B. Tech in Electronics and Communication Engineering (with Specialization in Data Science)

(a) Mission of the Department

Mission Statement - 1	Build an educational process that is well suited to local needs as well as satisfies the national and international accreditation requirements
Mission Statement - 2	Attract the qualified professionals and retain them by building an environment that fosters work freedom and empowerment.
Mission Statement - 3	With the right talent pool, create knowledge and disseminate, get involved in collaborative research with reputed universities, and produce competent graduands.

(b) Program Educational Objectives (PEO)

The Program Educational Objectives for the Electronics and Communication Engineering program describe accomplishments that graduates are expected to attain within a few years of graduation.

PEO – 1	Establish themselves as successful and creative practicing professional engineers, both nationally and globally, in the related fields of Electronics and Communication Engineering.
PEO – 2	Apply the acquired knowledge and skills in solving real-world engineering problems; develop novel technology and design products which are economically feasible and socially relevant.
PEO – 3	Develop an attitude of lifelong learning for sustained career advancement and adapt to the changing multidisciplinary profession.
PEO – 4	Demonstrate leadership qualities, effective communication skills, and to work in a team of enterprising people in the multidisciplinary and multicultural environment with strong adherence to professional ethics.

(c) Mission of the Department to Program Educational Objectives (PEO) Mapping

	Mission Statement. - 1	Mission Statement. - 2	Mission Statement. – 3
PEO - 1	H	H	H
PEO - 2	L	M	H
PEO - 3	M	L	H
PEO - 4	H	H	H

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

(d) Mapping Program Educational Objectives (PEO) to Program Learning Outcomes (PLO)

	Program Learning Outcomes (PLO)														
	Graduate Attributes (GA)												Program Specific Outcomes (PSO)		
	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Design, Prototype and Test Modern ECE Systems	Project Management Techniques	Implement ECE Systems
PEO - 1	M	H	M	H	H								H		M
PEO - 2	H	H	H	H	H		H	M		L	H		H	L	H
PEO - 3							M		H	M		H	L		
PEO - 4						H		H	H	H	H			H	L

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

Program Specific Outcomes (PSO)

Graduates of baccalaureate degree program in ECE (with specialization in Data Science) must demonstrate knowledge and hands-on competence in the ability to:

PSO – 1	Collect and manage data from Electronics and Communication systems while also applying and evaluating models to devise solutions to data science tasks.
PSO – 2	Interpret data analysis outcomes and effectively communicate in various data formats
PSO – 3	Apply data analytics to monitor and optimize wired and wireless communication networks.

(e) Program Structure for B.Tech in Electronics and Communication Engineering with Specialization in Data Science

1. Humanities & Social Sciences including Management Courses (H)

Course Code	Course Title	Hours/ Week L	T	P	C
18LEH101J	English	2	0	2	3
18LEH102J	Chinese	2	0	2	3
18LEH103J	French				
18LEH104J	German				
18LEH105J	Japanese				
18LEH106J	Korean				
18PDH101L	General Aptitude	0	0	2	1
18PDH102T	Management Principles for Engineers	2	0	0	2
18PDH103J	Social Engineering	1	0	2	2
18PDH201L	Employability Skills & Practices	0	0	2	1
	Total Learning Credits				**12**

2. Basic Science Courses (B)

Course Code	Course Title	Hours/ Week L	T	P	C
18PYB101J	Physics: Electromagnetic Theory, Quantum Mechanics, Waves and Optics	3	1	2	5
18CYB101J	Chemistry	3	1	2	5
18MAB101T	Calculus and Linear Algebra	3	1	0	4
18MAB102T	Advanced Calculus and Complex Analysis	3	1	0	4
18MAB201T	Transforms and Boundary Value Problems	3	1	0	4
18MAB203T	Probability and Stochastic Process	3	1	0	4
18MAB302T	Discrete Mathematics for Engineers	3	1	0	4
18BTB101T	Biology	2	0	0	2
	Total Learning Credits				**32**

3. Engineering Science Courses (S)

Course Code	Course Title	Hours/ Week L	T	P	C
18MES101L	Engineering Graphics and Design	1	0	4	3
18EES101J	Basic Electrical and Electronics Engineering	3	1	2	5
18MES103L	Civil and Mechanical Engineering Workshop	1	0	4	3
18CSS101J	Programming for Problem Solving	3	0	4	5
18ECS201T	Control Systems	3	0	0	3
	Total Learning Credits				**19**

4. Professional Core Courses (C)

Course Code	Course Title	Hours/ Week L	T	P	C
18ECC102J	Electronic Devices	3	0	2	4
18ECC103J	Digital Electronic Principles	3	0	2	4
18ECC104T	Signals and Systems	3	1	0	4
18ECC105T	Electromagnetics and Transmission Lines	3	0	0	3
18ECC201J	Analog Electronic Circuits	3	0	2	4
18ECC202J	Linear Integrated Circuits	3	0	2	4
18ECC203J	Microprocessor, Microcontroller and Interfacing Techniques	3	0	2	4
18ECC204J	Digital Signal Processing	3	0	2	4
18ECC205J	Analog and Digital Communication	3	0	2	4
18ECC206J	VLSI Design	3	0	2	4
18ECC301T	Wireless Communications	3	1	0	4
18ECC302J	Microwave & Optical Communications	3	0	2	4
18ECC303J	Computer Communication Networks	3	0	2	4
18ECC350T	Comprehension	0	1	0	1
	Total Learning Credits				**52**

5. Professional Elective Courses (E)

Course Code	Course Title	Hours/ Week L	T	P	C
	Professional Elective – 1	3	0	0	3
	Professional Elective – 2	3	0	0	3
	Professional Elective – 3	3	0	0	3
	Professional Elective – 4	3	0	0	3
	Professional Elective – 5	3	0	0	3
	Professional Elective – 6	3	0	0	3
	Total Learning Credits				**18**

6. Open Elective Courses (O)

Course Code	Course Title	Hours/ Week L	T	P	C
	Open Elective – 1	3	0	0	3
	Open Elective – 2	3	0	0	3
	Open Elective – 3	3	0	0	3
	Open Elective – 4	3	0	0	3
	Total Learning Credits				**12**

7. Project Work, Seminar, Internship In Industry / Higher Technical Institutions (P)

Course Code	Course Title	Hours/ Week L	T	P	C
18ECP101L	Massive Open Online Course- I	0	0	2	1
18ECP102L	Industrial Training - I				
18ECP103L	Seminar – I				
18ECP104L	Massive Open Online Course- II	0	0	2	1
18ECP105L	Industrial Training - II				
18ECP106L	Seminar – II				
18ECP107L	Minor Project	0	0	6	3
18ECP108L	Internship (4-6 weeks)				
18ECP109L	Project	0	0	20	10
18ECP110L	Semester Internship				
Total Learning Credits					15

8. Mandatory Courses (M)

Course Code	Course Title	Hours/ Week L	T	P	C
18PDM101L	Professional Skills and Practices	0	0	2	0
18PDM201L	Competencies in Social Skills	0	0	2	0
18PDM203L	Entrepreneurial Skill Development				
18PDM202L	Critical and Creative Thinking Skills	0	0	2	0
18PDM204L	Business Basics for Entrepreneurs				
18PDM301L	Analytical and Logical Thinking Skills	0	0	2	0
19PDM302L	Entrepreneurship Management				
18LEM101T	Constitution of India	1	0	0	0
18LEM102J	Value Education	1	0	1	0
18GNM101L	Physical and Mental Health using Yoga	0	0	2	0
18GNM102L	NSS	0	0	2	0
18GNM103L	NCC				
18GNM104L	NSO				
18LEM109T	Indian Traditional Knowledge	1	0	0	0
18LEM110L	Indian Art Form	0	0	2	0
18CYM101T	Environmental Science	1	0	0	0
Total Learning Credits					-

List of Professional Elective Courses (E)
Any 6 Courses

Course Code	Course Title	Hours/ Week L	T	P	C
18ECE271T	Introduction to Data Science	3	0	0	3
18ECE272T	Statistical Inference Techniques	3	0	0	3
18ECE371T	Regression and Multivariate Data Analysis	3	0	0	3
18ECE372J	Python for Data Sciences	2	0	2	3
18ECE373T	Cloud and Distributed Computing	3	0	0	3
18ECE374J	Data Simulation through R	2	0	2	3
18ECE471T	Data Science for Communication Networks	3	0	0	3
18ECE472T	Data Base Management Systems	3	0	0	3
18ECE473T	Data Security	3	0	0	3
18ECE332T	Principles of Artificial Intelligence	3	0	0	3
18ECE339T	Data Analysis and Visualization	3	0	0	3
18CSE392T	Machine Learning - 1	3	0	0	3
18CSE391T	Big Data tools and Techniques	3	0	0	3
18CSE484T	Deep Learning	3	0	0	3
18CSE355T	Data Mining and Analytics	3	0	0	3

List of Open Elective Courses (O)
Any 4 Courses

Course Code	Course Title	Hours/ Week L	T	P	C
18ECO101T	Short-Range Wireless Communication	3	0	0	3
18ECO102J	Electronic Circuits & Systems	2	0	2	3
18ECO103T	Modern Wireless Communication Systems	3	0	0	3
18ECO104J	Audio and Speech Processing	2	0	2	3
18ECO105T	Underwater Acoustics	3	0	0	3
18ECO106J	PCB Design and Manufacturing	2	0	2	3
18ECO107T	Fiber Optics and Optoelectronics	3	0	0	3
18ECO108J	Embedded System Design using Arduino	2	0	2	3
18ECO109J	Embedded System Design using Raspberry Pi	2	0	2	3
18ECO110J	3D Printing Hardware and Software	2	0	2	3
18ECO131J	Virtual Instrumentation	2	0	2	3
18ECO132T	Analytical Instrumentation	3	0	0	3
18ECO133T	Sensors and Transducers	3	0	0	3
18ECO134T	Industrial Automation	3	0	0	3
18ECO135T	Fundamentals of MEMS	3	0	0	3
18ECO121T	Basics of Biomedical Engineering	3	0	0	3
18ECO122T	Hospital Information Systems	3	0	0	3
18ECO123T	Biomedical Imaging	3	0	0	3
18ECO124T	Human Assist Devices	3	0	0	3
18ECO125T	Quality Control for Biomedical Devices	3	0	0	3
18ECO126T	Sports Biomechanics	3	0	0	3

(f) Program Articulation for B.Tech in Electronics and Communication Engineering with Specialization in Data Science

Course Code	Course Name	Program Learning Outcomes (PLO)													
		Graduate Attributes											PSO		
		Engineering Knowledge	*Problem Analysis*	*Design & Development*	*Analysis, Design, Research*	*Modern Tool Usage*	*Society & Culture*	*Environment & Sustainability*	*Ethics*	*Individual & Team Work*	*Communication*	*Project Mgt. & Finance*	*Life Long Learning*	*PSO-1*	*PSO-2*	*PSO-3*
18ECS201T	Control Systems	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
18ECC102J	Electronic Devices	H		-	-	H	-	-	L	H	M	-	M	L	L	-
18ECC103J	Digital Electronic Principles	H	M	H	-	H	-	-	-	H	-	-	-	M	-	L
18ECC104T	Signals and Systems	H	H	M	M	M	-	-	-	-	-	-	-	L	-	L
18ECC105T	Electromagnetics and Transmission Lines	M	H	-	-		-	-	-	-	-	-	L		-	M
18ECC201J	Analog Electronic Circuits	L	M	H	-	M	-	-	-	M	-	-	M	H	L	
18ECC202J	Linear Integrated Circuits	H	M	H	-	M	-	-	-	M	-	-	-	H	L	H
18ECC203J	Microprocessor, Microcontroller and Interfacing Techniques	M	M	M	-	H	-	-	-	-	H	-	H	L	-	M
18ECC204J	Digital Signal Processing	H	M	H	-	-	-	-	-	-	-	-	-	M	-	H
18ECC205J	Analog and Digital Communication	M	H	H	M	H	-	-	-	H	H	-	M	H	M	H
18ECC206J	VLSI Design	H	M	M	-	H	-	-	-	H	M	L	M	-	-	M
18ECC301T	Wireless Communication	H	H	H	H	M	-	-	-	-	M	-	M	M	-	H
18ECC302J	Microwave & Optical Communications	H	H	H	M	-	-	-	-	-	-	-	-	M	-	M
18ECC303J	Computer Communication Networks	-	-	M	-	L	L	M	-	-	-	-	M	-	-	H
18ECC350T	Comprehension	H	H	M	L	L	L	L	L	L	L	L	L	M	M	M
18ECP101L/ 18ECP104L	Massive Open Online Course-I/II	-	-	-	-	-	M	L	-	-	H	-	H	-	M	-
18ECP102L/ 18ECP105L	Industrial Training-I/II	H	M	M	M	M	L	M	H	H	M	H	M	L	L	L
18ECP103L/ 18ECP106L	Seminar-I/II	-	M	M	H	-	M	H	-	-	H	-	M	-	-	-
18ECP107L/ 18ECP108L	Minor Project / Internship (4-6 weeks)	H	H	H	H	M	M	H	M	M	M	M	L	M	M	M
18ECP109L/ 18ECP110L	Project / Semester Internship	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
18ECE271T	Introduction to Data Science	M	-	-	H	H	-	-	-	-	-	-	L	H	M	H
18ECE272T	Statistical Inference Techniques	M	H	-	H	H	-	L	-	-	-	-	-		L	H
18ECE371T	Regression and Multivariate Data Analysis	L	H	-	H	H	-	-	H	M	-	-	M	H	L	-
18ECE372J	Python for Data Science	M	H	-	H	-	-	-	M	-	-	-	-	L	-	M
18ECE373T	Cloud and Distributed Computing	M	-	-	H	-	-	-	M	-	-	-	-	L	-	M
18ECE374J	Data Simulation through R	L	L	H	-	M	-	-	-	-	-	-	-	L	L	-
18ECE471T	Data Science for Communication Networks	H	-	M	M	L	-	-	-	-	-	-	M	L	L	-
18ECE472T	Data Base Management Systems	H	-	M	M	L	-	-	-	-	-	-	M	L	L	-
18ECE473T	Data Security	M	-	M	M	-	-	-	-	-	-	-	H	-	M	-
18CSE392T	Machine Learning - 1	M	H	M	M	-	-	-	-	-	-	-	H	-	M	-
18CSE391T	Big Data tools and Techniques	H	-	H	H	H	-	-	-	-	-	-	L	H	M	H
18ECE339T	Data Analysis and Visualization	M	-	-	-	-	M	L	-	-	-	-	H	-	M	-
18CSE484T	Deep Learning	H	H	-	-	H	-	-	-	-	-	-	H	H	H	-
18CSE355T	Data Mining and Analytics	M	-	-	-	H	L	H	M	-	-	-	-	L	-	M
18ECE332T	Principles of Artificial Intelligence	H	H	H	-	-	-	-	-	-	-	-	-	H	H	H

H – High Correlation, M – Medium Correlation, L – Low Correlation, PSO – Program Specific Outcomes (PSO)

(g) Implementation Plan for B.Tech in Electronics and Communication Engineering with Specialization in Data Science

Semester - I

Code	Course Title	Hours/ Week L	T	P	C
18LEH102J-18LEH106J	Foreign Language (Chinese/ French/ German/ Japanese / Korean)	2	0	2	3
18MAB101T	Calculus and Linear Algebra	3	1	0	4
18CYB101J	Chemistry	3	1	2	5
18CSS101J	Programming for Problem Solving	3	0	4	5
18MES103L	Civil and Mechanical Engineering Workshop	1	0	4	3
18PDM101L	Professional Skills and Practices	0	0	2	0
18LEM102J	Value Education	1	0	1	0
18GNM102L	NCC / NSS / NSO	0	0	2	0
	Total Learning Credits				20

