning Outcomes (PLO)														
CLR-1 :	Describe the techniques involved in seed production of horticultural crops		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	Perform the knowledge on seed certification		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems through Agricultural Microbiology	Ability to implement knowledge gained in the applied field of seed	Ability to understand social and ethical responsibilities of seed technology
CLR-3 :	Paraphrase the knowledge on post harvest techniques					M								M	H		H	H	H	H
CLR-4 :	summarize the knowledge on seed marketing					H								L	H		H	H	H	H
CLR-5 :	Describe the seed quality maintenance					M		L	L					L	H		H	H	H	H
CLR-5 :	Describe the seed quality maintenance					M			L	L				M	H		H	H	H	H
Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:																		
CLO-1 :	Outline the seed production technology horticultural crops		3	90	80															
CLO-2 :	Explain in certification process		1	95	85															
CLO-3 :	Perform the post harvest practices of seed processing		2	80	70															
CLO-4 :	Summarize the storage techniques of seeds by scientific approaches		3	75	65															

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		6	6	9	15	11
S-1	SLO-1	Seed production- principles	Methods of seed production in tomato and brinjal	Seed drying	Seed packing	Seed policy
	SLO-2	History of indian seed industry	Methods of seed production in chillies and okra	Seed processing	Types of containers-seed storage	Seed act and rules
S-2	SLO-1	Deterioration of crop varieties	Methods of seed production in cluster bean	Air screen machine	Principles of seed storage - stages of seed storage	Central seed testing laboratories.
	SLO-2	Maintenance of genetic purity during seed production	Methods of seed production in cowpea and french bean	Upgrading equipments	FACTORS affecting seed longevity during storage	State seed testing laboratories.
S-3, 4	SLO-1	Lab 1. Identification of seed and seed structure	Lab 3. Principles and procedures - Seed sampling	Lab 9. Harvesting, Threshing & Seed Extraction- techniques.	Lab 11. Visit to seed production plots and examining field standards	Lab 14. Grow out tests and electrophoresis for varietal identification
	SLO-2					
S-5	SLO-1	Seed quality	Methods of seed production in dolichos and lab lab	Equipments for slurry	Conditions required for good storage	Seed law enforcement
	SLO-2	Different classes of seed	Methods of seed production in garden pea	Mist –o-matic treater	Seed godown sanitation	Seed inspectors, offenses and penalties.
S-6	SLO-1	Generation system of seed multiplication	Methods of seed production in cucurbits	Seed quality enhancement	Seed marketing	Seed control order 1983
	SLO-2	Factors affecting vegetable seed production.	Methods of seed production in cucumber and gourds	Establishing seed testing laboratory	seed demand forecasting and planning	Seed act, new seed bill 2004 and other issues related to seed quality regulation
S-7, 8	SLO-1	Lab 2. Seed quality analysis in Horticultural crops	Lab 4. Physical purity analysis	Lab 10. Seed Quality enhancement	Lab 12. Varietal identification-Emasculation and pollination	Lab 15. Seed production planning-Visit to Seed Processing Unit
	SLO-2					
S-9	SLO-1		Methods of seed production in pumpkin		Marketing structure and marketing organizations	Intellectual property rights

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		6	6	9	15	11
	SLO-2		Methods of seed production in musk melon and water melon		Sales generation activities, promotional media and pricing policy	Patenting, WTO, PPV & FR act.
S- 10	SLO-1		Methods of seed production in carrot and radish		Seed marketing	Varietal identification through
	SLO-2		Methods of seed production in turnip and beet root		Factors affecting seed marketing	Grow-out test
S-11, 12	SLO-1				Lab 13. Planting ratios, isolation distance, roguing, yield assessment, etc. in seed production plots	Lab 16. Visit to seed testing laboratory and Seed Certification Agency.
	SLO-2		Lab 5. Germination testing Moisture determination,			
S-13	SLO-1		Methods of seed production in cabbage			Electrophoresis
	SLO-2		Methods of seed production in cauliflower and knol khol			DNA markers
S14			Methods of seed production in potato			
			Methods of seed production in onion			
S-15, 16			Lab 6. Seed Viability test and Vigour tests			
S-17			Methods of seed production in palak			
			Methods of seed production in fenugreek and amaranthus			
S-18			Methods of seed production in moringa			
			Methods of seed production in exotic moringa			
S-19, 20			Lab 7. Seed dormancy and breaking methods			
S-21			Methods of seed production in baby corn			
			Methods of seed production in baby corn			
S-22			Seed certification			
			Field inspection and field counts			
S-23, 24			Lab 8. Seed health test - Studies on Physiological maturity,			

Learning Resources	1. Agrawal, R.L. (2008). <i>Seed Technology</i> . New Delhi : Oxford & IBH Publishing Co. pp. 1- 821.
	2. Dharmendra Jat, Sai Prasad, S. V. & Sheela Verma. (2014). <i>Seed Science and Technology (2nd ed.)</i> New Delhi: New Vishal Publications. pp. 1- 304.
	3. Khare, D . (2014). <i>Seed Technology (2nd ed.)</i> . Jodhpur: Scientific Publishers India. pp. 1- 944.

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember	40 %	30 %	35 %	30 %
	Understand				
Level 2	Apply	40 %	40 %	35 %	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	30 %	30 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. S M .Prabhu, Ph. D. Senior Breeder (Paddy Breeding and Transgenic) R&D centre, Rasi Seeds (P) Ltd., Attur, Salem – 636141.	Dr. Somasundaram G Senior Scientist ICAR - Indian Institute of Oil Palm Research (IIOPR) Research Centre Palode, Pacha (PO) Thiruvananthapuram-695562, Kerala. Somasundaram.G@icar.gov.in	Dr. G. Selvakumar , Assistant Professor (GPB) Dr. R. Mahendran, Assistant Professor (GPB) Dr. J. Vanitha, Tutor (GPB) Dr. N. Vinothini, Assistant Professor (SST)

THEORY

Unit I- Introduction to seed production

Seed production- principles – difference between seed and grain –importance and scope of vegetable seed production –history of indian seed industry - deterioration of crop varieties – factors affecting deterioration and their control- maintenance of genetic purity during seed production – seed quality - definition, characteristics of good quality seed – different classes of seed – generation system of seed multiplication- seed multiplication ratio - seed replacement rate- factors affecting vegetable seed production.

Unit II- Seed production and certification

Seed production - methods of seed production in solanaceous vegetables-tomatobrinjal -chillies-okra-leguminous vegetables- cluster bean-cowpea-french bean-dolichos lab lab-garden pea- cucurbits-cucumber-gourds-pumpkin-musk melon- water melon-root vegetables-carrot-radish-turnip-beet root-cole crops-cabbage- cauliflower-knol khol-tuberpotato-bulb crop-onion-leafy vegetables-palak-fenugreek- amaranthus, moringa-exotic- baby corn - seed certification, phases of certification, procedure for seed certification, field inspection and field counts etc.

Unit III- Post harvest handling

Seed drying – principles- moisture equilibrium between seed and air –types of drying –seed driers-seed processing – air screen machine and its working principle, different upgrading equipments and their use –seed extraction- seed treatment – importance- types- equipments used (slurry and mist –o-matic treater) - seed quality enhancement - establishing seed testing laboratory.

Unit IV- Seed storage and marketing

Seed packing– types of containers-seed storage- principles of seed storage - stages of seed storage - factors affecting seed longevity during storage - conditions required for good storage – seed godown sanitation – seed marketing – seed demand forecasting and planning- marketing structure - marketing organizations - sales generation activities, promotional media, pricing policy-factors affecting seed marketing.

Unit V- Seed quality control

Seed policy - seed act and rules - central seed committee, central seed certification board, state seed certification agency, central and state seed testing laboratories. seed law enforcement - duties and powers of seed inspectors, offences and penalties. seed control order 1983, seed act, new seed bill 2004 and other issues related to seed quality regulation – intellectual property rights, patenting, WTO, PPV & FR Act-Varietal Identification through grow-out test and electrophoresis.

Theory – Lecture Schedule

1. Seed production- principles – difference between seed and grain –importance and scope of vegetable seed production –history of indian seed industry
2. Deterioration of crop varieties – factors affecting deterioration and their control- maintenance of genetic purity during seed production
3. Seed quality - definition, characteristics of good quality seed – different classes of seed
4. Generation system of seed multiplication- seed multiplication ratio - seed replacement rate- factors affecting vegetable seed production
5. Methods of seed production in solanaceous vegetables-tomato brinjal -chillies-okra
6. Methods of seed production in- leguminous vegetables- cluster bean-cowpea-french bean
7. Methods of seed production in dolichos lab lab-garden pea
8. Methods of seed production in cucurbits, cucumber and gourds
9. Methods of seed production in pumpkin, musk melon and water melon
10. Methods of seed production in root vegetables-carrot, radish, turnip and beet root
11. Methods of seed production in cole crops-cabbage, cauliflower and knol khol
12. Methods of seed production in potato and onion
13. Methods of seed production in leafy vegetables-palak ,fenugreek and amaranthus
14. Methods of seed production in moringa-exotic
15. Methods of seed production in baby corn
16. Seed certification, phases of certification, procedure for seed certification, field inspection and field counts etc.
17. **In semester examination**
18. Seed drying – principles- moisture equilibrium between seed and air –types of drying –seed driers-seed processing
19. Air screen machine and its working principle, different upgrading equipments and their use –seed extraction, seed treatment, importance- types
20. Equipments for (slurry and mist –o-matic treater)

21. Seed quality enhancement and establishing seed testing laboratory
22. Seed packing– types of containers-seed storage
23. Principles of seed storage - stages of seed storage, factors affecting seed longevity during storage
24. Conditions required for good storage – seed godown sanitation
25. Seed marketing – seed demand forecasting and planning
26. Marketing structure - marketing organizations - sales generation activities, promotional media and pricing policy
27. Factors affecting seed marketing
28. Seed policy - seed act and rules - central seed committee, central seed certification board and state seed certification agency
29. Central and state seed testing laboratories
30. Seed law enforcement - duties and powers of seed inspectors, offences and penalties
31. Seed control order 1983, seed act, new seed bill 2004 and other issues related to seed quality regulation
32. Intellectual property rights, patenting, WTO, PPV & FR act.
33. Varietal identification through grow-out test
34. Varietal identification through electrophoresis – DNA markers

Practical Schedule

1. Identification of seed and seed structure
2. Seed quality analysis in Horticultural crops
3. Principles and procedures - Seed sampling
4. Physical purity analysis
5. Germination testing Moisture determination
6. Seed Viability test and Vigour tests
7. Seed dormancy and breaking methods
8. Seed health test - Studies on Physiological maturity
9. Harvesting, Threshing & Seed Extraction- techniques
10. Seed Quality enhancement
11. Visit to seed production plots and examining field standards
12. Varietal identification- Emasculation and pollination
13. Planting ratios, isolation distance, roguing, yield assessment, etc. in seed production plots
14. Grow out tests and electrophoresis for varietal identification
15. Seed production planning- Visit to Seed Processing Unit
16. Visit to seed testing laboratory and Seed Certification Agency
17. **University Practical examination**

Text Books

1. Agrawal, R.L. (2008). *Seed Technology*. New Delhi : Oxford & IBH Publishing Co. pp. 1- 821.
2. Dharmendra Jat, Sai Prasad, S. V. & Sheela Verma. (2014). *Seed Science and Technology* (2nd ed.) New Delhi: New Vishal Publications. pp. 1- 304.
3. Khare, D. (2014). *Seed Technology* (2nd ed.). Jodhpur: Scientific Publishers India. pp. 1- 944.
4. Padmavathi, S. (2012). *A Text Book of Seed Science and Technology*. New Delhi: New India Publishing Agency. pp. 1- 282.

Reference Books

1. Basra, A. S. (2006). *Handbook of Seed Science and Technology*. New York: Food Products Press. pp. 1- 749.
2. Lawrence O. Copeland & Miller McDonald. (2001). *Principles of Seed Science and Technology*. USA: Springer Science. pp. 1- 390.
3. Sreenivas, Y.S. (2009). *Seed Production of Commercial Vegetables*. Oxford: Oxford Book Company. pp. 1- 325.
4. Subir Sen & Nabinananda Ghosh. (2012). *Seed Science and Technology*. New Delhi: Kalyani Publishers. pp. 1- 277.
5. Vanangamudi, K., Prabhu, M. & Bhaskaran. (2010). *Vegetable Hybrid Seed Production and Management*. India: Agrobios. pp. 1- 339.

Web References

1. <https://agro.au.dk/en/research/research-areas/seed-science-and-technology/>
2. www.seednet.gov.in
3. <https://www.fabnet.up.ac.za/index.php/research-groups/seed-science>
4. <https://www.youtube.com/watch?v=j6MwsmmYql8&list=PLMwQyDnbQLRWkULTTg3wMpi8YK04PnzzP>

Journals

1. Asian seed and planting material
2. Seed Research
3. Journal of Asian Horticulture
4. Indian Horticulture
5. Agriculture and industry survey
6. Seed Science and Technology
7. Journal of Seed Science Research

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-		-	-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	CRH19603	Course Name	Insect Pests of Vegetable, Ornamental and Spice Crops	Course Category	S	Supportive Course	L	T	P	C
							2	0	1	3

Pre-requisite Courses	CRH19503	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Crop Protection	Data Book / Codes/Standards			

Course Learning Rationale (CLR): <i>The purpose of learning this course is to:</i>		Learning			Program Learning Outcomes (PLO)														
CLR-1 :	<i>Outline of economic importance of insects in vegetables, ornamental and spice crops</i>	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	<i>Explain the distribution, bionomics, symptoms of damage and management strategies of insect and non insect pests of vegetables</i>	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems through entomology	Ability to implement knowledge gained in the applied field of entomology	Ability to understand social and ethical responsibilities of entomology
CLR-3 :	<i>Describe the pests of ornamentals crops</i>				M								M	H		H	H	H	H
CLR-4 :	<i>Determine the pests of ornamentals</i>				H								L	H		H	H	H	H
CLR-5 :	<i>Recognize the major medicinal crop pest and their management</i>				M			L					M	H		H	H	H	H
CLR-6 :	<i>Understand the pests of spice crops</i>				M		L		L				L	H		H	H	H	H
					L	L		L					M	H		H	H	H	H
					L						H		M	H		H	H	H	H
Course Learning Outcomes (CLO): <i>At the end of this course, learners will be able to:</i>																			
CLO-1 :	<i>Paraphrase the pest surveillance in vegetable crops</i>	3	90	80															
CLO-2 :	<i>Gain knowledge on leafy vegetables</i>	2	95	85															
CLO-3 :	<i>Understand the pesticide tolerance limit</i>	1	75	70															
CLO-4 :	<i>Summarize the vegetables crops pests</i>	3	80	65															
CLO-5 :	<i>Identify the major spice crop pest and their management</i>	2	75	60															
CLO-6 :	<i>Understand the insecticide residue problem in vegetables</i>	2	75	65															

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		8	9	8	32	5
S-1	SLO-1	<i>Economic importance of insects in vegetables, ornamental and spice crops,</i>	<i>Pests of Brinjal,</i>	<i>Insect and non insect pests of Rose,</i>	<i>Insect of Chillies</i>	<i>Insect pests of processed vegetables and ornamental crops, bioecology, injury and IPM,.</i>
	SLO-2	<i>Ecology and pest management in vegetables and ornamentals spice crops</i>	<i>Pests of Bhendi</i>	<i>Lab: 6 Pests of rose , jasmine, crossandra and chrysanthemum</i>	<i>Lab:8 Pests of coleus, Phyllanthus and aswagantha</i>	<i>Lab:16 pests of processed vegetables and spices</i>
S-2	SLO-1	<i>Lab: 1 Assessment of damage / insect population in vegetables, spices and ornamentals</i>	<i>Lab: 3 Pests of Bhendi and tomato ornamentals</i>	<i>Pests of Jasmine and Crossandra</i>	<i>Pests of Onion and Garlic,</i>	<i>Insecticidal residues problems in vegetables and ornamental crops</i>
	SLO-2	<i>Pest surveillance in important vegetables,</i>	<i>Pests of Tomato,</i>	<i>Pests of Chrysanthemum and Marigold,</i>	<i>Pests of Ginger</i>	<i>Insecticidal residues tolerance limits in vegetables and ornamental crops</i>
S-3	SLO-1	<i>Pest surveillance ornamental and spice crops</i>	<i>Pests of Crucifers and Cucurbits,</i>	<i>Lab:7 Pests of marigold, tuberose, nerium and gloriosa</i>	<i>Lab:9 Pests of chillies, onion and garlic</i>	
	SLO-2	<i>Lab: 2 Pests of brinjal</i>	<i>Lab: 4 Pests of crucifers and cucurbits</i>	<i>Pests of daisy, lily, Nerium and Coleus, Phyllanthus, and Aswagantha</i>	<i>Pests of Turmeric</i>	
S-4	SLO-1	-	<i>Pests of Moringa</i>		<i>Pests of Coriander</i>	-
	SLO-2	-	<i>Pests of Amaranthus,</i>	-	<i>Lab: 10 Pests of turmeric , ginger and coriander</i>	-

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		8	9	8	32	5
S-5	SLO-1		Lab: 5 Pests of moringa , amaranthus, cowpea and lab lab		Pests of fenugreek	
	SLO-2		Pests of cowpea and lablab		Pests of mustard and fennel.	
S-6	SLO-1				Lab: 11 Pests of mustard, fenugreek and fennel	
	SLO-2				Pests of clove	
S-7	SLO-1				Pests of nutmeg and allspice	
	SLO-2				Lab: 12 Pests of clove, nutmeg and allspice	
S-8	SLO-1				Pests of cinnamon	
	SLO-2				Pests of tamarind	
S-9	SLO-1				Lab: 13 Pests of cinnamon, tamarind and vanilla	
	SLO-2				Pests of vanilla	
S-10	SLO-1				Pests of paprika	
	SLO-2				Lab: 14 Pests of cocoa, cardamom and paprika	
S-11	SLO-1				Pests of Cocoa	
	SLO-2				Pests of Cardamom	
S-12	SLO-1				Lab: 15 Pests of black pepper	
	SLO-2				Pests of black Pepper	

Learning Resources	1. David, B.V and Ramamurthy, V.V.(2011). Elements of Economic Entomology, Namrutha Publications, Chennai. pp1-386
	2. Manisegaran, S. and R.P.Soundararajan. (2010).Pest Management in Field Crops-Principles and Practices. Agrobios, Jodhpur, India. pp1- 316.

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember	40 %	40 %	35 %	30 %
	Understand				
Level 2	Apply	35 %	40 %	30 %	40 %
	Analyze				
Level 3	Evaluate	25 %	20 %	35 %	30 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. K. Ramesh Ph.D Principal Biologist –Rice Insecticide and Nematicide, South Asia Co-chair for insecticide resistance action committee(IRAC), India Corteva Agrisciences (Dow Dupont) Madhapur, Hyderabad, India e- mail :ramesh.kaliaperumal@corteva.com mobile : 9952885708	Dr. M. Kandibane Associate professor, Department of Agricultural Entomology, PAJANCOA&RI, Karaikal-609603	Dr. L.Ramazeame Ph.D (Assistant Professor) Agricultural entomology

THEORY

Unit I: Economic importance of insects in vegetables, ornamental and spice crops

Economic importance of insects in vegetables, ornamental and spice crops, Ecology and pest management in these crops, Pest surveillance in important vegetables, ornamental and spice crops.

Unit II: Pests of vegetables

Distribution, bionomics, symptoms of damage and management strategies of insect and non insect pests of Brinjal, Bhendi, Tomato, Crucifers, Cucurbits, Moringa, Amaranthus, cowpea, lab lab.

Unit III: Pests of ornamental crops

Distribution, bionomics, symptoms of damage and management strategies of insect and non insect pests of Rose, Jasmine, Crossandra, Chrysanthemum, Marigold, Tuberose, daisy, lily, Nerium and Gloriosa, Coleus, Phyllanthus, and Aswagantha.

Unit IV: Pests of spices

Distribution, bionomics, symptoms of damage and management strategies of insect of Chillies, Onion, Garlic, Ginger, Turmeric, Coriander, fenugreek, mustard, fennel, clove, nutmeg, all spice, cinnamon, tamarind, vanilla, paprika, Cocoa, Cardamom, black Pepper.

Unit V: Pests of stored products and insecticide residues

Insect pests of processed vegetables and ornamental crops, bioecology, injury and IPM, insecticidal residues problems in vegetables and ornamental crops, tolerance limits.

Assignment

1. Collection and submission of 50 pests of vegetables, ornamentals and spice crops.
2. Rearing a minimum of 20 insect pests and preparation of two riker mounts

Theory - Lecture Schedule

1. Economic importance of insects in vegetables, ornamental and spice crops,
2. Ecology and pest management in these crops,
3. Pest surveillance in important vegetables,
4. Pests surveillance in important ornamental and spice crops.
5. Pests of Brinjal
6. Pests of Bhendi
7. Pests of Tomato
8. Pests of Crucifers
9. Pests of Cucurbits
10. Pests of Moringa
11. Pests of Amaranthus
12. Pests of cowpea, lab lab
13. Pests of Rose
14. Pests of Jasmine, Crossandra,
15. Pests of Chrysanthemum, Marigold,
16. Pests of Tuberose, Daisy, Lily, Nerium, Coleus, Phyllanthus, Aswagantha, Nerium and Gloriosa
17. **In- semester examination**
18. Pests of Chillies
19. Pests of Onion and Garlic
20. Pests of Ginger
21. Pests of Turmeric
22. Pests of Coriander

23. Pests of Fenugreek
24. Pests of Mustard and Fennel
25. Pests of Clove, Nutmeg and Allspice
26. Pests of Cinnamon
27. Pests of Tamarind
28. Pests of Vanilla
29. Pests of Paprika
30. Pests of Cardamom
31. Pests of Black Pepper
32. Insect pests of processed vegetables and ornamental crops, bioecology, injury and IPM
33. Insecticidal residues problems in vegetables and ornamental crops
34. Pesticide residue tolerance limits in vegetables and ornamentals

Practical Schedule

1. Assessment of damage / insect population in vegetables, spices and ornamentals
2. Pests of brinjal
3. Pests of bhendi and tomato
4. Pests of crucifers and cucurbits
5. Pests of moringa , amaranthus, cowpea and lab lab
6. Pests of rose , jasmine, crossandra and chrysanthemum
7. Pests of marigold, tuberose, nerium and gloriosa
8. Pests of coleus, phyllanthus and aswagantha
9. Pests of chillies, onion and garlic
10. Pests of turmeric, ginger and coriander
11. Pests of mustard, fenugreek and fennel
12. Pests of clove, nutmeg and allspice
13. Pests of cinnamon, tamarind and vanilla
14. Pests of cocoa, cardamom and paprika
15. Pests of black pepper
16. Pests of processed vegetables and spices
17. **University practical examination**

Text Books

1. Ayyar, T.V.R. (1963). Hand Book of Economics Entomology for South India. Govt. Press Madras.pp1-516.
2. David, B.V. (2006). Elements of Economic Entomology. Popular Book Depot, Chennai.pp1-562.
3. Butani, D.K. (2009). Insects and Fruits. Periodical Expert Book Agency, New Delhi.pp1-415.
4. Butani, D.K. and Jotwani, M.G. (1984). Insects of Vegetables. Periodical Expert Book Agency, New Delhi. pp1-365.
5. Srivastava, K.P. and D.K.Butani, (1998). Pest Management in Vegetables (Part I & II) Research Periodicals and Book Publishing House, India. pp1-637

Reference Books

1. Shravan M Haldhar and Sushil K Maheshwari. (2018). Insect-Pests Management in Arid and Semi-arid Horticultural crops published by ICAR-Central Institute for Arid Horticulture, Bikaner (Rajasthan).pp1-345
2. Rangaswamy Muniappan, Merle Shepard,B and Gerald Carner . (2012). Arthropod pest of horticultural crops in tropical Asia, CABI publication. pp1-356.

