ACADEMIC CURRICULA

UNDERGRADUATE DEGREE PROGRAMME

(Regulations 2022)

Bachelor of Science

B.S. Physics
(Four Years)

B.S. (Hons.) Physics
(Four Years)

Learning Outcomes Based Curriculum framework (LOCF)

Academic Year

2022 - 2023

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur- 603203, Chengalpattu District, Tamil Nadu, India

Contents

1. Department Vision Statement	
Stmt - 1	To be recognized nationally and internationally as an exemplary department of physics
Stmt - 2	To provide core instruction in pure and applied physics to train new generation of leading physicists
Stmt - 3	To emerge as a hub of world class research to disseminate our knowledge through interaction with industry, academia and society at large

2. Department Mission Statement	
Stmt - 1	To provide world class teaching and state of art research environment to highly talented young minds
Stmt - 2	To perform frontier research in pure and applied physics, and to serve the society through technological advances
Stmt - 3	To provide an outstanding educational and research experience for the students, researchers and technologists
Stmt - 4	To enable the students to have wide range of career choices through outstanding learning experience
Stmt - 5	To infuse best scientific methods in teaching theoretical and experimental concepts of physics

3. Program Education Objectives (PEO)	
PEO - 1	Acquiring knowledge and skill of various fields of Physics ranging from fundamental core courses to application-based subjects
PEO - 2	To employ critical thinking, analytical and problem solving skills in the multidisciplinary areas pertaining to application of physics
PEO - 3	Capable of working effectively in diverse teams both in class-room and outside world and able to identify appropriate resources required for management and completion of project with ethical scientific conduct
PEO - 4	To emphasize the relevance of Physics as the important discipline for sustaining the existing industries and establishing new ones to self-empowering the students to create job opportunities and entrepreneurships
PEO - 5	To develop a national and international perspective in core and applied Physics to enable them for improving knowledge and skill for their career development in the chosen field of Physics

4. Program Specific Outcomes (PSO)	
PSO - 1	Graduates will acquire a comprehensive knowledge and sound understanding of fundamentals of Physics
PSO - 2	Graduates will develop practical, analytical and mathematical skills in Physics
PSO - 3	Graduates will be prepared to acquire a range of general skills, to solve problems, to evaluate information, to use computers productively, to communicate with society effectively and learn independently through out life

5. Consistency of PEO's with Mission of the Department					
	Mission Stmt. - 1	Mission Stmt. - 2	Mission Stmt. - 3	Mission Stmt. - 4	Mission Stmt. - 5
PEO - 1	H	H	H	H	H
PEO - 2	H	H	H	M	H
PEO - 3	M	H	H	H	L
PEO - 4	H	H	M	H	M
PEO - 5	H	H	M	H	M

H – High Correlation, M – Medium Correlation, L – Low Correlation

6. Consistency of PEO's with Program Learning Outcomes (PLO)														
	Program Learning Outcomes (PLO)													
	1.	*2.*	*3.*	*4.*	*5.*	*6.*	*7.*	*8.*	*9.*	*10.*	*11.*	*12.*	*13.*	*14.*	*15.*
	Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	Ethical Reasoning	Community Engagement	ICT Skills	Leadership Skills	Life Long Learning
PEO - 1	H	M	H	H	M	L	H	L	H	L	M	L	L	L	H
PEO - 2	H	H	H	H	M	M	H	M	H	L	M	L	H	M	H
PEO - 3	H	H	H	H	H	H	H	H	H	H	H	H	H	M	H
PEO - 4	H	M	H	H	H	H	H	H	H	M	H	H	M	M	M
PEO - 5	H	L	H	H	H	H	H	H	H	M	M	M	M	M	M

Curriculum B.S. Physics

7. Programme Structure

1. Professional Core Courses
(24 Courses)

Course Code	Course Title	Hours/ Week			C
		L	T	P	
UPY22101J	Physics-I	3	0	2	4
UCY22101T	General Chemistry-I	3	0	0	3
UMA22101T	Mathematics-I	3	1	0	4
UBT22102J	Biology-I	3	0	2	4
UPY22201J	Physics-II	3	0	2	4
UCY22201J	General Chemistry-II	3	0	4	5
UMA22201T	Mathematics-II	3	1	0	4
UBT22202J	Biology-II	3	0	2	4
UPY22301J	Optics and Lasers	4	0	4	6
UPY22302T	Mathematical Physics-I	3	1	0	4
UPY22303T	Classical Mechanics	3	1	0	4
UPY22401J	Electronics	4	0	4	6
UPY22402T	Quantum Mechanics-I	3	1	0	4
UPY22403T	Statistical Physics	3	1	0	4
UPY22501J	Solid State Physics	4	0	4	6
UPY22502T	Quantum Mechanics-II	3	1	0	4
UPY22503T	Mathematical Physics-II	3	1	0	4
UPY22601T	Computational Methods	3	3	0	6
UPY22602T	Atomic and Molecular Physics	3	1	0	4
UPY22603T	Electromagnetic Theory	3	1	0	4
UPY22701L	Advanced Laboratory	0	0	8	4
UPY22702T	Physics of Nanomaterials	3	1	0	4
UPY22703T	Nuclear and Particle Physics	3	1	0	4
UPY22704T	Semiconductor Device Physics	3	1	0	4
Total Learning Credits					**104**

2. Discipline Specific Elective Courses (D)
(5 Courses)

Course Code	Course Title	Hours/ Week			C
		L	T	P	
UPY22D01T	Physical Oceanography	3	0	0	3
UPY22D02T	Biophysics				
UPY22D03T	Energy Technology	3	0	0	3
UPY22D04T	Plasma Physics				
UPY22D05T	Science and Technology of Thin Films	3	0	0	3
UPY22D06T	Magnetism and Superconductivity				
UPY22D07T	Astrophysics	3	0	0	3
UPY22D08T	Photonics				
Total Learning Credits					**12**

3. Generic Elective Courses (G)
(4 Courses))

Course Code	Course Title	Hours/ Week			C
		L	T	P	
ULT22G01J	Tamil-I	2	0	2	3
ULH22G01J	Hindi-I				
ULF22G01J	French -I				
ULT22G02J	Tamil-II	2	0	2	3
ULH22G02J	Hindi-II				
ULF22G02J	French -II				
UCY22G01T	Material Science and Nanotechnology	3	0	0	3
UMA22G01T	Foundation of Statistics				
UBT22G01T	Algal Cultivation	0	3	0	
Total Learning Credits					**9**

4. Skill Enhancement Courses (S)
(3 Courses)

Course Code	Course Title	Hours/ Week			C
		L	T	P	
UPY22S01T	Digital Signal Processing	0	2	0	2
UPY22S02L	Electronic Instrumentation	0	0	4	2
UPY22S03T	Seminar	0	2	0	2
Total Learning Credits					**6**

5. Ability Enhancement Courses (AE)
(3 Courses)

Course Code	Course Title	Hours/ Week			C
		L	T	P	
ULE22AE1T	English	4	0	0	4
UES22AE1T	Environmental Studies	3	0	0	3
UCY22AE1T	Research Methodology	3	1	0	4
Total Learning Credits					**11**

6. Life Skill Courses (Jeevan Kaushal) (JK)
(3 Courses)

Course Code	Course Title	Hours/ Week			C
		L	T	P	
UJK22201L	Communication Skills	0	0	4	2
UJK22301T	Universal Human Values	2	0	0	2
UJK22401T	Professional Skills	2	0	0	2
Total Learning Credits					**6**

7. Extension Activity/Community Outreach (1 Course)					
Course Code	Course Title	Hours/ Week			C
		L	T	P	
UNS22201L	*NSS*	*0*	*0*	*0*	*0*
UNC22201L	*NCC*				
UNO22201L	*NSO*				
UYG22201L	*YOGA*				
UMI22S01L	*My India Project*	*0*	*0*	*0*	*1*
Total Learning Credits					***1***

8. Internship/ Project (P) (3 courses)					
Course Code	Course Title	Hours/ Week			C
		L	T	P	
UPY22P01L	*Internship*	*0*	*0*	*0*	*3*
UPY22P02L	*MOOC*				
UPY22P03L	*Major Project*	*0*	*0*	*24*	*12*
Total Learning Credits					**15**

As SRMIST strongly encourages the use of SWAYAM (Study Web of Active Learning by Learning by Young and Aspiring Minds) platform, the students are encouraged to choose at least one core/ elective course from SWAYAM on the recommendation of the faculty advisor and the credits will be transferred

8. Implementation Plan

Semester – I

Code	Course Title	Hours/ Week			C
		L	T	P	
ULT22G01J	Tamil-I	2	0	2	3
ULH22G01J	Hindi-I				
ULF22G01J	French-I				
ULE22AE1T	English	4	0	0	4
UPY22101J	Physics-I	3	0	2	4
UCY22101T	General Chemistry-I	3	0	0	3
UMA22101T	Mathematics-I	3	1	0	4
UBT22102J	Biology-I	3	0	2	4
Total Learning Credits					22
Total number of hours /week					25

Semester – II

Code	Course Title	Hours/ Week			C
		L	T	P	
ULT22G02J	Tamil-II	2	0	2	3
ULH22G02J	Hindi-II				
ULF22G02J	French-II				
UPY22201J	Physics-II	3	0	2	4
UCY22201J	General Chemistry-II	3	0	4	5
UMA22201T	Mathematics-II	3	1	0	4
UBT22202J	Biology-II	3	0	2	4
UJK22201L	Communication Skills	0	0	4	2
UNS22201L	NSS	0	0	0	0
UNC22201L	NCC				
UNO22201L	NSO				
UYG22201L	YOGA				
Total Learning Credits					22
Total number of hours /week					29

Semester – III

Code	Course Title	Hours/ Week			C
		L	T	P	
UPY22301J	Optics and Lasers	4	0	4	6
UPY22302T	Mathematical Physics-I	3	1	0	4
UPY22303T	Classical Mechanics	3	1	0	4
UPY22S01T	Digital Signal Processing	0	2	0	2
UES22AE1T	Environmental studies	3	0	0	3
UJK22301T	Universal Human Values	2	0	0	2
Total Learning Credits					21
Total number of hours /week					23

Semester – IV

Code	Course Title	Hours/ Week			C
		L	T	P	
UPY22401J	Electronics	4	0	4	6
UPY22402T	Quantum Mechanics-I	3	1	0	4
UPY22403T	Statistical Physics	3	1	0	4
UPY22S02L	Electronic Instrumentation	0	0	4	2
UMI22S01L	My India Project	0	0	0	1
UJK22401T	Professional Skills	2	0	0	2
UPY22D01T	Physical Oceanography	3	0	0	3
UPY22D02T	Biophysics				
Total Learning Credits					22
Total number of hours /week					25

Semester – V

Code	Course Title	Hours/ Week			C
		L	T	P	
UPY22501J	Solid State Physics	4	0	4	6
UPY22502T	Quantum Mechanics-II	3	1	0	4
UPY22503T	Mathematical Physics-II	3	1	0	4
UPY22D03T	Energy Technology	3	0	0	3
UPY22D04T	Plasma Physics				
UPY22D05T	Science and Technology of Thin Films	3	0	0	3
UPY22D06T	Magnetism and Superconductivity				
Total Learning Credits					20
Total number of hours /week					22

Semester – VI

Code	Course Title	Hours/ Week			C
		L	T	P	
UPY22601T	Computational Methods	3	3	0	6
UPY22602T	Atomic and Molecular Physics	3	1	0	4
UPY22603T	Electromagnetic Theory	3	1	0	4
UCY22G01T	Material Science and Nanotechnology	3	0	0	3
UMA22G01T	Foundation of Statistics				
UBT22G01T	Algal Cultivation	0	3	0	
UPY22D07T	Astrophysics	3	0	0	3
UPY22D08T	Photonics				
Total Learning Credits					20
Total number of hours /week					20

Semester –VII

Code	Course Title	Hours/ Week			C
		L	T	P	
UPY22701L	Advanced Laboratory	0	0	8	4
UPY22702T	Physics of Nanomaterials	3	1	0	4
UPY22703T	Nuclear and Particle Physics	3	1	0	4
UPY22704T	Semiconductor Device Physics	3	1	0	4
UPY22S03T	Seminar	0	2	0	2
UPY22P01L	Internship	0	0	0	3
UPY22P02L	MOOC				
UCY22AE1T	Research Methodology	3	1	0	4
Total Learning Credits					25
Total number of hours /week					26

Semester –VIII

Code	Course Title	Hours/ Week			C
		L	T	P	
UPY22P03L	Major Project	0	0	24	12
Total Learning Credits					12
Total number of hours /week					24

9. Program Articulation Matrix

Course Code	Course Name	Programme Learning Outcomes														
		Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	Ethical Reasoning	Community Engagement	ICT Skills	Leadership Skills	Life Long Learning
UPY22101J	Physics-I	H	-	H	-	-	-	-	-	-	-	-	-	-	-	H
UCY22101T	General Chemistry-I	H	H	-	-	-	-	H	H	-	-	-	-	-	-	H
UMA22101T	Mathematics-I	H	H	H	H	H	-	-	-	-	-	-	-	-	-	H
UBT22102J	Biology-I	H	-	-	-	-	-	-	-	-	-	-	-	-	-	H
UPY22201J	Physics-II	H	-	H	H	-	-	H	-	-	-	-	-	-	-	-
UCY22201J	General Chemistry-II	H	H	H	H	H	-	-	H	-	-	-	-	-	-	H
UMA22201T	Mathematics-II	H	H	M	H	-	-	-	-	-	-	-	-	-	-	H
UBT22202J	Biology-II	H	-	-	H	-	-	H	-	-	-	-	-	-	-	H
UPY22301J	Optics and Lasers	H	-	-	-	-	-	-	-	-	-	-	-	-	-	H
UPY22302T	Mathematical Physics-I	H	-	H	H	-	-	-	-	-	-	-	-	-	-	-
UPY22303T	Classical Mechanics	H	-	H	H	-	-	-	-	-	-	-	-	-	-	H
UPY22401J	Electronics	H	-	-	-	-	-	-	-	-	-	-	-	-	-	H
UPY22402T	Quantum Mechanics-I	-	-	H	H	-	-	-	-	-	-	-	-	-	-	-
UPY22403T	Statistical Physics	H	-	H	H	-	-	-	-	-	-	-	-	-	-	-
UPY22501J	Solid State Physics	H	H	H	H	-	-	-	-	-	-	-	-	-	-	-
UPY22502T	Quantum Mechanics-II	-	-	H	H	-	-	-	-	-	-	-	-	-	-	-
UPY22503T	Mathematical Physics-II	-	-	H	H	-	-	-	-	-	-	-	-	-	-	-
UPY22601T	Computational Methods	H	H	H	-	-	-	-	-	-	-	-	-	-	-	-
UPY22602T	Atomic and Molecular Physics	H	-	H	-	-	-	-	-	-	-	-	-	-	-	-
UPY22603T	Electromagnetic Theory	-	-	H	H	-	-	-	-	-	-	-	-	-	-	-
UPY22701L	Advanced Laboratory	-	H	-	-	-	H	-	-	-	-	-	-	-	-	-
UPY22702T	Physics of Nanomaterials	-	-	H	H	-	-	-	-	-	-	-	-	-	-	-
UPY22703T	Nuclear and Particle Physics	H	-	H	H	-	-	-	H	-	-	-	-	-	-	-
UPY22704T	Semiconductor Device Physics	-	-	H	H	-	-	-	-	-	-	-	-	-	-	-
UPY22D01T	Physical Oceanography	H	H	-	H	H	H	H	-	-	-	-	-	-	-	-
UPY22D02T	Biophysics	H	H	-	-	-	-	-	-	-	-	-	-	-	-	-
UPY22D03T	Energy Technology	H	-	-	H	H	-	-	H	-	-	-	H	-	-	-
UPY22D04T	Plasma Physics	H	-	-	H	H	-	H	-	-	-	-	-	-	-	-
UPY22D05T	Science and Technology of Thin Films	H	H	-	-	H	-	-	-	-	-	-	-	-	-	-
UPY22D06T	Magnetism and Superconductivity	H	-	-	H	H	-	-	-	-	-	-	-	-	-	H
UPY22D07T	Astrophysics	H	-	H	H	-	-	-	H	-	-	-	-	-	-	-
UPY22D08T	Photonics	H	-	H	H	-	-	-	-	-	-	-	-	-	-	-
ULT22G01J	Tamil-I	H	H	H	H	H	-	-	-	-	-	-	-	-	-	-
ULH22G01J	Hindi-I	H	H	H	H	H	-	-	-	-	-	-	-	-	-	-
ULF22G01J	French -I	H	H	H	H	H	-	-	-	-	-	-	-	-	-	-
ULT22G02J	Tamil-II	H	H	H	H	H	-	-	-	-	-	-	-	-	-	-
ULH22G02J	Hindi-II	H	H	H	H	H	-	-	-	-	-	-	-	-	-	-
ULF22G02J	French -II	H	H	H	H	H	-	-	-	-	-	-	-	-	-	-
UCY22G01T	Material Science and Nanotechnology	H	H	H	M	H	-	-	-	-	-	-	-	-	-	H
UMA22G01T	Foundation of Statistics	H	H	M	H	H	-	-	-	-	-	-	-	-	-	H
UBT22G01T	Algal Cultivation	H	-	-	H	H	-	-	-	-	-	-	-	-	-	-
UPY22S01T	Digital Signal Processing	H	H	H	H	-	-	-	-	-	-	-	-	-	-	H
UPY22S02L	Electronic Instrumentation	H	-	H	H	-	-	-	-	-	-	-	-	-	-	-
UPY22S03T	Seminar	H	H	-	-	H	-	H	-	H	M	-	-	M	-	-
ULE22AE1T	English	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UES22AE1T	Environmental Studies	-	-	-	-	-	H	H	-	-	-	-	H	-	-	-
UCY22AE1T	Research Methodology	-	H	-	H	H	-	-	H	H	H	-	-	-	-	-
UJK22201L	Communication Skills	H	-	-	-	-	-	-	-	-	-	-	H	-	-	H
UJK22301T	Universal Human Values	H	H	-	H	-	-	-	H	-	H	H	-	-	-	-
UJK22401T	Professional Skills	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UNS22201L	NSS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UNC22201L	NCC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UNO22201L	NSO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UYG22201L	YOGA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UMI22S01L	My India Project	M	-	M	-	-	M	-	M	-	-	-	H	M	M	H
UPY22P01L	Internship	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UPY22P02L	MOOC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UPY22P03L	Major Project	H	H	H	-	H	H	H	H	-	-	-	-	M	-	M
	Program Average	**H**	**H**	**H**	**H**	**H**	**H**	**H**	**H**	**H**	**H**	**H**	**H**	**M**	**M**	**H**

10. Structure of Courses in BS Physics

Distribution of different Courses in each semester with their credits for B.S.. (Physics)

Semester	Core Courses (CC)	Discipline Specific Electives Courses (DSE)	Generic Electives Cources (GE)	Skill Enehacment Courses (S)	Ability Enhancement Courses (AE)	Extension Activity/ Community Outreach (EA)	Jeevan Kaushal Courses (JK)	Internship/ Project (P)	
Sem I	**Foundation** Physics-I (4) General Chemistry-I (3) Mathematics-I (4) Biology-I (4)		GE-1 (3)		AE-1 (4)				**22**
Sem II	**Foundation** Physics-II (4) General Chemistry-II (5) Mathematics-II (4) Biology-II (4)		GE-2 (3)			EA-2 (0)	JK-1 (2)		**22**
Sem III	CC-3 (6) CC-4 (4) CC-5 (4)			S-1 (2)	AE-2 (3)		JK-2 (2)		**21**
Sem IV	CC-6 (6) CC-7 (4) CC-8 (4)	DSE-1 (3)		S-2 (2)		EA-3 (1)	JK-3 (2)		**22**
Sem V	CC-9 (6) CC-10 (4) CC-11 (4)	DSE-2 (3) DSE-3 (3)							**20**
Sem VI	CC12 (6) CC-13 (4) CC-14 (4)	DSE-4 (3)	GE-3 (3)						**20**
Sem VII	CC-15 (4) CC-16 (4) CC-17 (4) CC-18 (4)			S-3 (2)	AE-3 (4)			P-1 (3)	**25**
Sem VIII								P-2 (12)	**12**
Total Credits	**104**	**12**	**9**	**6**	**11**	**1**	**6**	**15**	**164****

****For B.S. (Hons.) Physics total number of credits are 176.**

Honours in Physics

1. Programme Structure Honours

1. Professional Core Courses (5 Courses, Minimum 12 Credits)					
Course Code	Course Title	Hours/ Week			C
		L	T	P	
UPY22H01T	Group Theory	3	1	0	4
UPY22H02T	Quantum Optics				
UPY22H03T	Advanced Computational Physics	2	2	0	4
UPY22H04T	Particle Physics	3	1	0	4
UPY22H05T	Quantum Materials and Devices				
Total Learning Credits					**12**

As SRMIST strongly encourages the use of SWAYAM (Study Web of Active Learning by Learning by Young and Aspiring Minds) platform, the students are encouraged to choose at least one core/ elective course from SWAYAM on the recommendation of the faculty advisor and the credits will be transferred

2. Implementation Plan

Semester – VI					
Code	Course Title	Hours/ Week			C
		L	T	P	
UPY22H01T	Group Theory	3	1	0	4
UPY22H02T	Quantum Optics				
Total Learning Credits					4
Total number of hours /week					4

Semester –VII					
Code	Course Title	Hours/ Week			C
		L	T	P	
UPY22H03T	Advanced Computational Physics	2	2	0	4
UPY22H04T	Particle Physics	3	1	0	4
UPY22H05T	Quantum Materials and Devices				
Total Learning Credits					8
Total number of hours /week					8

3. Program Articulation Matrix

Course Code	Course Name	Programme Learning Outcomes														
		Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	Ethical Reasoning	Community Engagement	ICT Skills	Leadership Skills	Life Long Learning
UPY22H01T	Group Theory	H	H	H	H	-	-	-	-	-	-	-	-	-	-	-
UPY22H02T	Quantum Optics	H	-	H	H	-	-	-	-	-	-	-	-	-	-	H
UPY22H03T	Advanced Computational Physics	H	H	H	-	-	-	-	-	-	-	-	-	-	-	-
UPY22H04T	Particle Physics	H	-	H	H	H	-	-	-	-	-	-	-	-	-	-
UPY22H05T	Quantum Materials and Devices	-	M	H	M	H	-	M	-	-	-	-	-	-	-	-
Program Average		**H**	**H**	**H**	**H**	**H**	-	**M**	-	-	-	-	-	-	-	**H**

Syllabus for B.S. Physics

SEMESTER I

Course Code	ULT22G01J	Course Name	Tamil-I	Course Category	G	Generic Elective Course	L	T	P	C
							2	0	2	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning	Program Learning Outcomes (PLO)

		Bloom's Level
CLR-1 :	*enable them to learn the nuances of modern poetry in tamil*	
CLR-2 :	*explore new historicism through the works of art written in tamil to enlighten the students to understand the changes in the modern society*	
CLR-3 :	*inculcate ways of life, moralities and ethical factors as an essential part of learning tamil literature*	
CLR-4 :	*develop strategies of comprehension of texts of different origin*	
CLR-5 :	*strengthen the language of the students both in oral and written*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Bloom's Level
CLO-1 :	*extend and expand their savoir-faire through the acquisition of skills to cater the needs of the modern era.*	*4*
CLO-2 :	*enable the students to appreciate their mother tongue and to enhance their thinking capacity*	*4*
CLO-3 :	*make them learn the basic rules of language and make them communicate better*	*4*
CLO-4 :	*develop strategies of comprehension of texts based on different culture and life styles*	*4*
CLO-5 :	*strengthen spoken and written skills of the student*	*4*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	Ethical Reasoning	Community Engagement	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*H*	-	*M*	-	*H*	-	-	-	-	-	-	-	-	-	-
CLO-2 :	*H*	-	*H*	-	*M*	-	-	-	-	-	-	-	-	-	-
CLO-3 :	*M*	*H*	-	*H*	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	*M*	-	*H*	-	*M*	-	-	-	-	-	-	-	-	-	-
CLO-5 :	-	*H*	-	*M*	*H*	-	-	-	-	-	-	-	-	-	-

அலகு – 1 – கவிதைகள்

தமிழ் இலக்கியப் போக்குகள் – தமிழ்க்கவிதை மரபு

கவிதைகள் - 1. பாரதியார் – கண்ணன் என் சேவகன், 2. பாரதிதாசன் – தமிழின் இனிமை, 3. அப்துல் ரகுமான் – அவதாரம்

1. து. நரசிம்மன் – மன்னித்துவிடு மகனே

அலகு – 2 – கவிதைகள்

நவீன கவிதை தோற்றம் – நவீன கவிதை வரலாறு.

கவிதைகள் 1. ராஜாசந்திரசேகர் – கைவிடப்பட்ட குழந்தை , 2. அனார் – மேலும் சில இரத்தக் குறிப்புகள், 3. சுகிர்தராணி – அம்மா

4. நா.முத்துக்குமார் – தூர்

அலகு – 3 – சிற்றிலக்கியம் & காப்பியம்

1. கலிங்கத்துப்பரணி – பொருதடக்கைவாள் எங்கே.... (பாடல் – 484)
2. அழகர் கிள்ளை விடு தூது – இதமாய் மனிதருடனே.... (கண்ணி – 45)
3. நந்திக்கலம்பகம் – அம்பொன்று வில்லொடிதல்.... (பாடல் – 77)
4. குற்றாலக் குறவஞ்சி – ஓடக் காண்பது... (பாடல் – 9)
5. மணிமேகலை – உலக அறவி புக்ககாதை – "மாசு இல் வால்ஒளி! – இந்நாள் போலும் இளங்கொடி கெடுத்தனை" (28 அடிகள்)

அலகு – 4 – தமிழ் இலக்கிய வரலாறு மற்றும் உரைநடை

1. சிற்றிலக்கியம் – தோற்றமும் வளர்ச்சியும்
2. புதுக்கவிதை – தோற்றமும் வளர்ச்சியும்
3. சிறுகதை – தோற்றமும் வளர்ச்சியும்
4. புதினம் – தோற்றமும் வளர்ச்சியும்
5. அச்சு ஊடகம் – தோற்றமும் வளர்ச்சியும்

உரைநடை

6. உ.வே. சாமிநாதையர் – சிவதருமோத்திரச் சுவடி பெற்ற வரலாறு.
7. தஞ்சாவூர்க் கவிராயர் – கூஜாவின் கோபம்.

அலகு – 5 – மொழிப்பயிற்சி

1. அகரவரிசைப்படுத்துதல்
2. கலைச்சொல்லாக்கம்
3. மரபுத்தொடர்
4. பழமொழி
5. தமிழில் சொல் வகைகள் – பெயர்ச்சொற்கள், வினைச்சொற்கள், பெயரடை, வினையடை...

Learning Resources	1. குறிஞ்சித்தேன், தொகுப்பும் பதிப்பும் - தமிழ்த்துறை ஆசிரியர்கள், எஸ்.ஆர்.எம். அறிவியல் மற்றும் தொழில்நுட்பக் கல்விநிறுவனம், காட்டாங்குளத்தூர், 603203, 2020 2. வல்லிக்கண்ணன், புதுக்கவிதை தோற்றமும் வளர்ச்சியும், ஆழி பதிப்பகம், சென்னை, 2018 3. கா. சிவத்தம்பி, தமிழில் சிறுகதை தோற்றமும் வளர்ச்சியும், என்.சி.பி.எச்., சென்னை, 2013 4. தமிழ் இணையக் கல்விக்கழகம் - http://www.tamilvu.org/ 5. மதுரை தமிழ் இலக்கிய மின் தொகுப்புத் திட்டம் - https://www.projectmadurai.org/

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	10%	10%	10%	10%	10%	10%	10%	10%	20%	-
Level 2	Understand	10%	10%	10%	10%	10%	10%	10%	10%	20%	-
Level 3	Apply	20%	20%	20%	20%	20%	20%	20%	20%	40%	-
Level 4	Analyze	10%	10%	10%	10%	10%	10%	10%	10%	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		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	Expert from Higher Technical Institutions	Internal Experts
	1. Dr. R..Srinivasan Associate Professor, Department of Tamil, Presidency College, Chennai,	*1. B.Jaiganesh, Assistant Professor & Head, FSH, SRMIST*
		2. T.R.Hebzibah Beulah Suganthi, Assistant Professor, FSH, SRMIST
		3.S.Saraswathy, Assistant Professor, FSH, SRMIST

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Course Code	ULH22G01J	Course Name	Hindi-I	Course Category	G	Generic Elective Course	L	T	P	C
							2	0	2	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1 :	*be able to converse well in the hindi language*	Blooms Levels
CLR-2 :	*read and write and clarity*	
CLR-3 :	*be willing listeners and translators –where need be*	
CLR-4 :	*acquire the values/thought contents of the writers and practice in it in life.*	
CLR-5 :	*find motivation through the various forms of literature and learn to overcome any challenges of life.*	
CLR-6 :	*discover the importance of the language in making education as a means of growth in life and not mere literacy.*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Blooms Levels	1 Disciplinary Knowledge	2 Critical Thinking	3 Problem Solving	4 Analytical Reasoning	5 Research Skills	6 Team Work	7 Scientific Reasoning	8 Reflective Thinking	9 Self-Directed Learning	10 Multicultural Competence	11 Ethical Reasoning	12 Community Engagement	13 PSO -1	14 PSO -2	15 PSO-3
CLO-1 :	*appreciate the hindi language in its various forms.*	*4*	*H*	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	*understand the philosophy of life and living through stories.*	*4*	-	*H*	-	*H*	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	*help the students learn and develop the fundamentals of life, through one-act plays.*	*4*	*H*	-	-	*H*	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	*share the richness of thought and content presented in the hindi language, into other languages so that the readers would stand to gain.*	*4*	*H*	-	*H*	*H*	*H*	-	-	-	-	-	*H*	-	-	-	-
CLO-5 :	*guide the students in the learning of the technical aspect of the hindi language, this would help them in the field of administration.*	*4*	-	*H*	-	*H*	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	*encourage the students to communicate with the public, on a large scale with the medium of main stream and documentary films.*	*4*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Program Learning Outcomes (PLO)

UNIT – 1

1. Vo Tera Ghar ye Mera Ghar – MALTI JOSHI
2. Mithaivala – SHRI BHAGAVATHY PRASAD VAJPEYI
3. Bachendri Pal – JEEVANI
4. Nadi aur Jeevan – DR. VIVEKI RAI
5. Pachees chauka Ded Sau – OMPRAKASH VALMIKI

UNIT – 2

1. Raat ke rahi – Sri Brajbusan
2. Akhbari vigyapan – Sri Cheerenjit

UNIT – 3

1. PATRKARITA
   a. Arth
   b. Paribhasha
   c. Swarup
   d. Prakar evam Daitava

UNIT – 4

1. FILM SAMIKSHA
a. 2 MAINSTREAM MOVIES
   b. 2 CLASSIC OR DOCUMENTARY

UNIT – 5

1. TECHNICAL TERMINOLOGY

Learning Resources	***The Prescribe Text Book Compiled and Edited by Department of Hindi*** *www.gadyakosh.com* *www.shabdkosh.com*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	10%	10%	10%	10%	10%	10%	10%	10%	20%	-
Level 2	Understand	10%	10%	10%	10%	10%	10%	10%	10%	20%	-
Level 3	Apply	20%	20%	20%	20%	20%	20%	20%	20%	40%	-
Level 4	Analyze	10%	10%	10%	10%	10%	10%	10%	10%	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		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	**Expert from Higher Technical Institutions**	**Internal Experts**
	1. Prof.(Dr.) S.Narayan Raju, Head, Department of Hindi,CUTN, Tamilnadu	*1. Dr.S Preeti. Associate Professor & Head, SRMIST*
		2. Dr. Md.S. Islam Assistant Professor, SRMIST
		3 Dr. S. Razia Begum, Assistant Professor, SRM IST

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Course Code	ULF22G01J	Course Name	French-I	Course Category	G	Generic Elective Course	L	T	P	C
							2	0	2	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning	Program Learning Outcomes (PLO)

		Blooms Levels
CLR-1 :	*extend and expand their savoir-faire through the acquisition of current scenario*	
CLR-2 :	*enable the students to overcome the fear of speaking a foreign language and take position as a foreigner speaking french*	
CLR-3 :	*make them learn the basic rules of french grammar.*	
CLR-4 :	*develop strategies of comprehension of texts of different origin*	
CLR-5 :	*strengthen the language of the students both in oral and written*	
CLR-6 :	*express their sentiments, emotions and opinions, reacting to information, situations*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Blooms Levels
CLO-1 :	*acquire knowledge about French language*	*4*
CLO-2 :	*strengthen the knowledge on concept, culture, civilization and translation of French*	*4*
CLO-3 :	*develop content using the features in French language*	*4*
CLO-4 :	*interpret the French language into other language*	*4*
CLO-5 :	*improve the communication, intercultural elements in French language*	*4*
CLO-6 :	*acquire knowledge about French language*	*4*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	Ethical Reasoning	Community Engagement	PSO -1	PSO -2	PSO-3
CLO-1 :	*H*	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	-	*H*	-	*H*	-	*H*	-	-	-	-	*M*	-	-	-	-
CLO-3 :	*H*	-	-	*H*	-	*H*	-	-	-	-	*M*	-	-	-	-
CLO-4 :	*H*	-	*H*	*H*	*H*	-	-	-	-	-	*H*	-	-	-	-
CLO-5 :	-	*H*	-	*H*	-	-	-	-	-	-	*H*	-	-	-	-
CLO-6 :	*H*	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-	-

Unité-I

Bonjour, ça va ? - Les pays et les nationalités - Les animaux domestiques- Les jours de la semaine les mois de l'année - Les nombres de 0 à 69 - La famille (1) - L'accent tonique - Les articles un/une et le/les - Bonjour, - Salut ! Je m'appelle Agnès -Mots et expressions – Entrer en contact- Se présenter.