Semester – II

Code	Course Title	Hours/ Week L	T	P	C
18LEH101J	English	2	0	2	3
18MAB102T	Advanced Calculus and Complex Analysis	3	1	0	4
18PYB101J	Physics: Electromagnetic Theory, Quantum Mechanics, Waves and Optics	3	1	2	5
18MES101L	Engineering Graphics and Design	1	0	4	3
18EES101J	Basic Electrical and Electronics Engineering	3	1	2	5
18PDH101L	General Aptitude	0	0	2	1
18LEM101T	Constitution of India	1	0	0	0
18GNM101L	Physical and Mental Health using Yoga	0	0	2	0
	Total Learning Credits				21

Semester - III

Code	Course Title	Hours/ Week L	T	P	C
18MAB201T	Transforms and Boundary Value Problems	3	1	0	4
18ECS201T	Control Systems	3	0	0	3
18ECC102J	Electronic Devices	3	0	2	4
18ECC103J	Digital Electronic Principles	3	0	2	4
18ECC104T	Signals and Systems	3	1	0	4
18ECC105T	Electromagnetics and Transmission Lines	3	0	0	3
18PDH103J	Social Engineering	1	0	2	2
18PDM201L	Competencies in Social Skills	0	0	2	0
18CYM101T	Environmental Science	1	0	0	0
	Total Learning Credits				24

Semester - IV

Code	Course Title	Hours/ Week L	T	P	C
18MAB203T	Probability and Stochastic Process	3	1	0	4
18BTB101T	Biology	2	0	0	2
18ECC201J	Analog Electronic Circuits	3	0	2	4
18ECC202J	Linear Integrated Circuits	3	0	2	4
	Professional Elective-1	3	0	0	3
	Open Elective-1	3	0	0	3
18PDH102T	Management Principles for Engineers	2	0	0	2
18PDM202L	Critical and Creative Thinking Skills	0	0	2	0
	Total Learning Credits				22

Semester - V

Code	Course Title	Hours/ Week L	T	P	C
18MAB302T	Discrete Mathematics for Engineers	3	1	0	4
18ECC203J	Microprocessor, Microcontroller and Interfacing Techniques	3	0	2	4
18ECC204J	Digital Signal Processing	3	0	2	4
18ECC205J	Analog and Digital Communication	3	0	2	4
	Professional Elective – 2	3	0	0	3
	Open Elective – 2	3	0	0	3
18ECP101L/ 18ECP102L/ 18ECP103L	Massive Open Online Course-I / Industrial Training-I / Seminar-I	0	0	2	1
18PDM301L	Analytical and Logical Thinking Skills	0	0	2	0
18LEM110L	Indian Art Form	0	0	2	0
	Total Learning Credits				23

Semester - VI

Code	Course Title	Hours/ Week L	T	P	C
18ECC206J	VLSI Design	3	0	2	4
18ECC302J	Microwave and Optical Communications	3	0	2	4
18ECC303J	Computer Communication Networks	3	0	2	4
18ECC350T	Comprehension	0	1	0	1
	Professional Elective-3	3	0	0	3
	Professional Elective-4	3	0	0	3
	Open Elective-3	3	0	0	3
18ECP104L/ 18ECP105L/ 18ECP106L	Massive Open Online Course-II / Industrial Training-II / Seminar-II	0	0	2	1
18PDH201L	Employability Skills and Practices	0	0	2	1
18LEM109T	Indian Traditional Knowledge	1	0	0	0
	Total Learning Credits				24

Semester - VII

Code	Course Title	Hours/ Week L	T	P	C
18ECC301T	Wireless Communications	3	1	0	4
	Professional Elective-5	3	0	0	3
	Professional Elective-6	3	0	0	3
	Open Elective-4	3	0	0	3
18ECP107L / 18ECP108L	Minor Project / Internship (4-6 weeks)	0	0	6	3
	Total Learning Credits				16

Semester - VIII

Code	Course Title	Hours/ Week L	T	P	C
18ECP109L / 18ECP110L	Project / Semester Internship	0	0	20	10
	Total Learning Credits				10

B. Tech in Electronics and Communication Engineering

(with Specialization in Data Science)

2018 Regulations

Engineering Science Courses (S)

Department of Electronics and Communication Engineering
SRM Institute of Science and Technology
SRM Nagar, Kattankulathur – 603203, Kancheepuram District, Tamilnadu

Course Code	18ECS201T	Course Name	CONTROL SYSTEMS	Course Category		Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18MAB102T	Co-requisite Courses	18ECC104T	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards		Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Learn about mathematical modeling techniques of mechanical and electrical systems			
CLR-2 :	Impart knowledge about the transient and steady state error and analysis			
CLR-3 :	Identify and analyze stability of a system in time domain using root locus technique			
CLR-4 :	Know about different frequency domain analytical techniques			
CLR-5 :	Acquire the knowledge of a controller for specific applications			
CLR-6 :	Impart knowledge on controller tuning methods			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)															
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Determine Transfer function of a system by mathematical modeling, block diagram reduction and signal flow graphs	1,2	80	80	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-2 :	Identify the standard test inputs, time domain specifications and calculate steady state error	1,2	85	80	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-3 :	Plot a root locus curve and analyze the system stability using Routh array	2,3	90	85	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-4 :	Analyze the frequency domain specifications from bode and polar plots	2,3	90	85	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-5 :	Design a closed loop control system for specific application	1,2,3	80	80	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-6 :	Identification of controller parameters and tuning	1,2,3	85	85	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Open and closed loop control system	Standard test signals and their expression	Poles and zeros of a system	Frequency domain analysis	Controllers-Significance and Need
	SLO-2	Feedback and Feed forward control systems	Type number and order of a system	Pole zero plot and concept of s plane	Frequency domain specifications	Stability of closed loop systems
S-2	SLO-1	Transfer function of a system and basis of Laplace transforms	Transfer function of First order system for Step and ramp signal	Proper, Strictly Proper and Improper systems	Frequency domain plots, minimum and non minimum phase systems	SISO and MIMO control systems
	SLO-2	Need for mathematical modeling	Transfer function of First order system Impulse and parabolic signal	Characteristic equation	Correlation between time and frequency domain	Types of controllers-ON-OFF,P,I,D
S-3	SLO-1	Representation of mechanical translational systems using differential equation and determination of transfer function	General transfer function of second order system	Concept of stability from pole zero location	Bode plot approach and stability analysis	Composite Controller-PI,PD and PID
	SLO-2		Identification of damping factor and classification based on it	Need for Stability analysis and available techniques	Rules for sketching bode plot	Controller parameters and tuning methods
S-4	SLO-1	Representation of mechanical rotational systems and determination of transfer function	Step response of critically damped second order system	Necessary and sufficient Condition for stability	Bode plot of typical systems	Design Specification, controller configurations- ON-OFF controller
	SLO-2		Step response of under damped second order system	Significance of Routh Hurwitz Technique		
S-5	SLO-1	Conversions of Mechanical system to Electrical system	Step response of over damped second order system	Computation of Routh array	Bode plot of typical systems	Design Specification, controller configurations-PID controller
	SLO-2	f-V and f-I electrical analogies	Step response of undamped second order system	Routh array of stable systems		

S-6	**SLO-1**	*Block diagram reduction rules and methodology*	*Time domain specifications and their significance*	*Routh array of Unstable systems*	*Polar plot and significance*	*Design of speed control system for DC motor*
	SLO-2		*Numerical solution*	*Routh array of Unstable systems*	*Nyquist stability criterion*	
S-7	**SLO-1**	*Evaluation of transfer function using block diagram reduction*	*Transient and steady state error analysis*	*Root locus technique*	*Sketching of polar plot on polar graphs*	*Design of control system for Twin Rotor Multi input Multi output System(TRMS) with one degree of freedom*
	SLO-2		*Static and dynamic Error coefficients*	*Rules for sketching root locus*		
S-8	SLO-1	*Signal flow graphs and evaluation of transfer function*	*Static error constants and evaluation of steady state error*	*Root locus plot of typical systems*	*Polar plot of typical systems*	*Case study 1*
	SLO-2					
S-9	SLO-1	*Block diagram to signal flow conversion*	*Dynamic error constants and evaluation of steady state error*	*Root locus plot of typical systems*	*Polar plot of typical systems*	*Case study 2*
	SLO-2					

Learning Resources	*1.* Nagrath.J and Gopal.M,, "Control System Engineering", 5th Edition, New Age, 2007 2. Benjamin C Kuo, "Automatic Control System", 9th edition, John Wiley & Sons, 2010	3. Gopal.M, "Control System Principles and Design", 2nd Edition, TMH, 2002 4. Sivanandam and Deepa, "Control system Engineering using MATLAB", 2nd edition, Vikas publishers, 2007

Learning Assessment						
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)				Final Examination (50% weightage)
		CLA – 1 (10%)	CLA – 2 (15%)	CLA – 3 (15%)	CLA – 4 (10%)	
Level 1	Remember	*40%*	*30%*	*30%*	*30%*	*30%*
	Understand					
Level 2	Apply	*40%*	*40%*	*40%*	*40%*	*40%*
	Analyze					
Level 3	Evaluate	*20%*	*30%*	*30%*	*30%*	*30%*
	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
1. *Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com*	1. *Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*Dr. T. Deepa, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*Mrs. R. Bakhya Lakshmi, SRMIST*

B. Tech in Electronics and Communication Engineering (with specialization in Data Science)

2018 Regulations

Professional Core Courses (C)

Department of Electronics and Communication Engineering
SRM Institute of Science and Technology
SRM Nagar, Kattankulathur – 603203, Kancheepuram District, Tamilnadu

Course Code	18ECC102J	Course Name	ELECTRONIC DEVICES	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18EES101J	Co-requisite Courses	Nil	Progressive Courses	18ECC201J, 18ECC202J, 18ECE203T, 18ECE303T, 18ECE321T, 18ECE322T
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Provide a basis for understanding semiconductor material, how a pn junction is formed and its principle of operation			
CLR-2 :	Explain the importance of diode in electronic circuits by presenting appropriate diode applications			
CLR-3 :	Discuss the basic characteristics of several other types of diodes that are designed for specific applications			
CLR-4 :	Describe the basic structure, operation and characteristics of BJT, and discuss its use as a switch and an amplifier.			
CLR-5 :	Describe the basic structure, operation and characteristics of MOSFET, and discuss its use as a switch and an amplifier.			
CLR-6 :	Use modern engineering tools such as PSPICE to carry out design experiments and gain experience with instruments and methods used by technicians and electronic engineers			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Explain the operation, characteristics, parameters and specifications of semiconductor diodes and special diodes	1	60	70	H	-	-	-	-	-	-	-	-	-	-	M	-	-	-
CLO-2 :	Illustrate important applications of semiconductor diodes and special diodes.	2	60	70	-	-	-	-	-	-	-	-	-	-	-	M	-	-	-
CLO-3 :	Review bipolar transistor construction, operation, characteristics and parameters, as well as its application in amplification and switching.	1	60	70	H	-	-	-	-	-	-	-	-	-	-	M	-	-	-
CLO-4 :	Review field-effect transistor construction, operation, characteristics and parameters, as well as its application in amplification and switching.	1	60	70	H	-	-	-	-	-	-	-	-	-	-	M	-	L	-
CLO-5 :	Construct a circuit, then make functional measurements to understand the operating characteristics of the device / circuit.	3	70	75	-	-	-	-	H	-	-	-	-	-	-	-	L	L	-
CLO-6 :	Solve specific design problem, which after completion will be verified using modern engineering tools such as PSPICE.	2	70	75	-	-	-	-	H	-	-	L	H	M	-	M	-	-	-

Duration (hour)		Semiconductor Diodes	Diode Circuits	Special Diodes	Bipolar Junction Transistors	MOS Field-Effect Transistors
		15	15	15	15	15
S-1	SLO-1	Basic semiconductor theory: Intrinsic & extrinsic semiconductors	HWR operation, Efficiency and ripple factor	Backward diode	Physical structure	Physical structure
	SLO-2	Current flow in semiconductors	Problem solving	Varactor diode	Device operation of BJT	Device operation of E-MOSFET & D-MOSFET
S-2	SLO-1	PN junction theory: Equilibrium PN junction	Center-Tapped Transformer FWR operation, Efficiency and ripple factor	Step recovery diode	Current-Voltage characteristics of CE BJT configuration	I-V characteristics of E-MOSFET
	SLO-2	Forward biased PN junction	Problem solving	Point-contact diode	Current-Voltage characteristics of CE BJT configuration	Problem solving
S-3	SLO-1	Reverse biased PN junction	Bridge FWR operation, Efficiency and ripple factor	Metal-semiconductor junction: Structure, Energy band diagram	Current-Voltage characteristics of CB BJT configuration	Derive drain current
	SLO-2	Relation between Current and Voltage	Problem solving	Forward & Reverse Characteristics of Schottky Diode	Current-Voltage characteristics of CB BJT configuration	Problem solving
S 4-5	SLO-1	Lab 1: PN Junction Diode Characteristics	Lab 4: Diode clipping and clamping circuits	Lab 7: Series and Shunt Regulators	Lab 10: BJT and MOSFET Switching Circuits	Lab 13: Repeat Experiments
	SLO-2					
S-6	SLO-1	Calculate depletion width	Filters: Inductor & Capacitor Filters	Tunnel Diode	Current-Voltage characteristics of CC BJT configuration	Derive transconductance
	SLO-2	Calculate barrier potential	Problem solving	Tunnel Diode	Current-Voltage characteristics of CC BJT configuration	Problem solving

S-7	SLO-1	*Derive diode current equation*	*Filters: LC & CLC Filters*	*Gunn Diode*	*BJT as an amplifier*	*CMOS FET*
	SLO-2	*Derive diode current equation*	*Problem solving*	*Gunn Diode*	*BJT as a switch*	*MOSFET as an amplifier*
S-8	SLO-1	*Effect of Capacitance in PN junction: Transition Capacitance*	*Diode Clippers*	*IMPATT Diode*	*BJT circuit models – h-parameter*	*MOSFET as a switch*
	SLO-2	*Diffusion Capacitance*	*Problem solving*	*IMPATT Diode*	*BJT circuit models – hybrid-π parameter*	*Problem solving*
S 9-10	SLO-1 SLO-2	*Lab 2: Zener diode characteristics*	*Lab 5: BJT Characteristics*	*Lab 8: MOSFET Characteristics*	*Lab 11: Photoconductive Cell, LED, and Solar Cell Characteristics*	*Lab-14: Model Examination*
S-11	SLO-1	*Energy band structure of PN Junction Diode*	*Diode Clampers*	*PIN Diode*	*BJT biasing circuits and stability analysis: Base bias and emitter bias*	*Biasing Circuits for MOSFET: Gate Bias*
	SLO-2	*Ideal diode and its current-voltage characteristics*	*Problem solving*	*PIN Photodiode*	*Problem solving*	*Problem Solving*
S-12	SLO-1	*Terminal characteristics & parameters*	*Voltage Multipliers*	*Avalanche photodiode*	*Voltage-divider bias*	*Self-bias*
	SLO-2	*Diode modeling*	*Zener diode: Characteristics, breakdown mechanisms*	*Laser diode*	*Problem solving*	*Problem Solving*
S-13	SLO-1	*DC load line and analysis*	*Zener resistances and temperature effects Zener diode as voltage regulator*	*Problem solving*	*Collector-feedback bias*	*Voltage-divider bias*
	SLO-2	*Problem solving*	*Problem solving*	*Problem solving*	*Problem solving*	*Problem Solving*
S 14-15	SLO-1 SLO-2	*Lab 3: Diode rectifier circuits*	*Lab 6: BJT Biasing Circuits*	*Lab 9: MOSFET Biasing Circuits*	*Lab 12: Simulation experiments using PSPICE*	*Lab 15: End-Semester Practical Examination*