Web References

1. http://agritech.tnau.ac.in/crop_protection/crop_prot_crop_insect_horti_pest_vegetables.html
2. http://agritech.tnau.ac.in/crop_protection/crop_prot_crop_insect_horti_pest_flowers.html
3. <http://ecoursesonline.iasri.res.in/course/view.php?id=168>
4. <https://youtu.be/RuQmgVsZSkk>
5. <https://youtu.be/ZB8kQcJ5fwo>
6. <https://youtu.be/uts3OwYRx4Y>

Journals

1. International Journal of pest management
2. Journal of vegetable crop production
3. Pest management in horticultural ecosystem

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	CRH19604	Course Name	Weed Management in Horticultural Crops	Course Category	S	Supportive Course	L	T	P	C
							1	0	1	2

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Agronomy	Data Book / Codes/Standards			

Course Learning Rationale (CLR):		The purpose of learning this course is to:			Learning			Program Learning Outcomes (PLO)														
CLR-1 :	Understand the weed species				1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	Explain the weed ecology system				Level of Thinking (Bloom)	Expedted Proficiency (%)	Expected Attainment (%)	Orchard Knowledge	Problem Analysis	Design & Development	Analysis, Design, Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems through Orchard Management	Ability to implement knowledge gained in the applied field of Orchard management	Ability to understand social and ethical responsibilities of Orchard and estate	
CLR-3 :	Identify the weed interactions for various resources																					
CLR-4 :	Determine the weed control methods																					
CLR-5 :	Perform the mode of action of herbicides																					
Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:																				
CLO-1 :	Identify the weeds and species				1	90	85	H			H			H		M	H		H	H	H	H
CLO-2 :	Explain the weed control programmes to reduce weed population				2	80	75	H			H					L	H		H	H	H	H
CLO-3 :	Identify the herbicides and methods of application to control the weeds				2	80	70	M		M	M			H		L	H		H	H	H	H
CLO-4 :	Understand the herbicides movement and persistence for effective selection of herbicides				3	75	75	M			H					M	H		H	H	H	H
CLO-5	Perform the herbicide residues and their management to create the eco-friendly environment				3	85	80	M								M	H		H	H	H	H

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		4	4	3	2	3
S-1	SLO-1	Weed introduction and harmful effects	Weed control methods-Prevention	Herbicides classifications	Herbicide selectivity	Weed management in major horticultural crops
	SLO-2	Beneficial effects of weeds	Weed control-eradication and physical methods	Herbicide characteristics	Herbicide absorption and translocation	Weed management in major horticultural crops
S-2,3	SLO-1	Field/Lab.1. Identification, classification and characterization of terrestrial weeds	Field/Lab.5. Study on biology of nut sedge and Bermuda grass, Parthenium and Celosia	Field/Lab.9. Practicing skill development on spray equipment and spray fluid calibration	Field/Lab.12. Study on phyto-toxicity symptoms of herbicides in different crops	Field/Lab.15. Economic analysis of different weed management methods in crops and cropping systems
	SLO-2					
S-4	SLO-1	Classifications of weeds	Concepts – cultural weed control methods	Herbicide formulations	Compatibility of herbicides and other agro-inputs	Weed shit and weed control in non-cropped areas
	SLO-2	Propagation and disseminations of weeds	Types of cultural weed control methods	Herbicide application methods	Mode of action of herbicides	Aquatic and problematic weeds-Control
S-5,6	SLO-1	Field/Lab.2. Identification, classification and characterization of aquatic weeds	Field/Lab.6. Practicing skill development on cultural and non-chemical weed management	Field/Lab.10. Practicing skill development on herbicide weed management in lowland, upland and rainfed ecosystems	Field/Lab.13. Herbicide residue determination by bioassay techniques	Field/Lab.16. Visit to problem and parasitic weed infestation areas/ herbicide industries
	SLO-2					
S-7	SLO-1	Weed biology and ecology	Weed control-Chemical methods	Herbicide equipment and their accessories	Herbicide residue management	-
	SLO-2	Crop weed association and weed seed bank	Weed control- Biological Methods	Herbicide Adjuvants	Persistence and degradation of herbicides	-

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		4	4	3	2	3
S-8,9	SLO-1	Field/Lab.3. Identification, classification and characterization of problem and parasitic weeds	Field/Lab. 7. Identification, classification and characterization of herbicides	Field/Lab.11. Calculation of herbicide quantity and recommendation for different eco systems	Field/Lab.14. Herbicide residue determination by volumetric, spectrophotometric methods and chromatographic methods.	--
	SLO-2					
S-10	SLO-1	Crop weed competition	Non-chemical weed management	Herbicide mixtures	Herbicides resistant weeds	--
	SLO-2	Allelopathy	Integrated weed Management	Advantages and limitations of herbicide usage in India	Herbicide resistant GM crops	--
S-11	SLO-1	Field/Lab.4. Weed survey and weed vegetation analysis – density, frequency, SDR and IVI	Field/Lab.8. Practicing skill development on herbicide application techniques	--	--	--
	SLO-2					--

Learning Resources	1. Das, T. K. (2008). <i>Weed Science – Basics and Applications</i>. Jain Brothers, New Delhi. Pp. 1-901. 2. Gupta, O.P. (2011). <i>Weed Management – Principles and Practices</i>. Agrobios. Pp. 1- 324. 3. Jayakumar, R. and Jagannathan, R. (2007). <i>Weed Science Principles</i>. Kalyani Publishers, Ludhiana. Pp. 1- 379.

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember	40 %	30 %	35 %	30 %
	Understand				
Level 2	Apply	40 %	40 %	35 %	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	30 %	30 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. D. Velmurugan, Associate territory manager, Dhanuka Agritech Limited Pudukottai – 622003	Dr. C. Chinnamuthu , Professor and Head Department of Agronomy , Tamil Nadu Agricultural University, Coimbatore -3	Dr. N. Krishnaprabu Dr. D. Selvakumar Dr. S. Marimuthu

THEORY

Unit I – Introduction to weeds

Weeds: Introduction, harmful and beneficial effects, classification, propagation and dissemination – Weed biology and ecology – Weed seed dormancy – Weed seed bank – Crop weed association – Crop weed competition and allelopathy effect.

Unit II – Weed control methods

Concepts of weed prevention, control and eradication – Methods of weed control: physical, cultural, chemical and biological methods – Non chemical weed management – Integrated Weed Management (IWM).

Unit III – Herbicides

Herbicides: Classification, characteristics, formulations, methods of application, advantages and equipment – Adjuvants – Herbicide mixture – Advantages and limitation of herbicide usage in India.

Unit IV – Herbicide selectivity

Selectivity of herbicides; Herbicide absorption and translocation – Compatibility of herbicides and other agro inputs – Mode of action of herbicides and their selectivity – Herbicide residue management – Persistence and degradation of herbicides in soil and plants – Herbicide resistant weeds – Herbicide resistant GM crops.

Unit V – Weed management in crops

Weed management in major horticultural crops – weed shift – weed control in non-cropped areas – aquatic and problematic weeds and their control. Weed management in major and horticultural crops – weed shift – weed control in non-cropped areas – Parasitic, aquatic and problematic weeds and their control.

Theory – Lecture Schedule

1. Weeds – Definition, classification and characteristics, harmful and beneficial effect of weeds.
2. Weed biology and ecological adaptation to different agro ecosystems.
3. Classification and characteristics of weeds of different agro ecosystems-lowland weeds, irrigated upland and rainfed land weeds.
4. Classification and characteristics of weeds – Aquatic, parasitic and obnoxious weeds.
5. Life cycle of weeds, weed migration, weed seed distribution, dormancy, germination, establishment and perennation of weeds in different ecosystems.
6. Crop weed interactions – Critical crop weed competition, competitive and allelopathic effects of weeds and crops.
7. Principles and methods of weed management: Preventive, cultural, mechanical.
8. **In- Semester Examination.**
9. Principles and methods of weed management: chemical, biological and alternate methods.
10. Classification and characteristics of herbicides and herbicide formulations – History and Development.
11. Herbicide Use Efficiency – Adjuvants, herbicide protectants and antidotes – Herbicide and herbicide mixtures in India
12. Interaction with moisture, fertilizer and other agrochemicals.
13. Mode of action of herbicides and their selectivity – Mechanism of action of herbicides and their selectivity.
14. Herbicide persistence and degradation in plants and soils-Herbicide residue and management.
15. Herbicide resistant weeds and their impact on weed management.
16. IWM in crops and cropping systems- Horticultural Crops.
17. Weed shift: Causes and management options for weed shift in crop production.

Practical Schedule

1. Identification, classification and characterization of terrestrial weeds
2. Identification, classification and characterization of aquatic weeds
3. Identification, classification and characterization of problem and parasitic weeds
4. Weed survey and weed vegetation analysis – density, frequency, SDR and IVI
5. Study on biology of nut sedge and Bermuda grass, parthenium and celosia
6. Practicing skill development on cultural and non-chemical weed management

7. Identification, classification and characterization of herbicides
8. Practicing skill development on herbicide application techniques
9. Practicing skill development on spray equipment and spray fluid calibration
10. Practicing skill development on herbicide weed management in lowland, upland and rainfed ecosystems
11. Calculation of herbicide quantity and recommendation for different eco systems
12. Study on phyto-toxicity symptoms of herbicides in different horticultural crops
13. Herbicide residue determination by bioassay techniques
14. Herbicide residue determination by volumetric, spectro-photometric methods and chromatographic methods.
15. Economic analysis of different weed management methods in crops and cropping systems
16. Visit to problem and parasitic weed infestation areas/ herbicide industries
17. **University Practical examination**

Text Books

1. Das, T. K. (2008). *Weed Science – Basics and Applications*. Jain Brothers, New Delhi. Pp. 1-901.
2. Gupta, O.P. (2011). *Weed Management – Principles and Practices*. Agrobios. Pp. 1- 324.
3. Jayakumar, R. and Jagannathan, R. (2007). *Weed Science Principles*. Kalyani Publishers, Ludhiana. Pp. 1- 379.
4. Mandal, R.C. (1990). *Weed, Weedicides and Weed Control – Principles and Practices*. Agro- Botanical Publ. pp. 1- 263

Reference Books

1. Bhagirath S. Chauhan, Gulshan Mahajan. (2014). *Recent advances in weed management*. Springer. Pp. 1-407.
2. Rao, V.S. (2000). *Principles of Weed Science*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi. Pp. 1- 555.
3. Walia, U.S. (2003). *Weed Management*. Kalyani Publishers, Ludhiana. Pp.1-396.

Web References

1. <http://erec.ifas.ufl.edu/weeds/powerpoints/Basic%20Principles%20of%20Weed%20Management.pdf>.
2. http://agritech.tnau.ac.in/agriculture/agri_weedmgt.html
3. <http://www.agrisk.umn.edu/cache/ARL02964.htm>
4. <http://www.eolss.net/sample-chapters/c10/E1-05A-31-00.pdf>
5. <https://dwr.icar.gov.in/>
6. <http://www.fao.org/docrep/006/y5031e/y5031e0j.htm>
7. <http://www.omafra.gov.on.ca/english/crops/pub811/12crop.htm>

Journals

1. Indian Journal of weed science
2. Indian Journal of Agronomy
3. Weed technology
4. Weed science
5. Journal of crop and weed
6. Weed biology and management
7. Weed research

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	AGE19605	Course Name	Organic Farming	Course Category	S	Supportive Course	L	T	P	C
							2	0	1	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Agronomy	Data Book / Codes/Standards			

Course Learning Rationale (CLR):		Learning			Program Learning Outcomes (PLO)														
The purpose of learning this course is to:		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	Understand the historical, biological and ecological concepts of organic farming.	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems	Ability to implement knowledge gained	Ability to understand social and ethical responsibilities
CLR-2 :	Gain the knowledge on soil organic carbon and their improvement.				H			H			H		M	H		H	H	H	H
CLR-3 :	Outline the importance of organic sources of nutrients on soil fertility management				H			H					L	H		H	H	H	H
CLR-4 :	Summarize the information on non-chemical approaches and ITK's practices.				M		M	M			H		L	H		H	H	H	H
CLR-5 :	Identify the steps involved in organic certification				M			H					M	H		H	H	H	H
Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:	1	90	85	M							M	H		H	H	H	H
CLO-1 :	Recognize the management of organic farming production system					H							L	H		H	H	H	H
CLO-2 :	Describe the techniques of preparation of different organic formulations					M		M	M				L	H		H	H	H	H
CLO-3 :	Perform the skill on resource recycling methods					M							M	H		H	H	H	H
CLO-4 :	Apply the skills on different stakeholders to get organic certification					M							M	H		H	H	H	H
CLO-5 :	Support the different stakeholders to get organic certification					M							M	H		H	H	H	H

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		6	7	5	5	11
S-1	SLO-1	Organic farming - definition	Natural Nutrient cycles	Organic carbon: status and improvement strategies	Role of Indigenous Technical Knowledge (ITK) in organic agriculture	Organic certification - NPOP guidelines
	SLO-2	Organic farming – scope and concepts	Soil health concepts - conservation of soil	Conservation Agriculture	Role of Indigenous Technical Knowledge (ITK) in organic agriculture	Certification agencies in India - crop production standards
S-2	SLO-1	History of organic farming	Organic production requirement	Non-chemical weed management: preventive and cultural methods	ITKs - scientific rationale – soil & nutrient management	Quality considerations
	SLO-2	Global scenario - relevance in the present context	Permitted and restricted inputs in organic farming	Non-chemical weed management: - physical methods	ITKs - scientific rationale - weed management	Labeling and accreditation process
S-3,4	SLO-1	Lab 1. Organic farming – crop preference	Lab 4. Soil conservation techniques under irrigated and rainfed situations	Lab 7. Hands on experience on ITK based biological preparations	Lab 10. Nutrient management and Nutrient budgeting in organic farming	Lab 13. Disease management in organic farming
	SLO-2	Biodiversity: importance and measure to preserve biodiversity	Biological intensive nutrient management; manures and other inputs	Non-chemical weed management: mechanical measures	ITKs - scientific rationale – water and pest management	Marketing of organic products
S-5	SLO-1	Biodiversity - pre requisites for Organic farming	Biological intensive nutrient management; on farm and off farm sources	Non-chemical weed management: biological measures	ITKs - scientific rationale - other uses of ITKs	Export opportunities for organic products
	SLO-2	Organic ecosystem	Organic waste recycling	Bio-intensive pest and disease management; use of biocontrol agents	ITKs - prospects in organic farming	Benefits of organic farming

Duration (hour)	Learning Unit / Module 1		Learning Unit / Module 2		Learning Unit / Module 3		Learning Unit / Module 4		Learning Unit / Module 5	
	6		7		5		5		11	
	SLO-2	Organic ecosystem concepts	Organic waste recycling - methods	Bio-intensive pest and disease management; bio-pesticides	ITKs - problems in organic farming	Problems of organic farming				
S-7,8	SLO-1	Lab 2. Soil sampling and analysis for organic carbon	Lab 5. On farm identification of soil problems in farmer's field – suggestive remedies	Lab 8. Seed treatment practices in organic management	Lab 11. Weed management in organic farming	Lab 14. Bio-diversified Integrated farming practices for different eco-systems				
	SLO-2									
S-9	SLO-1	Impacts of green revolution farming	Soil and crop improvement - green manures, cover crops, and inter cropping	Bio-intensive pest and disease management; pheromones	Strategies for integration of ITKs into scientific research process	Promotional activities for organic farming development				
	SLO-2	Impacts of green revolution farming	Soil and crop improvement - crop rotation, mulching and bio fertilizers	Trap crops, bird perches	Criteria for Validating ITKs	Promotional activities for organic farming development				
S-10	SLO-1	Government (central/ state) for promotion of organic agriculture	Traditional additives in organic farming	-	-	Economic evaluation of organic production systems				
	SLO-2	NGOs and other organizations for promotion of organic agriculture	Non-traditional additives in organic farming	-	-	Economic evaluation of organic production systems				
S-11,12	SLO-1	Lab 3. Soil sampling and analysis for soil biological parameters	Lab 6. Hands on experience on bio composting and vermicomposting	Lab 9. Bio-fertilizers and bio-inoculants usage in organic farming.	Lab 12. Insect management in organic farming	Lab 15. Organic certification procedures				
	SLO-2									
S-13,14	SLO-1	-	-	-	-	Organic crop management techniques – Warm season vegetables				
	SLO-2	-	-	-	-	Organic crop management techniques - Fruit trees				
S-15	SLO-1	-	-	-	-	Lab 16. Visit to organic farms, market outlets and organic certification centers				
	SLO-2	-	-	-	-	Organic Allied enterprises - honey bees and livestock production				
S-16, 17	SLO-1	-	-	-	-	Cost - benefit analysis and comparison with conventional systems				
	SLO-2	-	-	-	-					
S-18	SLO-1	-	-	-	-					
	SLO-2	-	-	-	-					
S-19	SLO-1	-	-	-	-					
	SLO-2	-	-	-	-					

Learning Resources	1. Arun. K. Sharma. (2011). Handbook of Organic farming. Agrobios (India), Jodhpur. pp. 1-627.	3. Lampkin, N., Measures, M. and Padel, S. (2014). Organic Farm Management Handbook. University of Wales, Aberystwyth. pp. 1-207
	2. Bansal, M. (2020). Basics of organic farming. CBS publishers and distributors Pvt. Ltd., New Delhi. pp. 1-143.	4. Maliwal, P.L. (2020). Principles of organic farming. Scientific Publishers (India). pp. 1-180

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember	40 %	30 %	35 %	30 %
	Understand				
Level 2	Apply	40 %	40 %	35 %	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	30 %	30 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
<i>Mr. Sivakumar</i> <i>Madras Iyer Thottam organic farm,</i> <i>Kondappa naicken palayam, Sathyamangalam, Tamil Nadu 638503.</i>	<i>Dr. E. Somasundharam</i> <i>Professor and Head</i> <i>Department of Sustainable Organic Agriculture</i>	<i>Dr. D. Selvakumar</i> <i>Dr. N. Krishnaprabu</i> <i>Dr. S. Marimuthu</i>

THEORY

Unit I - Components and principles of organic farming

Organic farming: Definition - Scope – principles, components and concepts - history of organic farming - global scenario - relevance in the present context; biodiversity: importance and measure to preserve biodiversity - pre requisites for Organic farming; Organic ecosystem and their concepts; Impacts of green revolution farming; Government (central/ state), NGOs and other organizations for promotion of organic agriculture.

Unit II - Organic sources of nutrients

Natural Nutrient cycles - Organic production requirement, permitted and restricted inputs in organic farming; biological intensive nutrient management; manures and other inputs - on farm and off farm sources - organic waste recycling - methods - Soil improvement and amendments - inter cropping, crop rotation, green manures, cover crops, mulching - bio fertilizers; traditional and non-traditional additives in organic farming. Organic carbon: status and improvement strategies – conservation Agriculture.

Unit III - Weeds, pest and disease management

Non-chemical weed management methods: preventive, physical, cultural, mechanical and biological measures - Bio-intensive pest and disease management; use of biocontrol agents, bio-pesticides pheromones, trap crops, bird perches.

Unit IV - Indigenous Technical Knowledge (ITK)

Role of Indigenous Technical Knowledge (ITK) in organic agriculture - scientific rationale - soil, nutrient, weed, water, pest management and Other uses of ITKs - prospects and problems in organic farming; Strategies for integration of ITKs into scientific research process - Criteria for Validating ITKs.

Unit V - Certification, exports and economic evaluation

Organic certification – NPOP guidelines - Certification agencies in India – crop production standards - Quality considerations - labeling and accreditation process - marketing and export opportunities. Benefits and problems of organic farming: promotional activities – economic evaluation of organic production systems - cost - benefit analysis and comparison with conventional systems.

Theory - Lecture Schedule

1. Organic farming: Definition - Scope – principles, components and concepts
2. History of organic farming - global scenario - relevance in the present context
3. Biodiversity: importance and measure to preserve biodiversity - pre requisites for Organic farming
4. Organic ecosystem and their concepts
5. Impacts of green revolution farming
6. Government (central/ state), NGOs and other organizations for promotion of organic agriculture
7. Natural Nutrient cycles - Soil health concepts - conservation of soil
8. Organic production requirement, permitted and restricted inputs in organic farming
9. Biological intensive nutrient management; manures and other inputs - on farm and off farm sources
10. Organic waste recycling - methods
11. Soil and crop improvement - green manures, cover crops, inter cropping, crop rotation mulching - bio fertilizers
12. Traditional and non-traditional additives in organic farming.
13. Organic carbon: status and improvement strategies – conservation Agriculture
14. Non-chemical weed management: preventive, physical and cultural methods
15. Non-chemical weed management: mechanical and biological measures
16. Bio-intensive pest and disease management; use of biocontrol agents, bio-pesticides
17. **In semester examination**
18. Bio-intensive pest and disease management; pheromones, trap crops, bird perches
19. Role of Indigenous Technical Knowledge (ITK) in organic agriculture
20. ITKs - scientific rationale - soil, nutrient and weed management
21. ITKs - scientific rationale - water, pest management and other uses of ITKs
22. ITKs - prospects and problems in organic farming
23. Strategies for integration of ITKs into scientific research process - Criteria for Validating ITKs

24. Organic certification - NPOP guidelines - Certification agencies in India - crop production standards
25. Quality considerations - labeling and accreditation process
26. Organic products for marketing and export opportunities
27. Benefits and problems of organic farming
28. Promotional activities for organic farming development
29. Economic evaluation of organic production systems
30. Organic crop management techniques – Warm season vegetables
31. Organic crop management techniques – Cool season vegetables
32. Organic crop management techniques - Fruit trees
33. Organic Allied enterprises - honey bees and livestock production
34. Cost - benefit analysis and comparison with conventional systems.