Unité-II

Salut ! Je m'appelle Agnès Les pronoms personnels sujets - Les verbes être et avoir- Les articles définis et indéfinis - La formation du féminine (1) - La formation du pluriel (1) - Les adjectives possessifs - Entrer en contact : salut, demander et dire comment ça va - Se présenter et présenter quelqu'un - Demander et dire la date.

Unité-III

Qui est –ce ?- les professions - Quelques objets - la fiche d'identité - La liaison - L'élision - Intonation descendre/montante – Qui est-ce ? Dans mon sac – Mots et expressions – Demander et répondre poliment – Demander des informations personnelles.

Unité-IV

Dans mon sac, j'ai… la formation du féminin (3) - la phrase interrogative - *qu'est – ce que.. ?/Qu'est – ce que C'est/Qui est – ce ?- la phrase négative - C'est/il est (1) - Les verbes du premier group* - Les verbes *aller et venir* -Demander et répondre poliment - Demander des informations personnelles

Unité-V

Il est comment ?-L'aspect physique - Le caractère - Les prépositions de lieu (1) -Les nombre à partir de 70 - les sons [ə]/[e]/[ɛ] – Allo ? La formation du féminin(3) - Les articles contractés - Les pronoms personnels tonique - Il y a - Les adverbes interrogatifs - Les nombres - Les prépositions de lieu - Les verbes du deuxième group - Le verbe faire - Décrire l'aspect physique et le caractère - Parler au téléphone

Learning Resources	***Theory:*** 1. "**Génération-A1"** Méthode de français, Marie-Noëlle COCTON, P.DAUDA, L.GIACHINO, C.BARACCO, Les éditions Didier, Paris, 2018. 2. ***Cahier d'activités avec deux discs compacts.***

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	10%	10%	10%	10%	10%	10%	10%	10%	20%	-
Level 2	Understand	10%	10%	10%	10%	10%	10%	10%	10%	20%	-
Level 3	Apply	20%	20%	20%	20%	20%	20%	20%	20%	40%	-
Level 4	Analyze	10%	10%	10%	10%	10%	10%	10%	10%	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		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	**Expert from Higher Technical Institutions**	**Internal Experts**
	1. Dr. C.Thirumurugan Associate Professor, Department of French, Pondicherry University	*1. Kumaravel K. Assistant Professor & Head, SRMIST*
		2. Ponrajadurai M Assistant Professor, SRMIST

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Course Code	ULE22AE1T	Course Name	English	Course Category	AE	Ability Enhancement Course	L	T	P	C
							4	0	0	4

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*extend and expand the integrity in an individual which shall never allow him/her to compromise upon a noble way of living*	Bloom's Level
CLR-2:	*enable the students to overcome the fear of speaking a foreign language and enable them to think through a foreign language*	
CLR-3:	*make them communicate an unbiassed way of thinking in a better manner*	
CLR-4:	*develop strategies of comprehension of texts based on different culture and life styles*	
CLR-5:	*help them express their sentiments, emotions and opinions, and reactions to information and situations in a civilized, cultured and humane manner.*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning
CLO-1:	*acquire knowledge of becoming better beings through the tools of Language and Literature*	*4*
CLO-2:	*acquire a strong knowledge on concept, culture, civilization through English Literature*	*4*
CLO-3:	*develop own content and to be able to translate using the features in English Language*	*4*
CLO-4:	*interpret the contents in the texts presented in English Language*	*4*
CLO-5:	*present an improved and healthier communication and intercultural elements acquired through English Literature*	*4*

Program Learning Outcomes (PLO)															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	Ethical Reasoning	Community Engagement	ICT Skills	Leadership Skills	Life Long Learning	
H	-	-	-	-	-	-	-	-	-	-	-	-	-	*H*	
H	-	-	-	-	-	-	-	-	-	-	-	-	-	*H*	
H	-	-	-	-	-	-	-	-	-	-	-	-	-	*H*	
H	-	-	-	-	-	-	-	-	-	-	-	-	-	*H*	
H	-	-	-	-	-	-	-	-	-	-	-	-	-	*H*	

UNIT I

POETRY

1. PUNISHMENT IN KINDERGARTEN – KAMALA DAS
2. PHALLUS I CUT – KALKI
3. OBITUARY _ A. K. RAMANUJAM
4. APOLOGIES FOR LIVING ON – MEENA KANDASAMY

UNIT II

LETTERS BY MATHRABOOTHAM PUBLISHED IN THE HINDU
(LETTERS WITH REGIONAL RELEVANCE AND NATIONAL SIGNIFICANCE)

1. ENJOY WITHIN LIMITS, SAYS MR MATHRUBOOTHAM
2. NOBEL? WHAT NOBEL, ASKS MR MATHRUBOOTHAM
3. MR MATHRUBOOTHAM IS FULLY SUPPORTING ALL NEW TECHNOLOGIES
4. PIZZA MAAVU : WELCOME TO MR MATHRUBOOTHAM FOOD RECIPIE WEBSITE

UNIT III

1. STORY THROUGH IMAGES
2. AUTOBIOGRAPHY OF CONCRETE OBJECTS
3. CAPTION WRITING
4. PUBLIC SPEAKING

UNIT IV

LISTENING AND READING

1. MONOLOGUES
2. CONVERSATIONS
3. LOUD READING
4. READING COMPREHENSION

UNIT V

LANGUAGE COMPONENTS

1. PARTS OF SPEECH
2. TENSES
3. ARTICLES
4. PREPOSITION
5. ERRORS IN SENTENCES

Learning Resources	***Theory:***
	1. Horizon- English Text Book – Compiled and Edited by the Faculty of English Department, FSH, SRMIST, 2020
	English Gramar in Use by Raymond Murphy

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
Level 4	Analyze	20%	-	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
		1. Dr. Shanthichitra, Associate Professor, & Head, Department of English, FSH, SRMIST
		2. Dr K B Geetha, Assistant Professor, Department of English, FSH, SRMIST

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Course Code	UPY22101J	Course Name	Physics-I	Course Category	C	Professional Core Course	L	T	P	C
							3	0	2	4

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*understand, explain and derive the various mechanics problems*
CLR-2:	*emphasize the basic mathematical formulation of mechanics problems*
CLR-3:	*apply the fundamental concepts of mechanics to solve mechanics problems*
CLR-4:	*develop problem solving and critical thinking*
CLR-5:	*develop basic understanding of waves and oscillations*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning Bloom's Level	Program Learning Outcomes (PLO)														
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
			Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1:	*understand vector to the language that is useful in physics*	4	*H*	-	*H*	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2:	*understand analogous concepts for rotational motion*	4	*H*	-	-	*H*	-	-	-	-	-	-	-	-	-	-	-
CLO-3:	*learn the laws of mechanics under the force field*	4	*H*	-	-	-	-	-	-	-	-	-	-	*H*	-	-	-
CLO-4:	*basic knowledge on simple harmonic oscillator under damping and driving conditions*	4	*H*	-	*H*	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5:	*gain knowledge on various waveforms and perform mechanics related experiments*	4	*H*	-	*H*	-	-	-	-	-	-	-	-	-	*H*	-	-

Unit-1: Scalar field and vector field, Vector triple product and Reciprocal sets of vectors, Area of a triangle using vector cross product, Work done in moving object along a vector, Determine a unit vector perpendicular to a plane, Equation for a plane using vector rules, Determine the velocity and acceleration of a particle from its parametric equations, Determine the component of velocity and acceleration in a direction of a particle from its parametric equations, Velocity and acceleration of a particle with a given position vector r, Physics of Gradient in a vector field, Laplacian operator and Grad of a scalar field, Understand the rotational properties from the Curl in a vector field, Reference frames, Inertial frame, Newton's Law of Motion, Galilean Transformation, Transformation equations for a Frame of Reference, Conservation of linear momentum, Conservation of linear angular momentum, Work, Kinetic energy, Concept of power and energy

Experiment no. 1: Newton's 2nd law-Demonstration track with measure Dynamics
Experiment no. 2: Determination of moment of inertia and acceleration due to gravity using Bifilar pendulum

Unit-2: Conservative Force Field, Potential Energy, Impulse, Torque, Conservation of Energy, Non-conservative force, Center of Mass, Center of mass frame of reference, Motion of the Centre of mass, Collision, elastic collision, inelastic collision, Moment of Inertia (MI), Physical significance of MI, Moment of Inertia of a uniform thin rod, Circular lamina, Rectangular lamina, Solid Sphere, Solid Cylinder, and hollow cylinder, Product of moment of Inertia, Principal moments

Experiment no. 3: Determination of rigidity modulus of the suspension wire - Torsional pendulum
Experiment no. 4: Determination of acceleration due to gravity-Compound bar pendulum

Unit-3: : Uniform force field, Uniformly accelerated motion, Weight and acceleration due to gravity, Freely falling bodies, Projectiles, Motion of a projectile in Uniform gravitational field, Potential energy in a uniform force field, Motion in a resisting medium, Friction, Central forces, Properties of central force fields, Equation of Motion for a particle in a central field, Determination of the orbit from central force, Kepler's laws of planetary motion, Law of gravitation from Kepler's laws, Motion in an inverse square field

Experiment no. 5: Determination of spring constant-expansion of a helical spring
Experiment no.6: Determination of Static friction, sliding friction and rolling friction

Unit-4: Oscillations in physical systems, Simple harmonic motion, The force law of simple harmonic motion, Energy in simple harmonic motion, Angular simple Harmonic oscillator, Simple pendulums,
Physical pendulum, Vertical and angular simple harmonic motion, Vibrations of molecules, Vibrations of molecules, Damped simple harmonic motion, Energy in damped oscillations, Driven oscillations, Resonance and its consequences, Power dissipation

Experiment no 7: Determination of Moment of inertia and angular acceleration with precision pivot bearing
Experiment no.8: Measurement of Free fall-Dynamics method

Unit-5: Transverse and Longitudinal waves, Sinusoidal waves, Wave speed on a stretched string, Energy and power of a wave traveling along a string, Wave equation, Principle of superposition, Interference of waves, Standing waves and resonance, Sound waves, Speed of sound waves, Formal derivation, Traveling sound waves, Intensity and sound level, Sources of musical sound: Standing waves with two open ends and one open end pipes, Beats, Doppler effect, Shock waves, Ultrasonics: Production, properties and applications

Experiment no. 9: Determination of Young's Modulus Uniform Bending
Experiment no. 10: Determination of frequency of AC mains using Sonometer.

Learning Resources	
	1. An Introduction to Mechanics David Kleppner, Robert Kolenkow McGraw Hill Education India, 2007
	2. Halliday, Resnick and Walker (2015), "Fundamentals of Physics" – 10th ed. Wiley, New York
	3. University Physics with Modern Physics, (12th Ed., H. D. Young and R. A. Freedman, 2011)
	4. Mechanics Berkeley Physics course, v.1 Charles Kittel (Tata McGraw Hill, 2007)
	5. Theory and Problems of Theoretical Mechanics (Schaum's Outline)1982, Murray R. Spiegel, McGraw Hill Education India

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Level 2	Understand	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Level 3	Apply	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 4	Analyze	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. DK Aswal, NPL, dkaswal@nplindia.org	*Prof. V Subramanian, IIT Madras, manianvs@iitm.ac.in*	Dr. Debabrata Sarkar, SRMIST
Dr. M Sathish, CSIR-CECRI, msathish@cecri.re.in	*Prof. C Venkateshwaran, University of Madras, venkateshwaran@unom.ac.in*	Dr. K Shadak Alee, SRMIST

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Course Code	UCY22101T	Course Name	General Chemistry - I	Course Category	C	Professional Core Course	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning Level of Thinking (Bloom)
CLR-1:	gain knowledge on the importance of basic organic chemistry.	
CLR-2 :	acquire knowledge about hydrocarbon and their reactions.	
CLR-3 :	promote the importance of silicon and metals.	
CLR-4 :	understand the principles of gaseous state	
CLR-5 :	Acquire in-depth understanding about the colligative properties	

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Program Learning Outcomes (PLO)														
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
			Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO -1	PSO -2	PSO-3
CLO-1 :	understand the basic concepts of organic chemistry	4	H											H			
CLO-2 :	gain knowledge about the organic reactions	4	H	H			H										
CLO-3 :	understand about the importance of silicon and metals	4	H				M										
CLO-4 :	apply the laws and the expressions related to the gaseous state	4	H			H											
CLO-5 :	acquire knowledge about the colligative properties of solutions	4		H					H								

UNIT- I: Introduction of Hybridisation and Isomerism

Hybridisation - sp, sp^2 and sp^3-Bond length- bond angle- dipole moment- inductive effect- mesomeric effect and hyperconjucation - Isomerism- geometrical and optical isomerism- optical activity- asymmetry- dissymmetry, elements of symmetry- R, S notations.

UNIT-II: Hydrocarbons

Methods of preparation of alkanes, properties - Reactions. Free radical mechanism of halogention of alkanes, Methods of preparation of alkenes -Stereochemistry of dehydrohalogenation (E1, E2, E1CB mechanism). Properties of alkenes -Electrophilic and nucleophilic addition mechanisms.

UNIT- III: General Principles of Metallurgy

Ore vs mineral, Principles of metallurgy, Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide. Types of metallurgy, Electrometallurgy - Extraction of Al, Hydrometallurgy with reference to cyanide process, Methods of purification of metals: Electrolytic refining, Vapour phase refining (van Arkel-de Boer process and Mond's process), Zone refining.

UNIT- IV: Gaseous State

Gaseous state - laws of gaseous state- gas constant R in different units - deviation from ideal behaviour- Van der waals equation for real gases - critical phenomenon - PV isotherm of real gases- critical temperature - critical volume. Molecular velocities - root mean square-average and most probable velocities. Maxwell distribution law collision number and mean free path - collision diameter.

UNIT-V: Colligative Properties of Dilute Solutions

Solution - dilute solutions - definition - Raoult's law for vapour pressure lowering (equation only) - Van't Hoff equation (no derivation) - Determination of molar mass from osmotic pressure measurement -Reverse osmosis. Boiling point elevation - Derivation of molal elevation constant (K_b) **- D**etermination of molar mass from boiling point elevation. Freezing point depression - Determination of molar mass from freezing point depression.

Learning Resources

Theory:

1. B.R. Puri, L.R. Sharma, K.K. Kalia, Principles of Inorganic Chemistry, Shobulal Nagin Chand and Co, 2001.
2. P. L. Soni, A Textbook of Inorganic Chemistry, Sultan Chand and Co., 1977.
3. R. Gopalan, Text Book of Inorganic Chemistry, 2nd edition, Hyderabad, Universities Press, (India), 2012.
4. R.T. Morrison and R.N. Boyd, S. K. Bhattacharjee, Organic Chemistry, 7th edition, Pearson India, 2011.
5. B.R. Puri, L.R. Sharma and M.S. Pathania, Principles of Physical Chemistry, 35th edition, New Delhi ShobanLal Nagin Chand and Co, 2013.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
Level 4	Analyze	20%	-	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers		
Expert from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
Dr. Ravikiran Allada, Director, Analytical Sciences and Technology Transfer, Novugen Pharma, Malaysia Email: ravianalytical@gmail.com	Prof. G. Sekar, Department of Chemistry, IIT Madras Email: Pgsekar@iitm.ac.in	Prof. M. Arthanareeswari, SRMIST
	Dr. Kanishka Biswas, Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru, Email: kanishka@jncasr.ac.in	Dr. T. Pushpa Malini, SRMIST

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Course Code	UMA22101T	Course Name	Mathematics-I	Course Category	C	Professional Core Course	L	T	P	C
							3	1	0	4

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning	Program Learning Outcomes (PLO)

		Bloom's Level	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
			Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO -1	PSO -2	PSO-3
CLR-1:	*learn the concept of differentiation*																
CLR-2 :	*apply the concepts of radius of curvature, evolute, envelope in problems of science and engineering*																
CLR-3 :	*learn the concept of integration by means of various methods*																
CLR-4 :	*apply the concept of integration in area and volume*																
CLR-5 :	*application of sequences and series in all problems involving science and engineering*																
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*																
CLO-1 :	*understand the concept of differentiation and its types*	*4*	*H*	*M*	*H*	*H*	*H*	-	-	-	-	-	-	*H*	-	-	-
CLO-2 :	*gain the knowledge of radius, centre, envelopre and circle of of curvature and apply them in the problems involving science and engineering*	*4*	*H*	*H*	*M*	*H*	*H*	-	-	-	-	-	-	*H*	-	-	-
CLO-3 :	*understand the concept of different methods of solving integrals*	*4*	*H*	*H*	*H*	*H*	*M*	-	-	-	-	-	-	*H*	-	-	-
CLO-4 :	*associate the rule of integration in finding length and area of a curve*	*4*	*H*	*H*	*M*	*H*	*H*	-	-	-	-	-	-	*M*	-	-	-
CLO-5 :	*gain the knowledge of convergence and divergence of series using different test and apply sequences and series*	*4*	*M*	*H*	*M*	*M*	*H*	-	-	-	-	-	-	*M*	-	-	-

Unit-1: Introduction- Derivatives of simple functions- Successive differentiation- Problems on algebraic and trigonometric functions.

Unit-2: Curvature and Radius of Curvature, circle of curvature, Evolutes, Envelope.

Unit-3: Introduction to integration- Methods of integration- Substitution method- Integration by parts- Bernoulli's Formula- Definite Integrals- Properties and applications of definite integrals.

Unit-4: Arc length, area, volume, surface area of revolution.

Unit-5: Introduction to sequences and series- Series of positive terms- Test of Convergence- Comparison test- Integral test- De Alembert's ratio test- Raabe's root test- Alternating series- Leibnitz's test- Absolute convergence- Conditional convergence.

Learning Resources

1. N. Piskunov, Differential and Integral Calculus Vol. 1-2, Mir Publishers, 1996.
2. P. R. Vittal, Allied Mathematics, 4th Edition Reprint, Margham Publications, Chennai, 2012.
3. S. Narayanan and T K Manicavachagom Pillay, Calculus, Vol.I, S. Viswanathan Printers and Publishers Pvt. Ltd., 2009.
4. S. Narayanan and T K Manicavachagom Pillay, Calculus Vol.II, S.Viswanathan Printers and Publishers Pvt. Ltd., 2010
5. T. M. Apostol, Calculus, Volumes 1 and 2 (2nd Edition), Wiley Eastern 1991.
6. J.E. Marsden, A.J. Tromba, A. Weinstein, Basic Multivariable Calculus, W.H.Freeman & Co Ltd; 3rd edition 2001

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (100% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
Level 4	Analyze	20%	-	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100%	

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Madhan Shanmugasundaram , Director, Infosys Technologies, Chennai madshan@gmail.com	*Prof. Y.V.S.S. Sanyasiraju, IIT Madras, sryedida@iitm.ac.in*	Dr.B.Vennila, SRMIST
	Prof. B. V. Rathish Kumar, IIT Kanpur, bvrk@iitk.ac.in	*Dr E. Sujatha, SRMIST*

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Course Code	UBT22102J	Course Name	Biology-I	Course Category	C	Professional Core Course	L	T	P	C
							3	0	2	4

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1 :	*present the importance of light in life processes*	
CLR-2 :	*understand the process of oxygen evolution and its reaction centres*	
CLR-3 :	*gain knowledge on the concepts on cells and its structures*	
CLR-4 :	*acquire knowledge on the various regulation process in animals*	
CLR-5 :	*have introduction on the various macromolecules and its structures*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Bloom's Level
CLO-1 :	*a perspective on the effect of light in life processes*	*4*
CLO-2 :	*provides an understanding on the oxygen production and the reaction centres*	*4*
CLO-3 :	*an insight into the structure of cell and microscopes is obtained*	*4*
CLO-4 :	*the regulatory system gives an understanding on the basic maintenance of the body*	*4*
CLO-5 :	*basic knowledge is gained about the macromolecules*	*4*

Program Learning Outcomes (PLO)															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural	ICT Skills	Life Long Learning	PSO -1	PSO -2	PSO-3
H	-	-	-	-	-	-	-	-	-	-	*H*	-	-	-
H	-	-	-	-	-	-	-	-	-	-	*H*	-	-	-
H	-	-	-	-	-	-	-	-	-	-	*H*	-	-	-
H	-	-	-	-	-	-	-	-	-	-	*H*	-	-	-
H	-	-	-	-	-	-	-	-	-	-	*H*	-	-	-

UNIT- I: Nature of light

Light and its importance in life process, effect of radiation on biological processes (plant and animals), pigments/receptors of light- chlorophylls, phyto-chromes rhodopsin, Photo Biological reactions,

Photoreception in animals, evolution of eye and visual processing

PRACTICALS :

1. Moll's half leaf experiment
2. To test / survey for colour blindness using Ishihara charts

UNIT- II: Light and dark reactions

Photolysis of water and oxygen evolution, O2 evolving complex, Oxygenic and An-oxygenic photosynthesis, reaction centres, Bacterial Photosynthesis

PRACTICALS:

1. Demonstration of Hill's reaction
2. Chemical separation of chloroplast pigments

UNIT- III: The Cell

The concept of cell, Prokaryotes and eukaryotes, Ultrastructure of cells (Bacteria, plant & animal), Microscope and its functioning,

PRACTICALS

1. Media preparation for cell growth
2. Preparation of slides for viewing live bacterial cells

UNIT –IV: Homeostasis

Ectothermic animals, Endothermic animals, Temperature regulation, control of blood glucose levels, Liver and its importance in maintaining homeostasis

UNIT - V: Introduction to Macromolecules

Carbohydrates, Lipids, Amino acids, Nucleic acids, Vitamins

PRACTICALS:

1. Qualitative analysis of carbohydrates
2. Qualitative analysis of amino acids

Learning Resources	1. D.J. Taylor, N.P.O. Green, G.W.Stout. Biological Science, Cambridge Publications 2. Lisa A. Urry, Michael L. Cain, Steven Alexander Wasserman, Peter V. Minorsky, Rebecca B. Orr · Pearson. Campbell Biology.

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (100% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Level 2	Understand	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Level 3	Apply	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 4	Analyze	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100%	

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

Course Designers	
Experts from Higher Technical Institutions	**Internal Experts**
1.Dr. M. Sujatha, Associate Professor & HOD, Department of Biotechnology, Ethiraj College for Women, Chennai 2.Dr. SUMATHI, Associate Professor, SRMC, Porur, Chennai	Dr. N. Prasanth Bhatt, SRMIST

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SEMESTER II

Course Code	ULT22G02J	Course Name	Tamil-II	Course Category	G	Generic Elective Course	L	T	P	C
							2	0	2	3

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

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

		Bloom's Level
CLR-1 :	generate in students a sensitivity to gender marginalization and eco sensitivity.	
CLR-2 :	an evolved consciousness in the minds to accommodate all is developed	
CLR-3 :	the ability to accept all and to co- exist is initiated	
CLR-4 :	create community connectivity and interdependence is initiated	
CLR-5 :	give them all the historical insights	

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Bloom's Level
CLO-1 :	acquire knowledge about Tamil Language	4
CLO-2 :	strengthen the knowledge on concept, culture, civilization and translation of Tamil	4
CLO-3 :	develop content using the features in Tamil language	4
CLO-4 :	use Tamil Language and Literature to enhance their creativity	4
CLO-5 :	improve communication and creative expression in Tamil language	4

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	Ethical Reasoning	Community Engagement	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	M	-	H	-	M	-	-	-	-	-	-	-	-	-	-
CLO-2 :	M	H	-	H	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	H	-	M	-	H	-	-	-	-	-	-	-	-	-	-
CLO-4 :	M	H	-	H	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	M	-	-	H	H	-	-	-	-	-	-	-	-	-	-

அலகு – 1 – பதினெண் மேற்கணக்கு

எட்டுத்தொகை : தமிழில் காலந்தோறும் அகமரபு – தமிழர் புறமரபு

1. ஐங்குறுநூறு – அன்னாய் வாழி வேண்டு (பாடல் – 203)
2. குறுந்தொகை – நிலந்தொட்டுப் புகார் (பாடல் – 130)
3. அகநானூறு – வந்து வினை முடித்தனன் வேந்தனும் பகைவர் (பாடல் – 44)
4. கலித்தொகை – நிரை திமில் களிறாக (நெய்தற்கலி பாடல் – 149)
5. புறநானூறு – சிறியகள் பெறினே (பாடல் – 235)

பத்துப்பாட்டு - சிறுபாணாற்றுப்படை (அடிகள் – 126 – 143)

அலகு – 2 - பதினெண் கீழ்க்கணக்கு :

களப்பிரர் காலம் – அறமும் வாழ்வியலும் .

1. திருக்குறள் – வினைத்திட்பம் (அதிகாரம் 67), உழவு (அதிகாரம் 104), 2. நாலடியார் – நல்லார் எனத்தான் (221), 3. திரிகடுகம் – கோலஞ்சி வாழும் குடியும் (33), 4. இனியவை நாற்பது (14), 5. களவழி நாற்பது – கவளங்கொள்யானை (14)

அலகு – 3 – பக்தி இலக்கியம்

பல்லவர் காலம் – பல்லவர் கால இலக்கியங்கள் – பக்தியும் தமிழும்.

1. சைவம் – பன்னிருதிருமுறைகள் - திருஞானசம்பந்தர் – வேயுறுதோளிபங்கன், திருநாவுக்கரசர் – மாசில் வீணையும் மாலை மதியமும், மாணிக்கவாசகர் – தந்தது உன் தன்னை கொண்டது என் தன்னை.
2. வைணவம் – நாலாயிரத் திவ்யப்பிரபந்தம் - பெரியாழ்வார் – கருங்கண் தோகை மயிற்பீலி அணிந்து, ஆண்டாள் – கருப்பூரம் நாறுமோ? கமலப்பூ நாறுமோ? ...., தொண்டரடிப்பொடி ஆழ்வார் – பச்சைமாமலை போல் மேனி
3. இஸ்லாமியம் - சீறாப்புராணம் - மானுக்குப் பிணை நின்ற படலம் – 5 பாடல்கள் (பாடல் எண்கள் : 61 – 65)
4. கிறித்துவம் - வேதக்கண் – ஆதி நந்தாவனப் பிரளயம் – ஏதேன் தோட்ட வர்ணனை (3 பாடல்கள்)

அலகு – 4 - தமிழ் இலக்கிய வரலாறு

சங்க கால வரலாறு – சங்க கால மக்களின் வாழ்வியல் – முச்சங்கம் அறிமுகம் – முச்சங்க வரலாறு – செம்மொழி இலக்கியங்கள்

1. சங்க இலக்கியங்கள், 2. நீதி இலக்கியங்கள், 3. ஐம்பெருங்காப்பியங்கள், 4. பக்தி இலக்கியங்கள்

அலகு – 5 - சிறுகதையும் மொழிப்பயிற்சியும்

தமிழ்ச் சிறுகதைப் போக்குகள் – தமிழ்ச் சிறுகதையும் தமிழ்ச்சமூக வாழ்வியலும்

சிறுகதைகள் – 1. புதுமைப்பித்தன் – அகலிகை, 2. அகிலன் – ஒருவேளைச்சோறு, 3. ஆண்டாள் பிரியதர்ஷினி – மாத்திரை, 4. பாரததேவி – மாப்பிள்ளை விருந்து, 5. தவிப்பு – குன்றக்குடி சிங்காரவடிவேல்

மொழிப்பயிற்சி : 1. செய்தி அறிக்கை எழுதுதல் , 2. விமர்சனம், 3. நேர்காணல், 4. பேச்சுக்கலை

Learning Resources	1. மௌவல், தொகுப்பும் பதிப்பும் - தமிழ்த்துறை ஆசிரியர்கள், தமிழ்த்துறை, எஸ்.ஆர்.எம். அறிவியல் மற்றும் தொழில்நுட்பக் கல்விநிறுவனம், காட்டாங்குளத்தூர், 603203, 2020. 2. தமிழண்ணல், புதிய நோக்கில் தமிழ் இலக்கிய வரலாறு, மீனாட்சி புத்தக நிலையம், மதுரை, 2017 3. மு. அருணாசலம், தமிழ் இலக்கிய வரலாறு, நூற்றாண்டு முறை (9ஆம் நூ. முதல் 16 வரை), தி பார்க்கர், சென்னை, 2005 4. தமிழ் இணையக் கல்விக்கழகம் - http://www.tamilvu.org/ 5. மதுரை தமிழ் இலக்கிய மின் தொகுப்புத் திட்டம் - https://www.projectmadurai.org/

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (100% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	10%	10%	10%	10%	10%	10%	10%	10%	20%	-
Level 2	Understand	10%	10%	10%	10%	10%	10%	10%	10%	20%	-
Level 3	Apply	20%	20%	20%	20%	20%	20%	20%	20%	40%	-
Level 4	Analyze	10%	10%	10%	10%	10%	10%	10%	10%	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		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	Expert from Higher Technical Institutions	Internal Experts
	1. Dr. R..Srinivasan, Associate Professor, Department of Tamil, Presidency College, Chennai.	*1. B.Jaiganesh, Assistant Professor & Head, FSH, SRMIST*
		2. T.R.Hebzibah Beulah Suganthi, Assistant Professor, FSH, SRMIST
		3.S.Saraswathy, Assistant Professor, FSH, SRMIST

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Course Code	ULH22G02J	Course Name	Hindi-II	Course Category	G	Generic Elective Course	L	T	P	C
							2	0	2	3

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

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

		Bloom's Level
CLR-1 :	be able to converse well in the Hindi Language	
CLR-2 :	read and write and clarity	
CLR-3 :	be willing listeners and translators –where need be	
CLR-4 :	acquire the values/thought contents of the writers and practice in it in life.	
CLR-5 :	find motivation through the various forms of literature and learn to overcome any challenges of life.	
CLR-6 :	discover the importance of the language in making education as a means of growth in life and not mere literacy.	