Learning Resources	1. *David A. Bell, Electronic Devices and Circuits, 5th ed., Oxford University Press, 2015* 2. *Donald Neamen, Electronic Circuits: Analysis and Design, 3rd ed., McGraw-Hill Education, 2011* 3. *Adel S. Sedra, Kenneth C. Smith, Microelectronic Circuits: Theory and Applications, OUP, 2014* 4. *Thomas L. Floyd, Electronic Devices", 9th ed., Pearson Education, 2013*	5. *Robert L. Boylestad, Louis Nashelsky, Electronic Devices and Circuit Theory, 11th ed., Pearson Education, 2013* 6. *Muhammad Rashid, Microelectronic Circuits: Analysis & Design, 2nd ed., Cengage Learning, 2010* 7. *Muhammed H Rashid, Introduction to Pspice using OrCAD for circuits and electronics, 3rd ed., Pearson, 2004* 8. *Laboratory Manual, Department of ECE, SRM University*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		-	

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*1. Mr. Manikandan AVM, SRMIST*
2. Mr. Hariharasudhan – Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*2. Dr. Diwakar R Marur, SRMIST*

Course Code	18ECC103J	Course Name	DIGITAL ELECTRONIC PRINCIPLES	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18EES101J	Co-requisite Courses	Nil	Progressive Courses	18ECC203J, 18ECC206J, 18ECE206J
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLR-1 :	Understand binary codes, digital arithmetic operations and able to simplify Boolean logic expressions																		
CLR-2 :	Describe how basic TTL and CMOS gates operate at the component level																		
CLR-3 :	Able to design simple combinational logics using basic gates and MSI circuits																		
CLR-4 :	Familiarize with basic sequential logic components: flip-flops, registers, counters and their usage, and able to design and analyze sequential logic circuits and Finite State Machines.																		
CLR-5 :	Know how to implement logic circuits using PLDs.																		
CLR-6 :	Use modern engineering tools such as PSPICE / Logisim to carry out design experiments and gain experience with instruments and methods used by technicians and electronic engineers																		
CLO-1 :	Simplify Boolean expressions; carry out arithmetic operations with binary numbers; apply parity method for error detection and correction.	1	90	75	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Explain the operational characteristics / properties of digital ICs; implement gates as well as other types of IC devices using two major IC technologies, TTL and CMOS.	1	80	70	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Identify eight basic types of fixed-function combinational logic functions and demonstrate how the devices / circuits can be used in building complete digital systems such as computers.	2,3	90	75	-	M	H	-	H	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Analyze and design Mealy and Moore models of sequential circuits using several types of flip-flops.	2,3	90	75	-	M	H	-	H	-	-	-	-	-	-	-	-	-	-
CLO-5 :	Implement multiple output combinational logic circuits using PLDs; Explain the operation of a CPLD and FPGA.	2	80	75	-	M	H	-	L	-	-	-	-	-	-	-	-	-	-
CLO-6 :	Solve specific design problem, which after completion will be verified using modern engineering tools such as PSPICE / Logisim	2	90	75	-	M	H	-	H	-	-	-	H	-	-	-	M	-	L

Duration (hour)		Binary Codes, Digital Arithmetic and Simplification of Boolean Functions	Logic Families	Combinational Systems	Sequential Systems	Memory and Programmable Logic
		15	15	15	15	15
S-1	SLO-1	Binary Codes, Digital Arithmetic and Simplification of Boolean Functions	Introduction	Binary arithmetic units	Flip-flop and Latch: SR latch,	RAM Memory decoding
	SLO-2	Error detecting codes	TTL Logic Family	Adder	JK flip-flop, T flip-flop, D flip-flop	ROM
S-2	SLO-1	Error correcting code	Totem-pole TTL	Design of Half adder	Master-slave RS flip-flop	Programmable Logic Devices (PLDs): Basic concepts
	SLO-2	Hamming Code	open-collector and tristate TTL	Design of Full adder	Master-slave JK flip-flop	PROM
S-3	SLO-1	Arithmetic number representation	Schottkey TTL, standard TTL characteristics	Subtractor	Registers & Counters	PROM as PLD
	SLO-2	Binary arithmetic	Metal Oxide Semiconductor logic families	Design subtractor using logic gates	Shift registers (SISO, SIPO, PISO, PIPO)	Programmable Array Logic (PAL)
S 4-5	SLO-1 SLO-2	LAB 1: Study of logic gates	LAB 4: Design and implement encoder and decoder using logic gates	LAB 7: Implement combinational logic functions using standard ICs	LAB 10: Design and implement Synchronous Counters	LAB 13: Construct combinational circuit using Logisim

S-6	SLO-1	*Hexadecimal arithmetic*	*N-MOS*	*n-bit parallel adder & subtractor*	*Universal shift register*	*Programmable Array Logic (PAL)*
	SLO-2	*Hexadecimal arithmetic*	*P-MOS*	*look ahead carry generator*	*Counters: Asynchronous/Ripple counters*	*Programmable Logic Array (PLA)*
S-7	SLO-1	*BCD arithmetic simplification*	*CMOS logic circuits*	*Decoder*	*Synchronous counters, Modulus-n Counter*	*Programmable Logic Array (PLA)*
	SLO-2	*Minimization of Boolean Functions: Algebraic simplification*	*Characteristics of MOS logic*	*Encoder*	*Ring counter, Johnson counter*	*Design combinational circuits using PLD's*
S-8	SLO-1	*Problems on Algebraic simplification*	*Compare MOS logic circuits(CMOS) with TTL digital circuit*	*Multiplexer*	*Up-Down counter*	*Design combinational circuits using PLD's*
	SLO-2	*Karnaugh map simplification*	*Electrical characteristics*	*Demultiplexer*	*Mealy and Moore model*	*Design combinational circuits using PLD's*
S 9-10	SLO-1 SLO-2	*LAB 2: Design and implement Adder and Subtractor using logic gates*	*LAB 5: Design and implement Multiplexer and Demultiplexer using logic gates*	*LAB 8: Verify characteristic table of flip-flops*	*LAB 11: Construct and verify shift registers*	*LAB 14: Model Practical Examination*
S-11	SLO-1	*Problems on Karnaugh map simplification*	*Fan-out*	*Code converters*	*Synchronous (Clocked) sequential circuits*	*Design of combinational circuits using PLD's*
	SLO-2	*Problems on Karnaugh map simplification*	*Propagation Delay*	*Magnitude comparators*	*Synchronous (Clocked) sequential circuits*	*Design sequential circuits using PLD's*
S-12	SLO-1	*Quine McCluskey*	*Power dissipation*	*Magnitude comparators*	*Synchronous (Clocked) sequential circuits*	*Design sequential circuits using PLD's*
	SLO-2	*Tabulation method*	*Noise margin*	*Parity generators (Odd parity)*	*Analyze and design synchronous sequential circuits*	*Design sequential circuits using PLD's*
S-13	SLO-1	*Problems on Quine McCluskey or Tabulation method.*	*Supply voltage levels*	*Parity generators (Even parity)*	*State reduction*	*Design sequential circuits using PLD's*
	SLO-2	*Exercise problems using Tabulation method*	*Operational voltage levels*	*Implementation of combinational logic by standard IC's.*	*State assignment*	*Design sequential circuits using PLD's*
S 14-15	SLO-1 SLO-2	*Lab 3: Design and Implement 2-bit Magnitude Comparator using logic gates*	*LAB-6: Design and implement code converters using logic gates*	*LAB 9: Construct and verify 4-bit ripple counter, Mod-10/Mod-12 ripple counters*	*Lab 12: Construct mini project work*	*LAB 15: University Practical Exam*

Learning Resources	1. *Morris Mano M, Michael D. Ciletti, Digital Design with an Introduction to the Verilog HDL, 5th ed., Pearson Education, 2014* 2. *Charles H Roth (Jr), Larry L. Kinney, Fundamentals of Logic Design, 5th ed., Cengage Learning India Edition, 2010* 3. *Thomas L. Floyd, Digital Fundamentals, 10th ed., Pearson Education, 2013*	4. *Ronald J. Tocci, Digital System Principles and Applications, 10th ed., Pearson Education, 2009* 5. *Donald P Leach, Albert Paul Malvino, Goutam Saha, Digital Principles and Applications, 6th ed., Tata-Mcgraw Hill, 2008* 6. *LAB MANUAL, Department of ECE, SRM University*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
r. Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		-	

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

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Experts from Industry	Experts from Higher Technical Institutions	Internal Experts

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Course Code	18ECC104T	Course Name	SIGNALS AND SYSTEMS	Course Category	C	Professional Core	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	18MAB201T	Progressive Courses	18ECC204J, 18ECS201T, 18ECE240T, 18ECE241J
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards			Nil

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Know about requirements of signal and system analysis in communication.			
CLR-2 :	Understand the analysis of Periodic and Aperiodic Continuous time Signals using Fourier series and transforms			
CLR-3 :	Educate about Continuous time system through Laplace transform and Convolution integral			
CLR-4 :	Understand the characterization of the Discrete time signals and system through DTFT, Convolution sum			
CLR-5 :	Understand the concept of Z-Transform for the analysis of DT system			
CLR-6 :	Develop expertise in time-domain and frequency domain approaches to the analysis of continuous and discrete systems and also the ability to apply modern computation software tool for the analysis of electrical engineering problems			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)															
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research	
CLO-1 :	Understand the various classifications of Signals and Systems	1	65	60	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CLO-2 :	Analyze Periodic and Aperiodic Continuous time Signals using Fourier series and Fourier Transform	2	65	60	-	H	-	-	-	-	-	-	-	-	-	-	-	-	-	
CLO-3 :	Analyze and characterize the Continuous time system through Laplace transform and Convolution integral.	2	65	60	-	H	-	-	-	-	-	-	-	-	-	-	-	-	-	
CLO-4 :	Analyze and characterize the Discrete time signals and system through DTFT, Convolution sum	2	65	60	-	H	M	-	-	-	-	-	-	-	-	-	-	-	-	
CLO-5 :	Analyze and characterize the Discrete time system using Z transform	2	65	60	-	H	M	-	-	-	-	-	-	-	-	-	-	-	L	
CLO-6 :	Apply the mathematical techniques used for continuous-time signal and discrete-time signal and system analysis	2	65	60	-	H	-	M	M	-	-	-	-	-	-	-	L	-	-	

Duration (hour)		Classification of Signals and Systems	Analysis of Continuous Time Signals	Analysis of LTI CT System	Analysis of DT Signals and Systems	Analysis of LTI DT System using Z-Transform
		12	12	12	12	12
S-1	SLO-1	Introduction to signals and systems	Introduction to Fourier series	System modeling	Representation of sequences	Z transform – introduction
	SLO-2	Requirements of signal and system analysis in communication	Representation of Continuous time Periodic signals	Description of differential equations	Discrete frequency spectrum and range	Region of convergence of finite duration sequences
S-2	SLO-1	Continuous time signals (CT signals)	Fourier series: Trigonometric representation	Solution of Differential equation	Discrete Time Fourier Transform (DTFT) – Existence	Properties of ROC
	SLO-2	Discrete time signals (DT signals)	Fourier series: Trigonometric representation	Differential equation: Zero initial conditions	DTFT of standard signals	Properties of ROC
S-3	SLO-1	Representation of signals: Step, Ramp, Pulse, Impulse	Fourier series: Cosine representation	Differential equation: Zero state response	Properties of DTFT	Properties of Z transform
	SLO-2	Representation of signals: Sinusoidal, Exponential	Fourier series: Cosine representation	Differential equation: Zero Input response	Properties of DTFT	Properties of Z transform
S-4	SLO-1	Basic operation on the signals	Symmetry conditions	Total Response	Inverse DTFT	Unilateral z transforms
	SLO-2	Problems on signal operations	Properties of Continuous time Fourier series	Step response	Practice on IDTFT	Properties of z transform
S-5	SLO-1	Classification of CT and DT signals: Periodic & Aperiodic signals.	Practice problems on Fourier series	Impulse response	Impulse response of a system with DTFT	Bilateral Z transforms

	SLO-2	Classification of CT and DT signals: Deterministic & Random signals.	Practice problems on Fourier series	Frequency response	Frequency response of a system with DTFT	Properties of z transform
S-6	SLO-1	Energy signal	Gibb's Phenomenon	Convolution integral	Practice problems	Relation between DTFT and Z transform
	SLO-2	Power signal	Parseval's relation for power signals	Properties of convolution	Practice problems	Practice problems
S-7	SLO-1	Even & Odd signals	Power density spectrum,	Practice Problems	Solution of linear constant coefficient difference equations	condition for causality in Z domain
	SLO-2	Even & Odd signals	Frequency spectrum.	Practice Problems	Initial conditions	condition for stability in Z domain
S-8	SLO-1	CT systems and DT systems	Fourier transform: Introduction	Signal and system analysis with Laplace transform	Solution of difference equations	Inverse Z transform
	SLO-2	Classification of systems: Static & Dynamic	Representation of Continuous time signals	Convergence of Laplace Transform	Zero input response	Power series expansion
S-9	SLO-1	Superposition theorem	Properties of Continuous time Fourier transform	Properties of Laplace transform	Solution of difference equations with Zero state response	Inverse Z transform with Partial fraction
	SLO-2	Linear & Nonlinear system	Properties of Continuous time Fourier transform	Properties of Laplace transform	Total response	Inverse Z transform with Partial fraction
S-10	SLO-1	Time-variant & Time-invariant system	Parseval's relation for energy signals	Inverse Laplace transform	Evaluation of Impulse response	Residue method
	SLO-2	Time-invariant system	Energy density spectrum	Problems	Evaluation of Step response	Convolution method
S-11	SLO-1	Causal system	Analysis of LTI system using Fourier Transform	Analysis and characterization of LTI system using Laplace transform	Convolution Properties	Analysis and characterization of DT system using Z-transform
	SLO-2	Noncausal system	Analysis of LTI system using Fourier Transform	Analysis and characterization of LTI system using Laplace transform	Convolution Sum	Analysis and characterization of DT system using Z-transform
S-12	SLO-1	Stable & Unstable,LTI System	Practice problems on Fourier Transform	Practice problems on Laplace transform	Circular convolution	Practice problems on LTI-DT systems in Z transform
	SLO-2	Unstable, LTI System	Practice problems on Fourier Transform	Practice problems on Laplace transform	Frequency response	Practice problems on LTI-DT systems in Z transform

Learning Resources	1. Alan V Oppenheim, Ronald W. Schafer Signals & Systems, 2nd ed., Pearson Education, 2015 2. P.Ramakrishna Rao, Shankar Prakriya, Signals & Systems, 2nd ed., McGraw Hill Education, 2015 3. Simon Haykin, Barry Van Veen, Signals and Systems, 2nd ed., John Wiley & Sons Inc., 2007 4. Lathi B.P, Linear Systems & Signals, 2nd ed., Oxford Press, 2009 5. John G. Proakis, Manolakis, Digital Signal Processing, Principles, Algorithms and Applications, 4th ed., Pearson Education, 2007. 6. Software: Matlab Student Version Release 2011a, Mathworks, Inc. The Matlab Student Version and toolboxes may be purchased through the Mathworks website at http://www.mathworks.com/

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
Level 2	Apply Analyze	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
Level 3	Evaluate Create	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	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
1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu	1. Dr. A. Ruhan Bevi, SRMIST

2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	2. Dr. D. Malathi, SRMIST

Course Code	18ECC105T	Course Name	ELECTROMAGNETICS AND TRANSMISSION LINES	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18PYB101J	Co-requisite Courses	Nil	Progressive Courses	18ECC301T
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards		Clark's Table, IS : 456-2000	