Practical Schedule

1. Organic farming – crop preference
2. Soil sampling and analysis for organic carbon
3. Soil sampling and analysis for soil biological parameters
4. Soil conservation techniques under irrigated and rainfed situations
5. On farm identification of soil problems in farmer's field – suggestive remedies
6. Hands on experience on bio composting and vermicomposting,
7. Hands on experience on ITK based biological preparations
8. Seed treatment practices in organic management
9. Bio-fertilizers and bio-inoculants usage in organic farming.
10. Nutrient management and Nutrient budgeting in organic farming
11. Weed management in organic farming
12. Insect management in organic farming
13. Disease management in organic farming
14. Bio-diversified Integrated farming practices for different eco-systems
15. Organic certification procedures
16. Visit to organic farms, market outlets and organic certification centers.
17. **Practical Examination**

Text Books

1. Arun. K. Sharma. (2011). *Handbook of Organic farming*. Agrobios (India), Jodhpur. pp. 1-627.
2. Bansal, M. (2020). *Basics of organic farming*. CBS publishers and distributors Pvt. Ltd., New Delhi. pp. 1-143.
3. Lampkin, N., Measures, M and Padel, S. (2014). *Organic Farm Management Handbook*. University of Wales, Aberystwyth. pp. 1-207
4. Maliwal, P.L. (2020). *Principles of organic farming*. Scientific Publishers (India). pp. 1-180.
5. Palaniappan, S. P and Annadurai, K. (2018). *Organic Farming: Theory and Practice*. (7th Edition), Scientific Publishers. pp. 1-257.
6. Reddy, S.R. (2017). *Principles of organic farming*. Kalyani publishers, India. pp. 1-117.

Reference Books

1. Barker, A.V. (2010). *Science and Technology of Organic Farming*. CRC Press. pp.1-240.
2. Dushyant Gehlot. (2010). *Organic farming: Components and management*. Agrobios (India), Jodhpur. pp. 1-376.
3. Masanobu Fukuoka, Larry Korn, Wendell Berry and Frances Moore Lappe. (2009). *The One-Straw Revolution: An Introduction to Natural Farming*. NYRB Classics, New York. pp. 1-200.
4. Panda, S.C. (2012). *Principles and Practices of Organic Farming*. Agrobios (India), Jodhpur. pp. 1-594.
5. Peter Fossel. (2014). *Organic Farming: How to Raise, Certify, and Market Organic Crops and Livestock*. Reprint edition, Voyageur Press, USA. pp. 1-176.

Web References

1. www.ifoam.org
2. www.apeda.org
3. www.cowindia.org
4. www.ncof.org
5. www.earthfooda.co.uk,
6. www.newfarm.org/training
7. <https://www.youtube.com/watch?v=JlWsxo5nNgg>

Journals

1. Organic Agriculture
2. Journal of Organic Agriculture and Environment
3. Organic Farming
4. International Journal of Sustainable Agricultural Management and Informatics
5. Journal of Sustainable Agriculture
6. Advances in Agronomy

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	AGS19603	Course Name	Entrepreneurship Development and Business Management	Course Category	S	Supportive Course	L	T	P	C
							1	0	1	2

Pre-requisite Courses	AGS19202	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Agricultural Economics	Data Book / Codes/Standards			

Course Learning Rationale (CLR):		The purpose of learning this course is to:			Learning			Program Learning Outcomes (PLO)																
CLR-1 :	Understand the basic concepts in entrepreneurship	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
CLR-2 :	Explain the business management.																							
CLR-3 :	Outline the managerial agri business functions and its applications																							
CLR-4 :	Describe the basic concepts of supply chain management																							
CLR-5 :	Paraphrase the human resource planning process																							
CLO-6	Interpret different types of business strategies and entrepreneurship concepts of learning methods and goals																							
Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:																						
CLO-1 :	Expose the students in assessing overall business environment in the Indian economy	3	90	80	M	M	M	M	H	M	H	H	M	H	H	H	H	H	H	H	H	H		
CLO-2 :	Attain the knowledge on business environment	1	90	85	H	M	M	H	M	H	M	M	L	H	H	H	H	H	H	H	H	H		
CLO-3 :	Determine the concept of small and medium enterprises	2	75	70	M	H	H	M	M	H	M	M	H	H	H	H	H	H	H	H	H	H		
CLO-4 :	Expose students to verbal and non-verbal communication	3	80	75	M	H	M	L	L	M	L	M	M	M	H	H	H	H	H	H	H	H		
CLO-5	Understand the social responsibility of business	2	85	80	M	M	H	M	M	M	M	M	M	H	H	H	H	H	H	H	H	H		
CLO-6	Describe the knowledge on HRM in an organization	2	85	80	M	H	M	M	H	L	H	L	M	H	H	H	H	H	H	H	H	H		

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		9	12	9	9	9
S-1	SLO-1	Concept and Types of Entrepreneurship	Principles of innovation	Importance of planning, monitoring and evaluation	Staffing (Personnel)	Total quality management
	SLO-2	Importance of Entrepreneurship	Business environment	Entrepreneurship development programs	Recruitment and Selection	Supply chain management
S 2-3	SLO-1	Lab: 1 Assessment of entrepreneurial traits	Lab: 4 Market survey for understanding customer needs	Lab:8 Listening and note taking, writing skills, oral presentation skills; field diary and lab record;	Lab:11 Preparing advertisements for popularization of product, news writing	Lab:14 Dyadic communication-face Face conversation, telephone conversation
	SLO-2					
S-4	SLO-1	SWOT / SWAR Analysis	MSME Classification	Management Functions	Directing – Principles,	Operations Management
	SLO-2	Government policy and programs	Opportunities for rural entrepreneurship	Principles and Departmentation	Business leadership skills	Social Responsibility of Business
S 5-6	SLO-1	Lab:2 Identification of new business opportunities	Lab: 5 Starting new business - Visit to firms / discussion with entrepreneurs	Lab:9 Indexing, footnote and bibliographic procedures. Reading and comprehension of general Technical articles, précis writing, summarizing, abstracting	Lab:12 Preparing project proposals, individual, group presentation, features of oral presentation	Lab:15 Rate of speech and clarity of voice, speaking Listening politeness, telephone etiquettes, organising general and group meeting, salient features
	SLO-2					
S-7	SLO-1	Assessing overall business environment	Agribusiness Importance	Organizational skills	Export and Import Policies	Communication Skills
	SLO-2	Decision making by individual entrepreneurs	Opportunities and Challenges	Management Functions	Public-private partnerships,	Verbal and non-verbal communication

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		9	12	9	9	9
S 8-9	SLO-1	Lab:3 SWOT / SWAR Analysis	Lab:6 Documenting Procedure for Establishing Agribusiness Firms	Lab:10 Conducting market survey to the demand for product	Lab:13 Presentation, evaluation of presentation and evaluation of sheet	Lab:15 Participation in seminars and conferences, Conducting and participating in mock interviews.
	SLO-2					
S-10	SLO-1	-	Government policy on Small and Medium Enterprises (SMEs) / SSIs.	-	-	-
	SLO-2	-	Entrepreneurial development process	-	-	-
S-11- 12	SLO-1	-	Lab:7 Government programs and institutions for entrepreneurship development	-	-	-
	SLO-2					

Learning Resources	1. Aswathappa, K. (2008). <i>Human Resource Management: Text and Cases (5th Edition)</i>. Tata McGraw-Hill Pub. Co. Ltd. New Delhi. pp. 1 - 276. 2. Chandra Prasanna. (2000). <i>Financial Management - Theory and Practice (4th Edition)</i>. Tata Mc Graw Hill Publishing Company Ltd., New Delhi. pp. 1- 450. 3. Philip Kotler. (2013). <i>Marketing Management (3rd Edition)</i>, Pearson Education, India. pp. 1 – 230.

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical Internal (15%)		
Level 1	Remember	40 %	30 %	35 %	30 %
	Understand				
Level 2	Apply	40 %	40 %	35 %	40 %
	Analyze				
Level 3	Evaluate	20 %	30 %	30 %	30 %
	Create				
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. K.Arun, Business Manager, EDII Periyakulam Horti Business Incubation Forum, Periyakulam	Dr. Venkatesa Palanisamy, Professor and Head, Centre for Agricultural and Rural Development Studies Department of Agricultural Rural Management, TNAU, Coimbatore	Dr. Anbarassan A Dr. Periasami N

THEORY

Unit I – Entrepreneur and Entrepreneurial Process

Concept and Types of Entrepreneurship - Characteristics of Entrepreneurs and Entrepreneurial Skills - Entrepreneurial process – Importance of Entrepreneurship. SWOT Analysis & achievement motivation, Government policy and programs and institutions for entrepreneurship development - Assessing overall business environment in the Indian economy-Overview of Indian social, political and economic systems and their implications for decision making by individual entrepreneurs.

Unit II – Entrepreneurship Opportunities

Innovation - principles of innovation - Sources of innovative opportunities - Business environment – Micro and Macro environment - MSME Classification and Opportunities for rural entrepreneurship Agribusiness – Importance, Opportunities and Challenges. Impact of economic reforms on Agribusiness/Agrienterprises- Globalization and the emerging business / entrepreneurial environment. Concept of entrepreneurship; entrepreneurial and managerial characteristics; managing an enterprise; motivation and entrepreneurship development;

Unit III – Entrepreneurship Skills

Importance of planning, monitoring, evaluation and follow up; managing competition; entrepreneurship development programs; SWOT analysis, Generation, incubation and commercialization of ideas and innovations. Government schemes and incentives for promotion of entrepreneurship. Government policy on Small and Medium Enterprises (SMEs) / SSIs. Entrepreneurial development process, business leadership skills – Developing organizational skill, controlling, supervising, problem solving, monitoring & evaluation - Management Functions – Planning – Types of Plans and Steps in Planning, Organizing – Principles and Departmentation.

Unit IV – Managerial Functions – Planning and Organizing

Staffing – Job Analysis, Human Resource Planning Process, Recruitment and Selection, Directing-Principles, Techniques and Supervision, Controlling – Process and Types. Business leadership skills, communication, direction and motivation skills. Export and Import Policies relevant to horticulture sector. Venture capital. Contract farming and joint ventures, public-private partnerships. Supply chain management and total quality management- Overview of horti inputs industry. Characteristics of Indian horticultural processing and export industry.

Unit V – Functional Areas of Management

Operations Management – Meaning and Scope, Meaning and Principles. Social Responsibility of Business. Communication Skills: meaning and process of communication, verbal and non-verbal communication; listening and note taking, writing skills, oral presentation skills developing organizational and managerial skills, problem solving skills. Field diary and lab record; indexing, footnote and bibliographic procedures.

Theory - Lecture Schedule

1. Concept of Entrepreneurship and Types of Entrepreneurship
2. Characteristics of Entrepreneurs and Entrepreneurial Skills, Entrepreneurial process -- Importance of Entrepreneurship
3. SWOT Analysis & achievement motivation, Government policy and programs and institutions for entrepreneurship development.
4. Innovation - principles of innovation - Sources of innovative opportunities
5. Business environment – Micro and Macro environment, Agribusiness – Importance, Opportunities and Challenges. Impact of economic reforms on Agribusiness/Agrienterprises
6. MSME Classification and Opportunities for rural entrepreneurship - KVIC classification, Startup and Business incubators
7. Agribusiness – Importance, Opportunities and Challenges, Agribusiness – Importance, Opportunities and Challenges. Impact of economic reforms on Agribusiness/Agri-enterprises
8. Management Functions – Planning – Types of Plans and Steps in Planning
9. In-Semester examination
10. Organizing – Principles and Departmentalization
11. Staffing – Job Analysis, Human Resource Planning Process, Recruitment and Selection
12. Directing – Principles, Techniques and Supervision
13. Controlling – Process and Types, . Business leadership skills, communication, direction and motivation skills.
14. Functional Areas of Management – Operations Management – Meaning and Scope
15. Supply Chain Management – Importance, Drivers and flows
16. Total Quality Management – Meaning and Principles
17. Marketing Management – Market Segmentation and Marketing Mix. Financial Management –Meaning, Objectives and Scope

Practical- Schedule

1. Assessment of entrepreneurial traits
2. Identification of new business opportunities
3. Exercise on SWOT Analysis of Agribusiness sector in India
4. Market survey for understanding customer needs
5. Starting new business - Visit to firms / discussion with entrepreneurs
6. Documenting Procedure for Establishing Agribusiness Firms
7. Government programs and institutions for entrepreneurship development
8. Listening and note taking, writing skills, oral presentation skills; field diary and lab record;
9. Indexing, footnote and bibliographic procedures. Reading and comprehension of general and Technical articles, précis writing, summarizing, abstracting
10. Conducting market survey to the demand for product, preparing advertisements for popularization of product, news writing,
11. Preparing project proposals, individual, group presentation, features of oral presentation,
12. Presentation, evaluation of presentation and evaluation of sheet
13. Dyadic communication-face Face conversation, telephone conversation
14. Rate of speech and clarity of voice, speaking Listening politeness, telephone etiquettes, organizing general and group meeting, salient features
15. Participation in seminars and conferences,
16. Conducting and participating in mock interviews.
17. **University final practical examination**

Text Books

1. Aswathappa, K. (2008). Human Resource Management: Text and Cases, Tata McGraw-Hill Pub. Co. Ltd. New Delhi, 5th Edition. pp. 1-207.
2. Chandra Prasanna. (2000). Financial Management - Theory and Practice. Tata Mc Graw Hill Publishing Company Ltd., New Delhi. pp. 1- 450.
3. Mohanty S K. (2007). Fundamentals of Entrepreneurship. Prentice Hall India Ltd. New Delhi. pp. 1-248.
4. Philip Kotler. (2013). Marketing Management, Pearson Education, India, 2013. pp. 200-350.

Reference Books

1. Chandrasekaran N. and G. Raghuram. (2014). Agribusiness Supply Chain Management. CRC Press, Taylor & Francis Group, Brooklyn. pp. 1-320.
2. Joseph, L. Massie. (1995). Essentials of Management. Prentice Hall of India Pvt. Ltd. New Delhi. pp. 1-260.
3. Mark J Dollinger. (1999). Entrepreneurship Strategies and Resources. Prentice-Hall, Upper Saddal Rover, New Jersey. pp. 1-415.

Web References

1. www.ediindia.org
2. www.iie.nic.in
3. www.msme.gov.in
4. www.nabard.org
5. www.niesbudtraining.org
6. www.nimsme.org
7. www.nsic.co.in

Journals

1. Journal of International Business Studies
2. Journal of Entrepreneurship and Innovation in Emerging Economies
3. International Journal of Agriculture Innovation, Technology and Globalisation
4. International Journal of Entrepreneurship and Small Business
5. Entrepreneurship Theory and Practice

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	AGS19604	Course Name	Fundamentals of Extension Education	Course Category	S	Supportive Course	L	T	P	C
							1	0	1	2

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Agricultural Social Sciences	Data Book / Codes/Standards			

Course Learning Rationale (CLR):		The purpose of learning this course is to:		
CLR-1 :	Understand fundamentals of extension education, planning and rural development efforts, extension administration			
CLR-2 :	Emphasize the importance of rural development and participatory extension			
CLR-3 :	Summarize different systems of Technology Transfer			
CLR-4 :	Comprehend the communication process and how adoption of innovation takes place			
CLR-5 :	Describe the importance of ICT in Extension education			

Learning			
1	2	3	
Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	

Program Learning Outcomes (PLO)																
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
Knowledge	Skills	Development	Analysis, Research	Image	Career			Team Work		Finance	Learning	Scientific	High	Extension	Implement in the Horticulture Management	Understand social responsibilities

Course Learning Outcomes (CLO):		Learning			Program Learning Outcomes (PLO)														
<i>At the end of this course, learners will be able to:</i>		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLO-1 :	Differentiate between different Extension systems in India	1	80	75	1	M				H			M	H		H	M	H	H
CLO-2 :	Explain of rural development process	2	75	70	2	H				H			L	H		H	M	H	H
CLO-3 :	Understand Extension efforts of Indian government	3	80	70	3	M				H			L	H		H	M	H	H
CLO-4 :	Appreciate the efforts of extension personnel in technology dissemination	3	80	75	3	M				H			M	H		H	M	H	H
CLO-5 :	Explain the basic principles of management and administration	2	80	70	2	L				H			M	H		H	M	H	H

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		12	6	15	6	9
S-1	SLO-1	Extension education: meaning, definition.	Transfer of technology: meaning and concepts, System of transfer of Technology	Communication – meaning, definition,	Teaching and learning-concepts and principles, Steps, Programming planning process – meaning, scope, principles and steps.	Extension administration: meaning, concept, scope, principles and functions.
	SLO-2	Nature, scope, objectives, principles, approaches and history of Extension education.	Models of Transfer of Technology	Elements and characteristics of communication	Evaluation: meaning, importance and methods	Concepts of human resource development (HRD)
S-2-3	SLO-1	Lab 1: Visit to ICFRE institutes to understand structure, functions, linkages and extension programmes	Lab 5: Visit to Village Panchayat to study about the development programmes	Lab 7: Exercises on distortion of message	Lab 12: Visit to village to study about prospects and problems of the village.	Lab 14: Practicing selected PRA techniques in a village setting
	SLO-2					
S-4	SLO-1	Horticulture extension: process, principles	Transfer of technology programmes like lab to land programme (LLP) national demonstration (ND), front line	Communication models- Aristotle, Shanon-Weaver, Berlo,	Scope and importance of Participatory Rural Appraisal (PRA)	Rural leadership –Meaning

			demonstration (FLD) and Krishi Vigyan Kendras (KVK).			
	SLO-2	Selected programmes of leading national and international forest institutes	Technology Assessment and Refinement Programme (TARP) etc. of ICAR.	Communication models - Schramm, Leagans, Rogers & Shoemaker	Scope and importance of Rapid Rural Appraisal (RRA).	Types of rural leadership
S-5-6	SLO-1	Lab 2: Visit to voluntary organization to understand the structure and functions	Lab 6: Visit to KVK to understand the extension activities	Lab 8: Script writing for farm broadcasts and telecasts	Lab 13: Identification of local leaders to study their role in extension work.	Lab 15: Evaluation of some selected case studies of forestry extension programmes.
	SLO-2					
S-7	SLO-1	Motivation of Farmers and rural youth for Horticulture extension work		Diffusion of Innovations – definition, elements;		ICT in Extension education
	SLO-2	Motivation of voluntary organizations for Horticulture extension work		Innovation – definition, attributes		ICT use in rural India.
S-8-9	SLO-1	Lab 3: Visit to State department of Horticulture to understand the organizational setup, roles, functions and various schemes.		Lab 9: Planning, preparation & use of NPVA like poster, chart, flash cards, folders etc.		Lab 16: Preparation of Village Agricultural productions plan
	SLO-2					
S-10	SLO-1	Rural Development: meaning, definition		Adoption – meaning, steps in adoption process.		
	SLO-2	objectives and genesis of rural development		Innovation decision process and adopter categories.		
S-11-12	SLO-1	Lab 4: Visit to All India Radio Station to study the various activities & programmes.		Lab 10: Planning, preparation & use of AVA like OHP & 35 mm slide projector transparencies.		
	SLO-2					
S-13	SLO-1			Factors influencing adoption of innovations		
	SLO-2			Consequences of innovations		
S-14-15	SLO-1			Lab 11: Exercise on practicing brainstorming techniques and presentation skills		
	SLO-2					

Learning Resources	1. Ahuja, B.N. (1997). <i>Theory and Practice of Journalism</i> . New Delhi: Surjeet Publications. pp.1-40.	5. Rogers, E.M. (1995). <i>Diffusion of Innovations</i> . New York: The Free Press. pp. 1-268.
	2. Dahama, O.P and Bhatnagar, O.P. (1985). <i>Education and Communication for Development</i> . New Delhi: Oxford & IBH Publishing Co. Pvt. Ltd., pp.1-70.	6. Singh, A.K. (2012). <i>Agricultural Extension</i> . New Delhi: Agrobios. pp.160-240.
	3. Neela Mukherjee. (1993). <i>Participatory Rural Appraisal: Methodology and Applications</i> . New Delhi: Concept Publishing Co. pp.1-160.	7. Supe, S.V. (1997). <i>An Introduction to Extension Education</i> . New Delhi: Oxford & IBH Publishing Co. Pvt. Ltd., pp.1-186.
	4. Ray, G.L. (1999). <i>Extension Communication and Management</i> . Calcutta: Naya Prokash. pp.1-358.	8. Van den Ban, A.W & Hawkins, H.S. (2002). <i>Agricultural Extension</i> . New Delhi: CBS Publishers & Distributors. pp.1-50.

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember Understand	40 %	30 %	30 %	40 %
Level 2	Apply Analyze	40 %	40 %	40 %	40 %
Level 3	Evaluate Create	20 %	30 %	30 %	20 %
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
P.Subha Nandhini Special Deputy Collector (Social Security Schemes) Tamil Nadu Government	Dr. C. Karthikeyan, Professor & Head (Social Sciences), Department of Social Sciences, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Killikulam, Vallandu Thoothukudi dt-628 252	Dr. Mohanraj K

THEORY

Unit I - Extension education

Extension education –meaning, definition, nature, scope, objectives, principles, approaches and history of extension education. Horticulture extension: process, principles and selected programmes of leading national and international forest institutes. People's participation in Horticulture programmes. Motivation of Farmers, rural youth and voluntary organizations for Horticulture extension work. Rural Development: meaning, definition, objectives and genesis.

Unit II Transfer of technology process

Transfer of technology - meaning and concepts. Systems of transfer of technology - Knowledge Generating System (KGS) - Knowledge Disseminating System (KDS) - Knowledge Consuming System (KCS). Constraints in Transfer of Technology - Transfer of technology programmes like lab to land programme (LLP) national demonstration (ND), front line demonstration (FLD) Krishi Vigyan Kendras (KVK), Technology Assessment and Refinement Programme (TARP) etc. of ICAR.

Unit III - Communication and adoption process

Communication: meaning, definition, elements and selected models. Audio – visual aids: importance, classification and selection. Diffusion of Innovations – definition, elements; Innovation – definition, attributes- Adoption – meaning-steps in adoption process- innovation decision process-adopter categories- Factors influencing adoption of innovations-Consequences of innovations.

Unit IV – Teaching and Participatory Extension

Teaching and learning-concepts and principles, Teaching steps, Programming planning process – meaning, scope, principles and steps. Evaluation: meaning, importance and methods. Scope and importance of Participatory Rural Appraisal (PRA) & Rapid Rural Appraisal (RRA).

Unit V - Management and administration

Management and administration-meaning, definition, principles and functions. Concepts of human resource development (HRD), rural leadership. ICT in Extension education- ICT use in rural India.