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Bloom's Level	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
			Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	Ethical Reasoning	Community Engagement	PSO -1	PSO -2	PSO-3
CLO-1 :	acquire knowledge about Medieval and Modern Poetry.	4	H	H	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	consider the relevance of the present trends in Hindi and their contemporary relevance.	4	-	H	-	H	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	help develop better understanding of the Hindi language by studying the stories with reference to current reality.	4	H	-	-	H	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	understand the usage of the present Advertising trends and its creative angles with the varied skills of Hindi Language.	4	H	-	H	H	H	-	-	-	-	-	H	-	-	-	-
CLO-5 :	make translation of good literature and any relevant document from the Hindi Language to English and Vice-versa.	4	-	H	-	H	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	help the learner to tackle Administrative terminologies, help them use Idioms and Phrases in their daily life, with ease.	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

UNIT – 1

1. KABIR (3Couplets)
2. SURDAS (3Couplets)
3. TULSIDAS (3Couplets)
4. THIRUVALLAVUR (3Couplets)
5. RAHIM (3Couplets)
6. SURYAKANTH TRIPATHI NIRALA - BADAL RAAG
7. NAGARJUN - PRETH KA BAYAAN
8. SOHANLAL DWEDI - LEHRON SE DARKAR NAUKA PAAR NAHI HOTI
9. MAKHANLAL CHATURVEDI - RASHTRA PREM
10. GOONGI MAA - AGNISHEKHAR

UNIT - 2

1. LADKIYAAN – MAMTA KALIYA
2. GUNDA – JAYSHANKAR PRASAD

UNIT – 3

1. VIGYAPAN

a. Bhumika aur Awdaharna
b. Shabd ki Vutpati
c. Paribhasha
d. Madhyam

UNIT – 4

1. TRANSLATION (HINDI TO ENGLISH AND ENGLISH TO HINDI)
2. LETTER WRITING

UNIT – 5

1. TECHNICAL TERMINOLOGY

Learning Resources	***The Prescribe Text Book Compiled and Edited by Department of Hindi*** *www.kavitakosh.org* *www.shabdkosh.com*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (100% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	10%	10%	10%	10%	10%	10%	10%	10%	20%	-
Level 2	Understand	10%	10%	10%	10%	10%	10%	10%	10%	20%	-
Level 3	Apply	20%	20%	20%	20%	20%	20%	20%	20%	40%	-
Level 4	Analyze	10%	10%	10%	10%	10%	10%	10%	10%	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		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	**Expert from Higher Technical Institutions**	**Internal Experts**
	1. Prof.(Dr.) S.Narayan Raju, Head, Department of Hindi,CUTN, Tamilnadu	*1. Dr.S Preeti. Associate Professor & Head, SRMIST*
		2. Dr. Md.S. Islam Assistant Professor, SRMIST
		3 Dr. S. Razia Begum, Assistant Professor, SRM IST

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Course Code	ULF22G02J	Course Name	French-II	Course Category	G	Generic Elective Course	L	T	P	C
							2	0	2	3

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

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

CLR-1 :	*strengthen the language of the students both in oral and written*
CLR-2 :	*express their sentiments, emotions and opinions, reacting to information, situations*
CLR-3 :	*make them learn the basic rules of french grammar.*
CLR-4 :	*develop strategies of comprehension of texts of different origin*
CLR-5 :	*enable the students to overcome the fear of speaking a foreign language and take position as a foreigner speaking french*
CLR-6 :	*extend and expand their savoir-faire through the acquisition of current scenario*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Bloom's Level
CLO-1 :	*acquire knowledge about French language*	*4*
CLO-2 :	*strengthen the knowledge on concept, culture, civilization and translation of French*	*4*
CLO-3 :	*develop content using the features in French language*	*4*
CLO-4 :	*interpret the French language into other language*	*4*
CLO-5 :	*improve the communication, intercultural elements in French language*	*4*
CLO-6 :	enable the students to overcome the fear of speaking a foreign language and take position as a foreigner speaking French	*4*

Program Learning Outcomes (PLO)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	Ethical Reasoning	Community Engagement	PSO -1	PSO -2	PSO-3
CLO-1	*H*	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2	-	*H*	-	*H*	-	-	-	-	-	-	*M*	-	-	-	-
CLO-3	*H*	-	-	*H*	-	-	-	-	-	-	*H*	-	-	-	-
CLO-4	*H*	-	*H*	*H*	*H*	-	-	-	-	-	*H*	-	-	-	-
CLO-5	-	*H*	-	*H*	-	-	-	-	-	-	*H*	-	-	-	-
CLO-6	*H*	-	-	*H*	*H*	-	-	-	-	-	-	-	-	-	-

Unité-I

Les loisirs -Les loisirs -Les activités quotidiennes -Les matières -Le temps et l'heure - Les fréquences- Les sons [u]/ [y] – Les loisirs – La routine – Mots et expressions – Exprimer ses gouts et ses préférence – Décrire sa journée

Unité-II

La routine - Les adjectifs interrogatifs - Les nombres ordinaux - L'heure - Le pronom personnel COD -Les pronominaux -Les verbes du premier groupe en –e_er,é_er,-eler,-eter -Le verbe prendre - Parler de ses gouts et de ses préférences - Décrire sa journée

Unité-III

Où faire ses courses ? -Les aliments - Les quantités - Les commerces et les commerçants - Demander et dire le prix - Les services - Les moyens de paiement - les sons [ã]/ [an] – Découvrez et dégustez ! Mots et expressions – Au restaurant : commander et commenter – Inviter et répondre à une invitation.

Unité-IV

Découvrez et dégustez Les articles partitifs -Le pronom en (la quantité) - Très ou beaucoup ? -La phrase négative (2) - C'est /Il est (2) - L'impératif - Il faut - Les verbes devoir, pouvoir, savoir, vouloir - Au restaurant : Commander et commenter - Inviter et répondre à une invitation

Unité-V

Tout le monde s'amuse- Les sorties - Situer dans le temps - La famille (2) - Les vêtements et les accessoires - Les sons [c]/[ɔn] - Les ados au quotidien - Les adjectifs démonstratifs - La formation du féminin (4) -Le pronom indéfini on -Le futur proche - Le passe composé -Les verbes du premier groupe en – yer -Les verbes voir et sortir Décrire une tenue – écrire un message amical.

Learning Resources	***Theory:*** 1. ''Génération-AI'' Méthode de français, Marie-Noëlle COCTON, P.DAUDA, L.GIACHINO, C.BARACCO, Les éditions Didier, Paris, 2018. *2. Cahier d'activités avec deux discs compacts.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (100% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	10%	10%	10%	10%	10%	10%	10%	10%	20%	-
Level 2	Understand	10%	10%	10%	10%	10%	10%	10%	10%	20%	-
Level 3	Apply	20%	20%	20%	20%	20%	20%	20%	20%	40%	-
Level 4	Analyze	10%	10%	10%	10%	10%	10%	10%	10%	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		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	**Expert from Higher Technical Institutions**	**Internal Experts**
	1. Dr. C.Thirumurugan Associate Professor, Department of French, Pondicherry University	*1. Kumaravel K. Assistant Professor & Head, SRMIST*
		2. Ponrajadurai M Assistant Professor, SRMIST

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Course Code	UPY22201J	Course Name	Physics-II	Course Category	C	Professional Core Course	L	T	P	C
							3	0	2	4

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning
CLR-1:	**Introduce vector calculus and its application to forces, fields and potentials**	Bloom's Level
CLR-2:	*Acquire knowledge of fundamental concepts electrostatics and electric field in matter*	
CLR-3:	*Learn fundamental concepts of electric field in matter and magnetic fields*	
CLR-4:	*Acquire analytical and problem solving skills on involving currents and magnetic field in matter*	
CLR-5:	*Use the knowledge of electric and magnetic fields to get basic idea of electromagnetic radiation.*	

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning Level
CLO-1:	*Apply vector calculus to solve problems involving forces and fields.*	4
CLO-2:	*Apply mathematical tools to explain electrostatic interactions.*	4
CLO-3:	*Solve problems related to charges, currents in vacuum and matter.*	4
CLO-4:	*Solve problems in magnetism that require knowledge of magnetic fields in matter.*	4
CLO-5:	*Apply fundamental concepts of electromagnetic phenomenon and radiation.*	4

	Program Learning Outcomes (PLO)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1:	H	-	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2:	H	-	-	H	-	-	-	-	-	-	-	-	-	-	-
CLO-3:	-	-	H	-	-	-	H	-	-	-	-	-	-	-	-
CLO-4:	H	-	-	-	-	-	H	-	-	-	-	-	-	-	-
CLO-5:	H	-	-	H	-	-	-	-	-	-	-	-	-	-	-

Unit-1: Fundamental theorems on gradients and divergences, Fundamental theorem on curls, Dirac Delta function, Three dimensional Dirac delta function, Introduction to Cylindrical Coordinates (CC) and Spherical Polar Coordinates (SPC), Introduction to Gradient, divergence and curl in SPC and CC and their applications, Helmoltz theorem and potentials, Scalar and vector potentials, Coulomb's law, Electric field of discrete and continuous charge distributions.
Experiment no. 1. Practice problem solving on E field of discrete and continuous charge distributions
Experiment no. 2. Calibration of Voltmeter using Potentiometer
Experiment no. 3. Calibration of Ammeter using Potentiometer

Unit-2: Divergence of electrostatic field, Gauss's law and applications, Line integral and Curl of Electrostatic field, Conservative nature of electrostatic field, Scalar electric potential, Poisson's and Laplace's equations, Potential of localized charge distribution, Boundary conditions, Work done to move charge, Energy of a point and continuous charge distribution, Basic properties of conductors and dielectrics, Uniqueness theorems, Method of images for calculating potentials
Experiment no. 4. Practice problems on Gauss law, electric potential and method of images
Experiment no. 5. Determination of Internal resistance of the given cell using Potentiometer
Experiment no. 6. Determination of Temperature Coefficient of Resistance using Post Office Box

Unit-3: Polarization in Dielectrics, Induced dipoles and concept of bound charges, Electric Displacement, Gauss law in Dielectrics, Boundary Conditions at Dielectric interface, Susceptibility, Permittivity
Dielectric constant, Energy in dielectrics, Magnetic fields and force: Lorentz force law, Currents: Line, surface and volume current densities, Continuity equation, Biot-Savart law, Magnetic field due to Steady straight-line currents.
Experiment no. 7. Practice problem solving on polarization, current density and Biot-Savart law
Experiment no. 8. EMF of thermocouple Potentiometer
Experiment no. 9. Comparison of EMFs of two cells using Ballistic Galvanometer

Unit-4: Divergence of magnetic field, Curl of magnetic field and Ampere's law, Applications of Ampere's law, Comparison with electrostatics, Magnetic vector potential and arbitrariness, Magnetostatic boundary conditions, Multipole expansion: Electric and Magnetic, Magnetization torque and force on magnetic dipoles, Bound currents: conceptual interpretation, Ampere's law in magnetized materials, Magnetic susceptibility and permeability, Introduction to Ferromagnetism and Magnetic domains.
Experiment no. 10. Practice problems on Ampere's law, boundary conditions and magnetization
Experiment no. 11. Determination horizontal component of earth magnetic field-Field along the axis of the coil
Experiment no. 12. Determination of Magnetic moment and Ratio of magnetic moments by Searle's vibration magnetometer method

Unit-5: Ohm's law and EMF, Faraday's law and induced electric field, Energy in magnetic fields, Maxwell's modification of Ampere's law, Maxwell's equations in vacuum and matter, Boundary Conditions, Sinusoidal waves and complex notation Maxwell's equations, The wave equation for E and B in vacuum, Solution of the wave equation, Transverse nature of EM waves, Energy and momentum in EM waves, Continuity equation, Poynting's theorem.
Experiment no. 13. Practice problems on Maxwell's equations and EM waves.
Experiment no. 14. Study of resonance in series LCR circuits.Calibration of Voltmeter using Potentiometer
Experiment no. 15. Study of resonance in parallel LCR circuits.Calibration of Ammeter using Potentiometer

Learning Resources	
	1. Introduction to Electrodynamics, 4th Ed., David J. Griffiths (Prentice Hall of India, 2012)
	2. Principles of Physics,10th Ed, ISV, R.Resnick, J. Walker, D.Halliday (Wiley, 2015)
	3. Electricity and Magnetism: Berkeley Physics Course Vol. 2, Edward M. Purcell (McGraw Hill Education, 2017)
	4. University Physics: Electricity and Magnetism, (12th Ed., H. D. Young and R. A. Freedman, 2011)
	5. Electromagnetics, Joseph Edminister (McGraw Hill, 2013)
	6. Electricity and Magnetism, A Mahajan, (McGraw Hill Education, 2017)

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Level 2	Understand	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Level 3	Apply	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 4	Analyze	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. M Sathish , CSIR-CECRI, msathish@cecri.re.in	Prof. C Vijayan, IIT Madras, cvijayan@iitm.ac.in	Dr. Rohit Dhir, SRMIST
Dr. DK Aswal , NPL, dkaswal@nplindia.org	*Prof. V Subramanian, IIT Madras, manianvs@iitm.ac.in*	Dr. C. Preferencial Kala, SRMIST

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Course Code	UCY22201J	Course Name	General Chemistry - II	Course Category	C	Professional Core Course	L	T	P	C
							3	0	4	5

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	gain knowledge on the importance of basic organic chemistry
CLR-2 :	enable the students to acquire quantitative skills in volumetric analysis.
CLR-3 :	Inculcate the practical and theoretical knowledge about the chemical kinetics
CLR-4 :	acquire knowledge in the fundamentals of electrochemistry
CLR-5 :	promote the importance of industrial chemistry

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Bloom's Level	Program Learning Outcomes (PLO)														
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
			Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO -1	PSO -2	PSO-3
CLO-1 :	understand the basic concepts of organic chemistry	4	H											H			
CLO-2 :	gain knowledge and practical skill in the quantitative analysis of wide range of compounds	4	H	H			H										
CLO-3 :	acquaint the fundamental concepts of chemical kinetics with the practical knowledge	4	H				M										
CLO-4 :	Apply the concepts of electrochemistry with the real time analysis	4			H	H											
CLO-5 :	utilize their chemistry knowledge for industrial applications	4				H	H		H		H						

UNIT- I: Carbohydrates, Benzene and Heterocyclic Compounds

Classification of carbohydrates–Properties and uses of glucose and fructose mutarotation - Chemistry of benzene - Preparation, mechanism of electrophillic substitution reactions. Heterocyclic compounds– Preparation and properties of pyrrole and pyridine.

PRACTICALS:

1. Estimation of ascorbic acid
2. Estimation of phenol
3. Estimation of aniline

UNIT- II: PRINCIPLES OF VOLUMETRIC ANALYSIS:

Definitions of Molarity, Molality, Normality and Mole Fraction - Their Calculations - Definition and Examples for Primary and Secondary standards - Calculation of Equivalent Weight of Acid, Base, Oxidising Agent, Reducing Agent and Salts.

Principles of Volumetric Analysis - Theories of Acid- Base, Redox, Complexometric Iodometric and Iodimetric titrations.

Theories of indicators - Acid-base indicators - Choice of indicators - Redox, Metal ion and Adsorption indicators.

PRACTICALS:

1. Estimation of HCl using standard oxalic acid
2. Estimation of NaOH using standard sodium carbonate
3. Estimation of $FeSO_4$ using standard oxalic acid

UNIT- III: Chemical Kinetics

Rate of reaction, order- molecularity, first order rate law and simple problems- Half-life period of first order reaction- pseudo first order reaction- zero and second order reactions. Arrhenius and collision theories.

PRACTICALS:

1. Kinetics of Iodination of Acetone
2. Determination of rate constant of acid –catalysed hydrolysis of an ester
3. Comparison of rate constant of hydrolysis of an ester reaction using two acids

UNIT –IV: Electrochemistry

Faradays laws of electrolysis - Specific conductance, equivalent conductance - Cell constant - Arrhenius theory Ostwald"s dilution law and Kohlrausch law - Nernst equation - Applications of EMF- Measurements.

PRACTICALS:

1. Determination of concentration of an acid by conductometric method.
2. Determination of concentration of the mixture of acids by conductometric method.
3. Estimation of Iron by potentiometric method.

UNIT - V: Industrial Chemistry

Hardness of water – Temporary and permanent hardness, disadvantages of hard water Boiler scales and sludges - Softening of hard water – Zeolite process - demineralization process and reverse osmosis – Purification of water for domestic use: use of chlorine, Ozone and UV light.

PRACTICALS:

1. Estimation of Chloride in the given water sample.
2. Estimation of Nickel using decinormal solution of EDTA
3. Estimation of hardness in the given water sample

Learning Resources	**Theory:** 1. Puri B.R., Sharma L.R., Kalia K.K., Principles of Inorganic Chemistry, Shobulal Nagin Chand and Co, 2001. 2. R. Gopalan, S. Sundaram, Allied Chemistry, Sultan Chand and Sons, 1995. 3. Lee, J.D., Concise Inorganic Chemistry, Fifth Edn., Wiley India. 4. Huheey, J.E., Keiter, E.A., Keiter, R. L., Medhi, O.K., Inorganic Chemistry-Principles of Structure and Reactivity, Pearson Education 2009.	**Practicals:** **1.** Jeffery, G.H., Bassett, J., Mendham, J., Denney, R.C.,Vogel's Textbook of Quantitative Chemical Analysis, 5th Edn., Longman Scientific & Technical, England, **1989 (John** Wiley and Sons Inc, 605 Third Avenue, NewYork NY 10158) 2. V.Venkateswaran, R. Veeraswamy, A.R.Kulandaivelu, *Basic Principles of Practical Chemistry*, 2nd Edition Sultan Chand and Sons,1997. 3. Daniels et al., *Experimental Physical Chemistry*, 7th edition, New York, McGraw Hill, 1970.

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Level 2	Understand	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Level 3	Apply	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 4	Analyze	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers		
Expert from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
Dr. Ravikiran Allada, Director, Analytical Sciences and Technology Transfer, Novugen Pharma, Malaysia Email: ravianalytical@gmail.com	Prof. G. Sekar, Department of Chemistry, IIT Madras Email: Pgsekar@iitm.ac.in	Dr. J. Arockiaselvi, SRMIST
	Dr. Kanishka Biswas, Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru Email: kanishka@jncasr.ac.in	Prof. M. Arthanareeswari, SRMIST

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Course Code	UMA22201T	Course Name	Mathematics II	Course Category	C	Professional Core Course	L	T	P	C
							3	1	0	4

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*learn the concept of matrices*	Bloom's level
CLR-2:	*apply the concepts eigen values and eigen vectors to diagonalize a matrix, to reduce it to orthogonal form,*	
CLR-3:	*learn various methods to find the roots of an equation*	
CLR-4:	*apply the concept of differential equations in problems of science*	
CLR-5:	*apply the concept of taylor series, composite function and jacobian in problems of science*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Program Learning Outcomes (PLO)														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO -1	PSO -2	PSO-3
CLO-1:	*understand the concept of matrices and apply them to solve system of linear equations*	H	M	M	M	-	-	-	-	-	-	-	M	-	-	-
CLO-2:	*apply the knowledge of matrices, eigenvalues and eigen vectors, reduce to quadratics form to solve problems in field of science*	H	H	M	H	-	-	-	-	-	-	-	H	-	-	-
CLO-3:	*solve the equations and find their roots applying various methods*	H	H	M	H	-	-	-	-	-	-	-	H	-	-	-
CLO-4:	*gain knowledge in solution of differential equations and its applications*	H	H	M	H	-	-	-	-	-	-	-	H	-	-	-
CLO-5:	*gain familiarity in the knowledge of jacobian, and taylor series and apply them to the problems involving science*	H	M	M	M	-	-	-	-	-	-	-	M	-	-	-

Unit-1:	Introduction to matrices- Types of matrices- Properties- Inverse of matrix- System of linear equation – Cramer's rule- Rank of matrix- Existence and uniqueness of the system of linear equation by rank.
Unit-2:	Characteristic equation- Eigen values and Eigen vectors of a real matrix- Cayley Hamilton theorem- Orthogonal reduction of a symmetric matrix to diagonal form.
Unit-3:	Polynomial equations- Irrational roots- Complex roots(up to third order)- reciprocal equations- Approximation of a roots of a polynomial equation- Newton's method- finding positive roots- Horner's method for finding the roots
Unit-4:	First order differential equation- Variable separable method- substitution method- Homogeneous differential equation- First order linear differential equation- Application of first order differential equation
Unit-5:	Introduction- Functions of two variables – Euler's theorem- Total derivative- Taylor's expansion with two variable up to second order terms- Jacobian of two and three variables

Learning Resources	
1.	Erwin kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, 2010.
2.	G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2010.
3.	Hughes-Hallett et al., Calculus - Single and Multivariable, 8th Edition, John-Wiley and Sons 2020.
4.	James Stewart, Calculus, 5th Edition, Thomson, 2003.
5.	T. M. Apostol, Calculus, Volumes 1 and 2 (2nd Edition), Wiley Eastern 1991.
6.	T.K. Manicavachagam Pillai, T. Natarajan, K.S. Ganapathy, Algebra, Vol. I, S. Viswanathan Pvt Limited, Chennai, 2009

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (100% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
Level 4	Analyze	20%	-	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate										-
Level 6	Create										-
	Total	100 %		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. Madhan Shanmugasundaram , Director, Infosys Technologies, Chennai madshan@gmail.com	*Prof. Y.V.S.S. Sanyasiraju, IIT Madras, sryedida@iitm.ac.in*	Dr.B.Vennila, SRMIST
	Prof. B. V. Rathish Kumar, IIT Kanpur, bvrk@iitk.ac.in	*Dr. E. Sujatha, SRMIST*

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Course Code	UBT22202J	Course Name	Biology-II	Course Category	C	*Professional Core Course*	L	T	P	C
							3	0	2	4

Pre-requisite Courses	NIL	Co-requisite Courses	NIL	Progressive Courses	NIL
Course Offering Department	**Biotechnology**	Data Book / Codes/Standards	NIL		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning	Program Learning Outcomes (PLO)

		Bloom's Level
CLR-1 :	To know the importance of nutrition and the various forms it is undertaken	
CLR-2 :	Understanding the necessity and importance of gaseous exchange in organisms	
CLR-3 :	To know the various transport mechanisms present in plants and animals	
CLR-4 :	To provide a basic idea of the ecology and its effect on the biosphere	
CLR-5 :	To gain knowledge on the evolutionary path taken by the organisms over a period of time	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Bloom's Level
CLO-1 :	Candidate gains knowledge on the various nutrition patterns in the living organism	*4*
CLO-2 :	Helps the candidate in knowing the function of respiration	*4*
CLO-3 :	The candidate will gain knowledge on the transport mechanisms in plant and animals	*4*
CLO-4 :	The candidate will come to know the importance of ecology and its conservation	*4*
CLO-5 :	Evolutionary study will give the candidate knowledge on processes undergone during the evolutionary process	*4*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO -1	PSO -2	PSO-3
CLO-1	*H*	-	-	-	-	-	-	-	-	-	-	*H*	-	-	-
CLO-2	*H*	-	-	-	-	-	-	-	-	-	-	*H*	-	-	-
CLO-3	*H*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-4	*H*	-	-	*H*	-	-	-	-	-	-	-	-	-	-	-
CLO-5	*H*	-	-	-	-	-	*H*	-	-	-	-	-	-	-	-

UNIT- I: Heterotropic Nutrition

Forms of heterotropic nutrition, Feeding mechanisms, Dietary reference values, Malnutrition

PRACTICALS

1. Measuring rates of photosynthesis
2. To investigate gaseous exchange in leaves

UNIT- II: Gaseous Exchange

Cell Respiration- Aerobic, Anaerobic, Gaseous exchange in invertebrates, Mammals

PRACTICALS

1. Use of respirometer to measure oxygen uptake in small invertebrates
2. To investigate the oxidation of a krebs cycle intermediate

UNIT- III: Transport

Plant water relations, Transpiration, Ascent of water in Xylem, Blood Vascular system, oxygen transport

PRACTICALS:

1. To Investigate Osmosis In Living Plant Cells
2. To determine the water potential of a plant tissue

UNIT–IV: Ecology

Approaches to ecology, Energy flow and Biogeochemical cycles, Food webs, Ecological pyramids, Community ecology, population ecology

PRACTICALS

1. To investigate the air content of a soil sample
2. To investigate the relative proportions of solid particles in a soil sample
3. To investigate the pH of soil and water samples

UNIT - V: Evolution- history of life

Theories of origin of evolution, Nature of the earliest organisms, Theory of evolution, Natural selection, Evidence for theory of evolution

Learning Resources

1. D.J. Taylor, N.P.O. Green, G.W.Stout. Biological Science, Cambridge Publications
2. Lisa A. Urry, Michael L. Cain, Steven Alexander Wasserman, Peter V. Minorsky, Rebecca B. Orr · Pearson. Campbell Biology.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Level 2	Understand	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Level 3	Apply	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 4	Analyze	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		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 Higher Technical Institutions	**Internal Experts**
1.Dr. M. Sujatha, Associate Professor & HOD, Department of Biotechnology, Ethiraj College for Women, Chennai 2.Dr. SUMATHI, Associate Professor, SRMC, Porur, Chennai	Dr. N. Prasanth Bhatt, SRMIST

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Course Code	UJK22201L	Course Name	Communication Skills	Course Category	JK	*Life Skill Course*	L	T	P	C
							0	0	4	2

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*To make the students learn the native speakers' accent.*	Bloom's Level
CLR-2:	*To educate them about word stress of English*	
CLR-3:	*The enable them to participate in group discussion and debates*	
CLR-4:	To improve the listening and speaking abilities in English	
CLR-5:	*LSRW skills all together is developed in every student*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Bloom's Level
CLO-1:	*Master the sound systems of English*	4
CLO-2:	*Have a better Word stress, Rhythm and Intonation*	4
CLO-3:	*Develop Neutral Accent*	4
CLO-4:	*Participate in any conversation with any native speaker*	4
CLO-5:	*Clear any standardized tests conducted to measure the English language ability like IELTS and TOEFL*	4

Program Learning Outcomes (PLO)															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	Ethical Reasoning	Community Engagement	ICT Skills	Leadership Skills	Life Long Learning
H	-	-	-	-	-	-	-	-	-	-	-	-	-	*H*
H	-	-	-	-	-	-	-	-	-	-	-	-	-	H
H	-	-	-	-	-	-	-	*H*	-	-	-	-	-	-
H	-	-	-	-	-	-	-	-	-	-	*H*	-	-	-
H	-	-	-	-	-	-	-	-	-	-	-	-	-	*H*

UNIT I

Listening

Techniques of effective listening

Listening and comprehension

Probing questions

Barriers to listening

Speaking

Pronunciation

Enunciation

Vocabulary

Fluency

Common Errors

UNIT II

Reading

Techniques of effective reading

Gathering ideas and information from a given text

I. Identify the main claim of the text
II. Identify the purpose of the text
III. Identify the context of the text
IV. Identify the concepts mentioned

Evaluating these ideas and information

I. Identify the arguments employed in the text
II. Identify the theories employed or assumed in the text

Interpret the text

I. To understand what a text says
II. To understand what a text does
III. To understand what a text means

UNIT III

Writing and different modes of writing

i) Clearly state the claims
ii) Avoid ambiguity, vagueness, unwanted generalizations and oversimplification of issues
iii) Provide background information
iv) Effectively argue the claim
v) Provide evidence for the claim
vi) Use examples to explain concepts
vii) Follow convention
viii) Be properly sequenced
ix) Use proper signposting technique

x) Be well structured
   a. Well-knit logical sequence
   b. Narrative sequence
   C. Category groupings

xi) Different modes of writing

E-mails
Proposal writing for higher studies
Recording the proceedings of meeting
Any other mode of writing relevant for learners

UNIT IV
Digital Literacy

Role of digital literacy in professional life
Trends and opportunities in using digital technology in workplace
Internet basics
Introduction to MS Office tools

I. Paint
II. Office
III. Excel
IV. Powerpoint

Effective use of social media
Introduction to social media websites
Advantages of social media
Ethics and etiquettes of social media
How to use Google search better
Effective ways of using social media
Introduction to Digital marketing

UNIT V
Non-verbal communication

Meaning of non-verbal communication
Introduction to modes of non-verbal communication
Breaking the misbeliefs
Open and closed body language
Eye contact and facial expression
Hand gestures
Learning from experts Activities based learning

Learning Resources	1. Horizon- English Text Book – Compiled and Edited by the faculty of English Departement, FSH, SRMIST, 2020 2. ***English Grammar in Use by Raymond Murphy*** 3. *Raymond Murphy, Intermediate English Grammar, Cambridge University Press, 2007* 4. *R.P. Bhatnagar, English for Competitive Examinations, Trinity Press, 3rd Edition,2016* *5. http://www.aptitudetests.org/verbal-reasoning-test* *6. https://www.assessmentday.co.uk/aptitudetests_verbal.htm*

	Bloom's Level of Thinking	Continuous Learning Assessment (100% weightage)							
		CLA – 1 (20%)		CLA – 2 (20%)		CLA – 3 (30%)		CLA – 4 (30%)#	
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	10%	-	10%	-	10%	-	10%
Level 2	Understand	-	10%	-	10%	-	10%	-	10%
Level 3	Apply	-	40%	-	40%	-	40%	-	40%
Level 4	Analyze	-	40%	-	40%	-	40%	-	40%
Level 5	Evaluate	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %	

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

Course Designers

External Experts	Internal Experts
Prof. Daniel David, Prof & Head, Department of English, MCC, Chennai	*Dr. Shanthichitra, Associate Professor, & Head, Department of English, FSH,SRMIST*
	Dr K B Geetha, Assistant Professor, Department of English, FSH, SRMIST

==========

Course Code	UNS22201L UNC22201L UNO22201L UYG22201L	Course Name	NSS/NCC/NSO/YOGA	Course Category	EA	Extension Activity/Community Outreach	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		

Assessment is Fully Internal

Learning Assessment	
Assessment Tools	**Marks**
Continuous Learning Assessment –I (CLA-I)	20 Marks
Continuous Learning Assessment –II (CLA-II)	30 Marks
Continuous Learning Assessment –III (CLA-III)	30 Marks
Continuous Learning Assessment –IV (CLA-IV)	20 Marks
Total Marks	100 Marks

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SEMESTER III

Course Code	UPY22301J	Course Name	Optics and Lasers	Course Category	C	Professional Core Course	L	T	P	C
							4	0	4	6

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*acquire knowledge on basic optics*	Bloom's Level
CLR-2:	*explore the concepts of interference*	
CLR-3:	*understand the fundamentals fresnel and fraunhofer diffraction*	
CLR-4:	*gain knowledge on basic optics experiments*	
CLR-5:	*study the fundamental concepts of a laser*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning
CLO-1:	*learn about the phenomenon of em waves at an interface*	4
CLO-2:	*understand the light propagation through various optical elements*	4
CLO-3:	*understand the fundamental concepts on interferometers*	4
CLO-4:	*apply the concept of diffraction to understand a spectrometer*	4
CLO-5:	*understand the basic properties of a laser and applications*	4

Program Learning Outcomes (PLO)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
H	-	-	-	-	-	-	-	-	-	-	*H*	-	-	-
H	-	-	-	-	-	-	-	-	-	-	*H*	-	-	-
H	-	-	-	-	-	-	-	-	-	-	*H*	-	-	-
H	-	-	-	-	-	-	-	-	-	-	*H*	-	-	-
H	-	-	-	-	-	-	-	-	-	-	*H*	-	-	-

Unit-1: Huygen's principle and its applications, Fermat's principle, Modern formulation of Fermat's principle, Law of reflection and refraction, Electromagnetic waves at an interface, Fresnel equations for s- and p-polarizations, Interpretation of Fresnel equations, Reflectance and Transmittance, Brewster's angle, Total internal reflection, Evanescent waves, The Stokes treatment of reflection and refraction

Experiment no. 1. Determination of wave lengths of mercury spectrum using prism in minimum deviation
Experiment no. 2. Determination of thickness of thin wire air-wedge

Unit-2: Superposition of waves, Addition of waves of the same frequency, Standing waves, Addition of waves of different frequency, Beats, group velocity, group index, Polarization: Linear, Circular, Elliptical, Polarizers, Malus's law, Dichroism, Wire-grid polarizers, Birefringence, Uniaxial Birefringent crystals, Birefringent polarizers, Polarization by Reflection, Full wave plate, Half wave plate, Quarter wave plate

Experiment no. 3. Spectrometer i-i' curve
Experiment no. 4. Spectrometer - Cauchy's constants

Unit-3: Interference, General conditions, Temporal and spatial coherence, Fresnel-Arago laws,Young's experiment, Interference in dielectric films, Michelson interferometer, Multiple beam interference, Irradiance of reflected and transmitted beams, Coefficient of finesse, Airy function, Fabry-Perot interferometer, Fabry-perot spectroscopy, Chromatic resolving power, Anti reflection coatings, Elementary theory of Coherence, Complete mutual coherence and incoherence, partial coherence, Fringe visibility, Coherence time and Coherence length

Experiment no. 5. Determination of wavelength of sodium light – Newton's Rings
Experiment no. 6. Determination of numerical aperture and acceptance angle of the optical fiber using laser

Unit-4: Fraunhofer and Fresnel diffraction, Several coherent oscillators and diffraction properties, Fraunhofer diffraction: Single slit, Double slit, Multi slits, Circular aperture, Resolution of imaging systems, Diffraction grating, grating equation, Grating spectroscopy, Fresnel diffraction, Fresnel half-period zone, Fresnel Diffraction-More Rigorous approach, Fresnel-Integrals & rectangular
Aperture, Fresnel-diffraction by circular aperture, Fresnel diffraction by a narrow obstacle, Babinet's principle

Experiment no. 7. Determination of wave lengths of mercury spectrum using diffraction grating in minimum deviation
Experiment no. 8. Spectrometer - Narrow angled prism

Unit-5: Spontaneous and Stimulated emission, Einstein A and B coefficients, Laser: The First laser (Pulsed Ruby), Resonant cavity, Longitudinal and transverse modes, Laser cavity configurations, Quality factor, Q-switching, Gaussian laser beams, Rayleigh range, He-Ne laser, Semiconductor laser, Liquid laser, Chemical laser, Applications of lasers

Experiment no. 9. Determination of dispersive power of a prism using spectrometer
Experiment no. 10. Determination of refractive index of the material of the prism by drawing the i-d curve

Learning Resources

1. Optics, Ajoy Ghatak, (McGraw Hill, 2010).
2. Optics, Eugene Hecht, (4thEdition, Addison Wesley, 2002).
3. Modern Classical Optics, Brooker, Geoffrey, (Oxford Univ. Press, 2003)
4. A Text Book of Optics, N. Subrahmanyam, Brij Lal, M. N. Avadhanulu, (S. Chand Limited, 2015)
5. B.Sc., Practical Physics, C. L. Arora, (S. Chand & Company Ltd., 2007)
6. Engineering Physics Practical, Gupta, Krishna Prakashan (Ninth Edition, Media publishers, 2010).
7. Fundamentals of Optics, F. Jenkins and H White, (McGraw Hill, 2017)

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Level 2	Understand	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Level 3	Apply	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 4	Analyze	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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Course Code	UPY22302T	Course Name	Mathematical Physics-I	Course Category	C	Professional Core Course	L	T	P	C
							3	1	0	4

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*teach the mathematical skills for the application in the physics*	Bloom's Level
CLR-2:	*apply the divergence and curl theorems for several physical problems*	
CLR-3:	*express the differential equations to the theoretical physics*	
CLR-4:	*learn about the series expansion*	
CLR-5:	*learn to represent the periodic functions*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	
CLO-1:	*apply mathematical concept to express the physical equations*	4
CLO-2:	*solve the theoretical and numerical problems*	4
CLO-3:	*use of the complex variable in the response theory and potential theory*	4
CLO-4:	*use the differential equations to express physical processes and set the boundary conditions*	4
CLO-5:	*able to resolve the unsolved and complex theoretical works in physics*	4

Program Learning Outcomes (PLO)															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
H	-	H	-	-	-	-	-	-	-	-	-	-	-	-
H	-	H	-	-	-	-	-	-	-	-	-	-	-	-
H	-	-	H	-	-	-	-	-	-	-	-	-	-	-
H	-	H	-	-	-	-	-	-	-	-	-	-	-	-
H	-	H	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1: Vector Analysis: Introduction, Cartesian Systems of Base vectors, an orthonormal basis, Vector algebra with coordinates, Differentiation of vector functions, Gradient, divergence & curl, Integration of vector functions, Gauss Divergence theorem, Curl (Stokes) theorem, Green's theorem, Some useful relationship involving vectors.