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Gain knowledge on the basic concepts and insights of Electric field			
CLR-2 :	Gain knowledge on the basic concepts and insights of Magnetic field and Emphasize the significance of Maxwell's equations.			
CLR-3 :	Interpret the wave propagation in guided waveguide.			
CLR-4 :	Acquire the fundamental knowledge on Transmission Line Theory.			
CLR-5 :	Acquire the knowledge on transmission line parameter calculation and impedance matching concepts.			
CLR-6 :	Acquire knowledge on theoretical concepts and analysis techniques to find solutions for problems related to electromagnetic wave propagation and Transmission line Theory.			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Apply the concepts and knowledge to solve problems related to electric field.	2	60	60	M	H	-	-	-	-	-	-	-	-	-	-	-	-	L
CLO-2 :	Analyze the concepts of Magnetic field and Maxwell's equations in the real world application.	2	60	60	H	M	-	-	-	-	-	-	-	-	-	-	-	-	L
CLO-3 :	Translate the phenomenon of guided wave propagation and its mode of propagation.	1	60	60	H	M	-	-	-	-	-	-	-	-	-	-	-	-	L
CLO-4 :	Describe the importance of transmission line theory applicable to low frequency transmission lines.	1	60	60	M	H	-	-	-	-	-	-	-	-	-	-	-	-	L
CLO-5 :	Solve transmission line parameter and impedance matching through analytical and graphical methods.	2	60	60	M	H	-	-	-	-	-	-	-	-	-	-	-	-	M
CLO-6 :	Demonstrate how electromagnetic waves are generated using Maxwell's equations and how Transmission lines are used to transfer electromagnetic energy from one point to another with minimum losses over a wideband of frequencies.	2	60	60	M	H	-	-	-	-	-	-	-	-	-	L	-	-	H

Duration (hour)		Electrostatics	Magnetostatics and Maxwells Equations	Electromagnetic Waves and Waveguides	Transmission Line Theory	Transmission Line Calculator and Impedance Matching
		9	9	9	9	9
S-1	SLO-1	Introduction	Energy density in electrostatic field	Introduction	Transmission line parameters	Introduction
	SLO-2	Rectangular co-ordinate	Problem discussion.	Waves in general	Transmission line parameters	Smith chart Introduction
S-2	SLO-1	Cylindrical & Spherical Co-ordinate	Biot savart law-Magnetic field intensity due to Infinite line charge	Plane wave in lossless dielectric	Transmission line equivalent circuit	Reflection coefficient, Standing wave ratio Input impedance calculation in smith chart
	SLO-2	Review of vector calculus	H- due finite and semi finite line charge	Plane wave in free space	Explanation	Practice problems.
S-3	SLO-1	Coulomb's Law and field intensity	Ampere's circuital law& application: Infinite line current	Plane wave in good conductor	Transmission line equation derivation	Single stub matching Introduction
	SLO-2	Problem based on coulomb's law	Infinite Sheet current	Problems based on plane waves in lossless, free space and good conductor	Problem discussion.	Procedure for single stub matching
S-4	SLO-1	Electric field due to continuous charge distribution-.Concept	Infinitely long coaxial Transmission line	Rectangular waveguide	Transmission line characteristics: lossless line	Problems solving in smith chart
	SLO-2	Derivation of E due Infinite Line charge	Problem based on ACL.	Rectangular waveguide-Problems	Distortionless line.	Problems solving in smith chart

S-5	SLO-1	*Electric field due to sheet charge*	*Magnetic flux density*	*Transverse Electric (TE) mode*	*Input impedance derivation*	*Impedance matching using Quarter wave transformer*
	SLO-2	*Problem based on sheet charge*	*Problem based on magnetic field and flux.*	*Transverse Electric (TE) mode-problems*	*Problems for input impedance calculation.*	*Problems.*
S-6	SLO-1	*Electric field due to volume charge*	*Maxwell's equation for static field*	*Transverse Electric (TE) mode*	*Standing wave ratio*	*Single stub tuner*
	SLO-2	*Electric flux density*	*Faraday's law*	*Transverse Electric (TE) mode-Problems*	*Calculation of standing wave ratio.*	*Problem discussion*
S-7	SLO-1	*Gauss law application-point charge*	*Transformer EMF*	*Wave propagation in guide*	*Reflection coefficient*	*Slotted Line (Impedance Measurement)*
	SLO-2	*Electric flux due infinite line charge*	*Motional EMF*	*Problem discussion*	*Problem discussion.*	*Problem discussion*
S-8	SLO-1	*Electric flux due sheet charge*	*Displacement current.*	*Power Transmission*	*Shorted line, open circuited line*	*Transmission Lines as circuit Elements*
	SLO-2	*Electric flux due coaxial cable*	*Maxwell's equation in time varying field*	*Calculation of Pavg and Ptotal*	*Matched line*	*Problem discussion*
S-9	SLO-1	*Relation between E&V*	*Time varying potential concepts*	*Power attenuation*	*Power calculations*	*Additional smith chart problem solving.*
	SLO-2	*Electric dipole and flux lines*	*Time varying potential derivation.*	*Calculation of αTE and αTE*	*Problem discussion.*	*Additional smith chart problem solving.*

Learning Resources	1. *Matthew N. O. Sadiku., S. V. Kulkarni, Elements of Electromagnetics, 6th ed., Oxford University Press, 2015* 2. *G. S. N. Raju, Electromagnetic Field Theory and Transmission Lines, Pearson Education, 2006* 3. *Nannapaneni Narayana Rao, Principles of Engineering Electromagnetics,6th ed., Pearson Education, 2016*	4. *William H. Hayt,Jr., John A.Buck., Engineering Electromagnetics, 8th ed., Tata McGraw-Hill 2012* 5. *John D.Ryder, Networks, Lines and Fields, PHI, 2009*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	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
1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*1. Dr. P. Eswaran, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECC201J	Course Name	ANALOG ELECTRONIC CIRCUITS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18ECC102J	Co-requisite Courses	18ECC202J	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Understand the operation and design of BJT amplifier circuits for a given specification			
CLR-2 :	Understand the operation and design of MOSFET amplifier circuits for a given specification			
CLR-3 :	Understand the effects of negative feedback on amplifier circuits, and analyze the different RC and LC oscillator circuits to determine the frequency of oscillation			
CLR-4 :	Understand the operation and design of various types of power amplifier circuits.			
CLR-5 :	Understand how matched transistor characteristics are used in the IC design and to be able to design BJT and MOSFET current sources.			
CLR-6 :	Gain hands-on experience to put theoretical concepts learned in the course to practice.			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Analyze and design bipolar amplifier circuits to meet certain specifications, and to Analyze the frequency response of amplifier circuits, taking into account various circuit capacitors, to determine the bandwidth of the circuit.	2,3	70	70	L	M	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Analyze and design MOSFET amplifier circuits to meet certain specifications, and to Analyze the frequency response of amplifier circuits, taking into account various circuit capacitors, to determine the bandwidth of the circuit.	2,3	70	70	L	M	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Understand the characteristics and principles of feedback amplifier circuits and oscillator circuits to analyze and design circuits to meet certain specifications.	2,3	70	70	L	M	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Analyze three principle classes of power amplifiers, and determine the maximum possible conversion efficiency of each type of power amplifier	2,3	70	70	L	M	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	Design the basic circuit building blocks that are used in the design of IC amplifiers, namely current mirrors and sources	2,3	70	70	L	M	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	Analyze and design analog electronic circuits using discrete components, and take measurement of various analog circuits to compare experimental results in the laboratory with theoretical analysis.	3	90	80	-	-	H	-	M	-	-	-	M	-	-	M	H	L	-

Duration (hour)		BJT Amplifiers	FET Amplifiers	Feedback amplifies & Oscillators	Oscillators & Power Amplifiers	IC Biasing & Amplifiers with Active Load
		15	15	15	15	15
S-1	SLO-1	Overview of DC analysis of BJT circuits	Overview of FET DC circuit analysis	Basic feedback concepts, general feedback structure	Crystal Oscillators	BJT current sources: Cascode current source, Widlar current source
	SLO-2	Overview of BJT models	Problem solving	Properties of negative feedback	Problem solving	Multi-transistor current source Problem solving
S-2	SLO-1	AC load line analysis	Graphical analysis, load lines, and small-signal models	Feedback Topologies: Voltage-Series & Current-Series feedback connections	Negative-resistance oscillator	FET current sources: 2-transistor MOSFET current source
	SLO-2	Problem solving	Problem solving	Problem solving	Problem solving	Problem solving
S-3	SLO-1	AC analysis of Common-Emitter BJT amplifier config. using hybrid-π model	AC analysis of Common-Source MOSFET amplifier configuration	Feedback Topologies: Voltage-Shunt & Current-Shunt feedback connections	Power Amplifiers: Definitions and amplifier types	FET current sources: Cascode current mirror and Wilson current mirror
	SLO-2	Problem solving	Problem solving	Problem solving	Q point placement	Problem solving
S 4-5	SLO-1 SLO-2	Lab 1: Learning to design amplifier and oscillator circuits	Lab 4: Design & analyze differential amplifier with resistive load	Lab 7: Design and analyze RC oscillators	Lab 10: BJT & FET Current Sources	Lab 13: Design and analyze differential amplifier with active load
S-6	SLO-1	AC analysis of Common-Base BJT amplifier configuration using hybrid-π model	AC analysis of Common-Gate MOSFET amplifier configuration	Practical Feedback Amplifier Circuits	Maximum dissipation hyperbola	Analysis of CE BJT amplifier circuit with active load

	SLO-2	Problem solving	Problem solving	Problem solving	Heat sink	Problem solving
S-7	SLO-1	AC analysis of Common-Collector BJT amplifier config. using hybrid-π model	AC analysis of Common-Drain MOSFET amplifier configuration	Oscillators: Principles of Oscillation	Class A amplifier	Analysis of CS FET amplifier circuit with active load
	SLO-2	Problem solving	Problem solving	Types of Oscillators	Problem solving	Problem solving
S-8	SLO-1	Multi-stage amplifier configurations: CE - CE, CE - CC amplifiers	BiFET amplifier configuration	Audio Frequency Oscillators: RC Phase-Shift Oscillator	Class B and Class AB push-pull amplifiers	DC and small-signal analysis of basic BJT differential pairs
	SLO-2	Problem solving	Problem solving	Problem solving	Problem solving	Problem solving
S 9-10	SLO-1	Lab 2: Design and analyze BJT amplifier configurations	Lab 5: Design and analyze negative feedback amplifier configurations	Lab 8: Design and analyze LC oscillators	Lab 11: Design and analyze BJT CE amplifier with active load	Lab 14: Model Practical Examination
	SLO-2					
S-11	SLO-1	Multi-stage amplifier configurations: CE - CB, and CC - CC amplifiers	Low Frequency response analysis of a basic FET CS amplifier	Audio Frequency Oscillators: Wein Bridge Oscillator	Class C amplifiers	DC and small-signal analysis of basic FET differential pairs
	SLO-2	Problem solving	Problem Solving	Problem Solving	Problem solving	Problem solving
S-12	SLO-1	Low Frequency response analysis of a basic BJT CE amplifier	High Frequency response analysis of a basic FET CS amplifier	Radio Frequency Oscillators: Hartley Oscillator	Class D and Class E amplifiers	Analysis of BJT differential amplifier with active load
	SLO-2	Problem Solving	Problem Solving	Problem solving	Amplifier distortions	Problem solving
S-13	SLO-1	High Frequency response analysis of a basic BJT CE amplifier	Design problems in MOSFET amplifier configurations	Radio Frequency Oscillators: Colpitts & Clapp Oscillators	IC Biasing & Amplifiers with Active Load: BJT current sources: 2- & 3-transistor current sources	Analysis of FET differential amplifier with active load
	SLO-2	Problem Solving	Operational voltage levels	Problem solving	Problem solving	Problem solving
S 14-15	SLO-1	Lab 3: Design and analyze multistage amplifier configurations	Lab 6: Design and analyze MOSFET amplifier configurations	Lab 9: Classes of power amplifier (efficiency calculation)	Lab 12: Design and analyze FET CS amplifier with active load	Lab 15: End Semester Practical Examination
	SLO-2					

Learning Resources	1. David A. Bell, Electronic Devices and Circuits, 5th ed., Oxford University Press, 2015 2. Donald Neamen, Electronic Circuits: Analysis and Design, 3rd ed., McGraw-Hill Education, 2011 3. Muhammad Rashid, Microelectronic Circuits: Analysis & Design, 2nd ed., Cengage Learning, 2010 4. Adel S. Sedra, Kenneth C. Smith, Microelectronic Circuits: Theory and Applications, OUP, 2014	5. Robert L. Boylestad, Louis Nashelsky, Electronic Devices and Circuit Theory, 11th ed., Pearson Education, 2013 6. Albert P. Malvino, David J. Bates, Electronic Principles, 8th ed., Tata McGraw Hill, 2015

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
r. Level 1	Remember	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
	Understand										
Level 2	Apply	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Analyze										
Level 3	Evaluate	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Create										
	Total	100 %		100 %		100 %		100 %		-	

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	2. Dr. M. Sangeetha, SRMIST

Course Code	18ECC202J	Course Name	LINEAR INTEGRATED CIRCUITS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18ECC102J	Co-requisite Courses	18ECC201J	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Study the basic principles, configurations and practical limitations of op-amp			
CLR-2 :	Understand the various linear and non-linear applications of op-amp			
CLR-3 :	Understand the operation and analysis of op-amp oscillators, single chip oscillators and frequency generators			
CLR-4 :	Identify the active filter types, filter response characteristics, filter parameters and IC voltage regulators.			
CLR-5 :	Gain knowledge on data converter terminology, its performance parameters, and various circuit arrangements for A/D and D/A conversions.			
CLR-6 :	Gain hands-on experience to put theoretical concepts learned in the course to practice.			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)															
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Infer the DC and AC characteristics of operational amplifiers and its effect on output and their compensation techniques	3	80	70	H	M	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Elucidate and design the linear and non-linear applications of an opamp and special application ICs	3	85	75	-	M	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Explain and compare the working of multivibrators using special application IC 555 and general purpose opamp	3	75	70	-	M	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Classify and comprehend the working principle of data converters and active filters	3	85	80	-	M	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	Illustrate the function of application specific ICs such as Voltage regulators, PLL and its application in communication	3	85	75	-	M	H	-	-	-	-	-	-	-	-	-	M	-	H
CLO-6 :	Analyze and design electronic circuits and systems using linear ICs, and take measurement of various analog circuits to compare experimental results in the laboratory with theoretical analysis	3	85	75	-	M	H	-	M	-	-	-	M	-	-	-	H	L	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Op-amp symbol, terminals, packages	Basic op-amp circuits: Inverting & Non-inverting voltage amplifiers	Waveform Generators: Sine-wave Generators - Design	Filters: Comparison between Passive and Active Networks	Digital to Analog Conversion: DAC Specifications
	SLO-2	Op-amp-Specifications	Voltage follower	Implementation & Solving problems	Active Network Design	Solving problems
S-2	SLO-1	Block diagram Representation of op-amp	Summing, scaling & averaging amplifiers,	Square Wave generators- Design	Filter Approximations	Weighted Resistor DAC
	SLO-2	Ideal op-amp & practical op-amp - Open loop & closed loop configurations	AC amplifiers	Implementation & Solving problems	Design of LPF & Solving problems	Solving problems
S-3	SLO-1	DC performance characteristics of op-amp	Linear Applications: Instrumentation Amplifiers	Triangle wave generators	Design of HPF & Solving problems	R-2R Ladder DAC
	SLO-2	Solving Problems	Instrumentation Amplifiers, Solving Problems	Saw-tooth Wave generators.	Design of BPF& Solving problems	Solving problems
S 4-5	SLO-1	Lab-1:Basic op-amp circuits	Lab 4: Comparators	Lab 7: Waveform generators: using op-amp & 555 Timer	Lab 10: Design of LPF, HPF, BPF and Band Reject Filters	Lab 13: Flash Type ADC
	SLO-2					
S-6	SLO-1	AC performance characteristics of op-amp	V-to-I Converters	IC 555 Timer: Circuit schematic	Design of Band Reject Filters	Inverted R-2R Ladder DAC
	SLO-2	Solving Problems	I-to-V converters	Operation and its applications	Solving problems	Monolithic DAC
S-7	SLO-1	Frequency response	Differentiators	IC 555 Timer: Monostable operation	State Variable Filters – All Pass Filters,	Analog to Digital conversion: ADC specifications
	SLO-2	Frequency response	Integrators	Applications & Solving problems	Solving problems	Solving problems