Theory -Lecture Schedule

1. Extension education: meaning, definition, nature, scope, objectives, principles, approaches and history
2. Horticulture extension: process, principles and selected programmes of leading national and international forest institutes.
3. Motivation of Farmers, rural youth and voluntary organizations for Horticulture extension work
4. Rural Development: meaning, definition, objectives and genesis
5. Transfer of technology: meaning and concepts, System of transfer of Technology and Models of Transfer of Technology
6. Transfer of technology programmes like lab to land programme (LLP) national demonstration (ND), front line demonstration (FLD) Krishi Vigyan Kendras (KVK), Technology Assessment and Refinement Programme (TARP) etc. of ICAR.
7. Communication – meaning, definition, elements and characteristics
8. Communication models - Aristotle, Shanon-Weaver, Berlo, Schramm, Leagans, and Rogers & Shoemaker.
9. In-Semester Examination
10. Diffusion of Innovations – definition, elements; Innovation – definition, attributes
11. Adoption – meaning, steps in adoption process, innovation decision process, adopter categories.
12. Factors influencing adoption of innovations; Consequences of innovations
13. Teaching and learning-concepts and principles, Steps, Programming planning process – meaning, scope, principles and steps. Evaluation: meaning, importance and methods
14. Scope and importance of Participatory Rural Appraisal (PRA) & Rapid Rural Appraisal (RRA).
15. Extension administration: meaning, concept, scope, principles and functions. Concepts of human resource development (HRD)
16. Rural leadership: Meaning, types.
17. ICT in Extension education, ICT use in rural India.

Practical Schedule

1. Visit to ICFRE institutes to understand structure, functions, linkages and extension programmes
2. Visit to voluntary organization to understand the structure and functions
3. Visit to State department of Horticulture to understand the organizational setup, roles, functions and various schemes.

4. Visit to All India Radio Station to study the various activities & programmes.
5. Visit to Village Panchayat to study about the development programmes
6. Visit to KVK to understand the extension activities
7. Exercises on distortion of message
8. Script writing for farm broadcasts and telecasts
9. Planning, preparation & use of NPVA like poster, chart, flash cards, folders etc.
10. Planning, preparation & use of AVA like OHP & 35 mm slide projector transparencies.
11. Exercise on practicing brain storming techniques and presentation skills
12. Visit to village to study about prospects and problems of the village.
13. Identification of local leaders to study their role in extension work.
14. Practicing selected PRA techniques in a village setting
15. Evaluation of some selected case studies of forestry extension programmes.
16. Preparation of Village Agricultural productions plan
17. **University Practical Examination**

Text Books

1. Ray, G.L. (1999). Extension Communication and Management. Calcutta: Naya Prokash. pp.1-358.
2. Rogers, E.M. (1995). Diffusion of Innovations. New York: The Free Press. pp. 1-34,210-268.
3. Singh, A.K. (2012). Agricultural Extension. New Delhi: Agrobios. pp.160-240.
4. Supe, S.V. (1997). An Introduction to Extension Education. New Delhi: Oxford & IBH Publishing Co. Pvt. Ltd., pp.1-186.
5. Van den Ban, A.W & Hawkins, H.S. (2002). Agricultural Extension. New Delhi: CBS Publishers & Distributors. pp.1-50.

Reference Books

1. Ahuja, B.N. (1997). Theory and Practice of Journalism. New Delhi: Surjeet Publications. pp.1-40.
2. Dahama, O.P and Bhatnagar, O.P. (1985). Education and Communication for Development. New Delhi: Oxford & IBH Publishing Co. Pvt. Ltd., pp.1-70.
3. Neela Mukherjee. (1993). Participatory Rural Appraisal: Methodology and Applications. New Delhi: Concept Publishing Co. pp.1-160.

Web References

1. www.manage.gov.in
2. <https://rural.nic.in/>
3. www.panchayat.gov.in
4. <https://wcd.nic.in/>
5. <http://agritech.tnau.ac.in/>
6. <https://caes.ucdavis.edu/outreach/ce>
7. <https://cals.cornell.edu/outreach-extension>
8. <https://ag4impact.org/sid/socio-economic-intensification/building-human-capital/agricultural-extension/>
9. <https://uscode.house.gov/view.xhtml?req=%28title%3A7%20section%3A3221%20edition%3Aprelim%29%20OR%20%28granuleid%3AUSC-prelim-title7-section3221%29&f=treesort&edition=prelim&num=0&jumpTo=true>
10. <https://nifa.usda.gov/program/agricultural-extension-programs-1890-institutions>

Journals

1. International Journal of Extension Education
2. Indian Journal of Extension Education
3. Journal of Extension Education
4. Indian Journal of Gender Studies
5. Journal of Rural Development
6. Yojana

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	SUP19602	Course Name	Apiculture, Sericulture and Lac Culture	Course Category	S	Supplementary Course	L	T	P	C
							1	0	1	2

Pre-requisite Courses	CRH 19301	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Crop Protection	Data Book / Codes/Standards			

Course Learning Rationale (CLR):		The purpose of learning this course is to:			Learning			Program Learning Outcomes (PLO)																
CLR-1 :	Obtain Knowledge on importance of beneficial insects	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
CLR-2 :	Describe the equipments and seasonal management of honey bee																							
CLR-3 :	Identify the bee pasturage, Insect pests and diseases of honey bee.																							
CLR-4 :	Attain knowledge on types of silkworm, Chawki rearing and late age silk worm raring																							
CLR-5 :	Obtain basic information on pest and diseases of silkworm and their management																							
CLO-6	Comprehend the lac cultivation and their product																							
Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:																						
CLO-1 :	Impart skills on beneficial insects	2	90	80	M											M	H		H	H	H	H		
CLO-2 :	Recognize the knowledge of honey bee species , equipments and seasonal management of honey bee	3	80	85	H											L	H		H	H	H	H		
CLO-3 :	Understand the bee pasturage, Insect pests and diseases of honey bee	1	75	70	M			L								M	H		H	H	H	H		
CLO-4 :	Determine different types of silkworm, Chawki rearing and late age silk worm raring	2	80	60	M				L							L	H		H	H	H	H		
CLO-5	Interpret the pest and diseases of silkworm and their management	3	75	60	L	L	L	L								M	H		H	H	H	H		
CLO-6	Understand the lac cultivation and their product	2	75	65	L								H			M	H		H	H	H	H		

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		7	12	6	15	8
S-1	SLO-1	Introduction to beneficial insects; Importance and History of apiculture	Lab: 3 Study of pests of honeybees and management practices	Lab: 7 Leaf Harvest method – Leaf preservation techniques – shoot harvest method.	Lab: 9 Rearing house– site selection – types – Environmental condition – Silkworm rearing tools and equipment's – Disinfectants.	Lab: 14 Study of lac insects-biology and behaviour
	SLO-2	Lab:1 Study of honey bee colonies, different bee hives, apiculture equipments	Bee colony maintenance,	Importance, History and development in India, Silkworm types and hosts; systematic position, distribution.	Leaf Harvest method – Leaf preservation techniques – shoot harvest method.	Lac rearing: scope and importance; national scenario, lac cultivation, food plants, pruning, inoculation, cropping, kinds of lac.
S-2	SLO-1	Species of honeybees: Rock bee, Little bee, Indian bee, European bee or Italian bee and Dammar bee; lifecycle	Lab: 4 Study of diseases of honeybees and management practices	Lab: 8 Mulberry pests and Diseases – Their management practices	Lab:10 Chawki rearing techniques – Chawki Rearing Centers.	Lab: 15 Cultural Practices in Lac cultivation
	SLO-2	Lab: 2 Management of colony in different season, honey extraction and bottling	Bee colony activities starting of new colony, location site, transferring colony, replacement of queen, combining colonies, swarm prevention, colony management in different seasons	Irrigated mulberry cultivation – Site, soil, climate, variety selection - Manures and Fertilizer application – Irrigation – Weeding – Plant protection measures – Pruning – Harvesting. – Rainfed mulberry cultivation	Mulberry pests and diseases their management practices.	Enemies of lac insects: predators, parasites, precautionary measures and control measures; Lac harvesting, scrapping

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		7	12	6	15	8
S-3	SLO-1	Caste determination in honey bees.	Lab: 5 Nursery field preparation methods – Manures and Fertilizers application methods – Mother plant selection – Mulberry cutting preparation – Pre-treatments - Irrigation methods – Plant protection techniques – uprooting – Transport.		Lab: 11 Late age worms rearing techniques – Feeding – Bed cleaning – Types of Montages - Cocoon harvest.	Lab: 16 Visit to commercial honey and Lac production units
	SLO-2		Equipment for apiary, Types of bee hives and their description		Grainage – seed cocoon selection – grainage unit activity – loose eggs production – egg card production.	
S-4	SLO-1	-	Lab: 6 Main field – primary & secondary tillage equipment's – Field preparation methods – Manures and Fertilizers application – Planting methods – Irrigation methods – weeding methods - Fertigation – Plant Protection methods – Pruning techniques.		Lab: 12 Silkworm pests and Diseases – Their management practices.	-
	SLO-2	-	Bee pasturage; Honey extraction, honey composition and value; bee wax and their uses.	-	Rearing house – site selection – types – Environmental condition – Silkworm rearing tools and equipment's – Disinfectants.	-
S-5	SLO-1				Lab: 13 Visit to Chawki Rearing Center, Late age worms Rearing unit and cocoon	
	SLO-2				Chawki and Late age worms rearing – mounting -cocoon harvest – cocoon market	

Learning Resources	1. Dandin, S.B., Jayaswal, J and Giridhar, K. (2003). Hand book of Sericulture Technologies. Central Silk Board, Bangalore, pp1-287.
	2. David, B.V and Ramamurthy, V.V. (2011). Elements of Economic Entomology, Namrutha Publications, Chennai, pp1- 386.

	Level of Thinking	Continuous Learning Assessment (35% weightage)		Final Practical Examination (15%)	Final theory Examination (50%)
		In Semester (20%)	Practical (15%)		
Level 1	Remember Understand	40 %	40 %	35 %	30 %
Level 2	Apply Analyze	40 %	30 %	40 %	40 %
Level 3	Evaluate Create	20 %	30 %	25 %	30 %
	Total	100 %	100 %	100 %	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. K. Ramesh Ph.D Principal Biologist –Rice Insecticide and Nematicide, South Asia Co-chair for insecticide resistance action committee(IRAC), India Corteva agrisciences (Dow Dupont) Madhapur, Hyderabad, India e- mail :ramesh.kaliaperumal@corteva.com mobile : 9952885708	Dr. K. Kandibane,Associate professor, Department of Agricultural Entomology, PAJANCOA&RI, Karaikal-609603	Dr. L.Ramazeame Ph.D (Assistant Professor) Agricultural Entomology Dr. N. Murugan Ph.D (Assistant professor) Sericulture

THEORY

Unit I - Introduction to beneficial insects

Introduction to beneficial insects; Importance and History of apiculture; Species of honeybees: Rock bee, Little bee, Indian bee, European bee, Italian bee and Dammar bee; lifecycle and caste determination in honey bees.

Unit II - Bee maintenance, honey and wax production

Bee colony maintenance, bee colony activities, starting of new colony, location site, transferring colony, replacement of queen, combining colonies, swarm prevention, colony management in different seasons, Equipment for apiary; types of bee hives and their description; Bee pasturage; Honey extraction, honey composition and value; bee wax and uses

Unit III – Sericulture history and mulberry cultivation

Importance, History and development in India; silkworm types and hosts; systematic position, distribution; Irrigated mulberry cultivation – Site, soil, climate, variety selection. Manures and Fertilizer application, Irrigation, Weeding, Plant protection measures, Pruning, Harvesting. Rainfed mulberry cultivation. Leaf Harvest method, Leaf preservation techniques, shoot harvest method. Mulberry pests and diseases, Management Practices.

Unit IV – Silkwork grainage unit and mulberry silkworm cocoon production

Grainage, seed cocoon selection, Grainage unit activity, loose eggs production, egg card production. Rearing house, site selection, types, Environmental condition. Silkworm rearing tools and equipment's, disinfectants. Chawki and Late age worms rearing, mounting, cocoon harvest, cocoon market. Silkworm pests and Diseases. Their management practices. Visit to Chawki Rearing Center, Late age worms rearing unit and cocoon market.

Unit V - Lac culture

Lac rearing: scope and importance; national scenario, lac cultivation, food plants, pruning, inoculation, cropping, kinds of lac; Enemies of lac insects: predators, parasites, precautionary measures and control measures; Lac harvesting, scrapping

Theory - Lecture Schedule

1. Introduction to beneficial insects; Importance and History of apiculture
2. Species of honeybees: Rock bee, Little bee, Indian bee, European bee or Italian bee and Dammar bee and their lifecycle
3. Caste determination in honey bees. Bee colony maintenance, bee colony activities
4. Starting of new colony, location site, transferring colony, replacement of queen, combining colonies, swarm prevention, colony management in different seasons
5. Equipment for apiary, Types of bee hives and their description
6. Bee pasturage; Honey extraction, honey composition and value; bee wax and their uses.
7. Importance, History and development in India, Silkworm types and hosts; systematic position, distribution.
8. Irrigated mulberry cultivation – Site, soil, climate, variety selection - Manures and Fertilizer application – Irrigation – Weeding – Plant protection measures – Pruning – Harvesting. – Rainfed mulberry cultivation.
9. **In – Semester Examination**
10. Leaf Harvest method – Leaf preservation techniques – shoot harvest method.
11. Mulberry pests and diseases – Management Practices.
12. Grainage – seed cocoon selection – grainage unit activity – loose eggs production – egg card production.
13. Rearing house – site selection – types – Environmental condition – Silkworm rearing tools and equipment's – Disinfectants.
14. Chawki and Late age worms rearing – mounting -cocoon harvest – cocoon market.
15. Lac rearing: scope and importance; national scenario, lac cultivation, food plants, pruning, inoculation, cropping, kinds of lac.
16. Enemies of lac insects: predators, parasites, precautionary measures and control measures; Lac harvesting, scrapping

Practical Schedule

1. Study of honey bee colonies, different bee hives, apiculture equipments
2. Management of colony in different season, honey extraction and bottling
3. Study of pests of honeybees and management practices
4. Study of diseases of honeybees and management practices
5. Nursery field preparation methods – Manures and Fertilizers application methods – Mother plant selection – Mulberry cutting preparation – Pre-treatments - Irrigation methods – Plant protection techniques – uprooting – Transport.
6. Main field – primary & secondary tillage equipment's – Field preparation methods – Manures and Fertilizers application – Planting methods – Irrigation methods – weeding methods - Fertigation – Plant Protection methods – Pruning techniques.

7. Leaf Harvest method – Leaf preservation techniques – shoot harvest method.
8. Mulberry pests and Diseases – Their management practices.
9. Rearing house– site selection – types – Environmental condition – Silkworm rearing tools and equipment's – Disinfectants.
10. Chawki rearing techniques – Chawki Rearing Centers.
11. Late age worms rearing techniques – Feeding –Bed cleaning –Types of Mountages - Cocoon harvest.
12. Silkworm pests and Diseases – Their management practices.
13. Visit to Chawki Rearing Center, Lateage worms Rearing unit and cocoon market
14. Study of lac insects-biology and behaviour
15. Cultural Practices in Lac cultivation
16. Visit to commercial honey and Lac production units
17. **University Practical Examination**

Text Books

1. Sunita, N.D, Guled, M.B., Mulla S.R. and Jagginavar. 2003. Beekeeping, UAS Dharwad
2. Singh, S. 1975. Bee keeping in India – ICAR, New Delhi., 214p.
3. Glover, P.M. 1937. Lac cultivation in India. Indian Lac Research Institute, Ranchi.

Reference Books

1. Paul DeBach and David Rosen 1991. Biological control by natural enemies. Cambridge University Press; 2 edition (27 June 1991).
2. Ganga,G. and SulochanaChetty, J. 1997. An introduction to Sericulture (2nd Edn.). Oxford & IBH publishing Co. Pvt. Ltd., New Delhi.
3. Lewis Davenport. 2017. Biological Control: Methods, Applications and Challenges. Agriculture Issues and Policies, Nova science publisher.

Web Reference

1. <https://www.studyandscore.com/studymaterial-detail/apiculture-introduction-bee-colony-and-bee-dance>
2. <https://www.slideshare.net/safeermanhas/apiculture-95442492>
2. http://agritech.tnau.ac.in/farm_enterprises/fe_apiculture_home.html
3. <https://youtu.be/ghzfT8igpIU>
4. <https://youtu.be/hvuZ1LQBTsc>

Journals

1. Journal of Apicultural Research
2. The Journal of Apicultural Science
2. Indian Journal sericulture
3. The Journal Sericulture science of Japan

Course Nature: Theory based Practical							
Total Marks (100)							
S.No.	Category	Assessment Tools					
		In- Semester Examination	Assignment	Record	Attendance	End-Semester Examination	Marks
1	Theory-External	-	-		-	50	50
2	Theory-Internal	20	-			-	20
3	Practical-External	-	-		-	15	15
4	Practical-Internal	-	5	5	5	-	15
Grand Total							100

Course Code	Course Title	T	P	C
STR19702	All India Study Tour	0	1	1
Course Orientation: To familiarize the students with the flora , fauna and other research activities of State Agricultural Universities, research institutes, forest industries, government and private organization of different parts of India. To expose the students to various national / heritage monuments as part of national integration activity.				

Course Outcome

The course will provide an opportunity for the students to study the functioning of important national and international institutes related to agriculture and allied fields. The students will be taken for a fifteen day trip to various national and international institutions and industries related to agriculture, horticulture, forestry and other allied fields in various regions of the country. During the tour programme, the students will gain first-hand information on different agro-climatic zones, crops grown, cultivation practices, socio-cultural and economic status of the farming communities. The students will be evaluated as indicated below:

Course Nature: Practical			
Total Marks (100)			
S.No.	Category	Assessment Tools	Marks
1	Practical-Internal	Purely internal based on the participation, involvement and contribution of students in the activities pertaining to the course and the assessment criteria be as follows, Written Test Behaviour (Punctuality and Discipline) Observation Note Book Viva-Voce Attendance	40 20 25 10 05
Grand Total			100

Course Code	STR19703	Course Name	Student READY - Placement in Villages	Course Category	S	Student READY	L	T	P	C
							0	0	10	10

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Agricultural Social Sciences			Data Book / Codes/Standards	Nil

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Describe the opportunity to the students to understand the rural setting in relation to horticultural activities
CLR-2 :	Explain the students with socio-economic conditions of the farmers and their problems.
CLR-3 :	Impart diagnostic and remedial knowledge to the students relevant to real field situations through practical training
CLR-4 :	Develop communication skills in students using extension teaching methods in transfer of technology.
CLR-5 :	Develop confidence and competence to solve agricultural problems
CLO-6	Explain students on-going extension and rural development programmes

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:
CLO-1 :	Understand farmers issues and address them effectively
CLO-2 :	Comprehend various farming activities
CLO-3 :	Relate and cross-verify theoretical concepts in field conditions
CLO-4 :	Discuss various institutions in rural setting and understand the importance of rural institutions in problem solving and development
CLO-5	Comprehend the role of horticultural departments in the growth of horticulture
CLO-6	Appreciate the role of NGOs in overall development of India

Learning		
1	2	3
Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
1	80	75
2	85	80
3	80	75
3	75	70
2	80	75
3	75	70

Program Learning Outcomes (PLO)														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems through RAWE and AIA	Ability to implement knowledge gained in the applied field of Agriculture	Ability to understand social and ethical responsibilities of Agriculture
M					H			M	H		H	M	M	L
H					H			L	H		H	M	M	L
M					H			L	H		H	M	M	L
M					H			M	H		H	M	M	L
L					H			M	H		H	M	M	L
M					H			H	L		M	M	M	L

Category	Assessment Tools	Marks
Practical-Internal	Purely internal based on the participation, involvement and contribution of students in the activities pertaining to the course and the assessment criteria be as follows,	
	Daily Observation Note	20
	Placement Record	25
	Exhibition	25
	Oral Presentation	25
	Attendance	05
Grand Total		100

Village Stay Program

Study of rural situation – village settlement pattern, demography, climate, land utilization pattern, resources inventory, infrastructure facilities, rural institutions, organizations, groups, customs, beliefs and value systems - Study of cropping pattern, cropping systems, extent of adoption of latest technologies and constraints – cereals, millets, pulses, oilseeds – productivity – Decline in productivity – Yield gap – constraints in production -Understanding social participation, leadership pattern, scientific orientation and role of women and youth in agricultural development -Extension methods and Audio Visual Aids – Practicing individual, group and mass contact methods - Studying the existing Indigenous Technical Knowledge and its importance for technology generation-Conducting PRA to assess the resources. Understanding the communication pattern in villages- Studying farm women associations / farmers associations / commodity groups and learning their functioning and use of their services for dissemination- Conducting need based skill demonstrations in the villages- Developing Whole Village Development Plan- Contacting individual farmers to assess the farming systems practiced by marginal, small, medium, big farmers and Farm Women- Preparation of Individual farm plan - Documentation of success stories of the farmers.

Unit II ADH Attachment

Study the organizational structure and schemes implemented by the various Development Departments- Study of Horticultural Department – Organization pattern, role and functions of Department of Horticulture.

Unit III NGO Attachment

Study of NGO – Roles and objectives – organizational pattern – sources of funding – extension activities of NGO – Contacting target groups.