Unit-2: Matrix Analysis: Vector Space, linear dependence, Hilbert space, linear operators Definition of matrix, Basic Matrix operations, Matrix Multiplication, Complex conjugation and transposition, Classification of matrices, , Determinant and its properties, Symmetric and skew-symmetric matrix, Hermitian and skew-Hermitian matrix, Orthogonal matrix, Unitary matrix, Trace of a matrix and its properties, Algorithm to find inverse matrix, solution of systems of linear equations, Eigenvalues and eigenvectors, Characteristic equation, Cayley –Hamilton theorem.

Unit-3: Functions of Complex Variables: Algebraic operations, Euler's formula, Single and multivalued functions, Analytic functions, Harmonic functions, contour Integrals, Cauchy Riemann Conditions, Cauchy's Integral Theorem, Cauchy Integral Formula. Differentiation inside the sign of Integration, Taylor series expansion, and Laurent series expansions

Unit-4: Differential equations: First order homogeneous and non-homogeneous equations with variable coefficients, Superposition principle, Second order homogeneous and non-homogeneous equations with constant coefficients, Second order homogeneous and non-homogeneous equations with variable coefficients, Partial differential equations of theoretical physics, Method of direct integration, Method of separation of variables.

Unit-5: : Fourier Series: Periodic function, Odd and even functions, Square and Triangular wave, Saw-Tooth wave, Euler formula for Fourier series, Fourier Cosine and Sine series, change of intervals, complex form of Fourier series, summation of Fourier series, Gibb's Phenomenon, Properties of Fourier Series.

Learning Resources

1. G. Arfken and H.J. Weber, *Mathematical Methods for Physicists*, 6th Ed., Academic Press, SanDiego, 2005.
2. P.K. Chattopadhyay, *Mathematical Physics*, Wiley Eastern, New Delhi, 2005.
3. C. Harper, *Introduction to Mathematical Physics*, Prentice Hall of India, New Delhi, 2004.
4. M.R. Spiegel, *Schaum's Outline of Advanced Mathematics for Engineers and Scientists*, 1st Ed., McGraw Hill, 2009
5. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, Delhi, 110006

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
Level 4	Analyze	20%	-	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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Dr. DK Aswal, NPL, dkaswal@nplindia.org	Prof. C Vijayan, IIT Madras, cvijayan@iitm.ac.in	Dr. Rohit Dhir, SRMIST

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Course Code	UPY22303T	Course Name	Classical Mechanics	Course Category	C	Professional Core Course	L	T	P	C
							3	1	0	4

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*understand, explain and derive the various mechanics problems*	Bloom's Level
CLR-2:	*develop solid background of mathematical methods to employ in modern physics.*	
CLR-3:	*apply the fundamental concepts of mechanics to solve mechanics problems*	
CLR-4:	*develop problem solving and critical thinking*	
CLR-5:	*develop basic understanding of speed of light and relativity*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Bloom's Level
CLO-1:	*understand system of particles in mechanics*	4
CLO-2:	*learn about the constraint forces, d'alembert's principle and lagrangian*	4
CLO-3:	*learn the hamiltonian and mechanics*	4
CLO-4:	*learn the basic aspects of relativity*	4
CLO-5:	*basic knowledge on special theory of relativity*	4

Program Learning Outcomes (PLO)														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
H	-	H	-	-	-	-	-	-	-	-	-	-	-	-
H	-	-	H	-	-	-	-	-	-	-	-	-	-	-
H	-	-	-	-	-	-	-	-	-	-	*H*	-	-	-
H	-	-	-	-	-	-	-	-	-	-	*H*	-	-	-
H	-	-	-	-	-	-	-	-	-	-	*H*	-	-	-

Unit-1: System of particles, Mechanics of a system of Particles, Internal and External forces, Center of Mass, Conservation of linear momentum and Angular momentum for a system of particles, Conservation of Energy for a system of particles, Generalized coordinates, Generalized momentum.

Unit-2: Degrees of Freedom, Constraints, Classification of Constraints with example, Principle of Virtual Work, D'Alemberts principle, Problem solving using D'Alemberts principle, Lagrange's equation from D'Alemberts principle, Newton's equation of motion from Lagrange's equation, Lagrangian of a (a) simple pendulum, (b) Compound pendulum, (c) Atwood's machine and others. Obtain equation of motion of a simple pendulum by using Lagrange's equation, Obtain equation of motion of an Atwood's machine by using Lagrange's equation.

Unit-3: Homogeneous space, Isotropic space and Homogeneous time, Homogeneity of Space and conservation of linear momentum, Isotropic space and conservation of angular momentum, Homogenety of time and conservation of Energy, Cyclic coordinates, Hamiltonian and Hamiltonian function H, Energy function and Jacobi's integral, Hamilton's equations or Hamilton's canonical equations of motion, Hamilton's equations in (a) Cartesian coordinates, (b) polar coordinates, (c) cylindrical coordinates, (d) spherical coordinates. Hamiltonian for a particle in a central force field, Hamiltonian for projectile near the surface of the earth, Hamiltonian for a Harmonic oscillator, the equation of motion for a Harmonic oscillator using Hamilton's equations, the equation of motion for an ideal spring-mass configuration.

Unit-4: Fundamental Frame of reference and Accelerated frame of reference, Newtonian Relativity, Michelson-Morley Experiment, The Universal speed, Galilean Transformations, Concept of space, mass and time, Ether Hypothesis: Explanation of negative result, Postulates of special theory of relativity, Explanation of the postulates, Problem solving: Newtonian relativity, Problem solving: Galilean Transformations.

Unit-5: Concept of Lorentz Transformation Equations, Derivation of Lorentz Transformation Equations, Consequences of the relativity, Length Contraction, Time Dilation, Simultaneity and relativity of time, Twin Paradox, Problem solving: Time Dilation, Problem solving:Length Contraction, Addition of velocities, Concept of variation of mass with velocity, Derivation of variation of mass with velocity, Mass Energy Equivalence, Concept of rest mass Equivalence, Relationship between total energy, rest energy and momentum

Learning Resources

1. Halliday, Resnick and Walker (2015), "Fundamentals of Physics" – 10th ed. Wiley, New York
2. University Physics with Modern Physics, (12th Ed., H. D. Young and R. A. Freedman, 2011)
3. Mechanics Berkeley Physics course, v.1 Charles Kittel (Tata McGraw Hill, 2007)
4. An Introduction to Mechanics David Kleppner, Robert Kolenkow McGraw Hill Education India, 2007
5. Theory and Problems of Theoretical Mechanics (Schaum's Outline)1982, Murray R. Spiegel, McGraw Hill Education India

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
Level 4	Analyze	20%	-	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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Dr. M Sathish, CSIR-CECRI, msathish@cecri.re.in	*Prof. C Venkateshwaran, University of Madras, venkateshwaran@unom.ac.in*	Dr. Rohit Dhir, SRMIST

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Course Code	UPY22S01T	Course Name	Digital Signal Processing	Course Category	S	Skill Enhancement Course	L	T	P	C
							0	2	0	2

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*study the parameters of a signal and generation of a signal with specific parameters*	Bloom's Level
CLR-2:	*estimate signal to noise ratio (snr) of a signal*	
CLR-3:	*estimate fundamental frequency component in a given signal using fourier transform*	
CLR-4:	*estimate mean square error (mse) between two signals*	
CLR-5:	*study various filtering techniques*	
CLR-6:	*design finite impulse response (fir) and infinite impulse response (iir) filters*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Program Learning Outcomes (PLO)														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1:	*understand about the parameters of a signal and generation of sequences*	4	*H*	*H*	*H*		-	-	-	-	-	-	-	-	-	-	-
CLO-2:	*understand the necessity of estimation of snr and mse*	4	*H*	*H*	-	*H*	-	-	-	-	-	-	-	-	-	-	-
CLO-3:	*understand how fourier transforms help in estimating frequency content of a signal*	4	*H*	*H*	-	*H*	-	-	-	-	-	-	-	-	-	-	-
CLO-4:	*understanding different types of fourier transformations*	4	*H*	*H*	-	*H*	-	-	-	-	-	-	-	-	-	-	-
CLO-5:	*understanding convolution and cross correlation of two signals*	4	*H*	*H*	-	*H*	-	-	-	-	-	-	-	-	-	-	-
CLO-5:	*gain knowledge on designing digital filters in scientific programming language like octave.*	4	-	-	-	*H*	-	-	-	-	-	-	-	-	*H*	-	-

Unit-1: Octave basics: commands, functions, variables, plotting etc. Generation of Unit Sample Sequence, Unit Step, Ramp Function, Discrete Time Sequence, Real Sinusoidal Sequence
Generate and Plot Sequences over an interval

Unit-2: Write an Octave code to create a signal equal to the sum of two sine waves with the following characteristics:
a) 3–second duration
b) Sampling frequency = 2 kHz
c) Sinusoid 1: frequency 50 Hz (low), amplitude 10, phase = 0
d) Sinusoid 2: frequency 950 Hz (high), amplitude 1, phase =0
Write an Octave code to create a sawtooth wave with a frequency of 50 Hz of 100 samples and a random noise signal of 100 samples. Compute the powers of both the signals in terms of dB.
Write an Octave code to estimate the Signal to Noise ratio (SNR) of a signal in terms of dB (Generate sinusoidal and noise signals of known powers for estimation of SNR).

Unit 3: Write an Octave code to estimate Mean Square Error (MSE) between a clean signal (signal free from noise) and a noisy signal, Study of Fourier Transform, Discrete Fourier Transform and Fast Fourier Transform, Write an Octave code to create a signal composed of two different frequencies and implement low pass and high pass filtering. Evaluate the output with fft function.

Unit 4: Write an Octave code to perform convolution and cross correlation between two signals.
Design of a Butterworth Analog Filter for Low Pass and High Pass.
Design a digital FIR lowpass filter using Octave with the following specifications:
a) Passband cutoff frequency: fp=2 kHz
b) topband cutoff frequency: fs=3 kHz
c) Passband Ripple: Rp=0.25 dB
d) Stopband attenuation: Rs= 0.25 dB
e) Sampling frequency: fs=20 kHz

Unit-5: Design a digital IIR lowpass filter using Octave with the following specifications:
a) Filter Order: 8th Filter type: elliptic IIR
b) Passband cutoff frequency: fp= 300 Hz
c) Passband Ripple: Rp= 0.5 dB
d) Stopband attenuation: Rs= 50 dB
Sampling frequency: fs= 4 kHz
Design a digital FIR bandpass filter using Octave with the following specifications:
a) Passband: 8–12 kHz
b) Stopband Ripple: Rs= 0.001
c) Passband Ripple: Rp= 0.001
d) Transition width: 3 kHz
Sampling frequency: fs= 44.1 kHz
Design a digital IIR bandpass filter with Butterworth characteristics using Octave meeting the following specifications:
a) Passband: 8–10 kHz
b) Sampling frequency: fs= 44.1 kHz
c) Filter Order: 4
d) Filter Characteristics: Butterworth
Obtain the filter coefficients and frequency response for the above FIR using the Blackman window method.

Learning Resources	1. Discrete Time Signal Processing, Oppenheim and Schafer (Pearson) 2. Digital Signal Processing: Principles, Algorithms and Applications, Proakis and Manolakis (Pearson)	3. Digital Signal Processing, Salivahanan (Tata McGraw Hill) 4. Digital Signal Processing, NagoorKani (Tata McGraw Hill) 5. Digital Signal Processing, Chen (Oxford)

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (100% weightage)							
		CLA – 1 (20%)		CLA – 2 (20%)		CLA – 3 (40%)		CLA – 4 (20%)#	
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-
Level 4	Analyze	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %	

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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Dr. V Subramanian, CLRI, subbu@clri.res.in	Prof. C Vijayan, IIT Madras, cvijayan@iitm.ac.in	Dr. Rudra Banerjee, SRMIST

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Course Code	UES22AE1T	Course Name	Environmental Studies	Course Category	AE	Ability Enhancement Course	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning	Program Learning Outcomes (PLO)

CLR-1 :	*teach the importance of environment*
CLR-2 :	*impart the knowledge about ecosystem*
CLR-3 :	*teach about Biodiversity*
CLR-4 :	*create awareness about environmental pollution*
CLR-5 :	*understand about Environment Protection*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Bloom's Level	1 Disciplinary Knowledge	2 Critical Thinking	3 Problem Solving	4 Analytical Reasoning	5 Research Skills	6 Team Work	7 Scientific Reasoning	8 Reflective Thinking	9 Self-Directed Learning	10 Multicultural Competence	11 Ethical Reasoning	12 Community Engagement	13 ICT Skills	14 Leadership Skills	15 Life Long Learning
CLO-1 :	*gain knowledge on the importance of natural resources and energy*	*4*	-	-	-	-	-	*H*	*H*	-	-	-	-	*H*	-	-	-
CLO-2 :	*understand the structure and function of an ecosystem*	*4*	-	-	-	-	-	*H*	-	-	-	-	-	*H*	-	-	-
CLO-3 :	*imbibe an aesthetic value with respect to biodiversity, understand the threats and its conservation and appreciate the concept of interdependence*	*4*	-	-	-	-	-	-	*H*	-	-	-	-	-	-	-	-
CLO-4 :	*understand the causes of types of pollution and disaster management*	*4*	-	-	-	-	-	-	*H*	-	-	-	-	-	-	-	-
CLO-5 :	*observe and discover the surrounding environment through field work*	*4*	-	-	-	-	-	*H*	-	-	-	-	-	*H*	-	-	-

UNIT I - INTRODUCTION TO NATURAL RESOURCES/ENERGY

Natural Resources – Definition – Scope and Importance – Need for Public Awareness – Renewable and Non-renewable Resources: Natural resources and associated problems. Forest resources and over-exploitation – Water resources and over-utilization – Mineral resource extraction and its effects - Food resources - food problems and Modern agriculture - Energy resources and its future.

UNIT II – ECOSYSTEMS

Concept of an ecosystem-structure and function of an ecosystem-producers, consumers and decomposers- ecological succession- food chains(any 2 Examples)- food webs(any 2 Examples)-ecological pyramids.

UNIT III-ENVIRONMENTAL POLLUTION /DISASTER MANAGEMENT

Definition-causes, effects and control measures of : Air, Water and Soil pollution- e-waste management- Disaster management: Natural and man-made-food/earthquake/cyclone, tsunami and landslides.

UNIT IV - SOCIAL ISSUES AND THE ENVIRONMENT

Sustainable development- Climate change: global warming, acid rain, ozone layer depletion and nuclear radiation- Environment Protection Act (any 2) air, water, wildlife and forest.

UNIT V - 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.

FIELD WORK

Students will visit any one of the following place of interest and submit a written report by the end of the semester:

1. Visit to a hospital/industry/canteen for solid waste management
2. Visit to a chemical industry to study about the practices followed there for waste disposal
3. Visit to Vandalur zoo for study of animal conservation/plants- flora and fauna
4. Study of simple ecosystems-lake/hill slopes
5. Naming the trees in the campus at SRM
6. Study of common plants, insects, birds in the neighbourhood
7. Study of common diseases and their prevention
8. Optional: Street plays and rally for awareness of obesity/diabetes/ vitamin D deficiency/health issues/ waste management/ solid waste management/ no plastics/ energy consumption/wild life protection.

Learning Resources	**Theory:**

1. Bharucha Erach, (2013), Textbook of Environmental Studies for Undergraduate Courses (Second edition). Telangana, India: Orient BlackSwan.
2. Basu Mahua, Savarimuthu Xavier, (2017), SJ Fundamentals of Environmental Studies. Cambridge, United Kingdom: Cambridge University Press
3. Dr.R.Jeyalakshmi.2014.,Text book of Environmental Studies, Devi publications, Chennai
4. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380013, India, Email:mapin@icenet.net (R)

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
Level 4	Analyze	20%	-	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers		
Experts from Industry	**Experts from Academic**	**Internal Experts**
1. Mr. Suresh S, Program Head, Hello FM	*1. Dr. G Balasubramania Raja, Prof & Head, Manonmaniam Sundranar University* *Mail- gbs_raja@yahoo.com*	*1. Dr. Rajesh R, Head, SRM IST*
		2.Dr.S.Albert Antony Raj, Associate Professor and Head, SRMIST

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Course Code	UJK22301T	Course Name	Universal Human Values	Course Category	JK	*Life Skill Course*	L	T	P	C
							2	0	0	2

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*generate in students a sensitivity to current regional and national issues such as gender marginalization eco sensitivity, vision for the nation and general humanness*	Bloom's Level
CLR-2:	*an expanded consciousness with a mind to accommodate all is developed*	
CLR-3:	*the ability to accept all and to co- exist is initiated*	
CLR-4:	*create community connectivity and interdependence*	
CLR-5:	*instill intrinsic link between freedom and responsibility for both individuals and communities*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	
CLO-1:	*become sensitive toward every living life and be able to respect every religion recognizing the universal values*	4
CLO-2:	*every way of life and culture will kindle the curiosity in them to know them and will be able appreciate the beauty in it*	4
CLO-3:	*the presumptuous or prejudiced mentality will be overcome by them*	4
CLO-4:	*critical thinking and accommodative nature will become so natural way of thinking for them*	4
CLO-5:	*will be able to explore their own emotions, hopes & fear and be able to describe them verbally*	4

Program Learning Outcomes (PLO)															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	Ethical Reasoning	Community Engagement	ICT Skills	Leadership Skills	Life Long Learning
H	-	-	-	-	-	-	-	-	-	*H*	-	-	-	-
H	-	-	-	-	-	-	-	-	*H*	-	-	-	-	-
H	-	-	*H*	-	-	-	-	-	-	-	-	-	-	-
H	*H*	-	-	-	-	-	-	-	-	-	-	-	-	-
H	-	-	-	-	-	-	*H*	-	-	-	-	-	-	-

UNIT I

LOVE & COMPASSION

1. FORMS OF LOVE
2. DEFENITIONS FOR LOVE, COMPASSION, EMPATHY
3. DISCUSSION ON PERSONALITIES LIKE BEGAN, PAARI VENDHAR FROM SANGAM LITERATURE
4. LEE MOKOBE'S POEM 'ON BEING A TRANS'

TRUTH

1. THE VALUE OF TRUTH, UNIVERSAL TRUTH
2. MYTHOLOGY OF HARISHCHANDRAN
3. BACON'S ESSAY OF TRUTH
4. THE POWER OF TRUTH

The students will be introduced to Forms of love – for self, parents, family, friend, spouse, community, nation, humanity and other beings both for living and non-living. Definition for Love, compassion, empathy, sympathy and non-violence will be explained to the students through the texts. Universal truth, truth as value, truth as fact (veracity, sincerity, honesty among others will be introduced. Personalities and individuals from history for practicing compassion and love and truth and narratives and anecdotes from history, literature including local folklore will be discussed for the students to get better understanding of the concepts of Love and Compassion and Truth. What will one gain or lose by practicing or by not practicing these values will be instilled in the learners 'mind through discussions. The learners will be allowed a space to express their experience as an individual and in a group. Situations will be simulated in the class room for the students to get better understanding of Love and Compassion and Truth. Case studies will be discussed in the class room for learners to have a deeper understanding.

UNIT II

NON- VIOLENCE

1. MAHATMA GANDHI'S NON-VIOLENCE
2. D.H LAWRENCE' POEM SNAKE
3. ASHOK MITHRAN'S SHORT STORY – RAT
4. ANECDOTE FROM ANNIE BESANT AND ALBERT CAMU'S LIFE

RIGHTEIUSNESS

1. DISCUSS RIGHTEOUSNESS
2. DHARMA AND ARAM – THE DIFFERENCE
3. RAMA, LAKSHAMAN, RAVANA AND SURPANAKA- A DISCUSSION
4. SIX BLINDMEN AND AN ELEPHANT

The students will be introduced to Non-violence. Its need. Love, compassion, empathy sympathy for others as pre-requisites for non-violence will be explained through the given text. Ahimsa as Non-Violence and Non killing as a virtue is to be instilled in a learner. Righteousness and Dharma and its prioritization is to be discussed through the given text. Personalities and individuals from history for practicing Nonviolence and Righteousness is to be introduced and narratives and anecdotes from history, literature including local folklore will be discussed for the students to get better understanding of the concepts of Nonviolence and Righteousness. What will one gain or lose by practicing or by not practicing these values will be instilled in the learners' mind through discussions. The learners will be allowed a space to express their experience as an individual and in a

group. Situations will be simulated in the class room for the students to get better understanding of Non-Violence and Righteousness. Case studies will be discussed in the class room for learners to have a deeper understanding.

UNIT III

PEACE

1. DEFINITION OF PEACE
2. HARMONY AND BALANCE WITH ORGANISATION AND SELF
3. MARTIN LUTHER KING'S I HAVE A DREAM
4. PROMETHEUS UNBOUND BY SHELLEY

SERVICE

1. MOTHER THERESA AND HER DARK LETTERS
2. LEE KUAN YEW' S LIFE STORY & NATURE OF DIFFERENT PROFESSIONS
3. THEMES OF TAGORE'S WHERE THE MIND IS WITHOUT FEAR
4. THEMES OF IF POEM BY KIPLING

The students will be introduced to what is peace and service. The need of peace, relation with harmony and balance and Individuals and organizations that are known for their commitment to peace will be discussed through the texts. What is service? Forms of service, for self, parents, family, friend, spouse, community, nation, humanity and other beings- living and non-living, persons in distress or disaster will be discussed through the texts. Peace and service as a virtue is to be instilled in a learner. Personalities and individuals from history for practicing Peace and service is to be introduced and narratives and anecdotes from history, literature including local folklore will be discussed for the students to get better understanding of the concepts of Peace and service. What will one gain or lose by practicing or by not practicing these values will be instilled in the learners' mind through discussions. The learners will be allowed a space to express their experience as an individual and in a group. Situations will be simulated in the class room for the students to get better understanding of Peace and service. Case studies will be discussed in the class room for learners to have a deeper understanding.

UNIT IV

RENUNCIATION

1. SELF- RESTRAIN, WAYS TO OVERCOME GREED, THE ART OF LETTING GO
2. BUDHA'S LIFE STORY
3. THE SHORT STORY OF ANTON CHECKOV- THE BET
4. RAMA THE SON AND BARATHA THE BROTHER AS EPITOMES OF RENUNCIATION

GRATITUDE

1. THE IDEA OF UNIVERSE TO TEACH HUMILITY AND GRATITUDE
2. THANKFULLNESS TO THE GIFT OF LIFE AND THE ABILTY TO COUNT ONE'S BLESSINGS
3. GRATEFUL TO EVERY LIFE TO MAKE OTHERS' LIFE EASIER
4. THEME OF THE POEM THE CRUTCHES BY BERTOLD BRECHT

The students will be introduced to Renunciation and gratitude. Self-restrain and ways of overcoming greed. Renunciation and gratitude with action as true renunciation and practice of gratitude as a virtue will be discussed through the texts. Personalities and individuals from history for practicing renunciation and possessing gratitude is to be introduced and narratives and anecdotes from history, literature including local folklore will be discussed for the students to get better understanding of the concepts. What will one gain or lose by practicing or by not practicing these values will be instilled in the learners' mind through discussions. The learners will be allowed a space to express their experience as an individual and in a group. Situations will be simulated in the class room for the students to get better understanding of renunciation and gratitude. Case studies will be discussed in the class room for learners to have a deeper understanding.

UNIT V

SCREENING OF MOVIES - THE WATER BY DEEPA MEHTA
THE TWO POPES BY FERNANDO MEIRELLES
ASSIGNMENT AND SEMINAR TO CHECK THE PERSONALITY OF THE LEARNER AND TO HAVE AN UNDERSTANDING OF HIS/HER ACQUIRED COGNIZANCE PERTAINING TO HUMAN VALUES.

Learning Resources	***Theory:*** Horizon- English Text Book – Compiled and Edited by the faculty of English Department, FSH, SRMIST, 2020

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (100% weightage)							
		CLA – 1 (20%)		CLA – 2 (20%)		CLA – 3 (40%)		CLA – 4 (20%)#	
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-
Level 4	Analyze	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %	

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

Course Designers	
Experts from Higher Technical Institutions	Internal Experts
Prof. Daniel David, Prof & Head, Department of English, MCC, Chennai	*Dr. Shanthichitra, Associate Professor, & Head, Department of English, FSH,SRMIST*
	Dr K B Geetha, Assistant Professor, Department of English, FSH, SRMIST

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SEMESTER IV

Course Code	UPY22401J	Course Name	Electronics	Course Category	C	Professional Core Course	L	T	P	C
							4	0	4	6

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*understand the concept of networks and semiconductors*	Bloom's Level
CLR-2:	*understand the working principles of a transistors*	
CLR-3:	*familiarize the operation of amplifiers and oscillators*	
CLR-4:	*understand the basic concepts of number systems*	
CLR-5:	*develop the digital circuit design concepts using logic gates*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning
CLO-1:	*apply skills to solve the circuits*	4
CLO-2:	*enable the students to explore the field of transistors*	4
CLO-3:	*understand the concepts and working principles in amplifiers and oscillators*	4
CLO-4:	*apply the concepts of number system in digital electronics*	4
CLO-5:	*understands the basic concepts of logic gates*	4

Program Learning Outcomes (PLO)															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
H	-	-	-	-	-	-	-	-	-	-	*H*	-	-	-
H	-	-	-	-	-	-	-	-	-	-	*H*	-	-	-
H	-	-	-	-	-	-	-	-	-	-	*H*	-	-	-
H	-	-	-	-	-	-	-	-	-	-	*H*	-	-	-
H	-	-	-	-	-	-	-	-	-	-	*H*	-	-	-

Unit-1: Circuit elements, Kirchhoff's Laws, Methods of analyzing circuits-Mesh and Nodal Method, Thevenin's Theorem, Norton's theorem, Intrinsic and Extrinsic semiconductor, PN junction diode–construction, Biasing of PN junction- VI characteristics of diode, Zener Diode-VI Characteristics, Solving Problems on Zener diode as voltage regulator, Bipolar Junction Transistors-BJT: Construction/Working, CE Configuration, CE-input and output characteristics, CB Configuration,CB-input and output characteristics, Introduction to Two port networks, Two port network analysis and problem solving, FET – Construction, Characteristics of JFET, Biasing of JFET, Depletion and Enhancement Mode, Depletion type MOSFET, Enhancement type MOSFET.

1. Experiment: Basic Experimentations – Demo class
2. Experiment: Obtain the static characteristics of a PN junction diode and then obtain the forward resistance of the diode at a given operating point.
3. Experiment: Study the V–I characteristics of a Zener diode and note down its breakdown potential.

Unit-2: RC coupled single stage amplifier- Construction, RC coupled single stage amplifier-Operation- Frequency response, Introduction to power amplifiers, Classification of power amplifiers, Class A amplifier, Class A amplifier: Construction/Working, Class B amplifier, Class B amplifier: Construction/Working, Class AB amplifier, Solving problems on power amplifier efficiency, Class C amplifier, Class C amplifier: Construction/Working, Class A Push pull amplifier, Class A Push pull amplifier: Construction/Working, Class B Push pull amplifier, Class B Push pull amplifier, Oscillator operations- Barkhausen criteria, Feedback amplifiers, Types of feedback and problem solving on feedback, Principle of oscillators, Hartley's oscillator, Colpitt's oscillators, Phase shift oscillator, Wien's bridge oscillator.

4. Experiment: Obtain the characteristics curves of BJT in CE Configuration
5. Experiment: Obtain the Drain and Transfer characteristics of FET
6. Experiment: CE amplifier and make the (i) Upper cut-off (ii) Lower cut-off frequencies and hence estimate the Bandwidth.

Unit-3: Operational Amplifiers (op-amp), Open loop and closed loop op-amp characteristics, Ideal op-amp with virtual ground, Inverting op-amp, Non-inverting op-amp, Op-amp Adder, Op-amp Subtractor, Op-amp Voltage follower, Op-amp as comparator, Solving problems on Op-amp applications, Op-amp as intergrator, differentiator, Clipping circuits-Positive clipper, Negative clipper, Biased clipper, Combination clipper, Applications of clipper, Basic idea of a clamper, Positive clamper, negative clamper and problem solving, IC555 (Timer IC), Astable-multivibrator, Astable-multivibrator, Monostable-multivibrator, Monostable-multivibrator.

7. Experiment: Revision/Repeat classes
8. Experiment: Design of Hartley Oscillator
9. Experiment: Study of timer circuit using IC555 and configuration for monostable and astable-multivibrator.

Unit-4: Introduction to Decimal number systems, Binary number systems, Octal number systems, Hexadecimal number systems, Binary Coded Decimal (BCD) code, Excess – 3 code, Gray code, Gray code to Binary code conversion, One's complement and two's complement, Binary Addition, Binary Subtraction and solving problems on binary arithmetic, Basic and derived logic gates– Symbols and their truth tables– AND–OR– NOT, Basic and derived logic gates– Symbols and their truth tables– AND–OR– NOT, NAND– NOR logic gates, XOR– XNOR logic gates, Universal logic gates-NAND and NOR, Basic laws of Boolean algebra, De– Morgan's theorems and problem solving, Reducing Boolean expressions using Boolean laws, Sum of Products (SOP) form of expressions, Product of Sum (POS) form of expressions, Min term and max terms, Karnaugh map simplification, Karnaugh map simplification.

10. Experiment: Verification of truth tables using logic gates
11. Experiment: NAND and NOR gates as Universal logic gates
12. Experiment: Verification of truth tables of Flip-Flops

Unit-5: Half adder, Full adders, Half subtractor, Full subtractor, Two's complement adder circuits, Two's complement subtractor circuits, Binary Coded Decimal (BCD) adder, Decoder, Encoder, Multiplexer and problem solving, Demultiplexer, RS flip-flop, Clocked RS flip-flop, D flip-flop, JK flip-flop, Master slave JK flip-flop, Shift left registers, Shift right registers, SISO Shift register, SIPO Shift register, Ripple counter, Ring counter, Up and Down counter, Decade counter.

13. Experiment: Design of Half adder, Full adder, Half subtractor and Full subtractor using logic gates
14. Experiment: Design of Decade counter and count table verification

15. Experiment: Revision/Repeat classes

Learning Resources	1. Principles of Electronics, Metha V.K., Mehta R. (S. Chand and Company Ltd., 2008) 2. Foundations of Analog and Digital Electronic Circuits, Anant Agarwal, Jeffrey Lang, (Morgan Kaufman, 2005) 3. Electron Devices and Circuits, Jacob Millman, Christos C Halkias, SatyabrataJit (Tata McGraw Hill, 2010)	4. Digital Fundamentals, Thomas L. Floyd (Pearson Education, 9th Edition, 2006) 5. Electronic Devices and Circuit Theory, Robert L. Boylestad and Louis Nashelsky (Pearson Education, 9thEdition, 2009).

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Level 2	Understand	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Level 3	Apply	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 4	Analyze	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. M Satish, CSIR-CECRI, msathish@cecri.re.in	Prof. C Venkateshwaran, University of Madras, venkateshwaran@unom.ac.in	Dr. Arul Verman, SRMIST
Dr. V. Jayaraman, IGCAR, Kalpakkam, vjram@igcar.gov.in	Dr. V Gunasekaran, Central University TN, gunasekaran@cutn.ac.in	Dr. Naga Rajesh, SRMIST

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Course Code	UPY22402T	Course Name	Quantum Mechanics I	Course Category	C	Professional Core Course	L	T	P	C
							3	1	0	4

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*understand the dual nature of light and wavelike properties of particles*	Bloom's Level
CLR-2:	*know the basics of linear vector space and to understand postulates of modern quantum mechanics*	
CLR-3:	*learn quantum mechanics solutions to simple 1d systems*	
CLR-4:	*solve the schrodinger's equation of hydrogen atom and obtain solutions*	
CLR-5:	*understand the theory of angular momentum*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning
CLO-1:	*understand the principle of duality*	4
CLO-2:	*understand the framework of modern quantum mechanics*	4
CLO-3:	*apply quantum mechanics to simple 1d problems*	4
CLO-4:	*understand quantum mechanics of hydrogen atom*	4
CLO-5:	*understand quantization of orbital and spin angular momenta*	4

Program Learning Outcomes (PLO)															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3	
-	-	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-	
-	-	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-	
-	-	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-	
-	-	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-	
-	-	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-	

Unit-1: Inadequacy of classical physics, blackbody radiation spectrum, Rayleigh-Jeans and Planck formulae, Photoelectric effect, Compton effect, wave nature of particles, de Broglie hypothesis, Davisson-Germer experiment, Free particle wave function and its difficulties, wave packets - phase velocity and group velocity, Heisenberg's uncertainty principle.