S-8	SLO-1	*Frequency compensation*	*Non-linear Applications: Precision Rectifiers*	*IC 555 Timer: Astable operation*	*Switched Capacitor Filters.*	*Ramp Type ADC*
	SLO-2	*Frequency compensation*	*Wave Shaping Circuits (Clipper and Clampers)*	*Applications & Solving problems*	*Solving problems*	*Solving problems*
S 9-10	SLO-1 SLO-2	*Lab 2: Integrators and Differentiators*	*Lab 5: Wave shaping circuits*	*Lab 8: Waveform generators: using op-amp & 555 Timer*	*Lab 11: IC Voltage regulators*	*Lab 14: Simulation experiments using EDA tools*
S-11	SLO-1	*Basic op-amp internal schematic*	*Log and Antilog Amplifiers,*	*PLL: Operation of the Basic PLL*	*Voltage Regulators: Basics of Voltage Regulator*	*Successive Approximation ADC*
	SLO-2	*operations of blocks*	*Analog voltage multiplier circuit and its applications,*	*Closed loop analysis of PLL*	*Specifications and characteristic parameters*	*Solving problems*
S-12	SLO-1	*Basic op-amp internal schematic*	*Operational Trans-Conductance Amplifier (OTA)*	*Voltage Controlled Oscillator*	*Linear Voltage Regulators using Op-amp,*	*Dual Slope ADC*
	SLO-2	*operations of blocks*	*Comparators : operation*	*Solving problems*	*IC Regulators (78xx, 79xx, LM 317, LM 337, 723),*	*Flash Type ADC,*
S-13	SLO-1	*Review of data sheet of an op-amp.*	*Comparators applications*	*PLL applications*	*Switching Regulators -operation*	*Solving problems on Flash Type ADC,*
	SLO-2	*Solving Problems*	*Sample and Hold circuit.*	*Solving problems*	*Types*	*Monolithic ADC*
S 14-15	SLO-1 SLO-2	*Lab 3: Rectifiers*	*Lab 6: Waveform generators: using op-amp & 555 Timer*	*Lab 9: Design of LPF, HPF, BPF and Band Reject Filters*	*Lab 12: R-2R ladder DAC*	*Lab 15: Simulation experiments using EDA tools*

Learning Resources

1. *Ramakant A. Gayakwad, Op-Amps and Linear Integrated Circuits, 4th ed., Prentice Hall, 2000*
2. *David A. Bell, Operational Amplifiers and Linear ICs, 3rd ed., OUP, 2013*
3. *Roy Choudhury, Shail Jain, Linear Integrated Circuits, 4th ed., New Age International Publishers, 2014*
4. *Robert F. Coughlin, Frederick F. Driscoll, Operational-Amplifiers and Linear Integrated Circuits, 6th ed., Prentice Hall, 2001*
5. *Sergio Franco, Design with operational amplifier and analog integrated circuits, McGraw Hill, 1997*
6. *LABORATORY MANUAL, Department of ECE, SRM University*
7. *David A Bell, Laboratory Manual for Operational Amplifiers & Linear ICs, 2nd ed., D.A. Bell, 2001*
8. *David La Lond, Experiments in Principles of Electronic Devices and Circuits, Delmar Publishers, 1993*
9. *Muhammed H Rashid, Introduction to PSpice using OrCAD for circuits and electronics, 3rd ed., Pearson, 2004*
10. *L. K. Maheshwari, M. M. S. Anand, Laboratory Experiments and PSPICE Simulations in Analog Electronics, PHI, 2006*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
Level 2	Apply Analyze	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 3	Evaluate Create	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Total	100 %		100 %		100 %		100 %		-	

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*1. Mr. Manikandan AVM, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*2. Dr. M. Sangeetha, SRMIST*

Course Code	18ECC203J	Course Name	Microprocessor, Microcontroller and Interfacing Techniques	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18ECC103J	Co-requisite Courses	Nil	Progressive Courses	18ECE204J, 18ECE205J
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards		Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Understand basic architecture of Intel 8086 microprocessor and Intel 8051 Microcontroller			
CLR-2 :	Familiarize the students with the programming and interfacing of microprocessors and microcontrollers with memory and peripheral chips			
CLR-3 :	Interface a microprocessor / microcontroller to external I/O devices and perform I/O device programming in assembly			
CLR-4 :	Use the computer to write and assemble ALPs and also run them by downloading them to the target microprocessor			
CLR-5 :	Understand the hardware / software interrupts and their applications, and as well the serial port programming			
CLR-6 :	Provide strong foundation for designing real world applications using microprocessors and microcontrollers.			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)															
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Apply a basic concept of digital fundamentals to Microprocessor based personal computer system	1	60	70	-	H	-	-	L	-	-	-	-	-	-		-	-	-
CLO-2 :	Solve basic binary math operations using the microprocessor. / microcontroller	2	60	70	M	-	-	-		-	-	-	-	-	-	M	-	-	-
CLO-3 :	Demonstrate programming proficiency using the various addressing modes of the target microprocessor / microcontroller	3	60	70	-	M	H	-	H	-	-	-	-	-	-		-	-	L
CLO-4 :	Distinguish and analyze the properties of Microprocessors & Microcontrollers.	1	60	70	-	M	-	-		-	-	-	-	-	-	H	-	-	-
CLO-5 :	Illustrate their practical knowledge through laboratory experiments.	3	60	70	-	M	M	-	H	-	-	-	-	H	-		-	-	H
CLO-6 :	Design, interface and program memory chips and various peripheral chips with microprocessor / microcontroller	3	60	70	-	-	M	-	H	-	-	-	-		-	H	L	-	M

		Learning Unit / Module 1: Intel 8086 – Architecture, Signals and Features	Learning Unit / Module 2: Programming with Intel 8086	Learning Unit / Module 3: 8086 Interfacing with Memory and Programmable Devices	Learning Unit / Module 4: Intel 8051 – Architecture and Programming	Learning Unit / Module 5: Interfacing of 8051
Duration (hour)		15	15	15	15	15
S-1	SLO-1	Introduction: History of computers, Block diagram of a microcomputer	Addressing modes of 8086	Semiconductor memory interfacing	Introduction: Differences between microprocessor and microcontroller	8051 parallel ports, and
	SLO-2	Intel 80x86 evolutions		Dynamic RAM interfacing	Intel's family of 8-bit microcontrollers, and feature of 8051 microcontroller	its programming
S-2	SLO-1	Features of 8086 microprocessor	Instruction Set of 8086: Data Transfer Instructions	Programmable Peripheral Interface 8255	Architecture of 8051	8051 timers, and
	SLO-2	Register organization of 8086	Example programs	Interfacing 8255 with 8086 and programming	Architecture of 8051	its programming
S-3	SLO-1	Architecture of 8086	Data Conversion Instructions, Arithmetic Instructions	Interfacing ADC with 8086 and programming	Signal descriptions of 8051	8051 interrupts, and
	SLO-2	Architecture of 8086	Example programs	Interfacing DAC with 8086 and programming	Signal descriptions of 8051	its programming
S-4,5	SLO-1	**Lab-1: (a) Learning to Program with 8086 processor kit; Learning the hardware features of the 8086 processor kit**	**Lab-4: General Purpose Programming in 8086**	**Lab-7: Interfacing DAC / ADC with 8086 / 8051**	**Lab-10: Programming timer / counter in 8086 / 8051**	**Lab-13: Simulation of 8051 using Keil Software**
	SLO-2					
S-6	SLO-1	Instruction queue and pipelining	Logical instructions and Processor control instructions	Stepper Motor interfacing – concept	Register set of 8051	8051 serial port, and
	SLO-2	Segmentation of memory used with 8086	Example programs	Example programs	Operational features of 8051	its programming
S-7	SLO-1	Methods of generating physical address in 8086	String instructions	Programmable Interval Timer 8254	Memory and I/O addressing by 8051	Interfacing program memory with 8086

	SLO-2	Pin signals of 8086: Common signals	Example programs	Interfacing 8254 with 8086 and programming	Interrupts and Stack of 8051	Interfacing data memory with 8086
S-8	**SLO-1**	Minimum mode signals	Branch Instructions	Programmable Interrupt Controller 8259	Addressing modes of 8051	Interfacing input devices: push-button / matrix keypad
	SLO-2	Maximum mode signals	Example programs	Interfacing 8259 with 8086 and programming	Example programs	Example programs
S-9,10	**SLO-1**	Lab-2: General Purpose Programing in 8086	Lab-5: **Simulation of 8086 using MASM Software / 8086 Emulator**	**Lab-8: Interfacing DC motor / stepper motor / servo motor with 8086 / 8051**	**Lab-11: Programming interrupts in 8086 / 8051**	**Lab-14: Model Practical Exam**
	SLO-2					
S-11	SLO-1	Minimum mode 8086 system, and	Assembly Language Programming of 8086	Programmable Keyboard / Display Controller 8279	8051 Instruction Set: Arithmetic and Logical Instructions	Interfacing display devices: LED / 7-segment / LCD displays
	SLO-2	Timings	Assembly Language Programming of 8086	Interfacing 8279 with 8086 and programming	Example Programs	Example programs
S-12	SLO-1	Maximum mode 8086 system, and	Stack structure, and	Programmable Communication Interface 8251 USART	Data Transfer Instructions	Interfacing DAC
	SLO-2	Timings	related programming	Interfacing 8251 with 8086 and programming	Example Programs	Interfacing ADC
S-13	SLO-1	Intel 8088 Microprocessor: Pins signals and Architecture	Interrupt structure, and	DMA Controller 8257	Boolean Variable Instructions and Branch Instructions	Interfacing DC motor / stepper motor / servo motor
	SLO-2	Differences between 8086 & 8088 microprocessors	related programming	Interfacing 8257 with 8086 and programming	Example Programs	Example programs
S-14,15	SLO-1	**Lab-3:** General Purpose Programing in 8086	**Lab-6: Interfacing 8255 with 8086 / 8051**	**Lab-9: General Purpose Programming in 8051**	**Lab-10: Programming serial communication in 8086 / 8051**	**Lab-15: End-Semester Exam**
	SLO-2					

Learning Resources	1. K. M. Bhurchandi and A. K. Ray, "Advanced Microprocessors and Peripherals-with ARM and an Introduction to Microcontrollers and Interfacing ", Tata McGraw Hill, 3rd edition 2015 2. MuhammadAli Mazidi and Janice GillispieMazidi, "The 8051 - Microcontroller and Embedded systems", 7th Edition, Pearson Education, 2011. 3. Doughlas.V.Hall, "Microprocessor and Interfacing : Programming and Hardware", 3rd edition, McGraw Hill, 2015	4. Kenneth.J.Ayala, "8051 Microcontroller Architecture, Programming and Applications", 3rd edition, Thomson, 2007 5. Subrataghoshal " 8051 Microcontroller Internals Instructions ,Programming And Interfacing",2nd edition Pearson 2010 6. Yu-cheng Liu, Glenn A.Gibson, "Microcomputer systems: The 8086/8088 family-Architecture,programming and design",2nd edition, Prentice Hall of India,2007

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
	Understand										
Level 2	Apply	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Analyze										
Level 3	Evaluate	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	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
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2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	

Course Code	18ECC204J	Course Name	DIGITAL SIGNAL PROCESSING	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18ECC104T	Co-requisite Courses	Nil	Progressive Courses	18ECE243J, 18ECE244J, 18ECE245T
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards			Nil

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Understand the operations involved in digital conversion of analog signals.			
CLR-2 :	Realize a digital filter in direct, cascade and parallel forms. Perform efficient computation of DFT using radix 2 FFT			
CLR-3 :	Design digital FIR filter using windowing technique and frequency sampling methods.			
CLR-4 :	Design IIR filters using both direct method and method involving conversion of analog filter to digital filter			
CLR-5 :	Understand sampling rate conversion and apply it for applications like QMF, sub band coding.			
CLR-6 :	Utilize the techniques for digital conversions, filter designs and multi rate signal processing to solve real time problems			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)															
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Determine the knowledge of sampling and quantization and understand the errors that arise due to quantization.	1	80	70	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Understand the concept of DFT and its efficient computation by using FFT algorithm.	1	75	70	-	M	-	-	-	-	-	-	-	-	-	-	-	-	
CLO-3 :	Design FIR filters using several methods	3	75	70	-	M	H	-	-	-	-	-	-	-	-	-	-	-	H
CLO-4 :	Design IIR filters using several methods	3	75	70	-	-	H	-	-	-	-	-	-	-	-	-	-	-	H
CLO-5 :	Discuss the basics of multirate DSP and its applications.	1	70	70	-	M	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	Apply the concepts of digital filter designs and multi rate signal processing for real time signals	2	70	70	-	M	-	-	-	-	-	-	-	-	-	-	M	-	-

		Learning Unit / Module 1: Signals and Waveforms	Learning Unit / Module 2: Frequency Transformations	Learning Unit / Module 3: FIR Filters	Learning Unit / Module 4: IIR Filters	Learning Unit / Module 5: Multirate signal Processing
Duration (hour)		15	15	15	15	15
S-1	SLO-1	Basic Elements of DSP	Realization of digital filters Direct form of realization	Design of Linear Phase FIR filters General consideration	Design of digital IIR filters Comparison of FIR and IIR filters	Introduction to Multirate signal processing
	SLO-2	Advantages and applications of DSP	Cascade form of realization	Causality and its implication Characteristics of practical frequency selective filters	Analog IIR filter design	Decimation
S-2	SLO-1	Continuous Time vs Discrete time signals	Parallel form of realization	Frequency response of symmetric FIR filter	Properties of Butterworth filters	Interpolation
	SLO-2	Continuous valued vs discrete valued signals	Introduction to DFT	N is odd	Properties of chebyshev filters Comparison of Butterworth and chebyshev filters	Spectrum of interpolated signal
S-3	SLO-1	Concepts of frequency in analog signals	Computation of DFT	Frequency response of symmetric FIR filter	Analog IIR filter design	Sampling rate conversion by a rational factor I/D
	SLO-2	Continuous and discrete time sinusoidal signals	Properties of DFT Periodicity, linearity and symmetry properties	N is even	Design of low pass Butterworth filter	Anti-aliasing and anti-imaging filters
S-4	SLO-1	**Lab 1 :Generation of basic signals**	**Lab 7: Linear convolution**	**Lab 13: Design of digital FIR Low Pass and High Pass filter using rectangular window**	**Lab 19: Design of analog Butterworth filter**	**Lab 25: Interpolation**
	SLO-2					
S-5	SLO-1	**Lab 2: Unit step, ramp and impulse**	**Lab 8: Circular convolution**	**Lab14: Design of digital FIR Band Pass and Band Stop filter using rectangular window**	**Lab 20: Design of analog Chebyshev filter**	**Lab 26: Effect of interpolation in frequency domain**
	SLO-2					
S-6	SLO-1	Sampling of analog signals Sampling theorem	Circular convolution	Frequency response of antisymmetric FIR filter	Analog IIR filter design	Polyphase structure of decimator Polyphase decimation using z transform