Course Nature: Practical			
Total Marks (100)			
S.No.	Category	Assessment Tools	Marks
1	Practical-Internal	Purely internal based on the participation, involvement and contribution of students in the activities pertaining to the course and the assessment criteria be as follows,	
		Daily Observation Note	20
		Placement Record	25
		Exhibition	25
		Oral Presentation	25
		Attendance	05
Grand Total			100

Course Code	STR19704	Course Name	Student READY - Placement in Industries	Course Category	S	Student Ready	L	T	P	C
							0	0	10	10

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Agricultural Social Sciences	Data Book / Codes/Standards			Nil

Course Learning Rationale (CLR):		The purpose of learning this course is to:			Learning			Program Learning Outcomes (PLO)														
CLR-1 :	Perform carrier opportunity by real industry exposure	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	Understand industries customs and practices				Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems through Placement in industries	Ability to implement knowledge gained in the applied field of Agriculture	Ability to understand social and ethical responsibilities of Agriculture			
CLR-3 :	Enhance employee ability skills																					
CLR-4 :	Enhance the students knowledge in horticulture based industries																					
CLR-5 :	Describe critical thinking, discipline, competencies and specific skills																					
Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:																				
CLO-1 :	Determine hands on practice within a real job situation	1	80	75	1	M	H			H	H		M	H		H	M	M	L			
CLO-2 :	Understand work culture and ethics	2	85	80	2	H	H			H	H		L	H		H	M	M	L			
CLO-3 :	Perform the knowledge on updated technologies	3	80	75	3	M	H			H	H		L	H		H	M	M	L			
CLO-4 :	Recognize work environment by an individual and in a group as an effective team member	3	75	70	3	M	H			H	H		M	H		H	M	M	L			
CLO-5	Outline a report based on the experiences in real work environment	2	80	75	2	L	H			H	H		M	H		H	M	M	L			

Category	Assessment Tools	Marks
Practical-Internal	Purely internal based on the participation, involvement and contribution of students in the activities pertaining to the course and the assessment criteria be as follows,	
	Daily Observation Note	20
	Placement Record	25
	Exhibition	25
	Oral Presentation	25
	Attendance	05
Grand Total		100

Placement in industries

The students shall be placed in different horticultural industries for practical exposure

- Cut flower industry
- Processing of fruits and vegetables
- Processing of spices and condiments
- Processing of medicinal plants
- Landscaping
- Marketing and logistics management
- Dry flower Industry

Course Nature: Practical			
Total Marks (100)			
S.No.	Category	Assessment Tools	Marks
1	Practical-Internal	Purely internal based on the participation, involvement and contribution of students in the activities pertaining to the course and the assessment criteria be as follows,	
		Daily Observation Note	20
		Placement Record	25
		Exhibition	25
		Oral Presentation	25
		Attendance	05
Grand Total			100

Course Code	STR19801	Course Name	Bio-inoculants Production Technology	Course Category	E	Experiential learning	L	T	P	C
							0	0	10	10

Pre-requisite Courses	AGE19203	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Microbiology	Data Book / Codes/Standards			

Course Learning Rationale (CLR):		Learning			Program Learning Outcomes (PLO)														
<i>The purpose of learning this course is to:</i>		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	Acquire skills on the isolation of nitrogen fixing bacteria	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems through Agricultural Microbiology	Ability to implement knowledge gained in the applied field of Agricultural Microbiology	Ability to understand social and ethical responsibilities of Agricultural Microbiology
CLR-2 :	Gain skills on Blue Green Algae (BGA) and Azolla cultivation																		
CLR-3 :	Gain knowledge on the isolation of P solubilizing bacteria and P mobilizing microorganisms																		
CLR-4 :	Learn about the operation of a bioreactor																		
CLR-5 :	Acquire skills on the mass production of bioinoculant																		
CLO-6 :	Gain knowledge on the establishment and marketing of bioinoculants																		

Course Learning Outcomes (CLO):		Learning			Program Learning Outcomes (PLO)														
<i>At the end of this course, learners will be able to:</i>		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLO-1 :	Demonstrate the isolation of the nitrogen fixing bacteria	3	90	80	M								L	H		H	H	H	H
CLO-2 :	Explain about BGA and Azolla cultivation	1	95	85	H								L	H		H	H	H	H
CLO-3 :	Elaborate about the biofertilizer industrial setup and its requirements	2	75	65	L	H	H	L					L	H		H	H	H	H
CLO-4 :	Attribute about the operation principles and maintenance of a bioreactor	1	80	70	L	H	H	L					L	H		H	H	H	H
CLO-5 :	Perform mass production of bio inoculants	3	75	60	H	H	H		L				M	H	L	H	H	H	H
CLO-6 :	Develop a biofertilizer unit	3	80	70	H	L	H						M	H		H	H	H	H

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		3	3	3	3	4
S-1	SLO-1	Week 1- : Isolation and Characterization of Rhizobium from root nodules of legumes	Week 4: Isolation and Characterization of phosphobacteria and Pseudomonas from rhizosphere soil	Week 7: Mass production of bioinoculants	Week 10: Mass production of Azolla and BGA	Week 13 : Seed Treatment of Bacterial Biofertilizer
	SLO-2					
S-2	SLO-1	Week 2: Isolation and Characterization of Azospirillum from rice roots	Week 5: Isolation and Characterization of Gluconacetobacter from sugarcane	Week 8: Development of lignite based bioinoculant	Week 11: Isolation of PPFM's from the phyllosphere of crops	Week 14: Development of liquid Biofertilizer
	SLO-2					
S-3	SLO-1	Week 3: Isolation and Characterization of Azotobacter from soil	Week 6: Isolation of zinc and silicate solubilizing bacteria	Week 9: Quality Assessment of bacterial biofertilizer	Week 12. Mass Production of Arbuscular mycorrhizal (AM) fungi	Week 15: Economics of biofertilizer production
	SLO-2					
S-4	SLO-1	-				Week 16: Visit to biofertilizer production unit

Learning Resources	1. Deshmukh, A. M., Khobragade, R. M., and Dixit, P. P. (2007). Handbook of biofertilizers and biopesticides (1 st Edn.). India, Oxford Book,ISBN: B1-B9473.15). ..pp 1-645 2. Subba, R. (2017). Soil microbiology (4 th Edn.), India: Oxford and IBH Publishing, (ISBN-10: 8120413830). pp 1-426

	Level of Thinking	Final internal Examination (100%)
Level 1	Remember	20 %
	Understand	
Level 2	Apply	40 %
	Analyze	
Level 3	Evaluate	40 %
	Create	
	Total	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. C. Vaithilingam Romvijay Biotech PVT LTD NH32, Mullodai, Kanniyakoil, Puducherry 607402	Dr.Sivakumaar PK, Professor, Department of Microbiology, Faculty of Agriculture, Annamalai University, Annamalaiagar-608002	Dr. Anbukarasi K Dr. Melvin Joe M

Practical

Biofertilizer- Introduction, status and scope. Structure and characteristic features of bacterial biofertilizers- Azospirillum sp., Azotobacter sp., Bacillus sp., Pseudomonas sp., Rhizobium sp. and Frankia; Azolla and BGA, fungal biofertilizers- AM mycorrhiza. Mass production of various nitrogenous bioinoculants -Rhizobium, Azospirillum, Azotobacter, Gluconacetobacter diazotrophicus, Azolla and BGA. Production of phosphatic bioinoculants-AM fungi and phosphate solubilizers. PPFM, PGPR, zinc solubilizers, silicate solubilizers, potash releasers and sulphur oxidizer. Fermentation- fermenter types and operation-downstream processing- Use of bioreactor in biofertilizer production-commercial bioinoculants production viz., BIS standards for quality testing of various bioinoculants. Newer formulations of biofertilizer. Application methods for biofertilizers. Visit to commercial biofertilizer production unit, Establishment of bioinoculants production unit- facilities and equipment's required for laboratory scale, pilot scale and large scale, marketing of products and project preparation for establishing bioinoculants production unit. Basic concepts on Artificial intelligence - Predictive microbiology (RSM)

Text Books

1. Deshmukh, A. M., Khobragade, R. M., and Dixit, P. P. (2007). Handbook of biofertilizers and biopesticides (1st Edn.). India: Oxford Book, ISBN: B1-B9473.15). pp. 1-645.
2. Glick, B. R. (2015). Beneficial plant-bacterial interactions (2nd Edn), Germany: Springer, (ISBN 978-3-030-44467-2). pp. 1-243.
3. Subba Rao, N.S. (1999). Biofertilizers in Agriculture and Agroforestry (3rd Edn), India : Oxford and IBH, (SBN:1881570290).pp.1-426.
4. Subba, R. (2017). Soil microbiology (4th Edn), India: Oxford and IBH Publishing, (ISBN-10: 8120413830).pp. 1-426.

Reference Books

1. Kannaiyan, S. (Ed.). (2002). Biotechnology of biofertilizers (1st Edn), Germany: Springer Science & Business Media, (ISBN 1-4020-0219-X). pp. 1-376.
2. Motsara, M.R., Bhattacharyya, P. and Srivastava, B., (1995). Biofertilizer-Technology, Marketing and Usage. 9(1st Ed). India: Fertilizer Development and Consultant Organization,(ISBN-139788185116389). pp. 1-184.
3. Rai M.K. 2006. Handbook of Microbial Biofertilizers.(1st Edn.), New York: Food Products Press, (ISBN 13: 978-1 55022-269 9). pp.1-543.
4. Singh, T., and Purohit, S. S. (2008). Biofertilizer Technology (1st Edn.), New Delhi: Agrobios. (ISBN 13: 9788177543827).pp 1-764.

Web-References

1. https://ecourses.icar.gov.in/e-Leaarningdownload3_new.aspx?Degree_id=01
2. <http://ecoursesonline.iasri.res.in/Courses/Agricultural%20Microbiology/AMBE101/Start%20to%20read%20the%20Course.html>
3. <https://sites.google.com/site/soilagrlmicrobiol/>
4. <https://www.rhizobia.co.nz/taxonomy/rhizobia>
5. <https://sites.google.com/site/soilagrlmicrobiol/books-book-chapters/Biofertilizers%20and%20sustainability.pdf?attredirects=0>
6. <https://www.youtube.com/watch?v=bq1bTdZtZC0>

Course Nature: Practical			
Total Marks (100)			
S.No.	Category	Assessment Tools	Marks
1	Practical-Internal	Purely internal based on the participation, involvement and contribution of students in the activities pertaining to the course	
		Continuous evaluation of routine activities	30
		Execution skill and Product generation/ Competence	20
		Written test	20
		Record and Observation Note	20
		Viva-Voce	05
		Attendance	05
Grand Total			100

Course Code	STR19802	Course Name	Production Technology of Bio-control Agents	Course Category	E	Experiential learning	L 0	T 0	P 10	C 10

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Plant Pathology	Data Book / Codes/Standards			

Course Learning Rationale (CLR):		Learning			Program Learning Outcomes (PLO)														
<i>The purpose of learning this course is to:</i>		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	Learn the principles of biological control of plant diseases & pests	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems	Ability to implement knowledge gained in the applied field	Ability to understand social and ethical responsibilities
CLR-2 :	Gain knowledge about the laboratory equipments used for biocontrol agent production				M			L					M	H		H	L	H	H
CLR-3 :	Acquire information on different biocontrol agents for the management of diseases and insect pests				M			M					L	H		H	L	H	H
CLR-4 :	Infer about the isolation and culturing of biocontrol agent				M								L	H		H	M	H	H
CLR-5 :	Perceive skill on selection of efficient biocontrol agent				M	M							M	H		H	L	H	H
CLO-6 :	Gain knowledge on mass production of biocontrol agents, quality testing and delivery				L								M	H		H	M	H	H

Course Learning Outcomes (CLO):		Learning			Program Learning Outcomes (PLO)														
<i>At the end of this course, learners will be able to:</i>		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLO-1 :	Exhibit skills on the isolation and culturing of micro-organisms responsible for plant disease management	1	95	80	M			L					M	H		H	L	H	H
CLO-2 :	Demonstrate on the screening of efficient bioagent	2	90	85	M								L	H		H	L	H	H
CLO-3 :	Extend mass multiply of the effective bioagent	2	85	70	M								L	H		H	M	H	H
CLO-4 :	Perusade on the quality control and production economics of bioinoculants	1	75	65	M	M							M	H		H	L	H	H
CLO-5 :	Appraise the concept of beneficial insects for insect pest management	2	75	60	L								M	H		H	M	H	H
CLO-6 :	Potential to setup a biocontrol unit	3	75	65	L	L	M		L		H		M	H		H	L	H	H

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		4	3	3	3	3
S-1	SLO-1	Week 1- Principles and concepts of biological control	Week 5 – Identification of antagonists (fungi and bacteria)	Week 8 – Screening Identification of suitable bioagent	Week 11- Mass multiplication <i>Trichoderma</i> sp, <i>Bacillus</i> sp., and <i>Pseudomonas</i> sp	Week 14 - Selection and maintenance of colonies <i>Coryca cephalonica</i> and <i>Maconellicoccus hirsutus</i>
	SLO-2					
S-2	SLO-1	Week 2- Laboratory equipments and their Principle.s	Week 6- Isolation of antagonistic microbes Rhizosphere soil , Phyllosphere microbes & Endophytes	Week 9 - Identification of potential biocontrol agent	Week 12 -Mass multiplication of <i>Paecilomyces</i> sp, and <i>Pasteuria</i> sp	Week 15 - Mass production <i>Trichogramma</i> , <i>Chrysoperla</i> and <i>Cryptolaemus montrouzieri</i>
	SLO-2					
S-3	SLO-1	Week 3- Culturing techniques and Media preparation	Week 7- Isolation of antagonistic microbes	Week 10- Morphology and molecular confirmation	Week 13- Carrier material and application methods	Week 16 - Mass production Enumeration, standardization and quality control.
	SLO-2					
S-4	SLO-1	Week 4- Culturing of soil microbes and antagonists				
	SLO-2					

Learning Resources	Text Books:	Reference Books: 1. Narayanasamy, P. (2008). <i>Biological Management of Diseases of crops</i> . New York:Springer. pp.1-673.

	1. Chaube, H.S. and Pundhir. V.S. (2009). <i>Crop diseases and their management</i>. New Delhi:PHI Learning Private Limited. pp. 1-724. 2. Mukherjee P.K, Horwitz B.A, et al. (2013). <i>Trichoderma biology and applications</i>. CABl. pp. 1-344.	

	Level of Thinking	Final Final Internal Evaluation (100%)
Level 1	Remember	20%
	Understand	
Level 2	Apply	40%
	Analyze	
Level 3	Evaluate	40%
	Create	
	Total	100%

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. N. Muralitharan Regional Manager NACL Industries limited. Ph- 9677780714	Dr. S. Nakkeeran, Professor, Department of Biotechnology, Centre for Plant Molecular Biology & Biotechnology, AC & RI, TNAU, Coimbatore -641003	Dr.L.Ramazeame (Assistant professor) Agricultural Entomology Dr. Rageshwari S Assistant Professor (Plant Pathology) Dr. Vinod Kumar S Assistant Professor (Plant Pathology)

Practical

Principle and concept of biological control; laboratory equipments; media preparation and sterilization methods; calibration of microscope; spore observation: use of haemocytometer, assessment of spore load and colony forming units; Antagonistic microorganisms: isolation of biocontrol agents viz., *Trichoderma* sp, *Pseudomonas* sp, *Bacillus* sp, *Paecilomyces* sp, and *Pasteuria* sp – morphological characterization and molecular characterization, in vitro screening, quality control, delivery system, screening with different carrier materials, compatibility study with other biocontrol agents, fungicides and pesticides, economics, project preparation. Natural enemies and entomopathogens: economic importance; establishment of model biocontrol agents, production units; selection and maintenance of healthy colonies of host insects: *Corcyra cephalonica* and *Maconellicoccus hirsutus*; mass production of *Trichogramma*, *Chrysoperla* and *Cryptolaemus montrouzieri* and entomopathogenic fungi: enumeration, standardization and quality control.

Text Books

1. Ashok Pande and Mukerji. (2006). Biological control of plant diseases. CRC Press. pp. 1-246.
2. Chaube, H.S. and Pundhir. V.S. (2009). Crop diseases and their management. New Delhi: PHI Learning Private Limited. pp 1-724.
3. Gnanamanickam S. S. (2002). Biological control of crop diseases. CRC Press. pp 1-480.
4. Mukherjee P.K, Horwitz B.A, et al. (2013). *Trichoderma* biology and applications. CABI. pp.1-344.
5. Upadhyy, R.K, Mukerji, K.G. and Chamola, B.P. (2000). Biocontrol potential and its exploitation in sustainable agriculture. Vol 1: Crop diseases, weeds, and nematodes. New York: Springer. pp. 1-294.

Reference Books

1. Ajay Singh, Nagina Parmar and Ramesh C.Kuhad. (2011). Bioaugmentation, Biostimulation and Biocontrol. New York: Springer.pp.1-364.
2. Narayanasamy, P. (2008). Biological Management of Diseases of crops. New York: Springer. pp.1-673.
3. Reddy P. P. (2014). Plant growth promoting rhizobacteria for horticultural crop protection. India: Springer. pp. 1-310.
4. Siddiqui Z. A. (2006). PGPR: biocontrol and biofertilization. Netherlands: Springer.pp. 1-318.
5. Zhang K-Q, Hyde K. D. (2014). Nematode-trapping fungi. Netherlands: Springer Science & Business. pp. 1-392.

Web-References

1. <https://www.youtube.com/watch?v=ARCbgCv6ln8>
2. <https://www.youtube.com/watch?v=Gews2FoBMZY>
3. <https://www.youtube.com/watch?v=hWdmL8sGCB4>
4. <https://www.youtube.com/watch?v=14zmmbXsyuM>

Journals

1. Biological control
2. Biocontrol science and technology
3. Biocontrol
4. Crop protection
5. European journal of plant pathology
6. Phytopathology

Course Nature: Practical			
Total Marks (100)			
S.No.	Category	Assessment Tools	Marks
1	Practical-Internal	Purely internal based on the participation, involvement and contribution of students in the activities pertaining to the course	
		Continuous evaluation of routine activities	30
		Execution skill and Product generation/ Competence	20
		Written test	20
		Record and Observation Note	20
		Viva-Voce	05
		Attendance	05
Grand Total			100

Course Code	STR19803	Course Name	Mushroom Cultivation Technology	Course Category	E	Experiential learning	L	T	P	C
							0	0	10	10

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Plant Pathology	Data Book / Codes/Standards			

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning			Program Learning Outcomes (PLO)														
CLR-1 :	Understand the importance of mushroom	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	Attain knowledge about mushroom nutritive and medicinal value	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems	Ability to implement knowledge gained in the applied field	Ability to understand social and ethical responsibilities
CLR-3 :	Learn about different types of mushroom				M			L					M	H		H	L	H	H
CLR-4 :	Obtain skill for mushroom cultivation				M	L		M					L	H		H	L	H	H
CLR-5 :	Gain information about different value added products of mushroom				M	L							L	H		H	M	H	H
CLO-6 :	Develop the potential needed for a business entrepreneur				M	M							M	H		H	L	H	H
					L		M						M	H		H	M	H	H
					L	L	M		L		H		M	H		H	L	H	H
Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:																		
CLO-1 :	Knowledge about the importance of mushroom	1	95	80															
CLO-2 :	Skill on spawn cultivation	2	90	85															
CLO-3 :	Skill in isolating and culturing techniques of different types of edible mushrooms	2	85	70															
CLO-4 :	Excel in various techniques of mushroom cultivation.	1	80	75															
CLO-5 :	Capable of preparing different value added products of mushroom	2	75	60															
CLO-6 :	Express confidence as an entrepreneur	3	75	65															

Duration (hour)	Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
	3	4	3	3	3
S-1	SLO-1 SLO-2	Week 1-Introduction to mushroom	Week 5- Preparation of media for isolation of mushroom	Week 8- Mother bed preparation for oyster mushroom	Week 11- Mother bed preparation for Paddy straw mushroom
S-2	SLO-1 SLO-2	Week 2- Different types of mushroom	Week 6- Isolation and maintenance of pure culture of mushroom	Week 9- Mother bed preparation for milky mushroom	Week 12- Exposure visit to different mushroom production units.
S-3	SLO-1 SLO-2	Week 3- Nutritional and medicinal value of mushroom	Week 7- Spawn preparation	Week 10 – Casing methods- Milky mushroom	Week 13- Pest and diseases of mushroom
S-4	SLO-1 SLO-2	Week 4- Types of media for isolation of mushroom culture			Week 14- Exposure visit to different mushroom production units.
					Week 15- Cost benefit analysis of mushroom cultivation.
					Week 16. - Value addition of mushroom

Learning Resources	Text Books:	Reference Book:
	1. Krishnamoorthy, A.S., Marimuthu, T., and S. Nakkeeran. (2005). Mushroom Biotechnology. Sivakasi, India: Vijay Books. 2. Singh, P.K. and Jha, S.K. (2014). Mushroom production and utilization. India: Scientific publishers. pp.1-189	1. Robin Gogoi, Yella Rathaiah, Tasvina Rahman Borah. (2006). Mushroom Cultivation Technology (pp. 1-130). India: Scientific publisher.

	Level of Thinking	Final Final Internal Evaluation (100%)
Level 1	Remember	20%
	Understand	
Level 2	Apply	40%
	Analyze	
Level 3	Evaluate	40%
	Create	
	Total	100%

Course Designers			
Experts from Industry		Experts from Higher Technical Institutions	Internal Experts
<i>D. Sekaran Arun mushroom agri farms Kottaikadu village Cheyyur (TK) Chengalpattu district Tamil Nadu- 603 304 Ph: +91 99403 38374, +91 99525 08318 Email: arunmushroomagri2004@gmail.com</i>		<i>Dr. A.S. Krishnamoorthy, Professor Registrar, Tamil Nadu Agricultural University Coimbatore – 641003. Ph: + 9790499006 milkmushapk2@yahoo.com</i>	<i>Dr. Rageshwari S (Assistant Professor) Plant Pathology Dr. Vinod Kumar S (Assistant Professor) Plant Pathology</i>

Practical

Introduction to mushroom - types of mushroom – nutritional and medicinal values of mushroom- button mushroom, oyster mushroom, milky mushroom, paddy straw mushroom, types of mushroom cultivation, media preparation - types of media - isolation and maintenance of pure culture of mushroom - different types of bed preparation - spawn preparation – cultivation of oyster mushroom, milky mushroom, button mushroom, and paddy straw mushroom, mother bed preparation – casing of mushroom beds, mushroom harvesting -pest and diseases of mushroom- management of pest and diseases of mushroom– value addition of mushrooms- cost benefit ratio. Visit to mushroom cultivation units.

Text Books

1. Gour Pathak and Yadav. (2020). Mushroom production and processing technology. India: Agrobios International Book Distributor. pp. 1-179.
2. Ragav J.C and Singh, U.C. (2014). Modern Mushroom Cultivation. India: Agrobios. pp. 1-244.
3. Reeti Singh and U.C. Singh. (2009). Modern mushroom cultivation. India: Agrobios. pp. 1-248.
4. Krishnamoorthy, A.S., Marimuthu, T., and S. Nakkeeran. (2005). Mushroom Biotechnology. Sivakasi, India: Vijay Books.
5. Marimuthu, T., A.S Krishnamoorthy, K.Sivaprakasam and R.Jeyarajan. (1989). Oyster mushroom production. Sivakasi, India: Vijay Books.
6. Singh, P.K. and Jha, S.K. (2014). Mushroom production and utilization. India: Scientific publishers. pp.1-189.

Reference Books

1. Robin Gogoi, Yella Rathaiah, Tasvina Rahman Borah. (2006). Mushroom Cultivation Technology. India: Scientific publisher. pp. 1-130.
2. Tavis Lynch. (2018). Mushroom Cultivation: An Illustrated Guide to Growing Your Own Mushrooms at Home. USA: Wuarto pulishing Group, USA Inc. pp. 1-144.