Unit-2: Linear vector space and its properties, Gram-Schmidt orthogonalization, Schrodinger's time-dependent equation and time-independent equation, postulates of quantum mechanics - wave function and its interpretation, operators, eigenvalue equations, expectation values, Orthogonality and completeness of eigenfunctions, Hermitian operator and its properties, Commutators and their physical significance.

Unit-3: Particle in infinite and finite square well potential, Barrier penetration problems in 1D, Quantum mechanical tunnelling, Simple harmonic oscillator – energy eigenvalues and eigenfunctions (algebraic method only).

Unit-4: Spherical polar coordinates, Schrodinger's equation of hydrogen atom in spherical polar coordinates, Variable separation – radial and angular equations, Solutions to radial and angular equations, Hydrogen atom energy quantization, Hydrogen atom spectrum, Energies of hydrogen-like atoms.

Unit-5: Theory of angular momentum, Angular momentum operators and their commutation relations, Raising and lowering operators, Eigenvalues and eigenfunctions of L^2 and L_z operator, Space quantization, Spin angular momentum, spin operators and their commutation relations, Pauli spin matrices and their eigenvalues and eigenvectors, Properties of Pauli spin matrices.

Learning Resources

1. Introduction to Quantum Mechanics, 3rd Ed., David J. Griffiths (Cambridge University Press 2017)
2. Concepts of Modern Physics, 6th Arthur Beiser (McGraw Hill, 2009)
3. Introductory Quantum Mechanics, R.L. Liboff, (Addison-Wesley, 2003)
4. Quantum Mechanics, G. Aruldhas (Prentice Hall 2008)
5. Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, 2nd Ed., R Eisberg & R Resnick (John Wiley & Sons, 1985)

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
Level 4	Analyze	20%	-	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. R Seshadri, Titan Company Limited, seshadri@titan.co.in	Dr. Ranjit Kumar Nanda, IIT Madras, nandab@iitm.ac.in	Dr. P. Sivakumar, SRMIST
Dr. M Satish, CSIR-CECRI, msathish@cecri.re.in	Prof. C Vijayan, IIT Madras, cvijayan@iitm.ac.in	Dr. Rohit Dhir, SRMIST

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Course Code	UPY22403T	Course Name	Statistical Physics	Course Category	C	Professional Core Course	L	T	P	C
							3	1	0	4

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*understanding the laws of thermodynamics and thermodynamic relations*	Bloom's Level
CLR-2:	*acquire a basic understanding on concepts of statistical mechanics*	
CLR-3:	*abstract from statistical ensembles partition functions the thermodynamic properties*	
CLR-4:	*introduce the fundamental basis of maxwell-boltzmann statistics and the understanding in of fermi dirac statistics*	
CLR-5:	*comprehend the principles of quantum statistics: bose einstein statistics*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Bloom's Level	Program Learning Outcomes (PLO)														
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
			Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1:	*analyze maxwell's thermodynamic relations-significance and applications*	4	H	-	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2:	*apply problem solving skills to determine the microstates of a given microstate of the system*	4	H	-	-	H	-	-	-	-	-	-	-	-	-	-	-
CLO-3:	*apply the concept of partition function to find the various thermodynamic properties of the system*	4	H	-	-	H	-	-	-	-	-	-	-	-	-	-	-
CLO-4:	*analyse the concepts of maxwell-boltzmann statistics and solve the occupancy of fermions in different quantum systems*	4	H	-	-	H	-	-	-	-	-	-	-	-	-	-	-
CLO-5:	*apply theory of bose -einstein distribution to explain condensation of cold gases*	4	H	-	H	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1: Principles of thermodynamics, first law of thermodynamics, heat and work, isothermal and adiabatic process, second law of thermodynamics- Kelvin -Planck statement and Clausius statement, concept of entropy, entropy change in reversible and irreversible process, Carnot's cycle, Carnot's engine and its efficiency, thermodynamic potentials: internal energy, enthalpy, Helmholtz free energy, Gibbs free energy, Maxwell's thermodynamical relations-Significance and applications
Unit-2: Basics of probability and statistics: Probability Distribution, Binomial distribution, Mean value and Fluctuations in case of Binomial distribution, Stirling's Approximation, Probability distribution for large-scale N: Poisson Distribution, Mean value and standard deviation in case of Poisson Distribution, Gaussian Distribution, Standard deviation in case of Gaussian Distribution, Basic postulates of Statistical Physics- Postulates of equal a priori probability, Ergodic Hypothesis, Specification of states - Macro state - Micro State, Concept of Phase Space, Density distribution in phase space, Liouville's theorem, Statistical Condition of equilibrium
Unit-3: Concepts of Statistical Ensembles: Microcanonical ensemble, Canonical ensemble, Canonical Partition function, Mean and Fluctuations in energy value of a system in a Canonical ensemble, Grand Canonical ensemble, Grand Canonical Partition function, Fluctuations in number of particles of a system in a Grand Canonical ensemble, Statistical interpretation of the basic thermodynamic variables, Entropy and Thermodynamic probability ($S = K \ln \Omega$): Boltzmann entropy relation, Statistical interpretation of Entropy, Partition function and thermodynamics properties of a classically ideal gas partition function of an ideal monatomic gas, Entropy of mixing and Gibb's paradox
Unit-4: Distinguishable particles: Maxwell–Boltzmann (M-B) statistics, Postulates of M–B statistics, M–B Distribution law of Energy distribution function, Maxwell–Boltzmann law of velocity distribution (most probable velocity - average velocity - RMS velocity) - Limitations of M–B statistics, Bridging Microscopic and Macroscopic behaviour - indistinguishability of particles and its consequences, Transition to quantum statistics and its implications, Fermi–Dirac Statistics, Postulates of Fermi–Dirac Statistics, Fermi–Dirac Distribution Law - Thermodynamic functions of an ideal Completely Degenerate Fermi Gas - Fermi Energy
Unit-5: Bose–Einstein Statistics, B–E distribution law, Thermodynamic functions of a Completely Degenerate Bose Gas - Bose–Einstein condensation, Properties of liquid He (qualitative description) - Radiation as photon gas - Bose's derivation of Planck's law.

Learning Resources	
1.	M. Zemansky, and R. Dittman, Heat and Thermodynamics, 8th Ed., McGraw-Hill Education, 2011.
2.	Introduction: Fundamental of Statistical Mechanics' by B.B. Laud, 2nd Edition, New Age International (P) Ltd., 2012.
3.	R.K. Pathria, P.D. Beale, Statistical Mechanics, 3rd Ed., Elsevier, 2011.
4.	K. Huang, Statistical Mechanics, 2nd Ed., Wiley, 2008
5.	F. Reif, Fundamentals of Statistical and Thermal Physics, Waveland Press, 2009.
6.	L.D. Landau and E.M. Lifshitz, Statistical Physics, 3rd Ed., Pergamon Press, 1980.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
Level 4	Analyze	20%	-	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. V Subramanian, CLRI, subbu@clri.res.in	Dr. Ranjit Kumar Nanda, IIT Madras, nandab@iitm.ac.in	Dr. Bhaskar Chandra Behera, SRMIST
Dr. M Satish, CSIR-CECRI, msathish@cecri.re.in	Dr.G.Kalpana, Anna University, g_kalpa@annauniv.edu	Dr. Rohit Dhir, SRMIST

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Course Code	UPY22S02L	Course Name	Electronic Instrumentation	Course Category	S	Skill Enhancement Course	L	T	P	C
							0	0	4	2

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*familiarize with measuring instruments used in electronics laboratory*	Bloom's Level
CLR-2:	*learning ways of measuring unknown resistance, capacitance and frequency*	
CLR-3:	*applications of diode in wave shaping circuits*	
CLR-4:	*measurement of physical parameters through electronic transducers*	
CLR-5:	*learn to understand and use various types of analog instruments.*	
CLR-6:	*develop knowledge of making measurements with impedance bridges*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning
CLO-1:	*understand the usage of ammeter, voltmeter and galvanometer*	4
CLO-2:	*impart the knowledge on measurement of resistance, capacitance and frequency*	4
CLO-3:	*understand the measurement of physical parameters such as strain, light intensity and temperature*	4
CLO-4:	*develop measurement skills with cathode ray oscilloscope (cro)*	4
CLO-5:	*acquire hands on skills in the usage of multimeters, rectifiers, amplifiers, oscillators etc.*	4
CLO-5:	*gain skills on the working and operations of impedance bridges*	4

Program Learning Outcomes (PLO)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1:	*H*	-	*H*	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2:	*H*	-	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-
CLO-3:	*H*	-	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-
CLO-4:	*H*	-	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-
CLO-5:	*H*	-	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-
CLO-5:	-	-	-	*H*	-	-	-	-	-	-	-	-	*H*	-	-

Unit I: Design of Multi Range Ammeter and Voltmeter using Galvanometer, Measurement of Resistance by Wheatstone's Bridge and measurement of bridge sensitivity, Measurement of Capacitance by De'Sauty's Bridge.
Unit 2: Measurement of Low Resistance by Kelvin's Double Bridge, Design and study of Sample and Hold circuit., Design and analyze the Clippers and Clampers circuits using junction diode
Unit 3: Study the characteristics of Light Dependent Resistor (LDR), Photodiode, and Phototransistor, Study the generation of Lissajous figures to find unknown frequency and phase shift Frequency measurement using Wein's Bridge
Unit 4: Determine output characteristics of a Linear Variable Differential Transformer (LVDT) & measure displacement using LVDT, Measurement of Strain using Strain Gauge, Determine the characteristics of Resistance Temperature Detector (RTD)
Unit-5: Determine the characteristics of Thermistors, Measurement of Temperature by Thermocouples and Study of Transducers like PT-100, J- type, K-type, Repeat/Revision of experiment

Learning Resources

1. Electronic circuits: Handbook of design and applications, U. Tietze and C. Schenk (Springer, 2008)
2. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller (Mc-Graw Hill, 1990)
3. Electronic Instrumentation, Kalsi (Tata McGraw Hill, 2004)
4. Modern Electronic Instrumentation and Measurement Techniques, Helfrick and Cooper (Pearson, 1992).
5. Instrumentation Measurement and Analysis, Nakra and Chaudry (Tata McGraw Hill, 2003)
6. Electronic Measurements and Instrumentation, Oliver and Cage (Tata McGraw Hill, 2009).
7. Measurement and Instrumentation Principles, Morris (Elsevier (Buterworth-Heinmann), 2001).
8. A Course in Electrical and Electronics Measurements and Instrumentation, Sawhney A. K. (Dhanpat Rai, 2015).
9. Instrumentation Devices and Systems, Rangan, Sarma and Mani (Tata McGraw Hill, 1997).
10. Introduction to Measurements and Instrumentation, Arun K. Ghosh (PHI, 2012).

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (100% weightage)							
		CLA – 1 (20%)		CLA – 2 (20%)		CLA – 3 (40%)		CLA – 4 (20%)#	
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	20%	-	20%	-	20%	-	20%
Level 2	Understand	-	20%	-	20%	-	20%	-	20%
Level 3	Apply	-	40%	-	40%	-	40%	-	40%
Level 4	Analyze	-	20%	-	20%	-	20%	-	20%
Level 5	Evaluate	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %	

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. M Satish, CSIR-CECRI, msathish@cecri.re.in	Prof. C Venkateshwaran, University of Madras, venkateshwaran@unom.ac.in	Dr. Naga Rajesh, SRMIST
Dr. V. Jayaraman, IGCAR, Kalpakkam, vjram@igcar.gov.in	Dr. V Gunasekaran, Central University TN, gunasekaran@cutn.ac.in	Dr. Rohit Dhir, SRMIST

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Course Code	UMI22S01L	Course Name	My India project	Course Category	EA	Extension Activity/Community Outreach	L	T	P	C
							0	0	0	1

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil

Course Offering Department	*Physics and Nanotechnology*	Data Book / Codes/Standards	*Nil*

Assessment Method – Fully Internal

Learning Assessment		
	Continuous Learning Assessment (100% weightage)	
	Review – 1 (Activities)	Review – 2 (Project report and Presentation)
Project Work	50%	50%
Total	100%	

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Course Code	UJK22401T	Course Name	Professional Skills	Course Category	JK	*Life Skill Course*	L	T	P	C
							2	0	0	2

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	*Career Development Centre*	Data Book / Codes/Standards		Nil	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*expose students to the requirements of job market*	Bloom's Level
CLR-2:	*develop resume building practice*	
CLR-3:	*increase efficiency in speaking during group discussions*	
CLR-4:	*prepare students for job interviews*	
CLR-5:	*instil confidence in students and develop skills necessary to face audience*	
CLR-6:	*develop speaking and presentation skills in students*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning
CLO-1:	*understand the importance of resume preparation and build resume*	*4*
CLO-2:	*acquire group discussion skills*	*4*
CLO-3:	*face interviews confidently*	*4*
CLO-4:	*Ask appropriate questions during an interview*	*4*
CLO-5:	*understand various types of presentation and use presentation skills in projects*	*4*
CLO-6:	*build confidence during any presentation*	*4*

Program Learning Outcomes (PLO)															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	Ethical Reasoning	Community Engagement	ICT Skills	Leadership Skills	Life Long Learning
M	-	-	-	-	-	-	M	-	-	-	-	*H*	M	*H*
M	-	*M*	-	-	H	-	M	-	H	-	-	*L*	H	*H*
M	-	*M*	-	-	L	-	M	-	H	-	-	*M*	H	*H*
M	-	*M*	-	-	L	-	M	-	M	-	-	*M*	H	*H*
M	-	*M*	-	-	H	-	M	-	M	-	-	*H*	M	*H*
M	-	*M*	-	-	*M*	-	*M*	-	-	-	-	*M*	*H*	*H*

Unit-1: Introduction of resume and its importance, Difference between a CV, Resume and Bio Data, Essential components of a good resume, common errors people make while preparing a resume, Resume building format, Resume building using templates, Resume building activity, Resume building activity – Feedback, Video resume – Tips and tricks, Video resume – Do's and Don'ts, Video resume – Templates

Unit-2: I Meaning and methods of group discussion, Procedure of group discussion, Group discussion – simulation, Group discussion – common errors, Group discussion – types – Topic based, Group discussion – types – Case study based, Group discussion – practice session- Topic based, Group discussion – Feedback, Group discussion – practice session- Topic based, Group discussion – Feedback, Group discussion – practice session- Case study based, Group discussion – Feedback

Unit-3: Meaning and types of interview (face to face, telephonic, video), Dress code, background research, STAR Technique (situation, task, approach and response) for facing an interview, Interview procedure (opening, listening skills, closure, asking questions), Important questions generally asked in an interview, Mock interview – face to face, Mock interview- Feedback

Unit-4: Types - Informative, Instructional, Arousing, Persuasive, Decision-making, Structure of a presentation – Introduction of the event, Introducing the speaker, vote of thanks, Working with audience – ice-breaking, Creating a 'Plan B', Getting the audience in the mood, working with emotions, Improvisation and unprepared presentations, man-woman view, feedback – appreciation and critique, Power point presentation, skit, drama, dance, mime, short films and documentary – Dos and Don'ts, PowerPoint presentation–logical arrangement of content, PowerPoint presentation–using internet source, citations, bibliography,

Unit-5: PowerPoint presentation–body language and stage etiquettes, PowerPoint presentation–practice session

Learning Resources

1. *Scott Bennett, The Elements of Resume Style: Essential Rules for Writing Resumes and Cover Letters That Work, AMACOM, 2014*
2. *David John, Tricks and Techniques of Group Discussions, Arihant, 2012*
3. *Singh O.P., Art of Effective Communication in Group Discussion and Interview, S Chand & Company, 2014*
4. *Paul Newton, How to deliver a presentation ; e-book*
5. *Eric Garner, A-Z of Presentation, Eric Garner and Ventus Publishing ApS, 2012, bookboon.com*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (100% weightage)							
		CLA – 1 (20%)		CLA – 2 (20%)		CLA – 3 (30%)		CLA – 4 (30%)#	
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-
Level 4	Analyze	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %	

CLA-1, CLA-2 and CLA-3 can be from any combination of these: Online Aptitude Tests, Classroom Activities, Case Studies, Poster Presentations, Power-point Presentations, Mini Talks, Group Discussions, Mock interviews, etc.

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Ajay Zener, Director, Career Launcher	-	*1. Mr Priyanand, Assistant Professor, CDC, E&T, SRMIST* *2. Ms Sindhu Thomas, Head in charge, CDC, FSH, SRMIST* *3. Ms Mahalakshmi, Assistant Professor, CDC, FSH, SRMIST*

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Course Code	UPY22D01T	Course Name	Physical Oceanography	Course Category	D	Discipline Specific Elective Course	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*introduce oceanography and oceanic process*	Bloom's Level
CLR-2:	*understand the ocean waves, tsunami and tides*	
CLR-3:	*learn about the physical properties of sea water*	
CLR-4:	*apply remote sensing of oceans*	
CLR-5:	*acquire knowledge about current climate change and role of oceans*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	
CLO-1:	*apply the knowledge of the ocean sciences various research and development applications*	4
CLO-2:	*monitor the physical and chemical properties of the sea water*	4
CLO-3:	*become oceanographers and climate scientists*	4
CLO-4:	*use the knowledge for the weather forecast and early warning for the fishers*	4
CLO-5:	*understand the prediction of the climate change*	4

Program Learning Outcomes (PLO)															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
H	-	-	*H*	-	-	-	-	-	-	-	-	-	-	-
H	-	-	-	-	*H*	-	-	-	-	-	-	-	-	-
H	-	-	-	*H*	-	-	-	-	-	-	-	-	-	-
H	-	-	-	-	-	*H*	-	-	-	-	-	-	-	-
H	*H*	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1: Introduction to Oceanography: General Introduction, Ocean and Sea, Major Oceans and its dimensions, seafloor features shoreline, Continental Shelf, Continental Slope, Continental Rise, Mid ocean Ridges, Seamounts, Guyots, Trenches, Island Arc, Atolls, Hydrothermal Vents and Cold Seeps, Geoid, Plate tectonics, Continental drift and sea floor spreading, Pangea, Gondwana, Evolution of the Indian Coast
Unit-2: Physical Oceanography: Temperature and Salinity distribution in Oceans- Horizontal and Vertical structures and time variation of temperature salinity -density-Sea level. Ocean mixed layer, barrier layer and thermal inversion Thermocline, Halocline and Pycnocline, Seasonal and permanent thermocline- distribution of dissolved Oxygen, Oxygen minimum layer, Nutrients and other tracers and age of ocean water and turnover time
Unit-3: Remote Sensing for Ocean monitoring: Introduction to remote sensing, electromagnetic radiation, solar and terrestrial radiation, atmospheric effects, absorption, transmission and scattering, atmospheric windows, Infrared remote sensing, thermal emission, atmospheric absorption, IR sensors, sea surface temperature retrieval, atmospheric correction, effect of cloud, thermal skin layer, skin and bulk SST.
Unit-4: Ocean Waves, Tides, current and circulations: Ocean wave classification, progressive waves, shallow water waves, Seismic Sea waves (Tsunami), wind waves, stationary waves, Sea and swell- Linear waves, surface currents, Coriolis effect, Ekman spirals, geostrophic currents, upwelling, sinking, circulation,
Unit-5: Oceans modelling and climate change: Introduction to Ocean Modelling, Mechanistic and Simulation models, Conservation of Mass and Momentum, Navier-Stokes equations and Ocean circulation modelling, Effects of ocean on climate - formation and spreading of deep-water masses in the ocean, Deep water circulation, meridional heat transport, ocean circulation and climate - Gulf Stream – effect of breakdown of thermohaline circulation on climate.

Learning Resources

1. I.S. Robinson: (1985) Satellite Oceanography- An Introduction for Oceanographers and Remote Sensing Scientists
2. Pickard G.L. and W.J. Emery (1995): Descriptive Physical Oceanography- Pergamon press,(1995or latest edition).
3. Robert H. Stewart (2003): Introduction to Physical Oceanography- online edition (public domain), Aug 2003.
4. Pond and Pickard :(1983) Introductory Dynamical Oceanography
5. Dorothée Herr and Grantly R. Galland (2009): The Ocean and Climate Change
6. Seelye Martin (2014): An Introduction to Ocean Remote Sensing, 2nd Edition, Cambridge Press
7. Pierson W. J., G. Neumann and R. W. James (1955) Practical methods for observing and forecasting Ocean waves
8. I. S. Robinson (2004) Measuring the Oceans from space: The principles and methods of
9. satellite Oceanography

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
Level 4	Analyze	20%	-	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
-	Dr. Jossia Joseph, Scientist, Scientist at National Institute of Ocean Technology (NIOT), Chennai; *Jossiaj@niot.res.in*	Dr. Sanjay Kumar Mehta, SRMIST
-	Dr. Rakesh V, Senior Scientist, CSIR Fourth Paradigm Institute; rakeshv82@gmail.com	Dr. Lakshmikumar T V, SRMIST

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Course Code	UPY22D02T	Course Name	Biophysics	Course Category	D	Discipline Specific Elective Course	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*understand the different bonds in biomolecules*	Bloom's Level
CLR-2:	*gain structural knowledge of biological systems*	
CLR-3:	*understand the different structures of proteins*	
CLR-4:	*gain knowledge about protein folding*	
CLR-5:	*understand transport and dynamic properties of biological systems.*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	
CLO-1:	*analyze the various forces responsible for biological molecular structure*	*4*
CLO-2:	*be familiar with different levels of conformation in biomolecules*	*4*
CLO-3:	*understand the different structures of proteins*	*4*
CLO-4:	*understand the dynamics of biological systems.*	*4*
CLO-5:	*gain the knowledge of cellular permeability and ion transport.*	*4*

Program Learning Outcomes (PLO)															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
H	-	-	-	-	-	-	-	-	-	-	-	-	-	-
H	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	*H*	-	-	-	-	-	-	-	-	-	-	-	-	-
-	*H*	-	-	-	-	-	-	-	-	-	-	-	-	-
H	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1: Intramolecular bonds – covalent – ionic and hydrogen bonds – biological structures –general features – water structure – hydration – ionization, and concept of pH, interfacial phenomena and membranes – self assembly and molecular structure of membranes, .
Unit-2: Primary structure – the bases – sugars and the phosphodiester bonds- double helical structure – the a b and z forms – properties of circular DNA – topology – polymorphism and flexibility of DNA – structure of ribonucleic acids – hydration of nucleic acids
Unit-3: Conformation of the peptide bond – secondary structures – Ramachandran plots – use of potential functions – tertiary structure – hydration of proteins – hydropathy index
Unit-4: Introduction to the protein folding problem, Anfinsen's experiment, Levinthal's paradox, Intermediates and folding pathways, Energy landscape theory and folding funnel; folding in vivo: molecular chaperones, intrinsically disordered proteins; protein unfolding, protein misfolding and aggregation: amyloid diseases and stability of protein/peptide drug formulations.
Unit-5: Ionic conductivity – transport across ion channels – mechanism - ion pumps- proton transfer – nerve conduction – techniques of studying ion transport and models, Structure of lipids and their assembly, structure and properties of biological membranes, membrane curvature, membrane transport processes

Learning Resources	
1. Kensal E Van Holde, Curtis Johnson and Pui Shing Ho. Principles of Physical Biochemistry, Pearson 2. Rodney Cotterill. Biophysics - An Introduction, Wiley, 2014 3. Biophysics: Molecules In Motion ; R. Duane. Academic Press , 1999	4. Biophysics ; R. Glaser, Springer Verlag , 2000. 5. Charles R. Cantor and Paul R. Schimmel. Biophysical Chemistry, Parts 1-3, W. H. Freeman, 1980

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
Level 4	Analyze	20%	-	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. K. Chandru, Trivitron Healthcare Pvt. Ltd. Chennai, chandru.k@trivitron.com	Prof. K. Chandraraj, IITM, Chennai, kcraj@iitm.ac.in	Dr. G. Devanand Venkatasubbu, SRMIST
Dr. Achuth Padmanaban, Baylor College of Medicine, USA, achuthz@gmail.com	Dr. P. Balasubramanian, NIT Rourkela, biobala@nitrkl.ac.in	Dr. Sivakumar, SRMIST

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SEMESTER V

Course Code	UPY22501J	Course Name	Solid State Physics	Course Category	C	Professional Core Course	L	T	P	C
							4	0	4	6

Pre-requisite Courses	Quantum Mechanics	Co-requisite Courses	Statistical Mechanics	Progressive Courses	Nil
Course Offering Department	Physics and Nanotechnology	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*acquire knowledge on crystallography*	Bloom's Level
CLR-2:	*gain knowledge of elastic waves in solids*	
CLR-3:	*understand the fundamental of quantum theory for solid*	
CLR-4:	*gain knowledge on different types of electronic effects*	
CLR-5:	*understand the mechanism of magnetic ordering*	
CLR-6:	*get hands-on training of various set up for experimental condensed matter physics*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning
CLO-1:	*explain the crystal structure*	4
CLO-2:	*analyze the elastic waves and phonon in solids*	4
CLO-3:	*apply the quantum mechanical understanding of the solids*	4
CLO-4:	*implement the understanding of dielectric and ferroelectric materials*	4
CLO-5:	*explain the origin of various types of magnetic order*	4
CLO-6:	*analyse results of various condensed matter physics experiments*	4

Program Learning Outcomes (PLO)															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
H	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-	-
H	*H*	-	*H*	-	-	-	-	-	-	-	-	-	-	-
H	*H*	-	*H*	-	-	-	-	-	-	-	-	-	-	-
H	*H*	-	*H*	-	-	-	-	-	-	-	-	-	-	-
H	*H*	-	*H*	-	-	-	-	-	-	-	-	-	-	-
-	-	-	*H*	-	-	-	-	-	-	-	-	*H*	-	-

Unit-1: Introduction to crystals, Symmetry of crystals, Wigner-Sitz Cell, Bravais lattices, Miller indices for direction and planes, Close packed structures, Packing fraction, Diffraction of x-rays, Laue equations and Braggs law, reciprocal lattice, Brillouin Zones and Ewald construction, structure factor and form factor
1. Introduction to error analysis
2. Experiment : Determine interplanar spacing in crystal using x-ray diffraction
3. Experiment : Identification of planes in x ray diffraction, Miller indices calculation

Unit-2: Elementary idea of bonding in solids, Lennard Jones potential, Vibrations of one dimensional monoatomic and diatomic chain, Phonon, Phonon momentum, Inelastic scattering of phonon, Density of states, Debye's theory of specific heat, Einstein's theory of specific heat, Thermal conductivity
4. Experiment: Lee's disc
5. Experiment: Stefan's constant
6. Experiment: Young's modulus determination

Unit-3: Theory of free electron gas, Fermi energy, Bloch theorem, Electrons in periodic potential, Kronig-Penny model, energy bands, metals, semimetals, semiconductors and insulators, Motion of electron in electric and magnetic fields, Hall Effect, Quantum Hall effect, Landau levels
7. Experiment : Band gap determination of a silicon diode
8. Experiment : Estimating carrier concentration using Hall effect of a semiconductor
9. Experiment: Determine temperature coefficient of resistance of semiconductor

Unit-4: Electronic effect, Macroscopic electric field, Local electric field at an atom, Dielectric constant and Polarizability, Structural phase transitions, Ferroelectric Crystals, Displacive transitions
10. Experiment: I-V Characteristics of LDR
11. Experiment : Two probe and four probe resistance measurement
12. Experiment: Magnetization measurement of bulk ferromagnet using vibrating sample magnetometer

Unit 5: Spin effect, Origin of magnetism, Different types of magnetism, Diamagnetism, paramagnetism, ferromagnetism, Curie law, Weiss Molecular theory, Ordering of spins, Heisenberg model, Qualitative description of spin waves, magnons, Qualitative discussion of magnetic anisotropy of ferromagnetic domains
13. Experiment: Magnetization measurement of thin film ferromagnet using vibrating sample magnetometer
14. Experiment: Analysis of magnetic domain images obtained using magnetic force microscope
15. Experiment: Revision

Learning Resources

1. C. Kittel, Introduction to Solid State Physics, 8th Ed., J. Wiley and Sons, 2005.
2. M.A. Wahab, Solid state Physics, 2nd Ed., Narosa Publishing House, 2006.
3. G.D. Mahan, Condensed Matter in a Nutshell, 1st Ed., Princeton University Press, 2010.
4. N.W. Ashcroft and D.M. Mermin, Solid State Physics, Holt, Rinehart and Winston, 1976.
5. A.J. Dekker, Solid State Physics, Macmillan, 2009.
6. M.A. Omar, Elementary Solid State Physics, Addison-Wesley, 2009.

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Level 2	Understand	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Level 3	Apply	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 4	Analyze	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. R Seshadri, Titan Company Limited, seshadri@titan.co.in	Dr. Ranjit Kumar Nanda, IIT Madras, nandab@iitm.ac.in	Dr. Jaivardhan Sinha, SRMIST
Dr. M Satish, CSIR-CECRI, msathish@cecri.re.in	Prof. C Vijayan, IIT Madras, cvijayan@iitm.ac.in	Dr. Rohit Dhir, SRMIST

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Course Code	UPY22502T	Course Name	Quantum Mechanics II	Course Category	C	Professional Core Course	L	T	P	C
							3	1	0	4

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*be able to apply schrdoinger's equation for multi-particle systems*	Bloom's Level
CLR-2:	*learn the nondegenerate and degenerate time-independent perturbation thoery*	
CLR-3:	*learn and apply variation theorem to many-electron atoms*	
CLR-4:	*learn time-dependent perturbation theory and its applications*	
CLR-5:	*understand the quantum theory of scattering of particles*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Bloom's Level
CLO-1:	*study quantum mechanics of multi-particle systems*	4
CLO-2:	*apply time-independent perturbation theory to physical systems*	4
CLO-3:	*apply approximation methods to multi-electron atoms*	4
CLO-4:	*apply time-dependent perturbation theory to spectroscopic problems*	4
CLO-5:	*understand the quantum theory of scattering under born's approximation*	4

Program Learning Outcomes (PLO)															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
-	-	H	H	-	-	-	-	-	-	-	-	-	-	-
-	-	H	H	-	-	-	-	-	-	-	-	-	-	-
-	-	H	H	-	-	-	-	-	-	-	-	-	-	-
-	-	H	H	-	-	-	-	-	-	-	-	-	-	-
-	-	H	H	-	-	-	-	-	-	-	-	-	-	-

Unit-1: Addition of angular momenta, system of two electrons – singlet and triplet states, Clebsch-Gordon coefficients, Schrodinger's equation of a two-particle system, Bosons and fermions, Exchange operator, Pauli's exclusion principle, Exchange force, Hund's rules.

Unit-2: Time-independent perturbation theory – nondegenerate and degenerate cases, Stark effect, Normal Zeeman effect and anomalous Zeeman effect, Fine structure correction – relativistic and spin-orbit coupling

Unit-3: Variation theorem – statement and proof, Ground state of helium atom, singly ionized lithium ion and negatively charged hydrogen ion, Excited states of helium atom – direct integral and exchange integral, Ortho- and para-helium, Covent bond in hydrogen molecule ion.

Unit-4: Time-dependent perturbation theory – constant perturbation with application to energy-time uncertainty relation, Harmonic perturbation, Fermi's golden rule, Incoherent perturbations, Einstein's coefficients, selection rules for *m* and *l*.

Unit-5: Basics of Rutherford scattering, differential and total cross-section, scattering amplitude, Relation between differential cross-section and scattering amplitude, Integral form of Schrodinger's equation, Born's approximation and its application to spherically symmetric potential (Yukawa and Coulomb).