	SLO-2	Aliasing Quantization of continuous amplitude signals	Matrix method and concentric circle method	N is odd and N is even	Design of low pass Chebyshev filter	Polyphase structure of interpolator Polyphase interpolation using z transform
S-7	SLO-1	Analog to digital conversion Sample and hold,	Efficient Computation of the DFT	Design of FIR filters Fourier series method	Design of digital filters Impulse invariance method	Advantages of multirate DSP
	SLO-2	Quantization and coding	Divide and Conquer Approach to Computation of the DFT Using FFT	Need for filter design using window Comparison of various windowing techniques	Design of digital filters Bilinear transformation	Applications of multirate DSP
S-8	SLO-1	Oversampling A/D converters	N Point DFT Decimation-in-Time FFT Radix-2 FFT Algorithm	Filter Design using windowing technique	Design of digital filters Impulse invariance method	Practical Applications of multirate DSP
	SLO-2	Digital to analog conversion Sample and hold	N Point DFT Decimation-in-Frequency FFT	Rectangular window	Design of digital filters Bilinear transformation	interfacing of digital systems with different sampling rates
S-9	SLO-1	Lab 3: Generation of waveforms	Lab9: Autocorrelation and cross correlation	Lab 15: Design of digital FIR Low Pass and High Pass filter using Hanning and Hamming window	Lab 21: Design of digital Butterworth filter using impulse invariance method	Lab 27: Decimation
	SLO-2					
S-10	SLO-1	**Lab 4: Continuous and discrete time**	**Lab10: Spectrum analysis using DFT**	**Lab 16: Design of digital FIR Band Pass and Band Stop filter using Hanning and Hamming window**	**Lab 22: Design of digital Butterworth filter using bilinear transformation**	**Lab 28: Effect of decimation in frequency domain**
	SLO-2					
S-11	SLO-1	Oversampling D/A converters	Radix-2 FFT Algorithm Implementation of FFT Using DIT	Filter Design using windowing technique Hanning window	Design of digital Chebyshev filters	Practical Applications of multirate DSP Sub band coding of speech signals
	SLO-2	Quantization noise	Implementation of FFT Using DIF	Filter Design using windowing technique Hamming window	Impulse invariance method	Filter banks Analysis filter bank
S-12	SLO-1	Errors due to truncation	IDFT	Filter Design using windowing technique	Design of digital Chebyshev filters	Synthesis filter bank
	SLO-2	Probability of error	Using DIT FFT	Blackmann window	Bilinear transformation	Subband coding filterbank
S-13	SLO-1	Errors due to rounding	IDFT	Design of FIR filters	Frequency transformation in analog domain	Quadrature Mirror Filter
	SLO-2	Probability of error	Using DIF FFT	Frequency sampling method	Frequency transformation in digital domain	Alias free filter bank
S-14	SLO-1	**Lab 5: Study of sampling theorem**	**Lab 11: Efficient computation of DFT using FFT**	**Lab 17: Design of digital FIR Low Pass, High Pass, Band pass and band stop filter using Blackmann window**	**Lab 23: Design of digital Chebyshev filter using impulse invariance method**	**Lab 29: Design of anti-aliasing filter**
	SLO-2					
S-15	SLO-1	**Lab 6: Aliasing effects**	**Lab12: Computation of IDFT**	**Lab 18: Design of digital FIR filter using frequency sampling method**	**Lab 24: Design of digital Chebyshev filter using bilinear transformation**	**Lab 30: Design of anti-imaging filter**
	SLO-2					

Learning Resources	1. John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing, Principles, Algorithms and Applications", Pearson Education, 4th edition, 2014 2. Alan V. Oppenheim, Ronald W. Schafer, "Discrete-Time Signal Processing", Pearson Education, 1st edition, 2015	3. Sanjit Mitra, "Digital Signal Processing –A Computer Based Approach", McGraw Hill, India, 4th Edition, 2013. 4. Fredric J. Harris, "Multirate Signal Processing for Communication Systems",1st edition, Pearson Education, 2007

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	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.,

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Course Code	18ECC205J	Course Name	ANALOG AND DIGITAL COMMUNICATION	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18MAB203T	Co-requisite Courses	Nil	Progressive Courses	18ECC301T, 18ECC302J, 18ECE221T & 18ECE223T
Course Offering Department	ECE	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Introduce and Understand the need for modulation, various Amplitude modulators/demodulators, frequency modulators and demodulators
CLR-2 :	Comprehend the radio transmitters and receivers using the modulators and demodulators and to analyze the noise performance
CLR-3 :	Introduce basics of Digital modulation and detection techniques
CLR-4 :	Analyze the pass band data transmission techniques in terms of probability of error
CLR-5 :	Introduce basics of spread spectrum techniques and information theory concepts
CLR-6 :	Gain hands-on experience to put theoretical concepts learned in the course to practice.

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Understand the concepts of analog modulation and demodulation techniques	2	80	70	M	-	-	-	-	-	-	-	-	H	-	-	H	-	-
CLO-2 :	Learn the function of radio transmitters and receivers and familiarize with noise performance of various receivers	2	85	75	-	M	H	-	-	-	-	-	-	-	-	-	H	-	-
CLO-3 :	Understand various digital modulation schemes and matched filter receiver	2	75	70	M	-	-	-	-	-	-	-	-	-	-	-	-	M	H
CLO-4 :	Understand and analyze various digital pass band data transmission schemes	2	85	80	-	-	-	M	-	-	-	-	-	-	-	-	-	M	-
CLO-5 :	Understanding data transmission using spread spectrum and error coding techniques	2	85	75	-	H	-	-	-	-	-	-	-	-	-	-	M	-	H
CLO-6 :	Analyze the operation of analog and digital communication systems and take measurement of various communication systems to compare experimental results in the laboratory with theoretical analysis	2	85	75	-	-	H	-	H	-	-	-	H	-	-	M	-	M	H

		Analog Modulation	Radio Transmitters and Receivers	Digital Modulation System and Baseband Detection	Passband Data Transmission	Spread Spectrum Techniques and Information theory Concepts
Duration (hour)		15	15	15	15	15
S-1	SLO-1	Modulation, Need for Modulation,	AM transmitter : Low Level,	Pulse modulation systems, Overview of PAM,PWM,PPM	Overview of ASK, FSK, PSK	Spread spectrum Communications, Frequency Hopping Spread Spectrum (FHSS)
	SLO-2	Amplitude Modulation, Types of Amplitude Modulation	AM transmitter : High Level Transmitter	Pulse modulation systems, Overview of PAM,PWM,PPM	Overview of ASK, FSK, PSK	Spread spectrum Communications, Frequency Hopping Spread Spectrum (FHSS)
S-2	SLO-1	Double sideband Full carrier	FM transmitter: Direct Method	Pulse modulation systems, Sampling and quantization	Generation, Signal Space Diagram and detection of FSK	Direct Sequence Spread Spectrum (DSSS)
	SLO-2	Double sideband Full carrier	FM transmitter: Direct Method	Pulse modulation systems, Sampling and quantization	Generation, Signal Space Diagram and detection of FSK	Direct Sequence Spread Spectrum (DSSS)
S-3	SLO-1	Double sideband Suppressed carrier	FM transmitter: Indirect Method	PCM systems	Probability of Error for FSK	Direct Sequence Spread Spectrum (DSSS)
	SLO-2	Single sideband Suppressed carrier, VSB	FM transmitter: Indirect Method	Bandwidth of PCM, PCM TDM signal multiplexing, Limitations of PCM system	Probability of Error for FSK	Code Division Multiple Access of DSSS
S 4-5	SLO-1	**Lab-1: AM modulator and Demodulator**	**Lab-4: Pre emphasis and De-emphasis**	**Lab-7: DPCM and its Demodulation**	**Lab-10: QPSK Modulation and Demodulation**	**Lab-13: *Mini Project***
	SLO-2					

S-6	**SLO-1**	Generation of AM waves: Linear method-Collector modulator	Classification of radio receiver, Functions and Characteristics of radio receiver	Data formatting	Generation, Detection, Signal Space Diagram of PSK	Code Division Multiple Access of DSSS
	SLO-2	Generation of AM waves: Linear method-Collector modulator	Tuned Radio Frequency receiver	Data formatting	Generation, Detection, Signal Space Diagram of PSK	OFDM Communication
S-7	**SLO-1**	Non-linear Modulation-Balanced Modulator	*Super-heterodyne receiver- AM*	Differential PCM (DPCM)	Probability of Error for PSK	OFDM Communication
	SLO-2	Non-linear Modulation-Balanced Modulator	*Super-heterodyne receiver- AM*	Differential PCM (DPCM)	Probability of Error for PSK	OFDM Communication
S-8	SLO-1	Demodulation of AM waves : Linear diode detector	*Super-heterodyne receiver- FM*	Delta modulation (DM)	Generation, signal space diagram and detection of QPSK	Measures of Information
	SLO-2	Demodulation of AM waves : Linear diode detector	*Super-heterodyne receiver- FM*	Delta modulation (DM), Noise in DM	Generation, signal space diagram and detection of QPSK	Measures of Information
S 9-10	SLO-1	**Lab-2: DSB-SC modulator and demodulator**	**Lab-5: PAM,PPM,PWM modulation and demodulation**	**Lab-8: DM and its Demodulation**	**Lab-11: DPSK Modulation and Demodulation**	**Lab-14: *Model Practical Exam***
	SLO-2					
S-11	SLO-1	Frequency modulation, Types of FM	*Sources of Noise*	Demodulation and detection process	Probability of Error for QPSK	Source encoding, Shannon's Channel capacity theorem
	SLO-2	Narrow Band FM, Wide Band FM, Phase modulation	*Sources of Noise*	Demodulation and detection process	Probability of Error for QPSK	Shannon's Channel capacity theorem
S-12	SLO-1	Generation of Narrowband FM	*Noise in AM (Envelope Detection),*	Maximum likelihood receiver structure, Matched filter receiver	Generation, signal space diagram and detection of π/4 QPSK	Linear block codes
	SLO-2	Generation of Narrowband FM	*Noise in AM (Envelope Detection),*	Maximum likelihood receiver structure, Matched filter receiver	Generation, signal space diagram and detection of π/4 QPSK	Linear block codes
S-13	SLO-1	Demodulation of FM : Foster seely discriminator	*Noise in FM*	Probability error of the Matched filter, Inter symbol interference, Eye pattern	Generation, signal space diagram and detection of QAM	Cyclic codes
	SLO-2	Demodulation of FM : Foster seely discriminator	*Threshold effect, Pre-emphasis and De-emphasis*	Probability error of the Matched filter, Inter symbol interference, Eye pattern	Generation, signal space diagram and detection of QAM	Cyclic codes
S 14-15	SLO-1	**Lab-3: FM Modulator and Demodulator**	**Lab-6: Pulse Code Modulation and Demodulation**	**Lab-9: PSK Modulation and Demodulation**	**Lab-12: BER performance analysis of various Modulation Schemes**	**Lab-15: University Practical Exam**
	SLO-2					

Learning Resources

1. *Simon Haykin and Michael Moher, "Communication Systems," 5th edition, John Wiley & Sons, 2013*
2. Singh. R. P & Sapre. S. D, "Communication Systems: *Analog & Digital," 3rd edition, McGrawHill Education, Seventh Reprint, 2016.*
3. Simon Haykin, "Communication Systems", John Wiley & Sons, 4th Edition, 20008.
4. Bernard Sklar, "Digital Communication, Fundamentals and Application", Pearson Education Asia, 2nd Edition, 2001
5. Taub & Schilling, "Principle of Communication Systems", McGraw Hill Inc, 2nd Edition, 2003.
6. John G. Proakis, "Digital Communication", McGraw Hill Inc, 5th Edition, 2008.
7. B.P. Lathi, "Modern Digital and Analog Communication System", Oxford University Press, 3rd Edition, 2005.
8. Shu Lin, Daniel Costello, "Error control coding – Fundamentals and Applications", Prentice Hall, Upper Saddle River, NJ, 2nd Edition, 2004.
9. *Lab Manual*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	Total	100 %		100 %		100 %		100 %		-	

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*Mrs. S. Vasanthadev Suryakala, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECC206J	Course Name	VLSI Design	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18ECC103J	Co-requisite Courses	Nil	Progressive Courses	18ECE301J
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards		Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Use Verilog HDL as a design-entry language for FPGA in electronic design automation of digital circuits			
CLR-2 :	Design, construct and simulate VLSI adders and multipliers.			
CLR-3 :	Understand MOSFET operation			
CLR-4 :	Implement a given logic function using appropriate logic styles for improved performance			
CLR-5 :	Understand the basic processes in IC fabrication, steps in the fabrication of MOS ICs, and as well the layout design rules.			
CLR-6 :	Use modern engineering tools such as HSPICE / Modelsim / Xilinx to carry out design experiments and gain experience with the design and analysis of MOS circuits and systems.			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)															
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Design and implement digital circuits using Verilog HDL to simulate and verify the designs.	3	85	75	-	H	H	-	H	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Design general VLSI system components, adder cells and multipliers to address the design of datapath subsystem.	3	85	75	-	H	H	-	H	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Examine the characteristics of MOS transistors	2	80	70	H	M	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Analyze CMOS inverter and other complex logic gates designed using different logic styles	2	80	70	-	L	L	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	Explain how the transistors are built, and understand the physical implementation of circuits.	2	80	70	-	L	L	-	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	Use HSPICE computer analysis program and Verilog HDL for simulation and analysis of MOS circuits and building blocks	3	85	75	-	M	M	-	H	-	-	-	H	M	L	M	-	-	M

Duration (hour)		Learning Unit / Module 1: Introduction to Verilog HDL & Coding	Learning Unit / Module 2: Subsystem Design	Learning Unit / Module 3: MOS Transistor	Learning Unit / Module 4: CMOS Inverter and Circuit Design Styles	Learning Unit / Module 5:
		15	15	15	15	15
S-1	SLO-1	Introduction to HDL & Verilog HDL	**General VLSI System Components:** Multiplexers	**Generic overview of the MOS device:** MOS transistor symbols	**CMOS Inverter Characteristics:** Operation and properties of static CMOS inverter	**Properties of basic materials used in microelectronics:** Silicon, Silicon dioxide
	SLO-2	Introduction to Verilog HDL, modules and ports	Decoders	MOS structure demonstrating (a) accumulation, (b) depletion, and (c) inversion; nMOS transistor demonstrating cutoff, linear, and saturation regions of operation	VTC of static CMOS inverter	Polysilicon and Silicon Nitride
S-2	SLO-1	**Lexical Conventions:** White Space and Comments, Operators	Comparators	**MOS Transistor under Static Conditions:** The threshold voltage	DC Inverter Calculations	**Basic Processes in Integrated-Circuit Fabrication:** Wafer Formation, Photolithography, Well and Channel Formation
	SLO-2	Numbers, Strings, Identifiers, System Names, and Keywords	priority encoder	Resistive operation	Symmetrical Inverter	Silicon Dioxide (SiO_2), Isolation, Gate Oxide
S-3	SLO-1	**Verilog Data Types:** Nets, Register Variables, Constants	shift and rotate operations	Saturation region	Inverter switching characteristics	Gate and Source/Drain Formations, Contacts and Metallization, Passivation, Metrology
	SLO-2	Referencing Arrays of Nets or Regs	**Adders:** Standard adder cells	Current-voltage characteristics	Output capacitance	**Some Recurring Process Steps:** Diffusion and Ion Implantation, Deposition, Etching, Planarization
S-4, 5	SLO-1	**Lab-0: Verilog Operators:**	**Lab-3:** Design using FSM and ASM	**Lab-6:** Realization of VLSI multipliers - I	**Lab-9:** Design and Analysis of CMOS	Lab-12: Design and Analysis of 4-input