Web-References

1. <https://www.youtube.com/watch?v=oormRweSf3E>
2. <https://www.youtube.com/watch?v=9JwkHjCTKtQ>
3. <https://www.youtube.com/watch?v=T8LrW-AFq9g>

Journals

1. International journal of medicinal mushroom.
2. Mycoscience
3. Mushroom science and Biotechnology
4. Journal of Mushrooms

Course Nature: Practical			
Total Marks (100)			
S.No.	Category	Assessment Tools	Marks
1	Practical-Internal	Purely internal based on the participation, involvement and contribution of students in the activities pertaining to the course	
		Continuous evaluation of routine activities	30
		Execution skill and Product generation/ Competence	20
		Written test	20
		Record and Observation Note	20
		Viva-Voce	05
		Attendance	05
Grand Total			100

Course Code	STR19804	Course Name	Commercial Beekeeping	Course Category	E	Experiential learning	L	T	P	C
							0	0	10	10

Pre-requisite Courses	Management of beneficial insects	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Crop protection	Data Book / Codes/Standards			Nil

Course Learning Rationale (CLR):		The purpose of learning this course is to:		
CLR-1 :	Obtain Knowledge on importance of bee species			
CLR-2 :	Learn about equipments required for honey production			
CLR-3 :	Gain knowledge on bee pasturage, Insect pests and diseases of honey bee and seasonal management of honey bee			
CLR-4 :	Acquire knowledge on bee products			
CLR-5 :	Obtain basic information on preparation of floral calendar and honey extraction			
CLO-6	Comprehend the preparation of bankable project			

Learning				Program Learning Outcomes (PLO)														
1	2	3		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Thinking (Bloom)	Efficiency (%)	Mastery (%)		Knowledge	Analysis	Development	Design, Research	Usage	Future	Sustainability		Team Work	Communication	Finance & Management	Interdisciplinary scientific approach	Agicultural	Element knowledge of applied field of microbiology	Understand social and responsibilities of microbiology

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems through Agricultural Microbiology	Ability to implement knowledge gained in the applied field of Agricultural Microbiology	Ability to understand social and ethical responsibilities of Agricultural Microbiology
CLO-1 :	Exhibit skills on honey bee species	3	90	80	H								M	H		H	H	H	H
CLO-2 :	Demonstrate on equipments & seasonal management of honey bees	2	70	80	H								L	H		H	H	H	H
CLO-3 :	Explain about the bee pasturage	1	75	70	M			L					M	H		H	H	H	H
CLO-4 :	Interpret about of pests and diseases affecting honey bee	2	80	60	M		L		L				L	H		H	H	H	H
CLO-5	Manage of swarming of honey bee	3	75	60	L	L		L					M	H		H	H	H	H
CLO-6	Demonstrate the methods of collection of bees' wax, bee pollen, propolis, bee venom and royal jelly	2	75	65	L						H		M	H		H	H	H	H

Duration (hour)	Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
	4	3	3	3	3
S-1	SLO-1	Week :1 Honey bee Species; identification and study of social biology	Week :5 Visit to migratory bee keeping sites Visit to commercial bee farm,	Week :8 Management in nectar flow season, Dearth period of honey bee	Week :11 Insect, mite and bird enemies of honeybees
	SLO-2	Week :2 Bee pasturage; preparation of bee floral calendar; Bees conservation	Week : 6 Honey extraction, processing, purity testing and value addition	Week :9 Management of swarming, absconding and laying workers;	Week :12 Brood and adult diseases
S-2	SLO-1	Week : Honey Beehives, beekeeping equipments	Week :7; Hive inspection, Maintenance of hive records	Week :10 Dividing of honey bee, Uniting bee colonies and Artificial feeding	Week : 13 Methods of collection of bees' wax, bee pollen, propolis, bee venom, royal jelly
	SLO-2	Week 3: Hiving feral Indian bee colony,			
S-3	SLO-1	Week : 4 Site selection for apiary			
	SLO-2				

Learning Resources	1. Abrol D.P. (2011). Beekeeping – A comprehensive guide to bees and beekeeping. Scientific Publishers, Jodhpur, pp1- 896. 2. Atwal, A.S. (2000). Essentials of Bee Keeping and Pollination. Kalyani Publishers, Ludhiana. pp1-394 .

	Level of Thinking	Final Internal Evaluation (100%)
Level 1	Remember	20%
	Understand	
Level 2	Apply	40%
	Analyze	
Level 3	Evaluate	40%
	Create	
	Total	100%

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. K. Ramesh Ph.D Principal Biologist –Rice Insecticide and Nematicide, South Asia Co-chair for insecticide resistance action committee(IRAC), India Corteva Agrisciences (Dow Dupont) Madhapur, Hyderabad, India e- mail :ramesh.kaliaperumal@corteva.com mobile : 9952885708	Dr. K. Kumar, Professor and Head, Department of Agricultural Entomology, PAJANCOA&RI, Karaikal-609603	Dr. L. Ramazeame Ph.D (Assistant Professor) Agricultural Entomology

Practical

Honey bee Species; identification and study of social biology; Bee pasturage; preparation of bee floral calendar; Bees conservation; honey harvest; Beehives, beekeeping equipments; Hiving feral Indian bee colony, site selection for apiary, visit to migratory bee keeping sites and commercial bee farm; Honey extraction, processing, purity testing and value addition; Hive inspection, maintenance of hive records, management in nectar flow season, dearth period, management of swarming, absconding and laying workers; Dividing, uniting bee colonies, artificial feeding, protecting bees from pesticides; Insect, mite and bird enemies of honeybees, brood and adult diseases; Methods of collection of bees' wax, bee pollen, propolis, bee venom, royal jelly; Marketing and economics of honey and bee products; preparation of bee keeping projects for bank funding

Text Books

1. Abrol D.P.(2011).Beekeeping – A comprehensive guide to bees and beekeeping. *Scientific Publishers, Jodhpur*, pp1-896.
2. Atwal, A.S. (2000). Essentials of Bee Keeping and Pollination. *Kalyani Publishers, Ludhiana*. pp1-394.
3. Tina Ranjan Das. (2006). Beekeeping with *Apis cerana indica* (in Tamil) Megens Jensens, Denmark, pp1-130.

Reference Books

1. Roger A. Morse, (1994). The new complete guide to beekeeping. *The Countryman Press, Woodstock, Vermont*,pp1-207.
2. Robert Owen. (2016). Australian bee keeping manual,Exisle Publishing, pp1-816.
3. Srivastava, K.P. and Dhaliwal,G.S. (2013). A text book of applied entomology, Volume 2. Kalyani Publishers, India,pp1-368.

Web Reference

1. <https://www.studyandscore.com/studymaterial-detail/apiculture-introduction-bee-colony-and-bee-dance>
2. <https://www.slideshare.net/safeermanhas/apiculture-95442492>
3. http://agritech.tnau.ac.in/farm_enterprises/fe_apiculture_home.html
4. <https://youtu.be/ghzfT8iqplU>
5. <https://youtu.be/hvuZ1LQBTsc>

Journals

1. Journal of Apicultural Research
2. The Journal of Apicultural Science

Course Nature: Practical			
Total Marks (100)			
S.No.	Category	Assessment Tools	Marks
1	Practical-Internal	Purely internal based on the participation, involvement and contribution of students in the activities pertaining to the course	
		Continuous evaluation of routine activities	30
		Execution skill and Product generation/ Competence	20
		Written test	20
		Record and Observation Note	20
		Viva-Voce	05
		Attendance	05
Grand Total			100

Course Code	STR19805	Course Name	Commercial Sericulture	Course Category	E	Experiential learning	L	T	P	C
							0	0	10	10

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Crop Protection	Data Book / Codes/Standards			

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning	Program Learning Outcomes (PLO)
CLR-1 :	Understand the importance of silk	1 2 3	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
CLR-2 :	Obtain skill on mulberry nursery production techniques	Level of Thinking (Bloom)	Agriculture Knowledge
CLR-3 :	Attain skill on mulberry cultivation	Expected Proficiency (%)	Problem Analysis
CLR-4 :	Obtain skill on Chawki silkworm rearing techniques	Expected Attainment (%)	Design & Development
CLR-5 :	Acquire skill on late age silkworm rearing and cocoon production techniques		Analysis, Design, Research
CLO-6	Develop the potential for business entrepreneur		Modern Tool Usage
			Society & Culture
			Environment & Sustainability
			Ethics
			Individual & Team Work
			Communication
			Project Mgt. & Finance
			Life Long Learning
			Ability to solve scientific problems
			Ability to implement knowledge gained in the applied field of mushroom cultivation
			Ability to understand social and ethical responsibilities in mushroom cultivation

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLO-1 :	Obtain knowledge on importance of silk	1	95	80	1	M							M	H		H	L	H	H
CLO-2 :	Establish mulberry saplings production unit	2	90	85	2	M	L		M				L	H		H	L	H	H
CLO-3 :	Establish a chawki silkworm rearing center	2	85	70	2	M	L						L	H		H	M	H	H
CLO-4 :	Develop a cocoon trading center	1	80	75	1	M	M						M	H		H	L	H	H
CLO-5	Establish a seri clinic center	2	75	60	2	L		M					M	H		H	M	H	H
CLO-6	Acquire confidence for an entrepreneur	3	75	65	3	L	L	M		L		H	M	H		H	L	H	H

Duration (week)	Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
	3	4	3	3	3
S-1	SLO-1 Week 1-Introduction to sericulture	Week 5- Nursery plant protection measures, irrigation and weed management methods	Week 8- Mulberry main field irrigation and weed management and plant protection measures (Chawki and Late age silkworm mulberry field)	Week11- Chawki rearing methods	Week 14- Cocoon harvest methods and cocoon market
S-2	SLO-1 Week 2- Nursery field preparation methods	Week 6- saplings uprooting and transporting system	Week 9- Mulberry leaf harvest and leaf preservation (Chawki and Late age silkworm mulberry field)	Week 12- Late age silkworm rearing methods	Week 15- Cost benefit analysis of mulberry cocoon production.
S-3	SLO-1 Week 3- Mother plant selection techniques	Week 7- Mulberry main field selection and preparation methods (Chawki and Late age silkworm mulberry field)	Week 10 – Selection and construction of Chawki and late age silkworm rearing house. Rearing tools and equipment's.	Week 13- silkworm pest and disease management	Week 16. - Exposure visit to different sericulture units..
S-4	SLO-1 Week 4- Nursery manure, bio-fertilizers and fertilizer application methods	Mulberry main field manures and fertilizers application (Chawki and Late age silkworm mulberry field)			

Learning Resources	Text Books:	Reference Book:
	1. Balavenkatasubbiah,M.MalReddy,N. Munirathnian Reddy, N. Rajashekar,K. and Sathish Verma.(2017).South zone mulberry sericulture, Central Sericultural Research and Training Institute, Mysuru. Pp. 1-89.	1. Jolly, M.S., S.K. Sen, T.N. Sonwalkar and G.K. Prasad. (1978). Sericultural Manual,Food and Agriculture Organization, Rome, Pp. 1-450.

	Level of Thinking	Final Internal Evaluation (100%)
Level 1	Remember	20%
	Understand	
Level 2	Apply	40%
	Analyze	
Level 3	Evaluate	40%
	Create	
	Total	100%

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
<i>Mr.R.V.Vinothkumar Vinayaga Chawki Rearing Center Manasipalliyam village Palladam (TK) Thirupur district Tamil Nadu Ph: +91 9942072679 Email: jsacrc1970@gmail.com</i>	<i>Dr.R. Krishnan, Professor O/o the Dean (Agriculture) Tamil Nadu Agricultural University Coimbatore – 641003. Ph: + 9443209452</i>	<i>Dr.N.Murugan, Assistant Professor</i>

Practical:

Introduction to sericulture, Nursery field preparation methods, Manures and Fertilizers application methods, Mother plant selection, Mulberry cutting preparation, Pre-treatments, Plant protection techniques, uprooting, Transport. Main field – primary & secondary tillage equipment's, Field preparation methods, Manures and Fertilizers application, Planting methods, Irrigation methods, Fertigation, weeding methods, Plant Protection methods, Pruning techniques, Harvesting. Leaf Harvest method, Leaf preservation techniques, shoot harvest method. Mulberry pests and diseases, Management Practices. Rearing house, site selection, types, Environmental condition. Silkworm rearing tools and equipment's, disinfectants. Chawki and Late age worms rearing, mounting, cocoon harvest, cocoon market. Silkworm pests and Diseases. Their management practices. Visit to Chawki Rearing Center, Late age worms rearing unit and cocoon market. Final Examination.

Reference Books

1. Balavenkatasubbiah, M. Mal Reddy, N. Munirathnian Reddy, N. Narendrakumar, J.B. Rajashekar, K. and Sathish Verma. (2017). South zone mulberry sericulture, Central Sericultural Research and Training Institute, Mysuru. Pp. 1-89.
2. Sivaprasath, V Himanatharaj, M.T. Sathish Verma and Mogali, T. (2015). Commercial Chawki Rearing, Central Sericultural Research and Training Institute, Mysuru. Pp. 1-54.
3. Sureshkumar, N. Singh, H. and A.K. Singh. (2015). A text book on silkworm rearing Technology, Central Silk Board, Bengaluru, Pp. 1-360.
4. Singh, T. and Saratchandra, B. (2004). Principles and techniques of silkworm seed production. Discovery publishing house, New Delhi, Pp. 1-360.

Journals

1. Indian Silk
2. Indian Journal of Sericulture
3. Seridoc

Course Nature: Practical			
Total Marks (100)			
S.No.	Category	Assessment Tools	Marks
1	Practical-Internal	Purely internal based on the participation, involvement and contribution of students in the activities pertaining to the course	
		Continuous evaluation of routine activities	30
		Execution skill and Product generation/ Competence	20
		Written test	20
		Record and Observation Note	20
		Viva-Voce	05
		Attendance	05
Grand Total			100

Course Code	STR19807	Course Name	Commercial Seed Production	Course Category	E	Experiential Learning	L	T	P	C
							0	0	10	10

Pre-requisite Courses	GPB19301, GBP19501, GPB19601	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Genetics and Plant Breeding	Data Book / Codes/Standards			

Course Learning Rationale (CLR):		The purpose of learning this course is to:		
CLR-1 :	Attain knowledge on types and characteristic features of seeds.			
CLR-2 :	Learn about commercial seed production techniques			
CLR-3 :	Learn about commercial hybrid test through both phenotypic and genotypic manner.			
CLR-4 :	Acquire knowledge on DNA markers in commercial seed production			
CLR-5 :	Infer about genetics of seeds and maintenance			

Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:		
CLO-1 :	Explain about and handle parental lines			
CLO-2 :	Select parental lines and their proportion of raising for hybridization			
CLO-3 :	Demonstrate emasculation and pollination techniques of commercial hybrid development			
CLO-4 :	Perform extraction of seeds from fruits			

Learning			
1	2	3	
Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	
	1	95	80
	2	90	85
	2	85	70
	1	75	65

Program Learning Outcomes (PLO)														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems	Ability to implement knowledge gained in the applied field of Agriculture	Ability to understand social and ethical responsibilities in plant pathology
M			L					M	H		H	L	H	
M			M					L	H		H	L	H	
M								L	H		H	M	H	
M	M							M	H		H	L	H	

Duration (Week)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		8	6	6	6	6
S-1	SLO-1	Week 1- Introduction to varieties their characteristic features for quality seed production; resistant, tolerance, adaptability, crossability, combining ability, yield	Week 5 – Male sterility and incompatibility system in hybrid seed production, development and maintenance of A, B and R lines	Week 8 Methods of synchronizing flowering in parental lines; staggered sowing	Week 11- Salient features of hybrid seed production in sorghum and bajra	Week 14 Extraction and post-harvest handling of hybrid seeds
	SLO-2					
S-2	SLO-1	Week 2- Seed quality concept and importance of genetic purity in seed production; their maintenance in self, cross pollinated crops and factors responsible for genetic deterioration	Week 6- Use of chemical hybridizing agents. Role of pollinators and their management	Week 9 - Emasculation, pollination, covering and tagging process in hybrid generation in crops	Week 12 - Salient features of hybrid seed production in maize, sunflower, cotton and other major vegetables	Week 15 - Hybrid test; GOT
	SLO-2					
S-3	SLO-1	Week 3- Seed production in self and cross pollinated crops	Week 7- Sowing strategies for the parents; sequence of plant rows, ratio and population density in relation to hybrid seed yield	Week 10- Salient features of hybrid seed production in rice	Week 13- Identification of fruit confined with perfect cross pollination and harvesting	Week 16 - DNA markers for hybrid confirmation
	SLO-2					
S-4	SLO-1	Week 4- Artificial modifications of reproductive system and structure according to pollination mechanisms for hybrid seed production				
	SLO-2					

Learning Resources	1.	Agrawal, R.L. (2008). <i>Seed Technology</i> . New Delhi : Oxford & IBH Publishing Co. pp. 1- 821.
	2.	Dharmendra Jat, Sai Prasad, S. V. & Sheela Verma. (2014). <i>Seed Science and Technology (2nd ed.)</i> New Delhi: New Vishal Publications. pp. 1- 304.
	3.	Khare, D . (2014). <i>Seed Technology (2nd ed.)</i> . Jodhpur: Scientific Publishers India. pp. 1- 944.

	Level of Thinking	Final Internal Evaluation (100%)
Level 1	Remember	20%
	Understand	
Level 2	Apply	40%
	Analyze	
Level 3	Evaluate	40%
	Create	
	Total	100%

Course Designers			
Experts from Industry		Experts from Higher Technical Institutions	Internal Experts
Dr. S M .Prabhu, Ph. D. Senior Breeder (Paddy Breeding and Transgenic) R&D centre, Rasi Seeds (P) Ltd., Attur, Salem – 636141.		Dr. T. Sabesan Associate rofessor Department of Genetics and Plant Breeding Faculty of Agriculture, Annamalai University, Annamalai nagar , Chidambaram - 608 002 sabavani@gmail.com	Dr. G. Selvakumar , Assistant Professor (GPB) Dr. R. Mahendran, Assistant Professor (GPB) Dr. J. Vanitha, Tutor (GPB)

Practical Schedule

1. Introduction to varieties their characteristic features for quality seed production; resistant, tolerance, adaptability, crossability, combining ability, yield
2. Seed quality concept and importance of genetic purity in seed production; their maintenance in self, cross pollinated crops and factors responsible for genetic deterioration
3. Seed production in self and cross pollinated crops
4. Artificial modifications of reproductive system and structure according to pollination mechanisms for hybrid seed production
5. Male sterility and incompatibility system in hybrid seed production, development and maintenance of A, B and R lines
6. Use of chemical hybridizing agents. Role of pollinators and their management
7. Sowing strategies for the parents; sequence of plant rows, ratio and population density in relation to hybrid seed yield
8. Methods of synchronizing flowering in parental lines; staggered sowing
9. Emasculation, pollination, covering and tagging process in hybrid generation in crops
10. Salient features of hybrid seed production in rice
11. Salient features of hybrid seed production in sorghum and bajra
12. Salient features of hybrid seed production in maize, sunflower, cotton and other major vegetables
13. Identification of fruit confined with perfect cross pollination and harvesting
14. Extraction and post-harvest handling of hybrid seeds
15. Hybrid test; GOT
16. DNA markers for hybrid confirmation

Text Books

1. Agrawal, R.L. (2008). *Seed Technology*. New Delhi : Oxford & IBH Publishing Co. pp. 1- 821.
2. Dharmendra Jat, Sai Prasad, S. V. & Sheela Verma. (2014). *Seed Science and Technology* (2nd ed.) New Delhi: New Vishal Publications. pp. 1- 304.
3. Khare, D. (2014). *Seed Technology* (2nd ed.). Jodhpur: Scientific Publishers India. pp. 1- 944.
4. Padmavathi, S. (2012). *A Text Book of Seed Science and Technology*. New Delhi: New India Publishing Agency. pp. 1- 282.

Reference Books

1. Basra, A. S. (2006). *Handbook of Seed Science and Technology*. New York: Food Products Press. pp. 1- 749.
2. Lawrence O. Copeland & Miller McDonald. (2001). *Principles of Seed Science and Technology*. USA: Springer Science. pp. 1- 390.
3. Sreenivas, Y.S. (2009). *Seed Production of Commercial Vegetables*. Oxford: Oxford Book Company. pp. 1- 325.
4. Subir Sen & Nabinananda Ghosh. (2012). *Seed Science and Technology*. New Delhi: Kalyani Publishers. pp. 1- 277.
5. Vanangamudi, K., Prabhu, M. & Bhaskaran. (2010). *Vegetable Hybrid Seed Production and Management*. India: Agrobios. pp. 1- 339.

Web-References

1. <https://agro.au.dk/en/research/research-areas/seed-science-and-technology/>
2. www.seednet.gov.in
3. <https://www.fabnet.up.ac.za/index.php/research-groups/seed-science>

Journals

1. Seed Science Research
2. Research Journal of Seed Science
3. Advanced Journal of Seed Science and Technology
4. Journal of Seed Science - Scimago

Course Nature: Practical			
Total Marks (100)			
S.No.	Category	Assessment Tools	Marks
1	Practical-Internal	Purely internal based on the participation, involvement and contribution of students in the activities pertaining to the course	
		Continuous evaluation of routine activities	30
		Execution skill and Product generation/ Competence	20
		Written test	20
		Record and Observation Note	20
		Viva-Voce	05
		Attendance	05
Grand Total			100

Course Code	STR19808	Course Name	Commercial Horticulture	Course Category	E	Experiential learning	L	T	P	C
							0	0	10	10

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Horticulture	Data Book / Codes/Standards			

Course Learning Rationale (CLR):		The purpose of learning this course is to:			Learning			Program Learning Outcomes (PLO)																	
CLR-1 :		Learn the basic knowledge on propagation			Level of Thinking (Bloom)	2	95	80	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
CLR-2 :		Gain knowledge on use of media and container in plant propagation							Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems	Ability to implement knowledge gained in the applied field of Agriculture	Ability to understand social and ethical responsibilities in plant pathology		
CLR-3 :		Attain knowledge about different propagation methods																							
CLR-4 :		Acquire technical knowledge on the propagation structures and rootstocks in plant multiplication																							
CLR-5 :		Acquire skills on the establishment micropropagation unit																							
CLR-6 :		Develop practice on commercial multiplication of horticultural crops																							
Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:																							
CLO-1 :		Exhibit skills on the planning and layout of commercial nursery			2	95	80	M		H				H		M	H		H	H	H	H			
CLO-2 :		Demonstrate he commercial propagation methods			2	90	85	H				H		H		L	H		H	H	H	H			
CLO-3 :		Perform multiplication of horticultural plants			1	85	70	H				H		H		L	H		H	H	H	H			
CLO-4 :		Apply independent skills to manage pest and disease in nursery plants			2	75	65	M	M					L		M	H		H	H	H	H			
CLO-5 :		Expertise in manage horticultural nurseries			1	75	60	H	M					H		M	H		H	H	H	H			
CLO6 :		Establish a commercial nursery			3	75	65	L		H		H				M	H		H	H	H	H			

Duration (hour)		Learning Unit / Module 1 40	Learning Unit / Module 2 30	Learning Unit / Module 3 30	Learning Unit / Module 4 30	Learning Unit / Module 5 30
S-1	SLO-1	Site selection and basic criteria for set up a new nursery for production of fruit seedlings and planting materials.	Certification, packaging and marketing quality control for planting materials produced in fruit nursery.	Management and maintenance of ornamental nursery.	Study of protected cultivation of flowers.	Post-harvest handling of flowers and vegetables
	SLO-2					
S-2	SLO-1	Raising of quality rootstocks of different fruit crops for grafting.	Ornamental nursery establishment – Site selection – basic criteria – study about suitable environmental factors.	Sale and marketing of produced planting materials and potted plants to create income generation.	Practicing nursery raising/procurement and transplanting in horticultural crops.	Quality control and marketing of planting materials produced in the nursery
	SLO-2					
S-3	SLO-1	Practicing of different types of grafting and budding in fruit crops	Practicing of different types of propagation methods / multiplication of plantlets and potted plants.	Study of protected cultivation of vegetables and different types of protected structures for different vegetables.	Management and maintenance of protected cultivation of vegetables and flowers.	Visit to commercial / local nurseries.
	SLO-2					
S-4	SLO-1	Studies of various management practices in grafted plants				
	SLO-2					

Learning Resources	1. Hartmann, H.T., D.E. Kester, F.T. Davies and R.L. Greneve. (1997). Plant propagation – Principles and Practices. Prentice Hall of India Private Ltd., New Delhi. pp 1-869
	2. Peter, K.V., S. Rajan and Baby Lissy Markose. (2007). Propagation of Horticultural. Crops. Horticulture Science Series – 6. New India Publishing Agency. pp 1-263

	Level of Thinking	Final Internal Evaluation (15%)
Level 1	Remember	20%
	Understand	
Level 2	Apply	50%
	Analyze	
Level 3	Evaluate	30%
	Create	
	Total	100%

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. Amol Chaudhari Manager R&D Farm Jain irrigation system Ltd. Udumalpet	Dr Vijay Rakesh Reddy, S. Scientist (Horticulture) ICAR-IIHR Bengaluru	Dr. Gopu Mr. Harish. A Mrs. Kanimozhi. C

Practical

Nursery production of fruit crops: Raising of rootstocks, grafting and budding of rootstocks, management of grafted plants, plant certification, packaging and marketing, quality control. Nursery production of ornamentals: Production of plantlets, production of potted plants, management and maintenance, sale and marketing. Protected cultivation of vegetables and flowers: Nursery raising/procurement and transplanting, management and maintenance of the crop, postharvest handling, quality control and marketing.