Learning Resources

1. Introduction to Quantum Mechanics, 3rd Ed., David J. Griffiths (Cambridge University Press 2017)
2. Introductory Quantum Mechanics, R.L. Liboff, (Addison-Wesley, 2003)
3. A Textbook of Quantum Mechanics, 2nd Ed., P. M. Mathews & K. Venkatesan Aruldhas (McGraw Hill Education 2008)
4. Principles of Quantum Mechanics, 2nd Ed., R. Shankar (Springer 2014)
5. Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, 2nd Ed., R Eisberg & R Resnick (John Wiley & Sons, 1985)

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
Level 4	Analyze	20%	-	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. R Seshadri, Titan Company Limited, seshadri@titan.co.in	Dr. Ranjit Kumar Nanda, IIT Madras, nandab@iitm.ac.in	Dr. P. Sivakumar, SRMIST
Dr. M Satish, CSIR-CECRI, msathish@cecri.re.in	Prof. C Vijayan, IIT Madras, cvijayan@iitm.ac.in	Dr. Rohit Dhir, SRMIST

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Course Code	UPY22503T	Course Name	Mathematical Physics-II	Course Category	C	Professional Core Course	L	T	P	C
							3	1	0	4

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*teach to solve the complex problems easily using tensorial method*	Bloom's Level
CLR-2:	*apply the special functions to various fields of applied physics*	
CLR-3:	*express and transformed the periodic functions using integral transforms*	
CLR-4:	*learn about the curve fitting*	
CLR-5:	*learn to draw inferences of the physical equations*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Bloom's Level
CLO-1:	*introduce advanced mathematical methods in physics and their applications*	4
CLO-2:	*enable students to use mathematical concepts required in physics*	4
CLO-3:	*develop expertise in solving the complex problems in physics.*	4
CLO-4:	*develop the skill to solve and express the advanced mathematics*	4
CLO-5:	*able to resolve the unsolved and complex theoretical works in physics*	4

Program Learning Outcomes (PLO)															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
-	-	H	H	-	-	-	-	-	-	-	-	-	-	-
-	-	H	H	-	-	-	-	-	-	-	-	-	-	-
-	-	H	H	-	-	-	-	-	-	-	-	-	-	-
-	-	H	H	-	-	-	-	-	-	-	-	-	-	-
-	-	H	H	-	-	-	-	-	-	-	-	-	-	-

Unit-I: Calculus of Residue: Basics, Zeros Singular points, Poles; essential singularity, Evaluation of residues; Cauchy Residue theorem; Cauchy Principal value; evaluation of definite integrals and contour integrals, dispersion relation
Unit-II: Special functions: Series solutions-Frobenius method, second solution, Hermite function; Hermite differential equation, Legendre and associated Legendre functions; Legendre equation, Laguerre function, Laguerre equation, Bessel's function, Bessel's equation
Unit-III Tensors analysis: Introduction, definitions, contraction, directs product, quotient rule, pseudo tensors, Levi-Civita symbol, irreducible tensors, non-Cartesian tensors, metric tensor. Christoffel symbols, covariant differentiation
Unit-Iv: integral transforms and Integral equations - Development of the Fourier integral, inversion theorem, Fourier transform, Laplace transforms, , properties of Laplace transform, inverse Laplace transformation. Fourier integral Theorem, Integral equations -Definitions and classifications: Fredholm, Volterra equations of first and second kind, transformation of a differential equation into an integral equation.
Unit-V: Elementary numerical analysis - Numerical differentiation, numerical integration by Simpson and Trapezoid rules, numerical solution of differential equations by Euler and Runge-Kutta method, finite difference method, linear and non-linear least square fitting,

Learning Resources

1. J.H. Mathews, *Numerical Methods: for Mathematics, Science and Engineering*, 2nd Ed., Prentice-Hall International, 1992.
2. G. Arfken and H.J. Weber, *Mathematical Methods for Physicists*, Academic Press, 6th Ed., SanDiego, 2005.
3. P.K. Chattopadhyay, *Mathematical Physics*, Wiley Eastern, New Delhi, 2005
4. C. Harper, *Introduction to Mathematical Physics*, Prentice Hall of India, New Delhi, 2004.
5. P.L. Devries, *A First Course in Computational Physics*, Wiley, New York, 1994.
6. A.W. Joshi, *Matrices and Tensors in Physics*, Wiley Eastern, New Delhi, 2002.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
Level 4	Analyze	20%	-	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. R Seshadri, Titan Company Limited, seshadri@titan.co.in	Dr. Ranjit Kumar Nanda, IIT Madras, nandab@iitm.ac.in	Dr. Sanjay Kumar Mehta, SRMIST
Dr. DK Aswal, NPL, dkaswal@nplindia.org	Prof. C Vijayan, IIT Madras, cvijayan@iitm.ac.in	Dr. Rohit Dhir, SRMIST

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Course Code	UPY22D03T	Course Name	Energy Technology	Course Category	D	Discipline Specific Elective Course	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*understand the energy challenges and the possible ways of tackling the same*	Bloom's Level
CLR-2:	*understand the basics of green energy production, storage and transport*	
CLR-3:	*understand the different ways in which various materials have been used in various energy conversion technologies*	
CLR-4:	*identify the use of materials for thermoelectric, wind, biomass and nuclear energy technologies*	
CLR-5:	*acquire knowledge on the role of technology in various kinds of energy storage*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Bloom's Level	Program Learning Outcomes (PLO)														
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
			Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1:	*identify the need for solving the energy problems and the expectations from current technology for same*	*4*	*H*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2:	*apply nanotechnology and nanomaterials in the designing of solar energy conversion systems*	*4*	*H*	-	-	-	*H*	-	-	-	-	-	-	-	-	-	-
CLO-3:	*analyze the role of nanotechnology in the development of other alternative energies such as thermoelectrics, wind, biomass and nuclear*	*4*	*H*	-	-	*H*	-	-	-	-	-	-	-	-	-	-	-
CLO-4:	*realize the use of various materials in the designing of different innovative energy storage technologies*	*4*	*H*	-	-	-	-	-	*H*	-	-	-	-	-	-	-	-
CLO-5:	*understanding the methods of hydrogen production, storage and fuel cell technologies*	*4*	*H*	-	-	-	-	-	-	-	-	-	-	*H*	-	-	-

Unit-1: Energy Challenge in the 21st Century - Energy conversion processes - Conventional fossil fuels - Processes involved in fossil fuels generation - Energy and climate - Greenhouse effect - Overview of alternative energy Sources - Prospects of renewable energy technologies
Unit-2: Renewable energy sources-Photovoltaics - Different types of photovoltaic devices Commercial solar cells, limitations & losses – charge carrier transport in semiconductors - Dye sensitized solar cells - Emission spectra and color as a function of particle size of a quantum dot – Quantum dot sensitized solar cells – organic solar cells - extremely thin absorber (ETA) solar cells – Perovskite solar cells - Plasmonic solar cells - Nanomaterials and coatings for antireflection, self-cleaning etc. - Solar thermal energy conversion - Light emitting diodes - Electrochromic devices
Unit-3: Heat energy and thermoelectrics, Requirements for thermoelectric materials - Application of thermionic and thermoelectric nanocomposites - Wind energy - Working principle of wind turbines - Biogas energy recovery - Nanotechnology in biogas energy recovery - Nuclear energy - Piezoelectric energy harvesting - Nano generators - Nano motors - Understanding the fundamental properties of nano motors - Nanomaterials for other energy conversion processes
Unit-4: Introduction of Energy storage - Energy storage devices - Different types of batteries - electrodes and electrolyte materials - Li-ion battery - Issues and challenges – Na-ion and Na-air battery - Supercapacitor - Principles and materials design - Nanostructured carbon, nano-oxides, nanocomposites - Miniaturized energy storage - Micro channel batteries, nanobatteries - Thermal energy storage - Phase change materials for thermal energy storage - CO_2 capture
Unit-5: Importance of hydrogen energy - Introduction to hydrogen production - Methods of hydrogen production – photoelectrochemical cell (PEC) Water splitting for producing hydrogen – Materials requirement and methods of improving efficiency of PEC - Hydrogen storage technology –potential storage materials hydrogen sorption - Hydrogen storage by Physiosorption and chemisorption methods - Properties of materials: physical storage, thermodynamic and kinetics – Reversible occlusion of gases - Hydrogen storage by chemisorption - Materials used for hydrogen storage and their storage efficiency – Introduction to fuel cells - Oxygen reduction reaction, cathodic reactions, reactions at anode surface - Practical fuel cell catalysts and Electrolytes - Nanostructured materials in low- temperature cell, Non-precious catalysts, electrolytes, High-temperature polymer electrolyte membranes, membrane-electrode assembly - Solid oxide fuel cells (SOFCs) - Applications of Fuel cells

Learning Resources	
	1. Javier Garcia-Martinez, Nanotechnology for the Energy Challenge, WILEY-VCH Verlag GmbH & Co., 2010
	2. Chetan Singh Solanki, Renewable Energy Technologies: A Practical Guide for Beginners, PHI Learning Private Limited, 2009
	3. Roel van de Krol, Michael Grätzel, Photoelectrochemical Hydrogen Production, Springer, 2011
	4. Darren P. Broom, Hydrogen Storage materials: The characterization of their properties, Springer, 2011
	5. Basu, S., Recent Trends in Fuel Cell Science and Technology, Springer and Anamaya, 2007.
	6. Baldev Raj, Marcel Van de Voorde, Yashwant Mahajan, Nanotechnology for energy sustainability, 3 volume set, Wiley-VCH Verlag GmbH, 2017

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
Level 4	Analyze	20%	-	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. Mandakini Biswal, KPIT technology Ltd., mandakini.biswal@kpit.com	Dr. Onkar Game, IIT Indore, ogame@iiti.ac.in	Dr. Meenal Deo, SRMIST
Dr. M Krishna Surendra, Saint Gobain Research, krishana.muvvala@saint-gobain.com	Prof. S Balakumar, University of Madras, balakumar@unom.ac.in	Dr. Karthigeyan A, SRMIST

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Course Code	UPY22D04T	Course Name	Plasma Physics	Course Category	D	Discipline Specific Elective Course	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*learn the basic character of plasma.*	Bloom's Level
CLR-2:	*learn the dynamic of plasma through kinetic theory*	
CLR-3:	*understand plasma phenomena through fluid dynamics*	
CLR-4:	*understand the concept of wave propagation in plasma*	
CLR-5:	*acquire knowledge on measurement methods of plasma characteristics*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Bloom's Level
CLO-1:	*apply knowledge of plasma for identification and characterization of plasma*	*4*
CLO-2:	*apply the principle of kinetic theory to plasma physics*	*4*
CLO-3:	*use the fluid theory to explain new observations in plasma*	*4*
CLO-4:	*infer wave propagation in plasma*	*4*
CLO-5:	*apply the measurement methods of plasma characteristics*	*4*

Program Learning Outcomes (PLO)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1:	*H*	-	-	-	-	-	*H*	-	-	-	-	-	-	-	-
CLO-2:	*H*	-	-	*H*	-	-	-	-	-	-	-	-	-	-	-
CLO-3:	*H*	-	-	-	*H*	-	-	-	-	-	-	-	-	-	-
CLO-4:	*H*	-	-	-	*H*	-	-	-	-	-	-	-	-	-	-
CLO-5:	*H*	-	-	-	*H*	-	-	-	-	-	-	-	-	-	-

Unit-1: Introduction to Plasma - Its definition, Composition and characteristics, Microscopic description of plasma, Motion of charged particle in uniform electric field, Motion of charged particle in uniform electric and magnetic field, Motion of charged particle and E x B-drift, Effect of a transverse force on charged particle, Drift due to a transverse force, Magnetic field inhomogeneity, Magnetic field spatial inhomogeneity, Magnetic field Curvature inhomogeneity, Magnetic Curvature Drift

Unit-2: Introduction to Kinetic Theory of Plasma, Distribution Function, Property of Distribution Function, Differential Flux, Velocity Distribution Functions, The meaning of f (v), Equations using Kinetic theory, Vlasvov Equation, Interpretation of Vlasvov Equation, Collisions, Plasma Oscillations, Oscillation and Damping, Collision less Damping, Landau Damping, Landau Damping Derivation

Unit-3: Introduction the Fluid theory of plasma, Introduction to convective derivative, Fluid equation using convective derivative, Derivation of Plasma Frequency, Ion Oscillation in Plasma, Ion Acoustics waves, Waves in Plasma, Classification and condition for wave plasma, Propagation of Electrostatic wave, (Oscillation perpendicular to B), Dispersion relation for plasma wave, Electromagnetic waves
Dispersion relation for Electromagnetic waves, Electromagnetic Waves with B0=0, Dispersion relation, MHD Waves Alfven Waves, Magneto sonic Waves

Unit-4: Introduction to MHD Equations, Conservation laws and MHD Equations, Flux Freezing, Introduction to Solar wind, Characteristic of Solar wind, Studies on solar wind models, Parker model of Solar wind, Introduction to Magnetic Reconnection, Magnetic Reconnection in Plasma, Condition of Magnetic Reconnection, Derivation of Magnetic Reconnection Expression, MHD dynamo-Homopolar Dynamo Theory, Magnetic Reconnection and Dynamo Action

Unit-5: Introduction to Plasma Diagnostics, Optical Diagnostics Methods, Frequency Dependence of Plasma Waves on density, Microwave Interferometry, Langmuir Probes, Construction and circuit, The I-V Curve, The Transition Region, Electron saturation - Space potential, Distribution functions, RF compensation, Double probes and hot probe, Other Local Diagnostics, Magnetic probes, Energy analyzers, RF current probe-Plasma oscillation probe

Learning Resources

1. Introduction to Plasma Physics, Gurnett D. A. and A. Bhattacharjee, (Cambridge, 2005).
2. Fundamentals of Plasma Physics, Paul M. Bellan, (Cambridge University Press, 2006).
3. Introduction to Plasma and Controlled Fusion, Frencies F chen, (Plenum Press, 1984).
4. The Physics of Plasmas, Richard Fitzpatrick, (Online book, 2011)
5. Topics in Plasma Diagnostics, Podgomyl I M, (Plenum Press, 1971)
6. An Introduction to Plasma Astrophysics and Magneto hydrodynamics, Marcel Goossens, (Springer, 2003).

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%		20%		20%		20%		20%	
Level 2	Understand	20%		20%		20%		20%		20%	
Level 3	Apply	40%		40%		40%		40%		40%	
Level 4	Analyze	20%		20%		20%		20%		20%	
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. N Vijayan, NPL, nvijayan @nplindia.org	Dr. M. Ameen Poyli, International School of Photonics, Cochin University of Science and Technology; ameenpoyli@cusat.ac.in	Dr. Trilochan Sahoo, SRMIST
Mr. R Seshadri, Titan Company Limited, seshadri@titan.co.in	Prof. C Vijayan, IIT Madras, cvijayan@iitm.ac.in	Dr. Alok Kumar, SRMIST

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Course Code	UPY22D05T	Course Name	Science and Technology of Thin Films	Course Category	D	Discipline specific elective course	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*learn the basic design and working principle of vacuum pumps and gauges*	Bloom's Level
CLR-2:	*understand the physics of physical vapour deposition methods*	
CLR-3:	*to gain knowledge about the chemical methods of various deposition techniques*	
CLR-4:	*understand the concept of thin film growth modes and acquire knowledge on various thickness measurement methods*	
CLR-5:	*familiarize with the working principle of various characterization techniques*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning
CLO-1:	*impart a sound basis for an understanding of vacuum technology.*	4
CLO-2:	*provide a fundamental knowledge on various principles and methods used in vacuum coating techniques.*	4
CLO-3:	*develop in depth understanding on the principle of working of different deposition techniques.*	4
CLO-4:	*introduce nucleation and growth mechanisms of thin films based on thermodynamics and molecular theory.*	4
CLO-5:	*familiarize with physics and techniques involved in the measurement and characterization of thin films.*	4

	Program Learning Outcomes (PLO)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1	H	-	-	H	-	-	-	-	-	-	-	-	-	-	-
CLO-2	H	-	-	H	-	-	-	-	-	-	-	-	-	-	-
CLO-3	H	-	-	H	-	-	-	-	-	-	-	-	-	-	-
CLO-4	H	-	-	H	-	-	-	-	-	-	-	-	-	-	-
CLO-5	H	-	-	-	H	-	-	-	-	-	-	-	-	-	-

Unit-1: Fundamentals of vacuum - basic definition and pressure regions of vacuum - kinetic theory of gases mean free path - types of flow – conductance - vacuum pumps and systems - rotary mechanical pump - roots pump - diffusion pump - turbo molecular pump - sputter ion pump - measurement of vacuum - concept of different gauges - capacitance gauges - Pirani gauge - ionization gauge and penning gauge - vacuum system components and operation.
Unit-2: Thermal evaporation - resistive heating - flash evaporation - laser evaporation - rf-heating - co-evaporation - electron bombardment heating - sputtering plasma - discharges and arc - sputtering variants - sputtering yield low pressure sputtering - rf-sputtering - reactive sputtering - magnetron sputtering - magnetron configurations - bias sputtering - evaporation versus sputtering.
Unit-3: Electrodeposition - electrolytic deposition - electro less deposition - anodic oxidation - spray pyrolysis - spin and dip coating - chemical vapor deposition (CVD) - homogenous and heterogeneous process - CVD reactions – pyrolysis - hydrogen reduction - halide disproportionation - transfer reactions - CVD processes and systems - low pressure CVD - laser enhanced CVD - metal organic CVD (MOCVD).
Unit-4: Introduction: nucleation and early stages of film growth - thermodynamic aspects of nucleation - capillary theory - thin film growth modes Volmert - Weber (VW) growth - Frank-van der Merwe (FM) growth - Stranski-Krastanov growth - thickness measurement - electrical methods - microbalance monitors - quartz crystal monitor - mechanical method (stylus) - optical interference methods – ellipsometry - interference fringes.
Unit-5: X-ray diffraction (XRD) - scanning electron microscopy - transmission electron microscopy - energy dispersive analysis - Auger electron spectroscopy - X-ray photoelectron spectroscopy - Rutherford backscattering spectroscopy - secondary ion mass spectrometry.

Learning Resources

1. M. Ohring, Materials Science of Thin Films: Deposition and Structure, 2nd Ed., Academic Press (An Imprint of Elsevier), 2002.
2. S. Campbell, The Science and Engineering of Microelectronic Fabrication, 2nd Ed., OUP, 1996.
3. Kaufmann, Characterization of Materials, 2nd Ed., Wiley, 2003.
4. K.L. Chopra, Thin Film Phenomena, Robert E. Krieger Publishing Company, 1979.
5. N.Yoshimura, Vacuum Technology: Practice for Scientific Instruments, Springer Publications, 2007.
6. D.M. Hoffman, B. Singh and J.H. Thomas, Handbook of Vacuum Science & Technology, Academic Press, 1998.
7. R.F. Bunshah, Handbook of Deposition Technologies for Films and Coatings, Science, Technology and Applications, Noyes Publications, 1994
8. The Vacuum Technology Book Volume II, Pfeiffer Vacuum [Online Book]

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
Level 4	Analyze	20%	-	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. S. Saravanan, RenewSys India Pvt. Ltd, Telangana, India, shrisharavanan@yahoo.co.uk	Prof. S. Balakumar, University of Madras, balakumar@unom.ac.in	Dr. Kovendhan M, SRMIST
Dr. N. VIJAYAN, CSIR-NPL, nvijayan@nplindia.org Experts from Higher Technical Institutions	Prof. V Subramanian, IIT Madras, manianvs@iitm.ac.in	Dr. Bhaskar Behera, SRMIST

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Course Code	UPY22D06T	Course Name	Magnetism and Superconductivity	Course Category	D	Discipline Specific Elective Course	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*acquire knowledge on basics of magnetism*	Bloom's Level
CLR-2:	*gain knowledge of occurrence of domains in ferromagnetic materials*	
CLR-3:	*understand the fundamental of magnetic exchange interaction*	
CLR-4:	*gain knowledge on magnetic phenomena*	
CLR-5:	*acquire knowledge about mechanism of superconductivity*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning
CLO-1:	*explain the origin of magnetism and magnetism pertaining to energy band in solids*	4
CLO-2:	*analyse the various magnetic energy to understand domains in magnetic materials*	4
CLO-3:	*explain the superexchange interaction to comprehend antiferromagnetism*	4
CLO-4:	*apply various magnetic anisotropy to explain magnetic phenomena in magnetic materials*	4
CLO-5:	*implement the understanding of superconductivity in various applications*	4

Program Learning Outcomes (PLO)															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
H	-	-	-	-	-	-	-	-	-	-	*H*	-	-	-
H	-	-	-	-	-	-	-	-	-	-	*H*	-	-	-
H	-	-	H	-	-	-	-	-	-	-	-	-	-	-
H	-	-	-	H	-	-	-	-	-	-	-	-	-	-
H	-	-	-	H	-	-	-	-	-	-	-	-	-	-

Unit-1: Magnetism: Atomic origins of magnetism, Langevin theory of paramagnetism, The Curie–Weiss law, Quenching of orbital angular momentum, Pauli paramagnetism, Energy bands in solids, Energy bands in a magnetic field, Susceptibility of Pauli paramagnets, Uses of paramagnets
Unit-2: Interactions in ferromagnetic materials, Weiss molecular field theory, Origin of the Weiss molecular field, Collective-electron theory of ferromagnetism, The Slater–Pauling curve, Ferromagnetic domains, Observing domains, Why domains occur, Magnetostatic energy, Magnetocrystalline energy, Magnetostrictive energy, Domain walls, Magnetization and hysteresis
Unit-3: Antiferromagnetism: Weiss theory of antiferromagnetism, Susceptibility above T_N, Susceptibility below T_N, Negative molecular field, Super exchange interaction, Antiferromagnetic in transition metals, RKKY theory, Uses of antiferromagnets
Unit-4: Magnetic phenomena: Magnetocrystalline anisotropy, Origin of magnetocrystalline anisotropy, Symmetry of magnetocrystalline anisotropy, Shape anisotropy, Demagnetizing field, Induced magnetic anisotropy, Nanoparticles and thin films: Magnetic properties of small particles, Experimental evidence for single-domain particles, Magnetization mechanism, Superparamagnetism, Inter-particle interactions
Unit-5: Introduction to superconductivity, Meissner effect, Type-I and Type-II superconductor, London penetration depth, Coherence length, BCS theory of superconductor, Energy gap in superconductor, Qualitative discussion of Josephson Effect, High temperature superconductor, Superfluidity

Learning Resources

1. Magnetism and Magnetic Materials – J M D Coey, Cambridge University Press 2012
2. Introduction to Solid State Physics - C Kiitel, , 7 th ed, John Wiley 2005
3. Magnetic Materials: Fundamentals and Application – Nicola A. Spaldin, Cambridge University Press 2011.
4. Magnetism in Condensed Matter, Stephen Blundell, 1st Edition, Oxford 2001.
5. B.D. Cullity, Introduction to Magnetic Materials, Addison- Wesley (1972)
6. C. Kittel, Introduction to Solid State Physics, 8th Ed., J. Wiley and Sons, 2005.
7. James F. Annet, Superconductivity, superfluids, and condensates, Oxford University Press, 2003.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
Level 4	Analyze	20%	-	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. N Vijayan, NPL, nvijayan @nplindia.org	Prof. C Venkateshwaran, University of Madras, venkateshwaran@unom.ac.in	Dr. Bhaskar Chandra Behera, SRMIST
Dr. V Subramanian, CLRI, subbu@clri.res.in	Prof. S Balakumar, University of Madras, balakumar@unom.ac.in	Dr. Jaivardhan Sinha, SRMIST

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SEMESTER VI

Course Code	UPY22601T	Course Name	Computational Methods	Course Category	C	Professional Core Course	L	T	P	C
							3	3	0	6

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*develop basic understanding of scientific programming*	Bloom's Level
CLR-2:	*develop skill to write algorithm of a problem and convert the algorithm to code*	
CLR-3:	*bridge the gap between the theory and computational applications*	
CLR-4:	*acquire advanced knowledge in current computational standards*	
CLR-5:	*acquire knowledge of advanced techniques like oop and parallel programming*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning
CLO-1:	*understand the basics of computational physics.*	4
CLO-2:	*understand and develop skill to do linear algebra*	4
CLO-3:	able to do derivative and integration numerically	4
CLO-4:	*learning parallel computation*	4
CLO-5:	*solve linear systems, statistical data analysis*	4

Program Learning Outcomes (PLO)															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Skills	PSO - 1	PSO - 2	PSO - 3
H	-	*H*	-	-	-	-	-	-	-	-	-	-	-	-
H	*H*	-	-	-	-	-	-	-	-	-	-	-	-	-
H	-	*H*	-	-	-	-	-	-	-	-	-	-	-	-
H	-	*H*	-	-	-	-	-	-	-	-	-	-	-	-
H	-	*H*	-	-	-	-	-	-	-	-	-	-	-	-

UNIT I Computer Architecture and Fortran

1. Computer architecture
    1. CPU, RAM and CACHE
2. Introduction to Computer Language69*
    1. Pseudocode and Flowchart
    2. Compiled languages
    3. Fortran: Inbuilt Datatypes, IO, IF and DO construct
    4. Plotting with gnuplot
3. Application
    1. Factorial and Fibonacci series
    2. Newton's equations of motion
    3. Lorenz attractor

UNIT II Fortran Language

1. Fortran Arrays: Static and allocatable. Revisit the Fibonacci series
2. Fortran Procedures
    1. Inbuilt and user defined modules, subroutine and functions
    2. Access external subroutines like LAPACK and BLAS
    3. Revisit the Factorial with recursive functions
3. Numerical Methods
    1. Linear algebra: Matrix manipulations (inverse, eigenvalue) using LAPACK and BLAS
    2. Random number generators: LCG and Marsaglia KISS
    3. Mandelbrot plot

UNIT III Advanced Fortran and Numerical methods

1. Fortran Pointers and OOP
    1. Pointers and Target; Association
    2. OOP: class,fields and methods
    3. Polymorphism
2. Numerical Methods
    1. Derivative
    2. Integrations: Trapezoidal and Simpson's 1/3 method
    3. Sorting: quick and heapsort
    4. Interpolation and extrapolation

UNIT IV Parallel Programming and Numerical Methods II

1. Parallel Computing: Fortran Coarray & images, Matrix multiplication with parallel method
2. Numerical Methods:
    1. ODE and Boundary value problem with RK4
    2. PDE: Laplace equations
    3. Root finding: Bisection and Newton-Raphson's method

UNIT V Numerical Methods III

1. Optimization of functions: Jacobi and conjugate gradient method
2. Statistical description of data
    1. Mean, Variance, Skewness
    2. Linear Correlation
    3. Least Squares as a Maximum Likelihood Estimator

Learning Resources	1. Press et. al., Numerical Recepies, 2nd ed, CUP, 1992 2. G.H. Golub, Matrix Computations, 3rd ed. John Hopkins University Press, 2013 3. Metcalf et. al., Modern Fortran Explained: Incorporating Fortran 2018, OUP, 2018

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
Level 4	Analyze	20%	-	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr.V Subramanian- CLRI, subbu@clri.res.in	Prof. K. Sethupathi, IIT Madras, ksethu@iitm.ac.in	Dr. Rudra Banerjee, SRMIST
Mr. R Seshadri, Titan Company Limited, seshadri@titan.co.in	Dr. Ranjit Kumar Nanda, IIT Madras, nandab@iitm.ac.in	Dr. Rohit Dhir, SRMIST

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Course Code	UPY22602T	Course Name	Atomic and Molecular Physics	Course Category	C	Professional Core Course	L	T	P	C
							3	1	0	4

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*develop the skills to solve real physical problems using quantum mechanics*	Bloom's Level
CLR-2:	*provide the accomplishments necessary for advanced courses such as optics, astrophysics, condensed matter physics and nuclear physics*	
CLR-3:	*emphasize the modern developments in experimental techniques in especially spectroscopy*	
CLR-4:	*realize the role and practical application of physics of atoms and moleculesin the modern world*	
CLR-5:	*develop the skills to solve real physical problems using molecular spectroscopy and also explore the concept of laser*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Bloom's Level
CLO-1:	*understand the concept of fine structure of hydrogen like atoms*	4
CLO-2:	*know about the concept of ls-coupling and jj-coupling schemes*	4
CLO-3:	*understand the idea of hartree-fock equations and thomas-reiche-kuhn sum rule*	4
CLO-4:	*understand the basic concepts of rotation and vibration of diatomic molecules*	4
CLO-5:	*know about the concept of franck-condon principle and understand the concepts of laser technology*	4

Program Learning Outcomes (PLO)															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
H	-	*H*	-	-	-	-	-	-	-	-	-	-	-	-
H	-	*H*	-	-	-	-	-	-	-	-	-	-	-	-
H	-	*H*	-	-	-	-	-	-	-	-	-	-	-	-
H	-	*H*	-	-	-	-	-	-	-	-	-	-	-	-
H	-	*H*	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1: Fine structure of hydrogen like atoms, mass correction, spin-orbit term, Darwin term, intensity of fine structure lines, the ground state of two-electron atoms, perturbation theory and variation method, many-electron atoms, *LS*- and *jj*-coupling schemes, Lande interval rule.
Unit-2: The idea of Hartree-Fock equations, the spectra of alkalis using quantum defect theory, selection rules for electric and magnetic multipole radiation, oscillator strengths and the Thomas-Reiche-Kuhn sum rule
Unit-3: Born-Oppenheimer separation for diatomic molecules, rotation, vibration and electronic structure of diatomic molecules, molecular orbital and valence bond methods for H_2^+ and H_2, correlation diagrams for heteronuclear molecules..
Unit-4: Rotation, vibration-rotation and electronic spectra of diatomic molecules, the Franck-Condon principle, electron spin and Hund's cases, idea of symmetry for diatomic and polyatomic molecules.
Unit-5: Multilevel rate equations and saturation, Rabi frequency, laser pumping and population inversion, He-Ne laser, solid state laser, free-electron laser, non-linear phenomenon, harmonic generation, laser accelerator, liquid and gas lasers, semiconductor lasers and diode.

Learning Resources	
	1. B.H. Bransden and C. J. Jochain, *Physics of Atoms and Molecules*, 2nd Ed., Pearson Education, 2003.
	2. E.U. Condon and G. H. Shortley, *The Theory of Atomic Spectra*, Cambridge University Press, 1989.
	3. C.J. Foot, *Atomic Physics*, Oxford Univ. Press, 2005.
	4. C.N. Banwell and E. M. McCash, *Fundamentals of Molecular Spectroscopy*, Tata McGraw-Hill, 2008
	5. W. Demtroder, *Atoms, Molecules and Photons*, Springer, 2006.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
Level 4	Analyze	20%	-	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. R Seshadri, Titan Company Limited, seshadri@titan.co.in	Dr. Ranjit Kumar Nanda, IIT Madras, nandab@iitm.ac.in	Dr. Junaid Masud Laskar, SRMIST
Dr. M Satish, CSIR-CECRI, msathish@cecri.re.in	Prof. C Vijayan, IIT Madras, cvijayan@iitm.ac.in	Dr. K. Shadak Alee, SRMIST

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Course Code	UPY22603T	Course Name	Electromagnetic Theory	Course Category	C	Professional Core Course	L	T	P	C
							3	1	0	4

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*develop theoretical knowledge in electrodynamics*	Bloom's Level
CLR-2:	*develop skills on solving analytical problems in electrodynamics*	
CLR-3:	*bridge the gap between the fundamental principles taught in electromagnetism and its practical application*	
CLR-4:	*acquire advanced knowledge in current understanding of electrodynamics.*	
CLR-5:	*understand the electrodynamics of radiating and relativistic systems.*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning
CLO-1:	*be familiar with some elementary phenomena and concepts in electrodynamics*	4
CLO-2:	*master the technique of deriving and evaluating formulae for the electromagnetic fields at an interface*	4
CLO-3:	*formulate the guided waves in a waveguide*	4
CLO-4:	*understand light propagation in a fibre*	4
CLO-5:	*calculate the electromagnetic radiation from radiating systems*	4

	Program Learning Outcomes (PLO)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1:	-	-	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-
CLO-2:	-	-	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-
CLO-3:	-	-	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-
CLO-4:	-	-	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-
CLO-5:	-	-	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-

Unit-1: Electrodynamics after Maxwell: Maxwell's modification to Ampere's law, Maxwell's equations in matter, boundary conditions and continuity equation, Poynting's theorem, Poynting vector, Electromagnetic waves in vacuum, Transverse nature of electromagnetic waves, Energy and momentum in electromagnetic fields, Radiation Pressure, Problem solving
Unit-2: Electromagnetic waves in matter, Reflection and transmission for TE and TM waves, Fresnel's equations, Brewster's angle, Electromagnetic waves in conductors, Skin depth, Conductors and Dielectrics, Reflection at a conducting surface, Boundary conditions, Frequency dependence of permittivity, Absorption and anomalous dispersion, Cauchy's Formula, Problem solving
Unit-3: Evanescent fields, Energy transport by evanescent fields, Frustrated total internal reflection, Rectangular waveguides, Transverse magnetic modes, Transverse electric modes, Wave propagation in a guide, Power transmission and transmission, Waveguide current and mode excitation, Problem solving
Unit-4: Waveguide resonators, TM and TE modes, Quality factor, Optical fibre, Numerical aperture, Attenuation, Electric dipole radiation, Power radiated, Magnetic dipole radiation, Far field approximation and comparison with Electric dipole power, Problem solving
Unit-5: Time Varying Potentials, Radiation from an arbitrary source, Total Power radiated and Larmor Formula as special case, Power radiated by a point charge: Larmor formula, Lienard's relativistic generalization

Learning Resources	1. D.J. Griffiths, Introduction to Electrodynamics, 4th Ed., Prentice-Hall India, 2013. 2. M. N. O. Sadiku, Elements of Electromagnetics, Oxford University Press, 2018 3. E.C. Jordan, and K. G. Balmain, Electromagnetic Waves and Radiating Systems, Prentice Hall, 1995.	4. J.D. Jackson, Classical Electrodynamics, 3rd Ed., Wiley 1998. 5. Schwinger et. al., Classical Electrodynamics, Persesus Books, 1998. 6. G.S. Smith, Classical Electromagnetic Radiation, Cambridge, 1997.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
Level 4	Analyze	20%	-	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. M Sathish , CSIR-CECRI, msathish@cecri.re.in	Prof. C Vijayan, IIT Madras, cvijayan@iitm.ac.in	Dr. K. Shadak Alee, SRMIST
Dr. DK Aswal , NPL, dkaswal@nplindia.org	Prof. V Subramanian, IIT Madras, manianvs@iitm.ac.in	Dr. Rohit Dhir, SRMIST

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Course Code	UCY22G01T	Course Name	Material Science and Nanotechnology	Course Category	G	Generic Elective Course	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*acquire basic knowledge about an emerging nanomaterial*
CLR-2:	*learn about various methods for naonmaterials synthesis*
CLR-3:	*acquire knowledge diverse analytical techniques for characterization of nanomaterials*
CLR-4:	*gain knowledge about importance of functionalization, surface modification of nanomaterials*
CLR-5:	*learn about nanomaterials for energy, environmental and healthcare applications*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning Level of Thinking (Bloom)	Program Learning Outcomes (PLO)														
			1 Disciplinary Knowledge	2 Critical Thinking	3 Problem Solving	4 Analytical Reasoning	5 Research Skills	6 Team Work	7 Scientific Reasoning	8 Reflective Thinking	9 Self-Directed Learning	10 Multicultural Competence	11 ICT Skills	12 Life Long Learning	13 PSO -1	14 PSO -2	15 PSO-3
CLO-1:	*understand the properties of emerging materials and nanotechnology*	*4*	*H*	-	-	-	-	-	-	-	-	-	-	*H*	-	-	-
CLO-2:	*understand methods for materials synthesis and identify suitable methods for specific materials*	*4*	*H*	-	-	*M*	-	-	-	-	-	-	-	-	-	-	-
CLO-3:	*understand suitable analytical techniques for nanomaterial characterization*	*4*	*H*	*H*	-	-	*H*	-	-	-	-	-	-	-	-	-	-
CLO-4:	*understand importance of doping, surface modification and functionalization of the nanomaterials*	*4*	-	*H*	*H*	*M*	-	-	-	-	-	-	-	-	-	-	-
CLO-5:	*apply nanomaterials and nanotechnologies towards sustainable goals like energy, environmental and healthcare applications*	*4*	-	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-	-

UNIT- I: Introduction to emerging nanomaterials

An overview and importance of emerging nanomaterials and nanotechnologies, emerging materials–crystalline, amorphous materials, porous carbon-based materials, graphene, silica, silica-based materials, polymeric carbon nitride, conducting polymers, quantum dots, organic – Inorganic hybrid materials, semiconducting materials, types of dimensional (1D,2D, and 3D), core – shell materials, bimetallic systems, metal dichalcogenides, discussion on various phenomenon at nanoscale materials, influence of nano morphologies and micro/macro, nanosizes on the properties.