	SLO-2	Arithmetic Operators, Bitwise Operators, Reduction Operators, Logical Operators, Relational Operators, Shift Operators, Conditional Operator, Concatenation Operator, Expressions and Operands, Operator Precedence	charts		Inverter using HSPICE	Dynamic NAND gate using HSPICE
S-6	**SLO-1**	**Verilog modelling:** Gate-level modelling	Ripple Carry Adder (RCA)	**Dynamic behavior:** MOSFET Capacitances, viz., MOS structure capacitances	**Secondary Parasitic Effects:** Leakage Currents, Parasitic Resistances	Simplified CMOS Process flow
	SLO-2	Realization of Combinational and sequential circuits	Carry Look-Ahead Adder (CLA)	Channel capacitance and Junction (or, depletion) capacitances	Inverter layout	
S-7	**SLO-1**	Compilation and simulation of Verilog code	Carry Select Adder (CSL)	Parasitic Resistances, viz., Drain and Source Resistance, Contact Resistance	**Power-Delay Product:** Static Power Consumption	**Layout design rules:** Well rules, transistor rules
	SLO-2	Test bench	Carry Save Adder (CSA)	**Non-ideal I-V effects:** Mobility Degradation, Velocity Saturation	Dynamic Power Consumption, Total Power Consumption, PDP	Contact rules, metal rules, via rules and other rules
S-8	**SLO-1**	Dataflow modelling	Carry Skip Adder (CSK)	Channel Length Modulation, Threshold Voltage Effects	**CMOS Circuit Design Styles:** Static CMOS logic styles	Gate Layouts
	SLO-2	Realization of Combinational and sequential circuits	Carry Bypass Adder (CBA)	Leakage, Temperature Dependence, Geometry Dependence, Subthreshold Current	CMOS circuits, pseudo-nMOS, tristate circuits, clocked CMOS circuits	Stick diagrams
S-9, 10	**SLO-1** / **SLO-2**	**Lab-1:** Realization of combinational and sequential circuits using gate-level and dataflow modeling	**Lab-4:** Realization of VLSI adders - I	**Lab-7:** Realization of VLSI multipliers - II	**Lab-10:** (a) Design and Analysis of complex CMOS gate using HSPICE (b) Design and Analysis of Pseudo-NMOS gates using HSPICE	Lab-13: Model Practical Examination
S-11	SLO-1	Behavioral modelling	**Multipliers:** Overview of multiplication (unsigned multiplication, shift/add multiplication algorithms, multiplication of signed numbers, types of multiplier architectures)	**Short-channel MOSFETS:** Hot carriers, Lightly-Doped Drain (LDD)	Differential Cascade Voltage Switch Logic (DCVSL), Pass Transistor Logic (PTL)	**CMOS Process Enhancements:** Transistors (Multiple Threshold Voltages and Oxide Thicknesses, Silicon-on-Insulator, High-k Gate Dielectrics, Higher Mobility, Plastic Transistors,)
	SLO-2	Realization of Combinational and sequential circuits	Braun multiplier	MOSFET scaling	**Dynamic CMOS logic styles:** Basic dynamic logic	
S-12	SLO-1	Switch-level modelling	Baugh-Wooley multiplier	**Short-channel effects:** Negative Bias Temperature Instability (NBTI), oxide breakdown	Signal integrity issues in dynamic design	Interconnects
	SLO-2	Realization of MoS circuits	Wallace Tree multiplier	Drain-Induced Barrier Lowering (DIBL), Gate-Induced Drain Leakage (GIDL), Gate Tunnel Current	Signal integrity issues in dynamic design	Circuit elements
S-13	SLO-1	Design using FSM	Booth multiplier	Tutorials	**Domino Logic Circuits:** Differential Domino logic, multiple-output domino	Beyond conventional CMOS
	SLO-2	Realization of sequential circuits	Booth multiplier	Tutorials	Compound domino, NORA, TSPC	Tutorials
S-14, 15	SLO-1 / SLO-2	Lab-2: (a) Realization of digital circuits using behavioral modeling (b) Realization of MOS circuits using switch-level mdeling	**Lab-5:** Realization of VLSI adders - II	Lab-8: Realization of RAM & ROM	**Lab-11:** (a) Design and Analysis of AND/NAND gate in DCVSL using SPICE (b) Design and Analysis of Pass-Transistor gates and CPL gates using HSPICE	Lab-14: End-Semester Practical Examination

Learning Resources	1. Jan Rabaey, Anantha Chandrakasan, B Nikolic, "Digital Integrated Circuits: A Design Perspective". Second Edition, Feb 2003, Prentice Hall of India. 2. Weste, Harris, "CMOS VLSI Design: A Circuits and Systems Perspective", 4th edition, Addision-Wesley, 2011. 3. Wayne Wolf, "Modern VLSI Design: IP-based Design", 4th edition, PHI, 2009.	4. R. Jacob Baker, "CMOS Circuit Design, Layout, and Simulation", Wiley, (3/e), 2010. 5. John P. Uyemura, "CMOS Logic Circuit Design", Kluwer, 2001. 6. S. Palnitkar , Verilog HDL – A Guide to Digital Design and Synthesis, Pearson , 2003 7. Paul. R.Gray, Robert G. Meyer, "Analysis and Design of Analog Integrated Circuits", Wiley, (4/e), 2001. 8. M.D.Ciletti , Modeling, Synthesis and Rapid Prototyping with the Verilog HDL, Prentice Hall, 1999

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	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
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2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*2. Dr. J. Manjula, SRMIST*

Course Code	18ECC301T	Course Name	WIRELESS COMMUNICATION	Course Category	C	Professional Core	L	T	P	C
							3	1	0	4

Pre-requisite Courses	18ECC205J, 18ECC105T	Co-requisite Courses	Nil	Progressive Courses	18ECE220T
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards		Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Understand the elements of Wireless Communication and mobile communications
CLR-2 :	Understand the Mobile Radio Wave Propagation - Large Scale Fading
CLR-3 :	Analyze how to apply Mobile Radio Wave Propagation - Small Scale Fading
CLR-4 :	Study the Capacity and Diversity concepts in wireless communications
CLR-5 :	Acquire the knowledge of Wireless System and Standards
CLR-6 :	Understand and design various wireless systems

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Acquire the knowledge of Wireless communication and basic cellular concepts	2	75	60	H	-	-	-	-	-	-	-	-	-	-	M	M	-	L
CLO-2 :	Understand` the essential Radio wave propagation and mobile channel models	2	75	60	H	H	H	H	-	-	-	-	-	-	-	M	M	-	H
CLO-3 :	Familiarize about Various performance analysis of mobile communication system.	2	75	60	H	H	H	-	-	-	-	-	-	-	-	-	-	-	H
CLO-4 :	Attain the knowledge of Diversity and capacity concepts	2	75	60	H	H	-	-	-	-	-	-	-	-	-	-	-	-	H
CLO-5 :	Be familiar with the various standards of Mobile Communication Systems	2	75	60	H	-	-	-	-	-	-	-	-	-	-	M	M	-	L
CLO-6 :	Explore the various concepts of wireless communication, its design with respect to fading and link performance	2	75	60	H	H	H	H	M	-	-	-	-	M	-	M	M	-	H

Duration (hour)		Wireless communication: Mobile communications	Large Scale Fading	Small Scale Fading	Improvement on Link performance	Wireless systems and standards
		12	12	12	12	12
S-1	SLO-1	Introduction to wireless communication and mobile radio communication	Introduction to Radio wave Propagation	Introduction Small scale multipath propagation	Introduction to diversity, equalization and capacity	AMPS Voice modulation Process
	SLO-2	Classification of wireless communications - simplex, half duplex, dull duplex	Large scale and small scale fading	Impulse response model of multipath channel		
S-2	SLO-1	Paging and Cordless systems	Friis transmission equation- Free space propagation model - pathloss model	Impulse response model of multipath channel	Space diversity	GSM system architecture and its interfaces
	SLO-2	Cellular telephone systems		Small scale multipath measurements - Direct Pulse measurement	Scanning diversity	
S-3	SLO-1	Timing diagram - landline to mobile	Two Ray model	Small scale multipath measurements - Sliding correlator measurement	Maximal ratio combiner	GSM frame structure
	SLO-2	Timing diagram - mobile to mobile		Small scale multipath measurements - Swept frequency measurement	Equal gain diversity	
S-4	SLO-1	Basic antenna parameters, Far field and near field	Simplified pathloss model	Parameters of mobile multipath channels - Time dispersion and Coherent bandwidth	Rake Receiver	GSM speech operations input - output
	SLO-2	Frequency reuse, sectored and omni-directional antennas	Emperical model - Okumara			
S-5	SLO-1	Channel assignment strategies	Emperical model - Hata model	Parameters of mobile multipath channels - Doppler spread and Coherent time	Capacity in AWGN	Forward CDMA process
	SLO-2	Handoff and its types	Emperical model - Walfish and bertoni model			
S-6	SLO-1	Interference and system capacity	Piecewise linear model - log normal model	Types of fading: Flat and Frequency selective fading	Capacity of flat fading channels	Reverse CDMA Process
	SLO-2					

S-7	**SLO-1**	Trunking and Grade of Service	Shadowing	Types of fading: Flat and Frequency selective fading	Equalizer and its mode	Multicarrier modulation
	SLO-2		Combined pathloss and shadowing			
S-8	**SLO-1**	Cell splitting	Outage Probabilty	Types of fading: Fast and Slow fading	Adaptive equalizer block diagram	OFDM Transmitter Block diagram
	SLO-2					
S-9	**SLO-1**	Sectoring	Cell Coverage Area	Types of fading: Fast and Slow fading	Types of Equalizers - elementary level only	OFDM Receiver Block diagram
	SLO-2					
S-10	**SLO-1**	Microcell zone concepts	*Solving problems – Brewster angle*	Ricean distribution	Introduction to MIMO antennas	Importance of Cyclic Prefix
	SLO-2					
S-11	**SLO-1**	*Umbrella cells*	*Solving problems –empirical model*	Rayleigh distribution	Introduction to MIMO antennas	Case study - Modern antennas
	SLO-2					
S-12	**SLO-1**	*Solving Problems*	*Solving problems – friis transmission formula*	*Solving problems – Doppler effect*	*Case study :Recent trends in Diversity and MIMO antennas*	Case study - Modern antennas
	SLO-2					

Learning Resources	1. *Rappaport.T.S., "Wireless Communications: Principles and Practice", 2nd Edition, Pearson, 2011.* 2. *John D Kraus , Ronald J Marhefka, Ahmed S Khan "Antenna and Wave Propagation", 4th Edition, Tata McGraw Hill, 2010* 3. *Constantine Balanis. A, "Antenna Theory: Analysis and Design", 3rd Edition, John Wiley, 2012.* 4. *Andreas.F.Molisch., "Wireless Communications", Wiley, 2nd Edition-2005, Reprint-2014*	5. *Andrea Goldsmith, " Wireless Communications", Cambridge University Press, Aug 2005* 6. *Schiller, "Mobile Communications", Pearson Education Asia Ltd., Reprint 2012* 7. *Lee W.C.Y., " Mobile Communications Engineering: Theory and Applications", McGraw Hill, New York, 2nd Edition, 1998*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	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.,

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2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*2. Dr. T. Ramarao, SRMIST*

Course Code	18ECC302J	Course Name	MICROWAVE & OPTICAL COMMUNICATIONS	Course Category	C	*Professional Core*	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*18ECC205J*	Co-requisite Courses	*Nil*	Progressive Courses	*18ECE226T & 18ECE323T*
Course Offering Department	*Electronics and Communication Engineering*	Data Book / Codes/Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Identify Microwave active devices and Microwave generators*
CLR-2 :	*Analyze Microwave passive devices*
CLR-3 :	*Explore Microwave Measurements*
CLR-4 :	*Analyze Optical Fibers Optical Sources, Amplifier and Transmitter Optical Detectors , Receiver and Performance Measurements*
CLR-5 :	*Explore Optical Communication System Design and Concepts*
CLR-6 :	*Analyze Microwave and optical components*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1 Level of Thinking (Bloom)	Learning 2 Expected Proficiency (%)	Learning 3 Expected Attainment (%)
CLO-1 :	Acquire knowledge on the theory of microwave transmission, microwave generators and associated components.	2	80	70
CLO-2 :	Analyse microwave passive devices and components.	2	80	70
CLO-3 :	Understand microwave measurements and associated techniques with equipment	2	80	70
CLO-4 :	Familiarize with the fundamentals of light transmission through fiber	2	80	70
CLO-5 :	Design a basic optical communication system.	2	80	70
CLO-6:	Understand the working principle of microwave components , Microwave measurements, optical sources, detector and fibers	2	80	70

Program Learning Outcomes (PLO)	1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO–1: Professional Achievement	14 PSO – 2: Project Management Techniques	15 PSO – 3: Analyze & Research
CLO-1 :	H	-	-	L	-	-	-	-	-	-	-	-	-	-	L
CLO-2 :	H	M	H	H	-	-	-	-	-	-	-	-	L	-	M
CLO-3 :	H	M	H	M	-	-	-	-	-	-	-	-	M	-	H
CLO-4 :	H	H	-	M	-	-	-	-	-	-	-	-	L	-	L
CLO-5 :	H	H	-	H	-	-	-	-	-	-	-	-	M	-	M
CLO-6:	H	H	H	H	-	-	-	-	-	-	-	-	M	-	H

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Introduction to microwaves and optical communications	High frequency parameters: S parameters and S matrix analysis for N-port microwave device	Impedance matching.	Elements of Optical fiber communication	Point-to-Point link –Analog system design considerations and design steps
	SLO-2					
S-2	SLO-1	History of Microwave Engineering, Microwave transmission and Applications; Maxwell Equations	Directional coupler	VSWR and Impedance measurement	Functional block diagram of a Transmitter and receiver module	Point-to-Point link – Digital system design considerations and design steps
	SLO-2					
S-3	SLO-1	Microwave Tubes	E and H plane Tee	Measurement of Power	Optical fiber structure, Light Propagation in Optical fibers: Ray theory , Total Internal reflection, Skew rays	Digital Link Design: Link power budget
	SLO-2	Klystron amplifier				
S-4-5	SLO-1	**Lab- 1 Characteristics of Reflex Klystron**	**Lab- 4 Gain and radiation pattern of Horn antenna**	**Lab- 7 Practice session**	**Lab- 10 Measurement of Numerical Aperture, propagation and bending losses of optical fiber**	**Lab- 13 Design of basic Optical Communication system using computational tool**
	SLO-2					
S-6	SLO-1	Reflex Klystron oscillators	Magic Tee	Measurement of Frequency and Q factor	Optical Sources: Light source materials, LED Structures	Rise time budget
	SLO-2					
S-7	SLO-1	Magnetron oscillators	Microwave Circulators, Isolators	Insertion loss measurements	LED Characteristics	Overview of Analog links: Radio over Fiber;
	SLO-2					
S-8	SLO-1	Microwave Bipolar Transistors	Attenuators and Phase Shifters	Attenuation measurements	Semiconductor Laser Diode, Laser Characteristics	Key link parameters
	SLO-2	**Field effect transistor**				

S-9-10	**SLO-1**	**Lab- 2 Study of power distribution in Directional coupler, E plane, H plane and Magic Tee**	**Lab- 5 Characteristics of filters, Microstrip patch antenna and parallel line coupler**	**Lab- 8 DC characteristics of LED and Laser diode**	**Lab- 11 Analysis of Analog optical link**	**Lab- 14 Practice Session**
	SLO-2					
S-11	**SLO-1**	IMPATT, TRAPATT and Tunnel diode	Rectangular Waveguides	Measurement of Scattering parameters	Optical Detectors: PIN and APD photo detector	Multichannel System: Need for multiplexing
	SLO-2					Operational principles of WDM, DWDM
S-12	**SLO-1**	Gunn diode	Rectangular Waveguides	Measurement of Scattering parameters	Responsivity and efficiency of APD	WDM Components: Coupler/Splitter, Fabry Perot Filter
	SLO-2					
S-13	**SLO-1**	Gunn Oscillation modes	Power Dividers	Functioning details of Vector Network Analyzer; Signal Analyzer; Spectrum analyzers	Fiber attenuation and dispersion	WDM Components: Optical MEMS switches
	SLO-2					
S-14-15	**SLO-1**	**Lab- 3 Impedance measurement by slotted line method**	**Lab- 6 Design of RF Filters and Amplifier using computational tool**	**Lab- 9 DC characteristics of PIN and APD photo-diode**	**Lab- 12 Analysis of Digital optical link**	**Lab- 15 Study experiment - Gunn Diode (Microwave) and Optical WDMA (Optical)**
	SLO-2					