Practical schedule

1. Site selection and basic criteria for setting up a new nursery for production of fruit seedlings and planting materials.
2. Raising of quality rootstocks of different fruit crops for grafting.
3. Practicing of different types of grafting and budding in fruit crops
4. Studies of various management practices in grafted plants
5. Certification, packaging and marketing quality control for planting materials produced in fruit nursery.
6. Ornamental nursery establishment – Site selection – basic criteria – study about suitable environmental factors.
7. Practicing of different types of propagation methods / multiplication of plantlets and potted plants.
8. Management and maintenance of ornamental nursery.
9. Sale and marketing of produced planting materials and potted plants to create income generation.
10. Study of protected cultivation of vegetables and different types of protected structures for different vegetables.
11. Study of protected cultivation of flowers.
12. Practicing nursery raising/procurement and transplanting in horticultural crops.
13. Management and maintenance of protected cultivation of vegetables and flowers.
14. Post-harvest handling of flowers and vegetables
15. Quality control and marketing of planting materials produced in the nursery
16. Visit to commercial / local nurseries.

Text Books

1. Hartmann, H.T., D.E. Kester, F.T. Davies and R.L. Greneve. (1997). Plant propagation – Principles and Practices. Prentice Hall of India Private Ltd., New Delhi. pp 1-869
2. Joe.J.Hanan. (1998). Green houses: Advanced Technology for Protected Horticulture, CRC Press, LLC. Florida. pp 1-720
3. Peter, K.V., S. Rajan and Baby Lissy Markose. (2007). Propagation of Horticultural. Crops. Horticulture Science Series – 6. New India Publishing Agency. pp 1-263

Reference Books

1. Prasad, S. and U. Kumar. (2005). Greenhouse management for horticultural crops. 2nd ed. Agrobios. pp 1-500
2. Tiwari, G.N. (2003). Green house technology for controlled environment. Narosa Publ. House. pp 1 – 547

Web-References

1. www.icar.org.in/ciphet.html
2. www.jains.com
3. www.gisdevelopment.net
4. www.lasercladding.com
5. www.epa.gov
6. <https://www.youtube.com/watch?v=qXdw-hBiu1A>

Journals

1. Hort. Science
2. Horticultural Technology
3. Floriculture Today
4. Hi-tech Horticulture
5. Acta Horticulture

Course Nature: Practical			
Total Marks (100)			
S.No.	Category	Assessment Tools	Marks
1	Practical-Internal	Purely internal based on the participation, involvement and contribution of students in the activities pertaining to the course	
		Continuous evaluation of routine activities	30
		Execution skill and Product generation/Competence	20
		Written test	20
		Record and Observation Note	20
		Viva-Voce	05
		Attendance	05
Grand Total			100

Course Code	STR19809	Course Name	Floriculture and Landscape Architecture	Course Category	E	Experiential learning	L	T	P	C
							0	0	10	10

Pre-requisite Courses	Nil	Co-requisite Courses	Rural Agricultural Work Experience	Progressive Courses	Nil
Course Offering Department	Horticulture	Data Book / Codes/Standards			

Course Learning Rationale (CLR):		The purpose of learning this course is to:			Learning			Program Learning Outcomes (PLO)														
CLR-1 :	Acquire skills on Landscaping.				1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	Gain knowledge on use of softwares in designing.				Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to establish landscaping garden	Ability to implement knowledge gained in the applied field of Floriculture	Ability to understand social and ethical responsibilities in the filed of floriculture.
CLR-3 :	Share knowledge on the flowering crops																					
CLR-4 :	Categorise different styles of Gardening																					
CLR-5 :	To learn skills on the establishment of hedges and edges in garden.																					
CLR-6 :	Acquire knowledge about establishment of Lawn making																					
Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:																				
CLO-1 :	Practice, gain confidence and competence in establishment of Garden designs.				3	90	80	M	M	H	H	M		H	L	L	H		H	H	H	H
CLO-2 :	Distinguish the plant and non plant components				3	95	85	H	M	H	H	L		H	L	L	H		H	H	H	H
CLO-3 :	Practice landscaping styles.				3	85	65	L	H	H	H	M		H	M	L	H		H	H	H	H
CLO-4 :	Identify the ornamental crops				1	80	70	L	H	H	H	M		H	L	L	H		H	H	H	H
CLO-5 :	Define Turfing				2	75	60	H	H	H	M	L		H	M	M	H	L	H	H	H	H
CLO-6 :	Analyze project report for landscaping designs				3	80	70	H	L	H	M	H		H	M	M	H	H	H	H	H	H

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		40	30	30	30	30
S-1	SLO-1	Pract 11: Preparation of project report, soil and water analysis, preparation of land and layout.	Pract 5:Harvesting and post harvest handling of produce	Pract 8: Institutional Management	Pract 11:Planning and designing, site analysis, selection and use of plant material for landscaping	Pract 14:Making of lawns, use of software in landscape
	SLO-2					
S-2	SLO-1	Pract 2:Plant materials for landscaping and their identification –Plant components	Pract 6: Marketing of produce	Pract 9:Visit to Flower growing areas and Export House	Pract12:Formal and informal garden, features, styles, principles and elements of landscaping	Pract 15:Making of bouquets, button hole, wreath, veni and festoons, car and marriage hall decoration
	SLO-2					
S-3	SLO-1	Pract 3: Study of various features of an ornamental garden with suitable plants and identification of plants for each feature.	Pract 7: Cost Analysis	Pract 10Attachment with private landscape agencies	Pract13: Preparation of landscape plans of home gardens, farm complexes, public parks, institutions, high ways, dams and avenues.	Pract 16:Dry flower Technology
	SLO-2					
S-4	SLO-1	Pract 4:Production and Management of commercial flowers				
	SLO-2					

Learning Resources	1. Arora, J.S. (2006). Introductory Ornamental Horticulture.(pp.1-188). Ludhiana: Kalyani Publishers. 2. Bhattacharjee,S.K. (2004). Landscape Gardening and Design with plants. Jaipur,: Aavishkar Publishers and Distributers.

	Level of Thinking	Final internal Examination (100%)
Level 1	Remember	20 %
	Understand	
Level 2	Apply	40 %
	Analyze	
Level 3	Evaluate	40 %
	Create	
	Total	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. Vasu Rainbow Landscaping Hosur	Dr Vijay Rakesh Reddy, S. Scientist (Horticulture) ICAR-IIHR Bengaluru	Dr. B. Gopu Mrs. C. Kanimozhi

Practical

Preparation of project report, soil and water analysis, preparation of land and layout-Production and Management of commercial flowers- Harvesting and postharvest handling of produce-Marketing of produce, Cost Analysis, Institutional Management- Visit to Flower growing areas and Export House, Attachment with private landscape agencies-Planning and designing, site analysis, selection and use of plant material for landscaping-Formal and informal garden, features, styles, principles and elements of landscaping- Preparation of landscape plans of home gardens, farm complexes, public parks, institutions, high ways, dams and avenues- Making of lawns, use of software in landscape.-Making of bouquets, button hole, wreath, veni and gazaras, car and marriage palaces-Dry flower Technology.

Text Books

1. Arora, J.S. (2006). Introductory Ornamental Horticulture. Ludhiana: Kalyani Publishers. . (pp.1-188).
2. Bhattacharjee,S.K. (2004). Landscape Gardening and Design with plants.Jaipur, Aavishkar Publishers and Distributers.
3. Dharmendra Kaulani and Arati Joshi.(2018). A textbook of Ornamental Horticulture. Nepal: Heritage Publishers.
4. Peter.K.V (2009). Ornamental plants. New Delhi: New India publishing agency.
5. Prasad, S. and Kumar, U. (2013). A hand book of Floriculture. Jodhpur: Agrobios. (pp.1-654).

Reference Books

1. Karuppaiah, P. and Manivannan, K.(2018). Ornamental Horticulture. Jodhpur: Agrobios. (pp.1-648).
2. Supriya Kumar Bhattacharjee.(2006). Ornamental Crop Production Technology Jaipur: Pointer Publisher. .(pp.1-344).
3. Supriya Kumar Bhattacharjee.(2005). Flowering Shrubs and Seasonal Ornamentals. Jaipur: Pointer Publisher. .(pp. 1-359).
4. Suresh K Malhotra Lallan Ram .(2017). Advances in Floriculture and Landscape Gardening. Nagaland :Central Institute of Horticulture. (pp.1 - 322).
5. Tiwari, A.K. (2012). Fundamentals of Ornamental Horticulture and Landscape Gardening. New Delhi: NIPA. (pp.1 – 588).

Web references

1. www.bestgarden.net
2. www.indiaagroneet.com
3. www.intuxford.tripod.com
4. www.webct.uark.edu
5. www.personal.psu.edu
6. www.sunny.crk.umn.edu/courses
7. www.lawngrasses.com
8. www.mediatoday@vsnl.com
9. www.hsi1942.org

Journals

1. Journal of ornamental Horticulture.
2. Journal of Floriculture and Landscaping.
3. Indian Journal of Horticulture.
4. The American Journal of Horticulture and Floriculture Research.
5. International journal of Horticulture and Floriculture.

Course Nature: Practical			
Total Marks (100)			
S.No.	Category	Assessment Tools	Marks
1	Practical-Internal	Purely internal based on the participation, involvement and contribution of students in the activities pertaining to the course	
		Continuous evaluation of routine activities	30
		Execution skill and Product generation/ Competence	20
		Written test	20
		Record and Observation Note	20
		Viva-Voce	05
		Attendance	05
Grand Total			100

Course Code	STR19810	Course Name	Protected Cultivation of High Value Horticulture Crops	Course Category	E	Experiential learning	L	T	P	C
							0	0	10	10

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Horticulture	Data Book / Codes/Standards			

Course Learning Rationale (CLR):		The purpose of learning this course is to:		
CLR-1 :	Gain knowledge on special practices in horticulture crops			
CLR-2 :	Infer technical knowledge on protected cultivation of cut flowers			
CLR-3 :	Gain information on cultivation systems and practices followed in green house cultivation			
CLR-4 :	Attain technical knowledge about micro irrigation system			
CLR-5 :	Learn about technical knowledge about Hi tech vegetable nursery production			
CLR-6 :	Appraise about postharvest handling			

Learning			
1	2	3	
Thinking (Bloom)	Proficiency (%)	Attainment (%)	

Program Learning Outcomes (PLO)															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Knowledge	Analysis	Development	Design, Research	Usage	Culture	Sustainability		Team Work	Communication	Finance	Learning	scientific	Implementation	Innovative in the field of Agriculture	Understand social responsibilities in horticulture

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems	Ability to implement knowledge gained in the applied field of Agriculture	Ability to understand social and ethical responsibilities in plant pathology
CLO-1 :	Explain the skills to manage protected cultivation	3	95	80	M			L					M	H		H	L	H	H
CLO-2 :	Imparting skills of emasculation and pollination in vegetable crops	2	90	85	M			M					L	H		H	L	H	H
CLO-3 :	Ability in large scale production of cut flowers	3	85	70	M								L	H		H	M	H	H
CLO-4 :	Elaborate about the quality control and postharvest technology	3	75	65	M	M							M	H		H	L	H	H
CLO-5 :	Establish hi-tech vegetable nursery production	3	75	60	L								M	H		H	M	H	H
CLO6 :	Create a commercial protected cultivation unit	3	75	65	L	L	M		L		H		M	H		H	L	H	H

Duration (hour)	Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
	40	30	30	30	30
S-1	SLO-1 SLO-2	Study of different media	Preparation of seed beds	Addition of manures of fertilizers	Visit to commercial polyhouses
S-2	SLO-1 SLO-2	Study of solarization	Study of jiffy bags	Practice of special horticultural techniques, Training and pruning techniques	Study of pollination techniques
S-3	SLO-1 SLO-2	Preparation of beds	Study of climate management techniques	Study of fertigation techniques	Study of harvesting techniques
S-4	SLO-1 SLO-2	Fixing of supports			Visit to export houses, Market intelligence, marketing of produce, cost analysis, institutional management.

Learning Resources	1. Prasad, S. and U. Kumar. (2005). Greenhouse management for horticultural crops. 2nd ed. Agrobios. pp 1-500
	2. Paul V. Nelson. (1991). Greenhouse operation and management. Ball publishing USA. pp 1-512

	Level of Thinking	Final Internal Evaluation (100%)
Level 1	Remember	20%
	Understand	
Level 2	Apply	50%
	Analyze	
Level 3	Evaluate	30%
	Create	
	Total	100%

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	<i>Dr. Pratapsingh Khapte</i> <i>Scientist (Vegetable Science)</i> <i>ICAR-Central Arid Zone Research Institute,</i> <i>Jodhpur - 342003</i>	<i>Dr. B. Gopu</i> <i>Mr. Harish. A</i>

Practical

Visit to commercial poly houses, Project preparation and planning. Specialized lectures by commercial export house. Study of designs of green- house structures for cultivation of crops. Land preparation and soil treatment. Planting and production: Visit to export houses; Market intelligence; Marketing of produce; cost analysis; institutional management. Report writing and viva-voce.

Practical schedule

1. Study of different media, organic – soilless – synthetic media. Preparation of different media mixtures for cultivation of Roses, Caranation, Chrysanthemum, Gerbera, Anthurium and Orchids.
2. Study of solarization – fumigation of polyhouses – methods of fumigation
3. Preparation of beds for growing cut flower crops and vegetables in polyhouses
4. Fixing of supports – trellies, arrangement of net supports – study of different types of nets Materials used for preparation of nets
5. Preparation of seed beds – poly trays – for raising nursery seedlings of capsicum, cucumber and tomato
6. Study of jiffy bags – propagation techniques of Roses, Gerbera, Carnation, Orchid Anthuriums and Chrysanthemum. Study of corms and cormels. Dormancy breaking techniques of Gladiolus
7. Study of climate management techniques – practices to manipulate the climate in polyhouses
8. Addition of manures of fertilizers – planting techniques of cut flower crops and vegetables
9. Practice of special horticultural techniques like pinching disbudding – deshooting – deleafing in cut flowers and vegetables, Training and pruning techniques in cut flower crops and vegetables
10. Study of fertigation techniques – Identification of different soluble fertilizers and their composition. Preparation of stock solutions. Practice fertigation in polyhouse grown crops
11. Visit to commercial polyhouses around colleges, Project preparation and planning. Specialized lectures by commercial export house.
12. Study of pollination techniques – Different methods of pollination – practice pollination in capsicum and tomato
13. Study of harvesting techniques for different purposes in cut flowers and vegetables.
14. Study of grading – pre-cooling – holding solutions for enhancement of vase life.
15. Study of different types of packaging materials, storage methods – visit to cold storages and commercial markets
16. Visit to export houses, Market intelligence, marketing of produce, cost analysis, institutional management.

Text Books

1. Joe.J.Hanan. (1998). Green houses: Advanced Technology for Protected Horticulture, CRC Press, LLC. Florida. pp 1-720
2. Prasad, S. and U. Kumar. (2005). Green house management for horticultural crops. 2nd ed. Agrobios. pp 1-500
3. Tiwari, G.N. (2003). Green house technology for controlled environment. Narosa Publ. House. pp 1-547

Reference Books

1. Paul V. Nelson. (1991). Greenhouse operation and management. Ball publishing USA. pp 1-512
2. Radha Manohar and Igathanathane. (2000). Greenhouse Technology and Management. BSP. BS Publication, Hyderabad. pp 1-234

Web-References

1. www.icar.org.in/ciphet.html
2. www.jains.com
3. www.gisdevelopment.net
4. www.lasercladding.com
5. www.epa.gov
6. <https://www.youtube.com/watch?v=qXdw-hBiu1A>

Journals

1. Hort. Science
2. Horticultural Technology
3. Floriculture Today
4. Hi-tech Horticulture
5. Acta Horticulture

Course Nature: Practical			
Total Marks (100)			
S.No.	Category	Assessment Tools	Marks
1	Practical-Internal	Purely internal based on the participation, involvement and contribution of students in the activities pertaining to the course	
		Continuous evaluation of routine activities	30
		Execution skill and Product generation/ Competence	20
		Written test	20
		Record and Observation Note	20
		Viva-Voce	05
		Attendance	05
Grand Total			100

Course Code	STR19811	Course Name	Agriculture Waste Management	Course Category	E	Experiential learning	L	T	P	C
							0	0	10	10

Pre-requisite Courses	AGE19401	Co-requisite Courses	Rural Agricultural Work Experience	Progressive Courses	Nil
Course Offering Department	Agroecology	Data Book / Codes/Standards			Nil

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning	Program Learning Outcomes (PLO)
CLR-1: Acquire skills on management of different agricultural waste		1 2 3	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
CLR-2: Share knowledge on methods of conversion of waste to wealth and waste into farm inputs		Level of Thinking (Bloom)	Agriculture Knowledge
CLR-3: Share knowledge on methods of recycling of agricultural waste and production of manures		Expected Proficiency (%)	Problem Analysis
CLR-4: Demonstrate integrated agricultural waste management		Expected Attainment (%)	Design & Development
CLR-5: Acquire skills on the analysis and grading of manures			Analysis, Design, Research
CLR-6: Impart knowledge on the establishment and marketing of manures			Modern Tool Usage
			Society & Culture
			Environment & Sustainability
			Ethics
			Individual & Team Work
			Communication
			Project Mgt. & Finance
			Life Long Learning
			Ability to solve scientific problems through Environmental Sciences
			Ability to implement knowledge gained in the applied field of Environmental Sciences
			Ability to understand social and ethical responsibilities of Environmental Sciences

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning	Program Learning Outcomes (PLO)
CLO-1: Attain knowledge on agricultural waste types and characteristics		1 90 80	M M H H M M H L L H H H H H H H
CLO-2: Practice, gain confidence and competence in management of agricultural wastes		3 95 85	H M H H L H L L H H H H H H H
CLO-3: Manage large quantity of agricultural and farm animal waste and decide on techniques to convert waste to farm inputs and waste to energy		3 85 65	L H H H M H M L H H H H H H H
CLO-4: Comprehend management of sustainable technologies for the agricultural wastes, recommend processes to recycle agricultural wastes		3 80 70	L H H H M H L L H H H H H H H
CLO-5: Production and marketing of compost, vermicompost, biogas and briquette		3 75 60	H H H M L H M M H L H H H H H H
CLO-6: Acquire knowledge on preparation of project on agricultural waste management and self enterprising activity		3 80 70	H L H M H L H M M H H H H H H H

Duration (Weekly)	Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
	3	4	4	2	3
S-1	SLO-1 SLO-2	Week 1:Collection and characterization of agricultural wastes	Week 4: Composting- different methods of composting	Week 8: Vermicomposting - collection and pre-processing of waste materials	Week 12: Establishment of biogas production unit
S-2	SLO-1 SLO-2	Week 2: Survey of different agricultural production systems	Week 5: Preparation of different types of compost	Week 9: Preparing of bedding materials and production of vermicompost	Week 13: Biodigester maintenance
S-3	SLO-1 SLO-2	Week 3: Visit to a landfill site	Week 6:Evaluation of compost maturity	Week 10:Maintenance, harvesting,storage and packing the vermicompost	Week 14: Biocharproduction
S-4	SLO-1 SLO-2	Week 7:Compost-Nutrient analysis	Week 11:visit to compost and vermicompost production unit		Week 15: Briquette making
					Week 16: Preparation of project proposal and work plan for establishing commercial compost and vermicompost production unit

Learning Resources	1. Foster, C.N. (2015). Agricultural Wastes: Characteristics, Types and Management (Waste and Waste Management). UK: Nova Science Publishers Inc. pp.1-287. 2. Zakaria, Z. A. (2018). Sustainable Technologies for the Management of Agricultural Wastes. Singapore: Springer. pp. 1-154.

	Level of Thinking	Final internal Examination (100%)
Level 1	Remember	20 %
	Understand	
Level 2	Apply	40 %
	Analyze	
Level 3	Evaluate	40 %
	Create	
	Total	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr.M.Panneer Selvam, Environmental Engineer, VIRDT, Dharmapuri.	Dr. A. Balusamy, Scientist, Division of Natural Resource Management, ICAR-Research Complex for North Eastern Hill Region.	Dr. M. Sanjeevagandhi, Assistant Professor (ENS), SRMIST.

Practical

Introduction: agricultural wastes – source segregation methods - plant and animal refuges - collection, storage and handling of solid, liquid and gaseous wastes from field, livestock and agro-industries - analyzing physical, chemical and biological properties. Survey of different agricultural production systems: observe types of wastes generated – quantification and classification of wastes – methods of waste processing. Visit to a landfill site: study about volume, size and chemical reduction techniques - leachate treatment facilities – assessment of pollution problems.

Composting: principles - factors affecting composting- different methods of composting-aerobic - windrow composting - aerated static pile composting - other methods of composting –sheet composting –in vessel composting – biodynamic composting - preparation of compost by trench method- anaerobic composting-merits- demerits-microorganisms in composting - EM compost - preparation of different types of compost -co-composting-troubleshooting - compost regulations - national and international standards for compost quality parameters - evaluation of compost maturity - maturity indices of compost - determinations of C:N ratio, temperature, colour, odour, moisture content, pH, EC and nutrient contents - detection of pathogens and heavy metals - compost stability test.