UNIT- II: Nanomaterials synthetic techniques

Various methods for nanomaterials synthesis – top-down and bottom-up, Sono-chemical, Hydrothermal, Solvothermal, Microwave assisted, grinding - high energy ball milling, Laser Ablation, Flame Ablation, Electrochemical, Chemical Vapour Deposition, Physical Vapour Deposition, Electrodeposition method, calcination, sol gel method- template assisted-non template assisted, self-assembly.

UNIT-III: Analytical techniques for characterization of nanomaterials

Discussion on various techniques for characterization of nanomaterials (to understand optical, structural, composition and surface properties)- Powder X-ray diffraction (PXRD), Solid state UV-Vis, - Diffuse reflectance infrared Fourier transform spectroscopy (DRIFT), X-ray photoelectron X-ray photoelectron spectroscopy (XPS), Scanning Electron Microscope (SEM), High Resolution Transmission Electron Microscopy (HR-TEM), Electron Energy Loss spectra (EELS), STEM, fluorescence, XRF (X-ray fluorescence), introduction (Synchrotron) to X-ray absorption spectroscopy- X-ray absorption near edge structure (XANES), Introduction to extended X-ray absorption fine structure (EXAFS).

UNIT- IV: Surface modification of Nanomaterials and their potential applications

Impact on surface modification-doping, functionalization, effect of heteroatom incorporation, metal sulphide, metal phosphide, introducing impurities to nanomaterials, effect of composition on catalytic efficiency and technological applications, surface modification-impact on nanomaterials properties.

UNIT-V: Nanomaterials for energy and environmental and healthcare applications

Electronics, nanoelectronics, engineering, medicinal application, drug delivery, healthcare products, earth science, membranes, ceramic membranes, environmental applications, including water purification, virus elimination. Sustainable Energy-Solar Energy Conversion, Dye-sensitized solar cells, hydrogen production, carbon-di-oxide conversion, water depollution.

Learning Resources

References:

1. C. N. R. Rao, A. Muller and A. K. Cheetam, (Eds) The Chemistry of Nanomaterials, Vol.1, and 2, Wiley – VCH, Weinheim, 2004.
2. Roco, M. C. "Nanoparticles and nanotechnology research." Journal of Nanoparticle Research 1.1 (1999): 1.
3. C. P. Poole, and Jr. F. J. Owens, Introduction to Nanotechnology, Wiley Interscience, New Jersey. 2003.
4. T. Pradeep, Nano: The Essentials in Understanding Nanoscience and Nanotechnology, Tata McGraw Hill, New Delhi, 2007.
5. K. J. Klabunde, Nanoscale materials in Chemistry, Wiley Interscience, New York, 2001
6. T. Tang and P. Sheng, Nano Science and Technology – Novel Structures and Phenomena,Taylor & Francis, New York, 2004.R. H. Thomson, Chemistry Of Natural Products, 2nd Edition, Springer publication, ISBN-10 : 8181288637
7. J. Clayden, N. Greeves, S. Warren and P. Wothers, Organic Chemistry, 1st Ed., Oxford University Press, 2001.
8. M.B. Smith & J.March, March's Advanced Organic Chemistry, 5th Ed., John Wiley & Sons, New York, 2001.

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
Level 4	Analyze	20%	-	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers		
Expert from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
Dr. Ravikiran Allada, Head R&D, Analytical, Novugen Pharma, Malaysia Email: ravianalytical@gmail.com	Dr. G. Sekar, Department of Chemistry, IIT Madras,	Dr. M. Arthanareeswari, SRMIST
	Dr. Kanishka Biswas, Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru	Dr. Karthikeyan Sekar, SRMIST

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Course Code	UMA22G01T	Course Name	Foundations of Statistics	Course Category	G	Generic Elective Course	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mathematics	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 limitations of statistics
CLR-2:	Employ frequency histogram and polygon
CLR-3:	Introduce the concept of central tendency
CLR-4:	Illustrate the standard deviation and its properties
CLR-5:	Understand the role of rank correlation and repeated ranks.

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Bloom's Level	1 Disciplinary Knowledge	2 Critical Thinking	3 Problem Solving	4 Analytical Reasoning	5 Research Skills	6 Team Work	7 Scientific Reasoning	8 Reflective Thinking	9 Self-Directed Learning	10 Multicultural Competence	11 ICT Skills	12 Life Long Learning	13 PSO -1	14 PSO -2	15 PSO-3
CLO-1:	Gain an insight on statistical concepts	*4*	*H*		*H*	*H*	*H*	-	-	-	-	-	-	*H*	-	-	-
CLO-2	Be familiar with the Graphical representation of data	*4*	*H*	*H*	*M*	*H*	*H*	-	-	-	-	-	-	*H*	-	-	-
CLO-3:	Understanding Mean, Median and Mode.	*4*	*H*	*H*	*H*	*H*	*M*	-	-	-	-	-	-	*H*	-	-	-
CLO-4:	Analyze thoroughly the measures of dispersion	*4*	*H*	*H*	*M*	*H*	*H*	-	-	-	-	-	-	*M*	-	-	-
CLO-5:	Classify the role of types of correlation	*4*	*M*	*H*	*M*	*L*	*H*	-	-	-	-	-	-	*L*	-	-	-

Unit-1: Statistics – Definition – Primary and secondary data – Limitations of Statistics – Statistical methods.
Unit-2**:** Graphical representation of data – Bar graph – Pie diagram– Classification of data – frequency histogram – Polygon – Ogive curves
Unit-3: Mean – Median – Mode – Properties – Merits – Demerits – graphical method.
Unit-4: Measures of Dispersion – Range - Mean Deviation about mean – Standard Deviation – Properties – Coefficient of variation.
Unit-5: Simple Correlation – Types of Correlation – Rank correlation – Repeated ranks.

Learning Resources	1. Pillai, R.S.N, Bagavathi, V. (2009), Statistics, Theory and Practice, 7th Edition, S. Chand Ltd, New Delhi. 2. Ken Black, (2013), Business Statistics for Contemporary Decision Making, 7th Edition, John Wiley Publications. 3.Gupta, S.P. (2011), Applied Statistical Methods, 4th Edition, Sultan Chand & Sons, New Delhi.	4.Probability and Statistics for Engineers (4th Edition), I.R. Miller,J.E.Freundand R.Johnson, 2015. 5.Fundamentals of Statistics(Vol. I & Vol. II), A. Gun,M. k.GuptaandB.Dasgupta, 2016 6.Lipschutz. S and Schiller. J, "Schaum's outlines - Introduction to Probability and Statistics", McGraw-Hill, New Delhi, 1998

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (100% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Practice	Theory	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	-	20%	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	-	20%	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	-	40%	40%	-
Level 4	Analyze	20%	-	20%	-	20%	-	-	20%	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100%	

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Madhan Shanmugasundaram , Director, Infosys Technologies, Chennai	Prof. Y.V.S.S. Sanyasiraju, IIT Madras, *sryedida@iitm.ac.in*	Dr.B.Vennila, SRMIST
	Prof. B. V. Rathish Kumar, IIT Kanpur, bvrk@iitk.ac.in	*Dr. C. Gunasundari, SRMIST*

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Course Code	UBT22G01T	Course Name	Algal Cultivation	Course Category	G	Generic Elective Course	L	T	P	C
							0	3	0	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*Impart knowledge about Algae*	Bloom's Level
CLR-2:	*Different types of Media*	
CLR-3:	*Cultivation methods*	
CLR-4:	*Extraction of Bioactive compounds*	
CLR-5:	*Applications of Algae*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning
CLO-1:	*Isolate algae from the environment*	4
CLO-2:	*Select the potential strain*	4
CLO-3:	*Cultivate algae*	4
CLO-4:	*Extract bioactive compounds*	4
CLO-5:	*Produce Biodiesel from algae in lab scale*	4

Program Learning Outcomes (PLO)															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
H	-	-	*H*	-	-	-	-	-	-	-	-	-	-	-
H	-	-	*H*	-	-	-	-	-	-	-	-	-	-	-
-	-	-	*H*	*H*	-	-	-	-	-	-	-	-	-	-
-	-	-	*H*	*H*	-	-	-	-	-	-	-	-	-	-
-	-	-	*H*	*H*	-	-	-	-	-	-	-	-	-	-

1. Algal collection methods
2. Algal Isolation techniques
3. Different types of Media
4. Media Preparation
5. Cultivation methods in Lab Scale
6. Harvesting methods and Drying

Learning Resources

1. BARSANTI, LAURA AND PAOLO GUALTIERI 2005 Algae-Anatomy, Biochemistry and Biotechnology. Taylor & Francis, London, New York.
2. BECKER, E.W. 1994 Microalgae-Biotechnology and microbiology. Cambridge University Press.
3. TRIVEDI, P.C. 2001 Algal Biotechnology. Pointer publishers, Jaipur, India.
4. VENKATARAMAN, L.V. AND E.W. BECKER 1985. Biotechnology and Utilization of Algae – The Indian Experience. Dept. Science and Technology, New Delhi and Central Food Research Institute, Mysore, India.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
Level 4	Analyze	20%	-	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers

Experts from Higher Technical Institutions	Internal Experts
1. Dr. M. Sujatha, Associate Professor & HOD, Department of Biotechnology, Ethiraj College for Women, Chennai 2. Dr. SUMATHI, Associate Professor, SRMC, Porur, Chennai	Dr. N. Prasanth Bhatt. SRMIST

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Course Code	UPY22D07T	Course Name	Astrophysics	Course Category	D	Discipline Specific Elective Course	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning
CLR-1 :	*learn the fundamental knowledge about the astronomical units and geometrical coordinate of solar and planetary systems and related events*	***Bloom's Level***
CLR-2 :	*define and interpret the observational properties of astronomical objects*	
CLR-3 :	understand the laws, their utilization and classification of the sequences of the staller objects	
CLR-4 :	understand the different components of the solar system and its core structure	
CLR-5:	interpret the concepts of universe expansion and characteristics of the galaxies in the universe	

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning
CLO-1 :	*perceive the basics of astronomy and astrophysical systems*	*4*
CLO-2 :	*account for laws, properties and concepts of all astronomical events*	*4*
CLO-3 :	*relate the acquired knowledge to the sun, stars and celestial systems*	*4*
CLO-4 :	*apply the concepts in modern astronomy related to solar system and milky way*	*4*
CLO-5:	*infer advances in modern astronomy and astrophysics*	*4*

	Program Learning Outcomes (PLO)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1	H	-	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2	H	-	-	H	-	-	-	-	-	-	-	-	-	-	-
CLO-3	H	-	-	H	-	-	-	-	-	-	-	-	-	-	-
CLO-4	H	-	-	-	-	-	H	-	-	-	-	-	-	-	-
CLO-5	H	-	-	-	-	-	H	-	-	-	-	-	-	-	-

Unit-I History of astronomy, Knowledge of Planetary Neighbourhood and Solar system, Astronomical Numbers and Units, Celestial Sphere; Introduction: Astronomical and Geographical Coordinate Systems, Horizon System, Equatorial System, Annual Motion of the Sun, Seasons; Basic Definitions: The Ecliptic's Tilt, Equinoxes and Solstice, Precession Time and timekeeping; Basic Definitions: Calendar Weeks, Months Years, Leap Years, Sidereal Time; Moon's Rotation, Eclipses: Lunar and Solar Eclipses, Shape and Size of Earth, Measuring the diameter of astronomical objects, Elementary Knowledge of Night Sky and Constellations.

Unit-II Recalling definitions of Newtons laws, Statements of Kepler's Laws, Stellar Parallax, Magnitude scale: Brightness, Radiant Flux and Luminosity; The Period Luminosity (P-L) Relation, Determination of Temperature and Radius of stars, Classification of binary stars, Determination of Masses from Binary orbits, Doppler Shift, Hertzsprung-Russell Diagram, Basic Definitions: Magnification Light, Gathering Power, Resolving Power, Diffraction Limit, Atmospheric Windows; Introduction and Classification of telescopes, Errors and rectification in telescopes, Qualitative Introduction to X-ray observation techniques, Gamma Ray Astronomy.

Unit-III The Sun, Hydrostatic Equilibrium, Sun's Interior, Solar Atmosphere, Sun's Energy Cycle; Introduction: Solar Neutrinos, Solar Seismology, Sun spots, Sun Flares, Solar Cycle; Overview of Stellar Evolution: Stages of star's formation, Tracking changes with HR diagram, Star Evolution Cycle (Qualitative Features), Introduction of Main Sequence stars-Mass limits, Supernovae (mass limits), Classifications of Supernova; Conceptual Definitions: White Dwarfs and Supernovae remnants, Neutron stars and Pulsar; Concepts and Definitions: Black Holes, Schwarzschild radius

Unit-IV Structure and Age of the Solar system, Conceptual idea of formation of the planets: The Nebular Model, Definitions: The Terrestrial Planets, Jovian planets, Gas planets, Asteroid belt, Kuiper belt, Oort cloud, Planetary Rings, Extra-Solar Planets, Comets-Meteors, Meteorites; Basic Structure of the Milky Way, Mass and Density; Stars and Star Clusters of the Milky Way, Galactic Nucleus, Edge of the Milky Way, Introduction to Density Waves and Spiral Arms of the Milky Way

Unit- V A Universe of Galaxies: Early Observations, Distances of Galaxies, Standard Candles (Cepheids and SNe Type1a), Cosmic Distance Ladder, Gravitational redshift: Hubble's Law, Classification of Galaxies (Qualitative); Concepts and Definitions: Galaxy Clusters, Super Clusters, Active Galaxies, Quasars, Dark Matter; Dark matter in Cluster of Galaxies (qualitative overview); Introductory Cosmology- Concept of Evolution of universe, Meaning of Red Shift and Age of Universe, Olber's Paradox, Visible Universe; Concepts and Definitions: the Big Bang, Cosmic Microwave Background, Beginning of the universe and various stages, Radiation Matter-Antimatter, fusion, galaxy formation and present; Idea of Epoch of Inflation

Learning Resources

1. Pathways to Astronomy, Thomas T Arny, Stephen E Schneider, (McGraw-Hill College, 2008)
2. Universe, Freedman and Kaufmann, (W. H. Freeman; 8th edition, 2008)
3. An Introduction to Modern Astrophysics, Bradley W Carroll and Dale A Ostlie (Addison-Wesley Publishing, 1996)
4. Introduction to Stellar Astrophysics,Bohm-Vitense, Erika. (3 Vols. Cambridge University Press, 1989)
5. Astrophysical Concepts, Martin Harwit (Springer Science & Business Media, Science2000)

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
Level 4	Analyze	20%	-	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
-	Prof. A C Sharma, GGSIP University, acsharma@gmail.com	Dr. Rohit Dhir, SRMIST
-	Prof. Alka Upadhayay, Thapar University, alka.iisc@gmail.com	Dr. Tushar Rana, SRMIST

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Course Code	UPY22D08T	Course Name	Photonics	Course Category	D	Discipline Specific Elective Course	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*acquire the knowledge on light matter interaction*	Bloom's Level
CLR-2:	*acquire knowledge for solving problems in laser physics*	
CLR-3:	*analyze Fabry-Perot cavity to understand laser resonator*	
CLR-4:	*gain knowledge on Q-switched and mode-locked lasers*	
CLR-5:	*enable the student for pursuing research in photonics related fields*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Bloom's Level	Program Learning Outcomes (PLO)														
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
			Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1:	*understand the basic processes involved in the interaction between atom and light*	4	H	-	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2:	*learn the theory for laser amplification*	4	H	-	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3:	*gain the knowledge on the nonlinearity associated with a laser amplifier*	4	H	-	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-4:	*understand on tuning the properties of a laser*	4	H	-	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5:	*acquire the knowledge on optical properties of metals*	4	-	-	H	H	-	-	-	-	-	-	-	-	-	-	-

Unit-1: Energy levels, Occupation of energy levels, Boltzmann distribution, Fermi-Dirac distribution, Interaction between an atom and electromagnetic mode, Spontaneous emission, Transition crosssection, Line shape function and transition strength, Relation between transition cross section and spontaneous life time, Stimulated emission and absorption, Transition induced by monochromatic light and broadband light, Einstein A and B coefficients, Line broadening, Life time broadening, Collision broadening, Inhomogeneous broadening, Enhanced spontaneous emission, Purcell factor
Unit-2: Thermal equilibrium between photons and atoms, Photon gas, Blackboady radiation spectrum, Thermography, Forms of luminescence: Cathodeluminescence, Chemiluminescence, Electroluminescence, Phtoluminescence, Fluorescence and Phosporescence, Theory of laser amplification, Gain and bandwidth, Gain coefficient, Phase shift coefficient for Lorentzian line shape, Amplifier pumping: Rate equations, Rate equations in the absence of amplifier radiation (Steady state population difference), Rate equations in the presence of amplifier radiation, Four level pumping, Comparison of three and four level pumping
Unit-3: Amplifier nonlinearity:Saturated gain in homogeniously broadened media and inhomogeneously braodened media, Hole burning, Amplifier noise (Amplified spontaneous emission), Fabry-Perot cavity, Coefficient of finesse/Quality factor (Qualitative description)
Unit-4: Theory of laser oscillation: Laser amplification, Feedback and loss in a resonator, Gain condition: laser threshold, Phase condition: Laser frequencies, Frequency pulling, Steady state internal photon flux density, Output photon flux density, Optimization of photon flux density, Properties of a Gaussian beam, Selection of the laser line,polarization, transverse and longitudinal modes, Pulsed lasers, Q-switching, Modelocking
Unit-5: Optical properties of metals, Effective permittivity of metals, Drude Model, Plasma frequency, Metal dielectric boundary-Surface plasmon plariton, Generation and detection of surface plasmon polaritons, Metallic nanospheres: Localized surface plasmons and applications

Learning Resources	
1. B.E.A. Saleh and M.C. Teich, Fundamentals of Phtonics, 2nd Ed., Wiley, 2012. 2. K. Thyagarajan and A.K. Ghatak, Lasers Theory and Applications, 1st Ed., Macmilan Publishers, 2010. 3. O. Svelto, Principles of lasers, 4th Ed., Springer, 1998.	4. A. Yariv, Quantum Electronics, 3rd Ed., John Wiley, New York, 1989 5. Seigman, Lasers, 3rd Ed., Oxford Univ. Press, 1986. 6. S. A. Maier, Plasmonics: Fundamentals and Applications, Springer, 2007

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%		20%		20%		20%		20%	
Level 2	Understand	20%		20%		20%		20%		20%	
Level 3	Apply	40%		40%		40%		40%		40%	
Level 4	Analyze	20%		20%		20%		20%		20%	
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. N Vijayan, NPL, nvijayan @nplindia.org	Dr. M. Ameen Poyli, International School of Photonics, Cochin University of Science and Technology; ameenpoyli@cusat.ac.in	Dr. K Shadak Alee, SRMIST
Mr. R Seshadri, Titan Company Limited, seshadri@titan.co.in	Prof. C Vijayan, IIT Madras, cvijayan@iitm.ac.in	Dr. Junaid Masud Laskar, SRMIST

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SEMESTER VII

Course Code	UPY22701L	Course Name	Advanced Laboratory	Course Category	C	Professional Core Course	L	T	P	C
							0	0	8	4

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning Bloom's Level
CLR-1:	*explore the synthesis and preparation procedures of various nanomaterials.*	
CLR-2:	*study the structure and microstructures of as-prepared nanomaterials.*	
CLR-3:	*learn the advanced characterization instruments.*	
CLR-4:	*apply the basics of computational modeling and simulation using dft.*	
CLR-5:	*solve wave equation using numerov's method*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning Bloom's Level	Program Learning Outcomes (PLO)														
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
			Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1:	*generate the interest on synthesis and fabrication of nanomaterials*	4		*H*			*H*										
CLO-2:	*provide basic knowledge of characterization methods*	4		*H*			*H*										
CLO-3:	*exploring the advanced characterization techniques, likesem, tem, and xps*	4		*H*			*H*										
CLO-4:	*understanding the importance of computational modeling and simulation in dft*	4		*H*			*H*										
CLO-5:	*solving the wave questions using numerov's method*	4		*H*			*H*										

1. Preparation of metal oxide nanoparticles using wet chemical precipitation method.
2. Examine the phase purity, crystallite size, strain, and lattice parameters of metal oxide nanoparticles using Powder X-ray diffraction technique.
3. Metal oxide nano thin film fabrication using dip coating / spin coating technique
4. Determination of average particle size and elemental analysis of metal oxide thin film using scanning electron microscopy (SEM) and composition using EDS
5. Estimation of particle size, interplanar spacing and composition analysis of metal oxide nanomaterials using High Resolution Transmission Electron Microscope (HR-TEM)
6. Identification of functional groups using FTIR spectroscopy for polymer coated metal oxide nanoparticles synthesized using wet chemical precipitation method.
7. Determination of the wavelength absorbance, particle size, and band gap using UV-Vis spectroscopy of metal oxide nano thin film fabricated using dip coating / spin coating technique
8. Determination of mineral concentration using XRF spectrometer for metal oxide / sulfide nanoparticles synthesized by chemical precipitation method.
9. Determination of electronic states and chemical composition of metal oxide thinfilms using X-ray photoelectron spectroscopy (XPS)
10. Determination of roughness, and depth profile of metal oxide nano thin film fabricated using dip coating / spin coating technique by AFM.
11. Modeling, geometrical optimization and determination of total energy, and HOMO-LUMO gap of simple organic and inorganic molecules using Gaussview and Gaussian09.
12. Solve Schrodinger wave equation in one dimension for harmonic oscillator using Numerov's method.
13. Calculation of scattering of light from metallic nano particles

Learning Resources

1. V. Raghvan, *Experiments in Materials Science*, 5th Ed., PHI Learning Pvt. Ltd., 2004.
2. P.M. Martin, *Handbook of Deposition Technologies for Films and Coatings*, 3rd Ed., Elsevier Inc., 2010.
3. Gauglitz, Günter, and Tuan Vo-Dinh, *Handbook of spectroscopy*, John Wiley and Sons, 2006.
4. Yang Leng, *Materials Characterization: Introduction to Microscopic and Spectroscopic Methods*, John Wiley and Sons, 2009.
5. Brundle, C. Richard, and Charles A. Evans, *Encyclopedia of Materials Characterization: Surfaces, Interfaces, Thin Films*, Gulf Professional Publishing, 1992.
6. Pretsch, Ernö, et al. *Structure Determination of Organic Compounds*, Vol. 13. Berlin: Springer, 2009.
7. Mario Birkholz, *Thin Film Analysis by X-ray Scattering*, John Wiley and Sons, 2006.
8. E.Hairer, S.P.Norsett, and G. Wanner, *Solving Ordinary, Differential Equations I*, Vol.1, 2000.
9. F. J. Garcı´a de Abajo, and A. Howie, *Retarded field calculation of electron energy loss in inhomogeneous dielectrics*, Phys. Rev. B 65, 115418, 2002.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	20%	-	20%	-	20%	-	20%	-	20%
Level 2	Understand	-	20%	-	20%	-	20%	-	20%	-	20%
Level 3	Apply	-	40%	-	40%	-	40%	-	40%	-	40%
Level 4	Analyze	-	20%	-	20%	-	20%	-	20%	-	20%
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. M Krishna Surendra, Saint Gobain Research, krishana.muvvala@saint-gobain.com	Prof. C Venkateshwaran, University of Madras, venkateshwaran@unom.ac.in	Dr. Jaivardhan Sinha, SRMIST
Mr. Navneethakrishanan, CLR Laboratories Pvt Ltd.	Prof. S Balakumar, University of Madras, balakumar@unom.ac.in	Dr. Debabrata Sarkar, SRMIST

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Course Code	UPY22702T	Course Name	Physics of Nanomaterials	Course Category	C	Professional Core Course	L	T	P	C
							3	1	0	4

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*acquire knowledge on dimensionality and size dependent properties*	Bloom's Level
CLR-2:	*gain knowledge on properties of nanomaterials*	
CLR-3:	*understand the techniques and their requirements for preparing nanomaterials.*	
CLR-4:	*gain knowledge on nanomaterial characterization techniques*	
CLR-5:	*acquire knowledge on the applications of nanomaterials*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Bloom's Level
CLO-1:	*explain the size dependent behavior of nanomaterials*	4
CLO-2:	*analyze the given nanomaterial and its properties*	4
CLO-3:	*utilize the suitable material for a particular application*	4
CLO-4:	*implement a suitable technique to study the nanomaterial*	4
CLO-5:	*explain the methods involved for the preparation of nanomaterials*	4

Program Learning Outcomes (PLO)														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
		H	H											
		H	H											
		H	H											
		H	H											
		H	H											

Unit-1: Difference between bulk and nanoscale materials and their significance, zero dimensional, one-dimensional and two dimensional nanostructures, quantum dots (QDs), calculation of the density of states (DOS) in 1, 2 and 3 dimensions, nano ribbons and nanowires, Carbon nanotubes (CNT), application of CNT, Synthesis of CNT, fullerenes/buckyballs/C60.
Seminar on CNT and QDs

Unit-2: Properties at the nanoscale, effect of confinement, quantum confinement, size quantization effect on electronic state, Optical properties of Nanomaterials , Brus equation, relation between metal nanoparticle size with colour, surface Plasmon, surface-to-volume ratio, Chemical properties of Nanomaterials, Mechanical properties of Nanomaterials
Seminar on Magnetic behaviour of Nanomaterials

Unit-3: Top-down approach and bottom-up approach, Nucleation and growth of nanosystems, Photolithography, electron-beam (e-beam) lithography, bottom-up approach, chemical methods, sol-gel processing, hydrothermal process, Sonochemical routes, Photochemical Synthesis
Seminar on Nucleation and growth of nanomaterial

Unit-4: Optical characterization (UV-Vis, PL), phenomena of diffraction radiation, X-ray diffraction, phase identification, Scherrer formula, strain and grain size determination, scanning electron microscope (SEM), transmission electron microscope (TEM)
Seminar on electron transition in nanomaterial and electron microscopy

Unit-5: Applications: nanoparticle-based drug delivery, nanomaterial based Li-ion battery, TiO_2 photocatalysis, spintronic devices and spin field effect transistors (SPINFET), magnetic tunnel junction based devices and tunnel magnetoresistance effect in tunnel junction. Micro-electromechanical system (MEMS), Nano-electromechanical systems (NEMS), Application in food and agriculture industry,
Nano sensors, Future Prospectus, Risk of Nanotechnology
Seminar on future prospects of nanotechnology

Learning Resources

1. T. Pradeep, A Textbook of Nanoscience and Nanotechnology, Tata McGraw Hill Education, 2012.
2. G. Cao, Y. Wang, Nanostructures and Nanomaterials: Synthesis, Properties, and Applications, 2nd Ed., Imperial College Press, 2004.
3. D. Bucknall, Nanolithography and Patterning Techniques in Microelectronics, CRC Press, 2005.
4. T.K. Sau, A.L. Rogach, Complex-shaped Metal Nanoparticles: Bottom-Up Syntheses and Applications, 1st Ed., Wiley-VCH, 2012.
5. P. Bandyopadhyay, M.Cahay, Introduction to Spintronics, 2nd Ed., CRC Press, 2015.
6. Nanomaterials: Synthesis, Properties and Applications, A. S. Edelstein and R. C. Cammarata, (Institute of Physics Pub., 2001)
7. Textbook of Nanoscience and Nanotechnology, B.S. Murty, ShankarBaldev Raj, B Rath James Murday, (Springer, Universities Press (India) Private Limited 2013)

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
Level 4	Analyze	20%	-	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. M Krishna Surendra, Saint Gobain Research, krishana.muvvala@saint-gobain.com	Prof. C Venkateshwaran, University of Madras, venkateshwaran@unom.ac.in	Dr. Anbumozhi Angayarkanni, SRMIST
Mr. Navneethakrishanan, CLR Laboratories Pvt Ltd.	Prof. S Balakumar, University of Madras, balakumar@unom.ac.in	Dr. Meenal Deo, SRMIST

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Course Code	UPY22703T	Course Name	Nuclear and Particle Physics	Course Category	C	Professional Core Course	L	T	P	C
							3	1	0	4

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning
CLR-1 :	*develop skills to describe and explain the properties of nucleus*	*Bloom's Level*
CLR-2 :	*understand various models of nuclear structure*	
CLR-3 :	*understand and explain the various theoretical formulation of nuclear decays*	
CLR-4 :	*gain knowledge of particle accelerators and detectors*	
CLR-5:	*provide basic introduction to elementary particles and their conservation laws*	

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning
CLO-1 :	*infer general concepts of ground state properties of a nucleus and its constituents*	*4*
CLO-2 :	*know about the role of nuclear models in explaining nuclear structure*	*4*
CLO-3 :	*understand the dynamics of nuclear decay processes*	*4*
CLO-4 :	*apprehend the fundamentals of particle acceleration and detections*	*4*
CLO-5:	*classify elementary particles according to their quantum numbers and fundamental interactions*	*4*

Program Learning Outcomes (PLO)														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
H	-	-	*H*	-	-	-	-	-	-	-	-	-	-	-
H	-	-	-	-	-	*H*	-	-	-	-	-	-	-	-
H	-	*H*	-	-	-	-	-	-	-	-	-	-	-	-
H	-	-	*H*	-	-	-	-	-	-	-	-	-	-	-
H	-	-	*H*	-	-	-	-	-	-	-	-	-	-	-

Unit: I

Importance of Nuclear Physics, Nucleus and its constituents, Properties of Nucleus: mass, radii and charge density, Binding Energy, mass defect; Binding energy curve, Isotopes and Abundance, Concepts of Nucleus spin, Angular momentum and Parity, Magnetic Dipole moment, Electric Quadrupole Moment, Properties of Nuclear Forces, Qualitative overview: Charge independence of Nuclear Forces, Spin Dependence of Nuclear Forces; Yukawa Theory: Qualitative facts, Mass Spectrometer

Unit: II

Liquid drop model and Semi-empirical mass formula, Nuclear stability, Qualitative discussion of evidences for nuclear shell structure, Shell Model: salient features, success and drawbacks; Bulk Nucleus Deformation; Collective Model: Qualitative Understanding

Unit: III

Laws of Disintegration: Half life and average life period, Theory of alpha emission, Gamow factor, Geiger Nuttall law, Alpha decay spectroscopy, Beta decay, Energy kinematics for beta decay, Positron emission, Electron capture, Beta Decay Spectrum, Neutrino hypothesis, Properties neutrinos and anti-neutrinos, Gamma Decays: Internal Conversion, Internal Pair Creation, Artificial Radioactivity, Applications of radioactivity: Energy, Carbon dating, Radioactive tracers

Unit: IV

Van-de-Graaff's Generator, Linear Accelerators, Cyclotron, Synchrotron; Basic idea of Charged and neutral particle (gamma ray and neutron) interaction with matter; Ionization Chambers, Scintillation Counters, Geiger Muller Counter, Semiconductor Detectors, Bubble Chamber

Unit: V

Introduction and Classification of Elementary Particles, Types of Interactions: gravitational, electromagnetic, strong, and weak interactions; Leptons, Quarks, Hadrons, Mesons, Baryons; Quantum Numbers: Spin, Charge, Parity, Isospin, Strangeness, Lepton and Baryon Numbers, Conservation of Charge, Parity, Isospin, Isospin component (*I*3), Strangeness, Lepton and Baryon Numbers, Charge Conjugation Parity (CP), Time Reversal (*T*) Symmetry, *CPT* Theorem, Introduction bosons, Higgs boson, Basic introduction to Standard model and beyond.

Learning Resources

1. Introductory Nuclear Physics, Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
2. Introduction to Nuclear and Particle Physics, VK Mittal, RC Verma, SC Gupta, (PHIL, 2013)
3. An Introduction to Nuclear Physics, W. N. Cottingham, D. A. Greenwood, Derek A. Greenwood (Cambridge University Press, 2001)
4. Nuclear Physics, Ghoshal S.N. (S. Chand Limited, 2008)
5. Basic ideas and concepts in Nuclear Physics - An Introductory Approach, K. Heyde (IOPInstitute)
6. Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
Level 4	Analyze	20%	-	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
-	Prof. A C Sharma, GGSIP University, acsharma@gmail.com	Dr. Rohit Dhir, SRMIST
-	Prof. Alka Upadhayay, Thapar University, alka.iisc@gmail.com	Dr. Alok Kumar, SRMIST

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Course Code	UPY22704T	Course Name	Semiconductor Device Physics	Course Category	C	Professional Core Course	L	T	P	C
							3	1	0	4

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*outline the classification of solids and its properties*	Bloom's Level
CLR-2:	*elucidate the importance of quantum physics and its related principle*	
CLR-3:	*know the physics of semiconductor junctions, metal– semiconductor junctions*	
CLR-4:	*understand light-matter interaction*	
CLR-5:	*understand the principles and operation of electronic devices*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning
CLO-1:	*describe origin of electrical and thermal properties of semiconductors*	4
CLO-2:	*applying quantum theory to understand solids*	4
CLO-3:	*illustrate device building blocks*	4
CLO-4:	*determining optical properties and applying it for applications*	4
CLO-5:	*interpret diverse electronic devices*	4
CLO-6:	*analyse semiconductor properties and applications*	4

Program Learning Outcomes (PLO)															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
-	-	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-
-	-	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-
-	-	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-
-	-	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-
-	-	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-
		H	*H*											

Unit-1: Atomic structure and energy levels, Bonding and types of solids, Kinetic molecular theory, Classification of materials: metal, semiconductor, insulator, Types of solids: crystalline, polycrystalline, amorphous, Defects in solids: point defects, line defects, planar defects, Electrical conduction in solids, Drude model, Temperature dependence of conductivity: metals, Matthiessen's rule, Coefficient of resistivity, Thermal conductivity, Thermal resistance, AC conductivity. Problem Solving: Resistance, Sheet Resistance, and Resistivity; Conductivity and Carrier Concentration; Mathieson's Rule; Ionic conductivity.
Unit-2: Elements of quantum physics: wave-particle duality, de–Broglie hypothesis, uncertainty principle, particle in a box- finite potential energy well, quantized electron energy, Hydrogen molecule: molecular orbital theory of bonding, Band theory of solids-energy band formation in semiconductors, Properties of electrons in band, Electron effective mass, Density of states in energy band, Statistics for semiconductors: Boltzmann, Fermi-Dirac, Concept of Fermi energy and electrochemical potential, Semiconductors: intrinsic and extrinsic, Electrons and holes: conduction in semiconductors, charge carrier concentration and recombination, Doping in semiconductors and its energy levels. Degenerate semiconductor. Problem Solving: Arrhenius equation; Probabilities of Finding Electrons and Holes at EC and EV; Intrinsic Fermi-Level Position.
Unit-3: Temperature dependence of conductivity: semiconductors and insulators, Temperature dependence of carrier concentration, Drift-Diffusion-Mobility, Continuity equation: time dependent and steady state, Metal-semiconductor junction: Schottky junction, Semiconductor-semiconductor junction, Charge carrier dynamics of P-N junction: biasing conditions, depletion width and capacitance, Applications and operation of junctions as rectifier: P-N junction, Schottky junction, Zener, Shockley. Problem Solving: drift velocity; diffusion length; depletion width; bias dependent junction capacitance variation.
Unit-4: Optical properties of materials, E-k diagram, Absorption of light in semiconductors: electron-hole pair generation, Beer–Lambert law, lattice absorption, band-to-band absorption-direct and indirect recombination, Luminescence, Phosphorescence, Polarization and optical anisotropy, Liquid crystals, Optical applications of semiconductors: LED, LASER, Photodetector, Photovoltaic cell, LCD. Problem Solving: relation between refractive index and dielectric constant; band gap from light absorption; charge carrier life-time; efficiency of solar cell; birefringence.
Unit-5: Working principle of two terminal electronic devices: varactor diode, PIN diode, IMPATT, tunnel diode, Gunn diode, Working principle of three terminal electronic devices: silicon-controlled rectifier (thyristor), unijunction transistor, bipolar junction transistor, field effect transistor. Problem Solving: tunnelling probability; various figure-of-merits of electronic devices

Learning Resources	
1.	S. O. Kasap, Principles of Electronic Materials and Devices, 4th Edition, McGraw–Hill, 2018.
2.	S. M. Sze, Physics of Semiconductors Devices, 3rd Edition, John Wiley, 2007.
3.	Donald A. Neamen, Semiconductor Physics and Devices – Basic Principles, 3rd edition, McGraw–Hill, 2003.
4.	Sima Dimitrijev, Principles of Semiconductor Devices, Oxford University Press, 2012.
5.	M. Balkanski and R. F. Wallis, Semiconductor Physics and Applications, Oxford University Press, 2000

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
Level 4	Analyze	20%	-	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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Course Code	UPY22S03T	Course Name	Seminar	Course Category	S	Skill Enhancement Course	L	T	P	C
							0	2	0	2

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	***Physics and Nanotecnology***	**Data Book / Codes/Standards**	***Nil***		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	enable the learners to communicate ideas in a succinct and clear manner.
CLR-2	produce competent, creative and imaginative graduates with a strong scientific acumen
CLR-3	expose students to current topics and research in the field of science
CLR-4	appreciate the components of seminar presentation
CLR-5	design a research study to address a specific research question and/or hypotheses

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning Level of Thinking (Bloom)	Program Learning Outcomes (PLO) 1 Disciplinary Knowledge	2 Critical Thinking	3 Problem Solving	4 Analytical Reasoning	5 Research Skills	6 Teamwork	7 Scientific Reasoning	8 Reflective Thinking	9 Self-Directed Learning	10 Multicultural Competence	11 ICT Skills	12 Lifelong Learning	13 PSO -1	14 PSO -2	15 PSO-3
CLO-1	explain and understand the basic concepts of research	*4*	*H*	-	-	-	*H*	-	-	-	-	-	-	-	-	-	-
CLO-2	formulate ideas and present their ideas in the scientific forum	*4*	-	*H*			-	-	-	-	-	-	*H*	-	-	-	-
CLO-3	construct research work which is logically and professionally presented.	*4*	-	-	-	-	*M*	-	*M*	-	*M*	-	-	-	-	-	-
CLO-4	gain the confidence to present their work in an open forum	*4*	-	*H*	-	-	-	-	-	*H*	-	-	-	-	-	-	-
CLO-5	critique and evaluate a research design	*4*	-	*H*	-	-	-	-	*H*	-	-	-	*M*	-	-	-	-

Assessment Method – Fully Internal

	Bloom's Level of Thinking	Continuous Learning Assessment (100% weightage)			
		Presentation (70%)		Interaction (30%)	
		Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-
Level 2	Understand	20%	-	20%	-
Level 3	Apply	40%	-	40%	-
Level 4	Analyze	20%	-	20%	-
Level 5	Evaluate	-	-	-	-
Level 6	Create	-	-	-	-
	Total	100 %		100 %	

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Course Code	UPY22P01L	Course Name	Internship	Course Category	P	Internship/ Project	L	T	P	C
							0	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Physics and Nanotechnology*	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	*assist the student's professional skill development useful to employer such as teamwork, communications and work ethics & details*
CLR-2:	*provide unique learning opportunities by exposing the student to the environment and expectations of professional performance*
CLR-3:	*expand the student's knowledge of a particular area(s) of interest to enhance employability*
CLR-4:	*help students to explore career alternatives/opportunities prior to their graduation*

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:
CLO-1:	*demonstrate the skill gained through work experience with mentors or successful professionals to support the early stages of their career*

	Continuous Learning Assessment (50% weightage)		Final Evaluation (50% weightage)	
	Review – 1	Review – 2	Project Report	Viva-Voce
Internship	20%	30 %	30%	20 %

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Course Code	UPY22P02L	Course Name	Massive Open Online Course	Course Category	P	Internship/ Project	L	T	P	C
							0	0	0	3

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:	*encourage initiative by Govt. of India to achieve the three cardinal principles of access, equity and quality in different learning communities.*

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:
CLO-1:	*demonstrate the knowledge and skill gained through learning of professional/elective courses taken on SWAYAM portal*
CLO-2:	*able to develop the professional skill on the subject areas beyond his curriculum*
CLO-3:	*experience unique and independent learning opportunity*
CLO-4:	*expand his/her knowledge of a particular area(s) of interest to enhance employability*

Learning Assessment	*Student shall be allowed to choose one Swayam course on the recommendation of faculty advisor and appropriate credits will be transferred as per BS regulations 2022*
MOOC	

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Course Code	UCY22AE1T	Course Name	Research Methodology	Course Category	AE	Ability Enhancement Course	L	T	P	C
							3	1	0	4

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	**Learning**
CLR-1:	practice the basic skills of research paper, review paper and thesis writing	
CLR-2 :	*develop the skill of technical writing*	
CLR-3 :	*evaluate different methods of scientific writing and reporting*	
CLR-4 :	*enable the students to* write conference abstract and research proposals	
CLR-5 :	*inculcate the knowledge of intellectual property and rights*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Level of Thinking (Bloom)	Program Learning Outcomes (PLO)														
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
			Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO -1	PSO -2	PSO-3
CLO-1 :	differentiate between various kind of academic writings	*4*	-	*H*	-	-	*M*	-	*H*	-	-	-	-	-	-	-	-
CLO-2 :	practice the basic skills of performing quality literature review.	*4*	-	*H*	-	-	*H*	-	-	*H*	-	-	-	-	-	-	-
CLO-3 :	target the research work to suitable journal and communicate for publication	*4*	-	-	-	-	-	-	-	-	*H*	-	-	*M*	-	-	-
CLO-4 :	identify and avoid the plagiarism	*4*	-	-	-	*H*	-	-	-	-	*H*	-	-	-	-	-	-
CLO-5 :	*develop competence on data collection and process of scientific documentation*	*4*		*H*	-	-	-	-	*H*	-	*H*	-	-	-	-	-	-

UNIT- I: Academic & research writing
Introduction, Importance of academic writing, Basic rules of academic writing, English in academic writing, Types of academic writing - descriptive, analytical, persuasive and critical.

UNIT-II: Metrics and plagiarism
Plagiarism: Introduction; Tools for the detection of plagiarism; Avoiding plagiarism, Journal Metrics – Types of bibliometric indicators (Generation), Author metrics.

UNIT- III: Literature review and review paper writing
Literature review: Introduction, Source of literature; Process of literature review, Online literature databases; Literature management tools, Review Paper Writing

UNIT- IV: Research paper and thesis writing
Research paper writing, Referencing and citation, Submission and, Post submission, Thesis Writing, Abbreviations, nomenclature, writing references, Research proposal writing; Abstract/ Conference Paper/ Book/ Book Chapter writing; Open Educational Resources (OERs) for learning & Research.

UNIT-V: Research ethics and intellectual property rights
Challenges in Indian research & writing; Team management (mentor and collaborators), Time Management, Ethics in research – authorship, acknowledgement, competing interest, COPE guidelines, Intellectual property rights – Copy rights and Patent rights.

Learning Resources

Theory:

1. Dawson, C, Practical research methods. UBS Publishers, New Delhi, 2002
2. Walpole R.A., Myers R.H., Myers S.L.and Ye King: Probablity and statstics for engineers and scientist, Pearson Prentice Hall, Pearson Education, Inc. 2007
3. Kothari C.K., Research Methodology-Methods and Techniques (New Age International, New Delhi), 2004

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
Level 4	Analyze	20%	-	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers		
Expert from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
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	Dr. Kanishka Biswas, Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru Email: kanishka@jncasr.ac.in	Prof. M. Arthanareeswari, SRMIST

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SEMESTER VIII

Course Code	UPY22P03L	Course Name	Major Project	Course Category	P	Internship/Project	L	T	P	C
							0	0	24	12

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Physics and Nanotechnology*	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*produce competent, creative and imaginative graduates with a strong scientific acumen*
CLR-2	*apply of the acquired knowledge, skills, and tools pertinent to the field of physics*
CLR-3	*promote independent and collaborative research work in the domain of physics*
CLR-4	*inculcate the ethical responsibility of the graduate in the scientific society*
CLR-5	*identify the challenges and solutions pertinent to the field of physics*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning Level of Thinking (Bloom)	Program Learning Outcomes (PLO)														
			1 Disciplinary Knowledge	2 Critical Thinking	3 Problem Solving	4 Analytical Reasoning	5 Research Skills	6 Teamwork	7 Scientific Reasoning	8 Reflective Thinking	9 Self-Directed Learning	10 Multicultural Competence	11 ICT Skills	12 Lifelong Learning	13 PSO -1	14 PSO -2	15 PSO-3
CLO-1	*demonstrate the key areas of research*	*4*	*H*	-	-	-	*H*	-	*H*	-	-	-	-	-	-	-	-
CLO-2	*develop laboratory and experiment related skills*	*4*	-	*H*			*H*	*H*	-	-	-	-	-	-	-	-	-
CLO-3	*posses' competence on data collection and process of scientific documentation*	*4*	-	*M*	-	-	*M*	-	-	-	-	-	*M*	-	-	-	-
CLO-4	*gain the knowledge of research ethics*	*4*	-	-	-	-	*M*	*M*	-	*H*	-	-	-	-	-	-	-
CLO-5	*solve problems in their area of research*	*4*	-	-	*H*	-	-	-	*H*	-	-	-	-	*M*	-	-	-

	Continuous Learning Assessment (50% weightage)		Final Evaluation (50% weightage)	
	Review – 1	Review – 2	Project Report	Viva-Voce
Major Project	20%	30 %	30%	20 %

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Syllabus for B.S. (Hons.) Physics

SEMESTER VI

Course Code	UPY22H01T	Course Name	Group Theory	Course Category	C	Professional Core Course	L	T	P	C
							3	1	0	4

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*Learn and evaluate the symmetry*	Bloom's Level
CLR-2:	*Understand role of symmetry in physics*	
CLR-3:	*Able to evaluate the groups of a system*	
CLR-4:	*Able to understand the group theory in quantum mechanics*	
CLR-5:	*Apply group theory in solid state physics*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Bloom's Level
CLO-1:	*To able to define symmetry in mathematical formalism*	4
CLO-2:	*Able to represent the symmetry and symmetric operations*	4
CLO-3:	*Develop the understanding the symmetry in quantum mechanics*	4
CLO-4:	*Acquire the knowledge of space groups in real space*	4
CLO-5:	*Acquire the knowledge of space groups in reciprocal space*	4

Program Learning Outcomes (PLO)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	Ethical Reasoning	Community Engagement	ICT Skills	Leadership Skills	Life Long Learning
H	-	H	-	-	-	-	-	-	-	-	-	-	-	-
H	H	-	-	-	-	-	-	-	-	-	-	-	-	-
H	-	-	H	-	-	-	-	-	-	-	-	-	-	-
H	-	-	H	-	-	-	-	-	-	-	-	-	-	-
H	-	-	H	-	-	-	-	-	-	-	-	-	-	-

UNIT I: Definition of Group Theory

1. Definition of a Group, Example of a Group Basic Definitions, Rearrangement Theorem, Cosets , Conjugation and Class.
2. Symmetry elements and operations
    1. Symmetry Planes
    2. Inversion centre
    3. Proper and Improper axis & rotations
    4. Products of Symmetry operations
    5. Optical Isomerism
    6. Symmetry Point Group

UNIT II: Representation of Groups

1. Representation Theory
    1. Reducible and Irreducible representation
    2. Schur's Lemma and Great Orthogonality Theorem
    3. Character Table
    4. Representation of Cyclic Groups
2. Character of Representation
    1. Definition of Character
    2. Characters and Class, Matrices
    3. Schoenflies Symmetry Notation
    4. The Hermann–Mauguin Symmetry Notation
    5. Symmetry Relations and Point Group Classifications

UNIT III: Group Theory and Quantum Mechanics

1. Symmetry operations and basis functions, basis functions for irreducible representation, Projection Operations on an Arbitrary Function, Group Theory of Schrödinger's equation
2. Electronic States of Molecules
    1. General Concept of Equivalence
    2. Homonuclear and Heterogeneous Diatomic Molecules
    3. NH_3 and CH_3 molecule
    4. π & σ bond

UNIT IV: Space Group in Real Space

1. Mathematical Background for Space Groups(SG), SG Symmetry operations, Symmorphic and Nonsymmorphic SG
2. Bravis Lattice and SG:
    1. Examples of Symmorphic SG,

2. Cubic SG and the Equivalence Transformation
3. Examples of Nonsymmorphic SG

3. 2D Space Group:
   1. Oblique, Square, Rectangular and Hexagonal SG
4. Determination of Crystal Structure and SG

UNIT V: Space Groups in Reciprocal Space

1. Reciprocal Space, Translational Group and Bloch's Theorem, PG in ***r*** and ***k*** space. SG-representation,
2. Common Cubic-Lattices
   1. *Γ*-point
   2. points with $k \neq 0$
3. *Diamond Structure: Nonsymmorphic Space Group*
   1. *Factor Group and Γ-point*
   2. *points with $k \neq 0$*
4. *Finding Character Tables*

Learning Resources	***Theory:*** 1. M.S. Dresselhaus, G. Dresselhaus, A. Jorio, Group Theory: Application to the Physics of Condensed Matter, Springer, 2008 2. F.A. Cotton, Chemical Applications of Group Theory, 3rd ed, Wiley, 2008 3. A. W. Joshi, Elements Of Group Theory For Physicists, New Age International, 2018 4. Rakshit Ameta, Suresh C. Ameta, Chemical Applications of Symmetry and Group Theory, AAP, 2016

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
Level 4	Analyse	20%	-	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr.V Subramanian- CLRI, subbu@clri.res.in	Prof. K. Sethupathi, IIT Madras, ksethu@iitm.ac.in	Dr. Rudra Banerjee, SRMIST
Mr. R Seshadri, Titan Company Limited, seshadri@titan.co.in	Dr. Ranjit Kumar Nanda, IIT Madras, nandab@iitm.ac.in	Dr. Rohit Dhir, SRMIST

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Course Code	UPY22H02T	Course Name	Quantum Optics	Course Category	C	Professional Core Course	L	T	P	C
							3	1	0	4

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*Emphasize the importance of Quantum optics to quantum information science*	Bloom's Level
CLR-2:	*Understand quantum nature of light*	
CLR-3:	*Learn cavity-based light-matter interaction*	
CLR-4:	*Acquire more advanced knowledge on quantum optics*	
CLR-5:	*Learn atom-photon interactions*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Bloom's Level	Program Learning Outcomes (PLO)													
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
			Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1:	*Concepts on Photon statistics*	4	H	-	-	-	-	-	-	-	-	-	-	H	-	-	-
CLO-2:	*Non-classical behaviour of light: Photon antibunching*	4	H	-	-	-	-	-	-	-	-	-	-	H	-	-	-
CLO-3:	*Detect and generate squeezed states of light*	4	H	-	-	H	-	-	-	-	-	-	-	-	-	-	-
CLO-4:	*Formulate the photon number states*	4	H	-	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5:	*Gain knowledge on atom-cavity coupling*	4	H	-	-	-	-	-	-	-	-	-	-	H	-	-	-

Unit-1: Photon Statistics, Coherent light: Poissonian photon statistics, Classification of light by photon statistics, Super-Poissonian light, Sub-Poissonian light, Thermal light, Theory of photodetection, Quantum theory of photodetection, shot noise in photodiodes, Observation of sub-Poissonian photon statistics
Unit-2: Introduction to the intensity interferometers, Hanbury Brown-Twiss experiments and classical intensity fluctuations, Second order correlation function, Hanbury Brown-Twiss experiments with photons, Photon bunching and antibunching, Experimental demonstration of photon antibunching, Single Photon sources
Unit-3: Light waves as classical harmonic oscillators, Light as a quantum harmonic oscillator, The vacuum field, Coherent states, Shot noise and number-phase uncertainty, Squeezed states, Setection of Squeezed light, Generation of squeezed states
Unit-4: Operator solution of the harmonic oscillator, The number state representation, Photon number states, Coherent states, Quantum theory of Hanbury Brown-Twiss experiments, Two-level atom approximation, Coherent superposition states, Density matrix, Time-dependent Schrodinger equation, The weak field limit: Einstein's B coefficient, The strong field limit: Rabi oscillations
Unit-5: Optical Cavities, Atom-cavity coupling, Weak coupling: Preliminary considerations, Free-space spontaneous emission, Spontaneous emission in a single mode cavity (Purcell effect), Experimental demonstration, Strong coupling: Cavity quantum electrodynamics, Experimental observations of strong coupling, Applications of cavity effects and quantum information science

Learning Resources	6. Quantum Optics: An Introduction, Mark Fox, (Oxford University Press) 7. Quantum Optics, M.O. Scully, M.S. Zubairy, (Cambridge University Press)	8. Introduction to Quantum Optics: From Light Quanta to Quantum Teleportation, Harry Paul (Cambridge University Press) 9. Quantum Optics for Beginners, Z. Ficek, M. R. Wahiddin (Pan Stanford Publishing)

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
Level 4	Analyze	20%	-	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. N Vijayan, NPL, nvijayan @nplindia.org	Dr. M. Ameen Poyli, International School of Photonics, Cochin University of Science and Technology; ameenpoyli@cusat.ac.in	Dr. K Shadak Alee, SRMIST
Mr. R Seshadri, Titan Company Limited, seshadri@titan.co.in	Prof. C Vijayan, IIT Madras, cvijayan@iitm.ac.in	Dr. Junaid M. Laskar, SRMIST

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Course Code	UPY22H03T	Course Name	Advanced Computational Physics	Course Category	C	Professional Core Course	L	T	P	C
							2	2	0	4

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*Develop skills to solve Problems in physics numerically*	Bloom's Level
CLR-2:	*Learn advance tools for computational physics*	
CLR-3:	*Learn methods to solve various real life problems numerically*	
CLR-4:	*Learn and apply methods used across the academics and industry*	
CLR-5:	*Learn ab-initio methods*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning
CLO-1:	*Learn and apply molecular dynamics simulations*	4
CLO-2:	*Solve single particle Schrodinger's equation*	4
CLO-3:	*Apply Monte Carlo method*	4
CLO-4:	*Apply Quantum simulation*	4
CLO-5:	*Use Quantum Monte Carlo*	4

Program Learning Outcomes (PLO)															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	Ethical Reasoning	Community Engagement	ICT Skills	Leadership Skills	Life Long Learning
H	-	H	-	-	-	-	-	-	-	-	-	-	-	-
H	H	-	-	-	-	-	-	-	-	-	-	-	-	-
H	-	H	-	-	-	-	-	-	-	-	-	-	-	-
H	-	H	-	-	-	-	-	-	-	-	-	-	-	-
H	-	H	-	-	-	-	-	-	-	-	-	-	-	-

UNIT I: Molecular Dynamics

1. Equations of motions for atomic systems
2. Finite difference methods
3. MD for rigid bodies
4. constraint dynamics
5. Verlet algorithm

UNIT II: Solving single-particle Schrodinger's equation

1. Eigenvalue problems
2. Infinite square well potential
3. Hydrogen atom

UNIT III: Monte Carlo simulation

1. Monte Carlo integration
2. Importance Sampling
3. Metropolis method

UNIT IV: Quantum Simulations I

1. *Ab-initio* molecular dynamics
2. Path integral simulations

UNIT V: Quantum Simulations II

1. Quantum random walk
2. Quantum Monte Carlo

Learning Resources	
	1. Press et. al., Numerical Recepies, 2nd ed, CUP, 1992
	2. Thijssen, Computational Physics, 2nd ed, CUP, 2007

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
Level 4	Analyse	20%	-	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr.V Subramanian- CLRI, subbu@clri.res.in	Prof. K. Sethupathi, IIT Madras, ksethu@iitm.ac.in	Dr. Rudra Banerjee, SRMIST
Mr. R Seshadri, Titan Company Limited, seshadri@titan.co.in	Dr. Ranjit Kumar Nanda, IIT Madras, nandab@iitm.ac.in	Dr. CP Kala, SRMIST

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Course Code	UPY22H04T	Course Name	Particle Physics	Course Category	C	Professional Core Course	L	T	P	C
							3	1	0	4

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning
CLR-1 :	*have a basic understanding of particles and properties*	*Bloom's Level*
CLR-2 :	*understand the various symmetries and conservation laws followed by elementary particles*	
CLR-3 :	*Introduce relativistic quantum mechanics and Dirac equation*	
CLR-4 :	*learn fundamentals of bound states in quark model*	
CLR-5:	*basic understanding of the fundamental interactions of physics*	

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	
CLO-1 :	*understand the role of symmetries and conservation laws in high energy physics*	*4*
CLO-2 :	*Infer and apply symmetries and conservation laws in particle physics*	*4*
CLO-3 :	*apply mathematical tools using relativistic quantum mechanics*	*4*
CLO-4 :	*learn and apply the basic concepts of quark model of hadrons and understand their properties*	*4*
CLO-5:	*understand the idea various interactions, electroweak unification and the Standard model*	*4*

Program Learning Outcomes (PLO)															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
H	-	-	*H*	-	-	-	-	-	-	-	-	-	-	-
H	-	*H*	-	-	-	-	-	-	-	-	-	-	-	-
H	-	*H*	-	-	-	-	-	-	-	-	-	-	-	-
H	-	*H*	-	-	-	-	-	-	-	-	-	-	-	-
H	-	-	-	*H*	-	-	-	-	-	-	-	-	-	-

Unit: I
The Standard Model of particle physics, Particle classification: fermions and bosons, Particles and antiparticles, Free particle wave equations, Helicity states: helicity conservation, Lepton flavours, Quark flavours, The cosmic connection

Unit: II
Translation and rotation operators, The parity operation, Pion spin and parity, Parity of particles and antiparticles, Tests of parity conservation, Charge conjugation invariance, Charge conservation and gauge invariance, Baryon and lepton conservation, *CPT* invariance, *CP* violation and *T* violation, Neutron electric dipole moment, Isospin in the two-nucleon and pion-nucleon systems, strangeness and hypercharge

Unit: III
Elements of relativistic quantum mechanics, Klein-Gordon equation, Dirac equation, Dirac matrices, spinors, positive and negative energy solutions, physical interpretation, nonrelativistic limit of the Dirac equation, Helicity, Dirac bilinears

Unit: IV
Hyperfine Structure, Positronium, Quarkonium, baryon decuplet, Quark spin and colour, baryon octet, Quark-antiquark combinations: the light pseudoscalar mesons, light vector mesons, other tests of the quark model, Mass relations and hyperfine interactions, Magnetic moments of baryons, Mesons built of light and heavy quarks, The top quark

Unit: V
Introductory topics: Classical and quantum pictures of interactions, Yukawa theory of quantum exchange, boson propagator, Feynman diagrams, Electromagnetic interactions, Renormalisation and gauge invariance, Strong interactions, Weak and electroweak interactions, Gravitational interactions, The interaction cross-section, Decays and resonances

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
Level 4	Analyze	20%	-	20%	-	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
-	Prof. A C Sharma, GGSIP University, acsharma@gmail.com	Dr. Rohit Dhir, SRMIST
-	Prof. Alka Upadhayay, Thapar University, alka.iisc@gmail.com	Dr. Alok Kumar, SRMIST

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Course Code	UPY22H05T	Course Name	Quantum Materials and Devices	Course Category	C	Professional Core Course	L	T	P	C
							3	1	0	4

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1:	*Teach the basics of Second quantization and its applications.*	Bloom's Level
CLR-2:	*Approach quantum many body systems using Green's function and Path integral techniques.*	
CLR-3:	*Understand the basics of Quantum theory of magnetism and its applications to technologies.*	
CLR-4:	*Use NEGF formalism to understand quantum transport at nanoscale devices.*	
CLR-5:	*Give overview to basics of modern topological aspects in quantum materials and condensed matter physics.*	

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Learning
CLO-1:	*Analyze the behaviour of Fermi and Bose gas and their applications to real systems.*	4
CLO-2:	*Incorporate Green's function techniques and Keldysh formalism to quantum many body systems.*	4
CLO-3:	*Appreciate the insight about the interplay of spin in magnetic systems and its applications.*	4
CLO-4:	*Apply NEGF formalism to model quantum transport in nano electronic devices.*	4
CLO-5:	*Implement the concepts of topology to quantum materials.*	4

	Program Outcomes (PO)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1:	-	-	-	M	-	-	H	-	-	-	-	-	-	-	-
CLO-2:	-	-	H	-	H	-	-	-	-	-	-	-	-	-	-
CLO-3:	-	M	-	-	-	-	M	-	-	-	-	-	-	-	-
CLO-4:	-		-	-	M	-	M	-	-	-	-	-	-	-	-
CLO-5:	-	M	-	-	H	-	-	-	-	-	-	-	-	-	-

Unit-1: Elements of Quantum Statistics:
Review of quantum mechanics – Basics of second quantization - Creation and annihilation operators for Bosons and Fermions – Fermi-Dirac and Bose-Einstein statistics – Ideal Fermi and Bose gases – Free electron model – Bose-Einstein condensation – Laser cooling techniques – Superfluidity in ultracold atomic gases.

Unit-2: Green's Function Techniques in Quantum Many-Body Systems:
Schrodinger, Heisenberg and Interaction pictures – Overview of path integrals – Feynman path integral in real and imaginary time – Propagators – Spectral representations – Fourier transform of propagators – Equilibrium Green's function – Nonequilibrium Green's function (NEGF) - Overview of Keldysh formalism.

Unit-3: Quantum Theory of Magnetism:
Landau diamagnetism and Pauli paramagnetism – Kondo effect – Hubbard model - Magnetism in metals and insulators – Quantum spins – Heisenberg model – Magnetic tunnel-junction sensors – Magneto-resistive random access memory (MRAM) – Emerging memory technologies

Unit-4: Quantum Topological Materials:
Electrons in a magnetic field – Quantum Hall effect – Berry phases – Aharonov-Bohm effect - Berry curvature – Chern numbers - Majorana zero modes - Lieb and kagome lattices - Physics of the Kitaev Model

Unit-5: Quantum Transport at Nanoscale:
Kubo linear response theory - NEGF current operator - Lippmann-Schwinger scattering theory - Resonant tunnelling of electrons - NEGF-DFT for multi-terminal devices - Spin transport in semiconductor nanostructures – Spin-transfer torque (STT) – Spin-orbit torque (SOT) - Spin dynamics.

Learning Resources

1. *Quantum Wells, Wires and Dots-Theoretical and computational physics of semiconductor nanostructures* - Paul Harrison, Alex Valavanis., Wiley Publications, 2016
2. *Quantum theory of materials*- Efthimios Kaxiras, John D. Joannopoulos, Cambridge University Press, 2019
3. *Propagators for many particle systems* – Robert Mills, Gordon and Breach Science Publishers, 1969
4. *The Quantum theory of Magnetism* – Norberto Majlis, 2007
5. *Quantum Statistical Mechanics* – Leo P. Kadanoff and Gordon Baym, W. A. Benjamin, Inc, 2018
6. *Green's functions in Quantum physics* – E. N. Economou, Springer series in Solid-State Science, 2006

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%		20%		20%		20%		20%	
Level 2	Understand	20%		20%		20%		20%		20%	
Level 3	Apply	40%		40%		40%		40%		40%	
Level 4	Analyze	20%		20%		20%		20%		20%	
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
-	Dr. Ranjit Kumar Nanda, IIT Madras, nandab@iitm.ac.in	Dr. Arijit Sen, SRMIST
-	Prof. S Balakumar, University of Madras, balakumar@unom.ac.in	Dr. Jaivardhan Sinha, SRMIST

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