Vermicomposting: infrastructure required for vermicompost - site selection- methods- windrow – wedge – container - commercial model - continuous flow systems - collection and pre-processing of waste materials - precautions during the process - selection of earthworm - preparing of bedding materials - controlling temperature and moisture – vermiweeds - natural enemies and their control - maintenance and harvesting the vermicompost and worms – sieving - storage - packing-designing different commercial vermicomposting bin - integrating traditional composting and vermicomposting - value-added products – vermiwash - enriched vermicompost - visit to compost and vermicompost production unit. Biogas production: typical biodigester designs, fixed dome biodigester-floating dome biodigester, tubular bag biodigester - advantages – disadvantages- biodigester maintenance and troubleshooting, utilization of slurry as fertilizer, quality control of biogas plants, economic analysis of biogas production - -visit to commercial biogas production unit-- prepare a lay out plan.

Rapid thermo-chemical processing of agricultural wastes- pyrolysis -biochar production– briquette making - equipment for briquetting – selection of raw materials – steps involved in briquettes – mixing and blending the materials - pressure maintenance – storage, packing and Marketing. Preparation of project proposal and work plan for establishing commercial compost and vermicompost production unit- report preparation - working out cost benefit ratio for compost production -marketing of compost products.

Text Books

1. Foster, C.N. (2015). *Agricultural Wastes: Characteristics, Types and Management (Waste and Waste Management)*. UK: Nova Science Publishers Inc. pp. 1-287.
2. Loehr, R. (1974). *Agricultural Waste Management: Problems, Processes, and Approaches*. USA: Academic Press. pp. 1-590.

Reference Books

1. Afuilio, A. (2014). *Integrated solid waste management. Hand book for Beginners, Planners, Environmentalists, Students and policy makers*. Nairobi, Kenya: Warmra Twechoprise. pp. 1-218.
2. Diaz, I.F., Bertoldi, M.D., & Bidlingmaier, W. (2007). *Compost science and technology*, Elsevier pub. pp. 1-380.
3. Dinesh, K., & Maheshwari. (2014). *Composting for Sustainable Agriculture (Sustainable Development and Biodiversity)*. Switzerland: Springer international publishing. pp. 1-290.
4. Edwards, C. A., Arancon, N. Q., & Sherman, R.L. (2010). *Vermiculture Technology: Earthworms, Organic Wastes, and Environmental Management*. USA: CRC Press. pp. 1- 623.
5. Jeffrey, P.T. (2013). *Eco-Fuel Briquettes*. Latvia: LAP Lambert Academic Publishing. pp. 1-200.
6. Kelly Smith. (2012). *How to build, maintain and use a compost system*. Florida: Atlantic publishers. pp. 1-288.
7. Roland Ulrich. (2014). *Creating humus on farm – The controller heat method of composting*. Colorado: Outskirts press. pp. 1-56.
8. Yong, S.O., Uchimiya, S.M., Chang, S. X., & Bolan, N. (2015). *Biochar-production characterization and applications*. USA. CRC press. pp. 1-438
9. Zainul, A.Z. (2018). *Sustainable Technologies for the Management of Agricultural Wastes*. Singapore: Springer, pp. 1-154.

Web -References:

1. <http://www.Compost.css.cornell.ed>
2. <http://www.composting council.org>
3. <http://www.eartheavy.com>
4. <http://www.Epa.gov/compost>
5. <http://www.fao.org/3/a-bp845e.pdf>
6. https://www.ctc-n.org/system/files/dossier/3b/briquette_production_manual_2.pdf
7. <https://www.planetnatural.com>
8. <https://www.youtube.com/watch?v=2YLPB52zVX8>
9. <https://www.youtube.com/watch?v=9lg1BKMdJS0>

Journal

1. Global Ecology and Conservation
2. International Journal of Environment and Waste Management
3. International Journal of Recycling of Organic Waste in Agriculture

Course Nature: Practical			
Total Marks (100)			
S.No.	Category	Assessment Tools	Marks
1	Practical-Internal	Purely internal based on the participation, involvement and contribution of students in the activities pertaining to the course	
		Continuous evaluation of routine activities	30
		Execution skill and Product generation/ Competence	20
		Written test	20
		Record and Observation Note	20
		Viva-Voce	05
		Attendance	05
Grand Total			100

Course Code	STR19812	Course Name	Food Processing	Course Category	E	Experiential learning	L	T	P	C
							0	0	10	10

Pre-requisite Courses	HOR 19506, HOR 19603	Co-requisite Courses	Rural Agricultural Work Experience	Progressive Courses	Nil
Course Offering Department	Horticulture	Data Book / Codes/Standards			Nil

Course Learning Rationale (CLR):		The purpose of learning this course is to:		
CLR-1 :	Gain knowledge on processing of agricultural produces			
CLR-2 :	Develop analytical and entrepreneurial skills in food processing			
CLR-3 :	Learn hands on experience in processing food products			
CLR-4 :	Understand business strategic involved in running a food processing industry			
CLR-5 :	Acquire technical knowledge on the food processing setup			
CLO-6	Expertise in establishment of food industries			

Learning			
1	2	3	
Learning (Bloom)	Proficiency (%)	Assessment (%)	

Program Learning Outcomes (PLO)																
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
Knowledge	Analysis	Development	Design, Research	Usage	Culture	Learning		Team Work	Communication	Finance	Learning	Scientific	High Food	Implementation	Gained in the Food	Understand social responsibilities of Food Technology

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Food Processing sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems through Food Technology	Ability to implement knowledge gained in the applied field of Food Technology	Ability to understand social and ethical responsibilities of Food Technology
CLO-1 :	Comprehend the techniques of value added products of agricultural produces	1	90	80	H	H	M	L	H		H	L	M	H	H	H	H	H	H
CLO-2 :	Interpret on analysis of the marketability of food product	2	95	85	H	M	H	H	L		H	L	L	H		H	H	H	H
CLO-3 :	Comprehend project proposals of a food processing industry	2	85	65	M	H	H	H	M		H	M	M	H		H	H	H	H
CLO-4 :	Prepare a project proposal for running a value added food product industry	3	80	70	M	H	H	H	M		H	L	L	H		H	H	H	H
CLO-5	Demonstrate sales strategies of a food processing industry	3	75	60	H	H	H	M	L		H	M	M	H	L	H	H	H	H
CLO-6	Manage and initiate a food product enterprise	3	90	80	H	L	H	M	H		H	M	M	H	M	H	H	H	H

Duration (hour)	Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
	30	30	30	30	40
S-1	SLO-1 SLO-2	Practical 1: identification of product, analyzing the existing status	Practical 4: Processing of value added products from bakery products	Practical 7: Preparation of ready to eat food	Practical 10: Preparation of fish pickles
S-2	SLO-1 SLO-2	Practical 2: Processing of value added products from cereals	Practical 5: Processing of value added products from milk and milk products	Practical 8: Preparation of sugar based value added products	Practical 11: Analysis of sensory evaluation
S-3	SLO-1 SLO-2	Practical 3: Processing of value added products from millets	Practical 6: Preparation of convenience foods	Practical 9: Preparation of chocolates	Practical 12: evaluation of cost analysis
S-4	SLO-1 SLO-2				Practical 13: Identifying suitable packaging material for the developed product
					Practical 14: Designing layout of food processing industry
					Practical 15: Quality assessment and maintenance of production records Food safety standards
					Practical 16: Pilot scale production

Learning Resources	1. Khader, V. (2001). Text book of Food Science and Technology. Directorate of Information and Publications of Agriculture, ICAR, KrishiAnusandhanBhawan, Pusa, New Delhi
	2. Sudheer, K.P and V.Indira. (2007). Post Harvest Technology of Horticultural Crops. New India Publishing Agency, PitamPura, New Delhi

	Level of Thinking	Final internal Examination (100%)
Level 1	Remember	20 %
	Understand	
Level 2	Apply	40 %
	Analyze	
Level 3	Evaluate	40 %
	Create	
	Total	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Elangovan, Avvai Foods Enterprise, No.92, Puliyan kuti, Kokkeri vai, Papanasam Taluk, Ammapet, Thanjavur - 614402	Dr. Selvi J, Assistant Professor, Department of Food Science and Technology, Community Science College and Research Institute, TNAU, Madurai- 625104	Dr. P.Sheela, Assistant Professor (Food Science and Nutrition)

Practical

Identification of product available in the market, analyzing the existing status, market survey and identifying the target customer. Processing of value added product from cereals, millets, milk and milk products. Preparation of bakery products, convenience foods, and ready to eat foods, sugar based value added products, manufacturing of chocolates, pickles from fish. Analysis of sensory evaluation and cost analysis. Identifying suitable packaging material for the developed products. Designing and layout of food processing industry and identifying the resources. Project proposal preparation, quality assessment and maintenance of production records and food safety standards and pilot scale production

Text Book

1. James G. Brennan. (2006). Food Processing Handbook. Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, Germany.
2. M. Shafiur Rahman. (2007). Handbook of Food Preservation, (2nd Ed). CRC Press, Boca Raton, FL, USA.
3. Norman N. Potter and Joseph H. Hotchkiss. (1995). Food Science, (5th Ed). Chapman & Hall, NY, USA.
4. Srilakshmi, B. (2018). Food Science (7th Ed). New Age International Ltd, publishers, New Delhi, India, PP: 1-508.
5. Stavros Yanniotis. (2008). Solving Problems in Food Engineering. Springer Science + Business Media, NY, USA.

Reference Books

1. Potter, N. (2005). Food Science, CBS Publishers and Distributors, Delhi
2. Verma, L.R. and V.K. Joshi. (2000). Post Harvest Technology of Fruits and Vegetables. Vol. 1 and 2. Indus Publishing Company. New Delhi.
3. Vijaya Khader. (2001). Textbook of Food Science and Technology, Indian Council of Agricultural Research, New Delhi.

Web-References

1. <http://www.ifis.org>
2. http://www.fao.org/infoods/index_en.stm
3. <https://fstjournal.org>
4. www.foodnetbase.com
5. www.cfs.purdue.edu/class

Journals

1. Trends in Foods Science and Technology
2. Annual Reviews of Food Science and Technology
3. Food Research International
4. Indian Food Industry
5. Indian food packer

Course Nature: Practical			
Total Marks (100)			
S.No.	Category	Assessment Tools	Marks
1	Practical-Internal	Purely internal based on the participation, involvement and contribution of students in the activities pertaining to the course	
		Continuous evaluation of routine activities	30
		Execution skill and Product generation/ Competence	20
		Written test	20
		Record and Observation Note	20
		Viva-Voce	05
		Attendance	05
Grand Total			100

Course Code	STR19813	Course Name	Processing of Fruits and Vegetables for Value addition	Course Category	E	Experiential learning	L	T	P	C
							0	0	10	10

Pre-requisite Courses	HOR 19506, HOR 19603	Co-requisite Courses	Rural Agricultural Work Experience	Progressive Courses	Nil
Course Offering Department	Horticulture	Data Book / Codes/Standards			Nil

Course Learning Rationale (CLR):		The purpose of learning this course is to:	
CLR-1 :	Gaining knowledge on processing of Horticultural produces		
CLR-2 :	Develop analytical and entrepreneurial skills in value addition		
CLR-3 :	Understand providing hands on experience in value addition of horticultural produces		
CLR-4 :	Describe business strategic involved in running a food processing industry		
CLR-5 :	Obtain technical knowledge on the food processing setup		
CLO-6	Learn about establishment of food industries		

Learning		
1	2	3
Thinking (Bloom)	Efficiency (%)	Attainment (%)

Program Learning Outcomes (PLO)															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Knowledge	Analysis	Development	Design, Research	Usage	Culture	&	/	Team Work	Communication	Finance	Learning	Scientific through	Environmental Sciences	Implementation	Gained in the field of

Understand social responsibilities of Environmental Sciences	Environmental Sciences	of	the	in	the	Element	Sciences	Environmental	Sciences	Through	Scientific	Learning	Finance	Communication	Team Work	/	&	Culture	Usage	Design, Research	Development	Analysis	Thinking (Bloom)

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Agriculture Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems through Environmental Sciences	Ability to implement knowledge gained in the applied field of Environmental Sciences	Ability to understand social and ethical responsibilities of Environmental Sciences
CLO-1 :	Comprehend the techniques of value added products of horticultural produces	1	90	80	H	H	M	L	H		H	L	M	H	H	H	H	H	H
CLO-2 :	Attain knowledge on analyze the marketability of a food product	2	95	85	H	M	H	H	L		H	L	L	H		H	H	H	H
CLO-3 :	Comprehend project proposals of a food processing industry	2	85	65	M	H	H	H	M		H	M	M	H		H	H	H	H
CLO-4 :	Prepare a project proposal for running a value added food product industry	3	80	70	M	H	H	H	M		H	L	L	H		H	H	H	H
CLO-5	Demonstrate sales strategies of a food processing industry	3	75	60	H	H	H	M	L		H	M	M	H	L	H	H	H	H
CLO-6	Manage and initiate a food product enterprise	3	90	80	H	L	H	M	H		H	M	M	H	M	H	H	H	H

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		30	30	30	40	30
S-1	SLO-1	Practical 1: identification of product, analyzing the existing status	Practical 4: Preparation of RTS	Practical 7: Processing of canned products	Practical 10: fermented beverages	Practical 13: Identifying suitable packaging material for the developed product
	SLO-2					
S-2	SLO-1	Practical 2: Preparation of jam and jelly	Practical 5: Processing of dehydrated fruits	Practical 8: Preparation of toffee and fruit bars	Practical 11: Analysis of sensory evaluation	Practical 14: Designing layout of food processing industry
	SLO-2					
S-3	SLO-1	Practical 3: Preparation of marmalade and squash	Practical 6: Processing of dehydrated vegetables	Practical 9: Preparation of pickles and sauces	Practical 12: evaluation of cost analysis	Practical 15: Quality assessment and maintenance of production records Food safety standards
	SLO-2					
S-4	SLO-1					Practical 16: Pilot scale production
	SLO-2					

Learning Resources	1. Khader, V. (2001). Text book of Food Science and Technology. Directorate of Information and Publications of Agriculture, ICAR, KrishiAnusandhanBhawan, Pusa, New Delhi
	2. Sudheer, K.P and V.Indira. (2007). Post Harvest Technology of Horticultural Crops. New India Publishing Agency, PitamPura, New Delhi

	Level of Thinking	Final internal Examination (100%)
Level 1	Remember	20 %
	Understand	
Level 2	Apply	40 %
	Analyze	
Level 3	Evaluate	40 %
	Create	
	Total	100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Elangovan, Avvai Foods Enterprise, No.92, Puliyanakudi, Kokkeri vai, Papanasam Taluk, Ammapet, Thanjavur - 614402	Dr. Selvi J, Assistant Professor, Department of Food Science and Technology, Community Science College and Research Institute, TNAU, Madurai- 625104	Dr. P.Sheela, Assistant Professor (Food Science and Nutrition)

Practical

Identification of product available in the market, analyzing the existing status, market survey and identifying the target customer. Preparation of jam, jelly, marmalade and RTS. Processing of dehydrated fruits and vegetable products, canned products, toffee and fruit bars. Preparation of pickles and sauces. Processing of fermented beverages. Identifying suitable packaging material for the developed products. Designing and layout of food processing industry and identifying the resources. Project proposal preparation, quality assessment and maintenance of production records and food safety standards and pilot scale production

Text Book

1. James G. Brennan. (2006). Food Processing Handbook. Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, Germany.
2. M. Shafiur Rahman. (2007). Handbook of Food Preservation, (2nd Ed). CRC Press, Boca Raton, FL, USA.
3. Norman N. Potter and Joseph H. Hotchkiss. (1995). Food Science, (5th Ed). Chapman & Hall, NY, USA.
4. Srilakshmi, B. (2018). Food Science (7th Ed). New Age International Ltd, publishers, New Delhi, India, PP: 1-508
5. Stavros Yanniotis. (2008). Solving Problems in Food Engineering. Springer Science + Business Media, NY, USA.

Reference Books

1. Potter, N. (2005). Food Science, CBS Publishers and Distributors, Delhi
2. Verma, L.R. and V.K. Joshi. (2000). Post Harvest Technology of Fruits and Vegetables. Vol. 1 and 2. Indus Publishing Company. New Delhi.
3. Vijaya Khader. (2001). Textbook of Food Science and Technology, Indian Council of Agricultural Research, New Delhi.

Web-References

1. <http://www.ifis.org>
2. http://www.fao.org/infoods/index_en.stm
3. <https://fstjournal.org>
4. www.foodnetbase.com
5. www.cfs.purdue.edu/class

Journals

1. Trends in Foods Science and Technology
2. Annual Reviews of Food Science and Technology
3. Food Research International
4. Indian Food Industry
5. Indian food packer

Course Nature: Practical			
Total Marks (100)			
S.No.	Category	Assessment Tools	Marks
1	Practical-Internal	Purely internal based on the participation, involvement and contribution of students in the activities pertaining to the course	
		Continuous evaluation of routine activities	30
		Execution skill and Product generation/ Competence	20
		Written test	20
		Record and Observation Note	20
		Viva-Voce	05
		Attendance	05
Grand Total			100

Course Code	STR19814	Course Name	Poultry Production Technology	Course Category	E	Experiential learning	L	T	P	C
							0	0	10	10

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Animal Husbandary	Data Book / Codes/Standards			

Course Learning Rationale (CLR):		The purpose of learning this course is to:		
CLR-1 :	Understand the importance of Poultry sector			
CLR-2 :	Obtain knowledge on different poultry species and their utilities			
CLR-3 :	Learn about different types of breeds, strains of broilers and layers			
CLR-4 :	Obtain skill for chicken rearing			
CLR-5 :	Practice on different egg products preparation			
CLR-6 :	Develop skill for business entrepreneur			
Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:		
CLO-1 :	Rehearse on chicken rearing and different species of poultry			
CLO-2 :	Present skills on poultry management in different climate condition			
CLO-3 :	Illustrate on dressing of broilers and quails			
CLO-4 :	Acquisition of skill in various techniques of vaccination and artificial insemination in chicken			
CLO-5 :	Demonstrate about different egg products preparation			
CLO6 :	Exhibit skill as an entrepreneur			

Learning		
1	2	3
Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)

Program Learning Outcomes (PLO)														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Poultry field Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Ability to solve scientific problems	Ability to implement knowledge gained in the applied field of Chicken rearing	Ability to understand social and ethical responsibilities in poultry
M			L					M	H		H	L	H	H
M	L		M					L	H		H	L	H	H
M	L							L	H		H	M	H	H
M	M							M	H		H	L	H	H
L		M						M	H		H	M	H	H
L	L	M		L		H		M	H		H	L	H	H

Duration (Weeks)	Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
	3	3	4	3	3
S-1	SLO-1 SLO-2	Week 1-Introduction to poultry sector	Week5- Summer and winter management of broilers	Week8- Egg products and additive supplementation	Week 14- Exposure visit to commercial layer, broiler farm
S-2	SLO-1 SLO-2	Week 2- Different types of breeds and strains of broilers and layers	Week 6- collection and handling of eggs and Egg quality determination	Week 9- Broiler rearing – dressing and cut-up parts	Week 15- Economics of broiler and layer farming
S-3	SLO-1 SLO-2	Week 3- Preparation of Poultry house – Farm equipment's	Week7- Egg candling and preservation	Week10 – Termites, azolla production and feeding	Week 16. –Exposure visit to hatchery unit, feed mill and processing unit
S-4	SLO-1 SLO-2	Week 4- Litter material selection and management- Brooding			

Learning Resources	1. Sreenivasaiah, P.V. (2006). Scientific Poultry Production (3 rd ed). Lucknow: International Book Distributing Co.pp-1-1487 2. R.A.Singh (1990) .A Text Book of Poultry production (3 rd ed) .Ludhiana: Kalyani publishers, rajendernagar.pp-1-315.=

	Level of Thinking	Final Internal Evaluation (15%)
Level 1	Remember	20%
	Understand	
Level 2	Apply	40%
	Analyze	
Level 3	Evaluate	40%
	Create	
	Total	100%

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
<i>Dr. B. George Stephenson</i> <i>Manager -Technical</i> <i>Novas international Pvt.Ltd</i> <i>Mobile: 9500107918</i>	<i>Dr. T. Vasanthakumar</i> <i>Assistant Professor</i> <i>Livestock farm complex</i> <i>Veterinary college and research institute, Orathanadu</i> <i>Thanjavur (Dt)</i> <i>Mobile:9025250970</i>	<i>Dr. G. Prabakar,Assistant Professor,</i> <i>Veterinary Science</i>

Practical

Poultry Industry in India - Current status of broiler and layer industry – Scope of broiler and layer production in India - Introduction to Broilers and Layers – Commercial strains of broilers and layers. Housing management – Location and layout of commercial broiler and layer farm- Farm equipment's -Preparation of poultry house- Litter material selection and management - Summer management of broiler -Winter management of broiler – Lighting management- collection and handling of eggs-Determination of internal and external egg qualities- Hatchery management – egg handling – egg preservation – egg products - broiler rearing – dressing of broilers – different cut-up-parts – Additive and supplementation of additives- Termite production – Azolla feeding – Quail rearing -Medication and Vaccination techniques – Artificial insemination technique - Postmortem inspection - Disposal of dead birds - Waste management -Biosecurity measures- Economics of broiler and layers farming- Visit to commercial broiler farm, layer farm, feed plant, hatchery unit and processing plant.

Text Books

1. P.V. Sreenivasaiah (2006). Scientific Poultry Production (3rded): Lucknow: International Book Distributing Co. pp. 1-1487.
2. Gopalakrishnan, C.A., and Lal, D.M.M (1992). Livestock and Poultry Enterprises for Rural Development. Ghaziabad, Uttar Pradesh: Vikas Publications Private Limited. pp. 1- 1096.
3. Sastry, N.S.R and Thomas, C.K. (2005). Livestock Production Management (3rded).Ludhiana: Kalyani Publishers. pp. 1-850.

Reference Books

1. D. Narahari (1997).Commercial Broiler production. (2nded). Delhi: Emkay Publication.pp-1-153.
2. Robert. J. Etches (2000) Reproduction in Poultry: UK: CABI publishing, pp-1-318
3. A. K. Biswas and P. K. Mandal (2014.)Text book of Poultry, egg and Fish Processing Technology. New Delhi: Studium press (india) Pvt. Ltd.

Web-References

1. https://www.youtube.com/watch?v=uwU6-_mK4II
2. <https://www.youtube.com/watch?v=nRWRYvLsudw>
3. <https://www.youtube.com/watch?v=EgFQQdVvJME&t=70s>
4. https://www.youtube.com/watch?v=_UyyLRqah3E
5. <https://www.youtube.com/watch?v=TJIXePc7MgQ>

Journals

1. Indian Journal of Poultry Science
2. British Poultry Science
3. World Poultry Science
4. Poultry Science
5. Indian Journal of Animal science

Course Nature: Practical			
Total Marks (100)			
S.No.	Category	Assessment Tools	Marks
1	Practical-Internal	Purely internal based on the participation, involvement and contribution of students in the activities pertaining to the course	
		Continuous evaluation of routine activities	30
		Execution skill and Product generation/ Competence	20
		Written test	20
		Record and Observation Note	20
		Viva-Voce	05
		Attendance	05
Grand Total			100