Learning Resources

1. David M. Pozar, "Microwave Engineering", 4th Edition, John Wiley & Sons, 2012.
2. David M. Pozar, "Microwave & RF Design of Wireless Systems", John Wiley & Sons, 2001.
3. Samuel Y. Liao, "Microwave Devices and Circuits", 3rd Edition, Pearson Education, 2013.
4. Robert. E. Collin, "Foundations for Microwave Engineering", 2nd edition, Wiley, Reprint 2014.
5. Annapurna Das, Sisir K. Das, "Microwave Engineering", 3rd Ed., McGraw Hill, 2015.
6. I. Hunter, "Theory and design of microwave filters", The Institution of Engineering &Technology, 2001.
7. Keiser G, "Optical Fiber Communication Systems", 5th Edition, 6th Reprint, McGraw Hill Education (India), 2015.
8. Vivekanand Mishra, Sunita P. Ugale, "Fiber Optic Communication: Systems and Components", Wiley-India, 1st edition, 2013
9. Djafar.K. Mynbaev and Lowell and Scheiner, "Fiber Optic Communication Technology", Pearson Education Asia, 9th impression, 2013
10. John M. Senior, " Optical fiber Communications: Principles and Practice", Pearson Education, 3rd Edition, 2009
11. R.P. Khare, "Fiber Optics and Optoelectronics", Oxford University Press, 2007.
12. 12. Rajiv Ramaswami, Kumar N. Sivaranjan, Galen H.Sasaki "Optical Networks A practical perspective", 3nd edition, 2013

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	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
1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*1. Dr. P. Sandeep Kumar, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*2. Dr. T. Ramarao, SRMIST*

Course Code	18ECC303J	Course Name	COMPUTER COMMUNICATION NETWORKS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18CSS101J	Co-requisite Courses	Nil	Progressive Courses	18ECE320T
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards		Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Introduce the basic concepts in the field of computer networks.			
CLR-2 :	Understand the functional aspects of OSI model architecture.			
CLR-3 :	Acquire knowledge of the Network Layer protocols			
CLR-4 :	Analyze the various issues and challenges of Transport Layer.			
CLR-5 :	Familiarize the various Application Layer Protocols.			
CLR-6:	Utilize the networking concepts to analyze the performance of Routing protocols.			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)															
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research	
CLO-1 :	Express the basic services and concepts related to internetworking.	1	60	65	-	-	-	-	-	-	H	-	-	-	-	M	-	-	-	
CLO-2 :	Explain the basic OSI model architecture and its lower layer functions.	1	60	65	-	-	M	-	-	-	L	-	-	-	-	-	-	-	H	
CLO-3 :	Illustrate the various Network Layer concepts, mechanisms and protocols.	2	65	65	-	-	H	-	-	L	M	-	-	-	-	-	-	-	-	
CLO-4 :	Describe the services and techniques of Transport Layer.	1	60	65	-	-	-	-	-	-	M	-	-	-	-	-	-	-	H	
CLO-5 :	Discuss the various services and protocols in Application Layer.	1	60	65	-	-	M	-	-	-	-	-	-	-	-	-	-	-	H	
CLO-6 :	Analyze the various Networking concepts and Routing protocols.	2	60	65	-	-	-	-	L	-	-	-	-	-	-	M	-	-	H	

Duration (hour)		DATA COMMUNICATION & NETWORKING BASICS	OSI LOWER LAYERS	NETWORK LAYER	TRANSPORT LAYER	APPLICATION LAYER
		15	15	15	15	15
S-1	SLO-1	Introduction to Data Communication and Networking	Network models	*Introduction to Network Layer*	*Introduction to Transport Layer*	*Introduction to Application Layer*
	SLO-2	Data transfer modes-Serial and Parallel transmission	OSI layer architecture	Need for Internetworking	*TCP/IP Model*	*Application Layer Paradigms*
S-2	SLO-1	Protocols & Standards	Data Link Layer-Introduction	*Addressing-Classful*	*User Datagram Protocol(UDP)*	*Client Server Interaction*
	SLO-2	Layered Architecture	Link Layer Addressing	*Addressing-Classful*	*User Datagram Protocol(UDP)*	*Client Server Interaction*
S-3	SLO-1	Principles of Layering & Description	Error Detection	*Addressing-Classless*	*Transmission Control Protocol(TCP)*	*SIP*
	SLO-2	Brief description of concepts in OSI & TCP/IP model	Error Detection	*Addressing-Classless*	*Transmission Control Protocol(TCP)*	*SIP*
S 4-5	SLO-1	**Lab 1: To build and configure a simple network of four nodes connected with point-to-point links.**	**Lab 4: To simulate token ring protocol and to study its performance.**	***Lab 7:To simulate CSMA/CA protocol and to study its performance***	***Lab 10: Implementation and study of Selective Repeat protocol.***	***Lab 13: Create a Socket (TCP&UDP) between two computers and enable file transfer between them.***
	SLO-2					
S-6	SLO-1	Switching Types- Circuit- & Packet switching	Error Correction	*Network Layer Protocol-IPV4*	*TCP Services & Features*	*Compression Techniques*
	SLO-2	Switching Types- Message switching, Comparison of switching types	Error Correction	*Internet Protocol(IP)-IPV4*	*TCP Services & Features*	*Compression Techniques*
S-7	SLO-1	LAN, MAN & WAN	Data link control-LLC	*Internet Protocol(IP)-IPV6*	*Congestion Control*	*Introduction to Cryptography*

	SLO-2	LAN, MAN & WAN	Data link control-LLC	*Internet Protocol(IP)-IPV6*	*Congestion Control*	*Types, Attacks and Services*
S-8	**SLO-1**	Network topologies-Types	Data link control-MAC	*Routing Protocols- Distance Vector& Link State*	*Congestion Control*	*DES*
	SLO-2	Comparison of topologies	Data link control-MAC	*Routing Issues-Delivery, Forwarding and Routing*	*Congestion Control*	*DES*
S 9-10	**SLO-1**	**Lab 2: *To simulate star and bus network topologies.***	**Lab 5: Implementation of Error detection and Correction scheme.**	***Lab 8: Implementation and study of stop and wait protocols***	***Lab 11: To configure a network using Link State Routing protocol .***	***Lab 14: Implementation of Data Encryption and Decryption.***
	SLO-2					
S-11	**SLO-1**	*IEEE standards for LAN-Ethernet*	*Flow & Error Control Protocol*	Routing Information Protocol-RIP	*QOS-Quality of Service*	*RSA*
	SLO-2	*Types of Ethernet*	*Flow & Error Control Protocol*	Routing Information Protocol-RIP	*QOS-Quality of Service*	*RSA*
S-12	**SLO-1**	*Token Bus*	*ARQ Schemes*	*Open Shortest Path First-OSPF*	*Techniques to improve QOS*	*Email*
	SLO-2	*Token Ring*	*ARQ Schemes*	*Open Shortest Path First-OSPF*	*Techniques to improve QOS*	FTP
S-13	**SLO-1**	*FDDI*	*HDLC*	*Border Gateway Protocol-BGP*	*Techniques to improve QOS*	*HTTP*
	SLO-2	*FDDI*	*HDLC*	*Border Gateway Protocol-BGP*	*Techniques to improve QOS*	*SNMP*
S 14-15	**SLO-1**	***Lab 3: To simulate token bus protocol and to study its performance.***	**Lab 6:To simulate CSMA/CD protocol and to study its performance**	***Lab 9: Implementation and study of Go back N protocol.***	***Lab 12: To configure a network using Distance Vector Routing protocol.***	***Lab 15: Mini Project***
	SLO-2					

Learning Resources	1. Behrouz A.Fehrouzan, "Data communication & Networking", Mc-Graw Hill, 5th Edition Reprint, 2014. 2. Andrew S.Tanenbaum, "Computer Networks", Pearson Education India, 5th Edition, 2013.	3. William Stallings, "Data & Computer Communication", Pearson Education India, 10th Edition, 2014. 4. James F. Kurose, Keith W. Ross, "Computer Networking: A Top–Down Approach Featuring the Internet", Pearson Education,6th Edition, 2013. 5. "Lab Manual" , Department of ECE, SRM Institute of Science and Technology

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	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

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2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECC350T	Course Name	COMPREHENSION	Course Category	C	Professional Core	L	T	P	C
							0	1	0	1

Pre-requisite Courses	NIL	Co-requisite Courses	NIL	Progressive Courses	NIL
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards		Nil	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Acquire skills to solve real world problems in Analog and Digital Electronics (Discrete & IC)*
CLR-2 :	*Acquire skills to solve real world problems in Analog and Digital Communication*
CLR-3 :	*Acquire skills to solve real world problems in Signals & Systems, and DSP*
CLR-4 :	*Acquire skills to solve real world problems in Microprocessors & Microcontrollers, and VLSI Design*
CLR-5 :	*Acquire skills to solve real world problems in Electromagnetics and Transmission Lines*
CLR-6 :	*Acquire skills to solve real world problems in Microwave and Optical Communications*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Program Learning Outcomes (PLO) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
					Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Practice and gain confidence and competence to solve problems in Analog and Digital Electronics (Discrete & IC)*	3	85	80	H	H	H	L	L	L	L	L	L	L	L	L	M	L	M
CLO-2 :	*Practice and gain confidence and competence to solve problems in Analog and Digital Communication*	3	85	80	H	H	M	L	L	L	L	L	L	L	L	L	M	M	M
CLO-3 :	*Practice and gain confidence and competence to solve problems in Signals & Systems, and DSP*	3	85	80	H	H	M	L	L	L	L	L	L	L	L	L	M	L	M
CLO-4 :	*Practice and gain confidence and competence to solve problems in Microprocessors & Microcontrollers, and VLSI Design*	3	85	80	H	H	M	L	L	L	L	L	L	L	L	L	M	M	M
CLO-5 :	*Practice and gain confidence and competence to solve problems in Electromagnetics and Transmission Lines*	3	85	80	H	H	H	L	L	L	L	L	L	L	L	L	M	L	M
CLO-6 :	*Practice and gain confidence and competence to solve problems in Microwave and Optical Communications*	3	85	80	H	H	M	L	L	L	L	L	L	L	L	L	M	M	M

Duration (hour)		3	3	3	3	3
S-1	SLO-1	***Tutorial on** Analog Electronics (Discrete & IC)*	***Tutorial on Digital Communication***	***Tutorial on Microprocessors & Interfacing***	***Tutorial on Transmission Lines***	***Tutorial on Optical Communication***
	SLO-2	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Problem Solving*
S-2	SLO-1	***Tutorial on Digital Electronics***	***Tutorial on Signals and Systems***	***Tutorial on Microcontrollers & Interfacing***	***Tutorial on VLSI Design***	*Model Test*
	SLO-2	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Model Test*
S-3	SLO-1	***Tutorial on Analog Communication***	***Tutorial on Digital Signal Processing***	***Tutorial on Electromagnetics***	***Tutorial on Microwave Communication***	*Final Test*
	SLO-2	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Final Test*

Learning Resources	*1. R.S.Khurmi, J.K.Gupta, Mechanical Engineering: Conventional and Objective Types, S.Chand & Co., 2018*	*2. R.K.Jain, Conventional & Objective Type Question & Answers on Mechanical Engineering for Competitions, Khanna Publishers, 2014*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage) CLA – 1 (10%) Theory	CLA – 1 (10%) Practice	CLA – 2 (15%) Theory	CLA – 2 (15%) Practice	CLA – 3 (15%) Theory	CLA – 3 (15%) Practice	CLA – 4 (10%)# Theory	CLA – 4 (10%)# Practice	Final Examination (50% weightage) Theory	Final Examination (50% weightage) Practice
Level 1	Remember / Understand	40%	-	30%	-	30%	-	30%	-	30%	
Level 2	Apply / Analyze	40%	-	40%	-	40%	-	40%	-	40%	
Level 3	Evaluate / Create	20%	-	30%	-	30%	-	30%	-	30%	
	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
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B. Tech in Electronics and Communication Engineering (with specialization in Data Science)

2018 Regulations

Professional Elective Courses (E)

Department of Electronics and Communication Engineering
SRM Institute of Science and Technology
SRM Nagar, Kattankulathur – 603203, Kancheepuram District, Tamilnadu

Course Code	18ECE271T	Course Name	INTRODUCTION TO DATA SCIENCE	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards		Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLR-1 :	Develop practical data analysis skills, which can be applied to practical problems.																		
CLR-2 :	Explain how math and information sciences can contribute to building better algorithms and software.																		
CLR-3 :	an overview of simple statistical models and the basics of machine learning techniques of clustering, associations, classification, regression and text analysis																		
CLR-4 :	do regression, correlation and knowledge discovery of the data																		
CLR-5 :	implement Data Visualization Techniques																		
CLR-6 :	understanding of the basics of the ethical use of data science																		
Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:																		
CLO-1 :	Describe what Data Science is and the skill sets needed to be a data scientist	1	85	65	M	-	-	-	-	-	-	-	-	-	-	M	L		
CLO-2 :	Describe the Data Science Process and how its components interact.	1	85	65	H	-	M	M	L	-	-	-	-	-	-	L	H	H	H
CLO-3 :	Apply basic machine learning algorithms (Linear Regression, k-Nearest Neighbors (k-NN), k-means, Naive Bayes) for predictive modelling	2	85	65	M		H	H	H	-	-	-	-	-	-	L	H	M	H
CLO-4 :	Be able to translate a real-world problem into mathematical terms.	3	85	65	H	H	H	H	H	-	-	-	-	-	-	L	H	H	H
CLO-5 :	Identify basic Feature Selection algorithms (Filters, Wrappers, Decision Trees, Random Forests) and use in applications.	2	85	65	L	H	H	H	H	-	-	-	-	-	-	L	H	M	H
CLO-6 :	Create effective visualization of given data	4	85	65	L	H	H	H	H	-	-	-	-	-	-	-	H	H	H

Duration (hour)		Learning Unit / Module 1 Introduction to Data Science	Learning Unit / Module 2 Data	Learning Unit / Module 3 Machine Learning for Data Science	Learning Unit / Module 4 Data Collection	Learning Unit / Module 5 Analysis and Evaluation, Jobs
		9	9	9	9	9
S-1	SLO-1	What is Data Science?	Data Types	What is Machine Learning?	Introduction to Data Collection	Introduction to Quantitative methods
	SLO-2					
S-2	SLO-1	Where do we see Data Science?	Data Collection	Regression	Surveys, Question Types	Introduction to Qualitative methods
	SLO-2					
S-3	SLO-1	How does data science relate to other Fields?	Data Pre Processing	Gradient Descent	Survey Audience, Services	Comparing models
	SLO-2					
S-4	SLO-1	Information vs Data	Data Analysis and Analytics	Supervised Learning-Introduction	Analyzing Survey Data	Training, Testing and A/B testing
	SLO-2					
S-5	SLO-1	Computational Thinking	Descriptive Analytics	Logistic Regression,Softmax Regression	Pros and Cons of Surveys	Cross-Validation
	SLO-2					
S-6	SLO-1	Skills for Data Science	Diagnostic Analytics	Classification with KNN	Interview and Focus groups	Data Science Jobs- Marketing
	SLO-2					
S-7	SLO-1	Tool for Data Science	Predictive and Perspective Analytics	Decision Tree	Pros and Cons of Interview and Focus	Data Science Jobs- Retail and Sales

	SLO-2				groups	
S-8	SLO-1	Issues of Ethics, Bias	Explorative Analysis	Random forest, Navie Bayes, SVM	Log and Diary Data	Data Science Jobs - Legal
	SLO-2					
S-9	SLO-1	Privacy in Data Science	Mechanistic Analysis	Unsupervised Learning	User Studies in Lab and Field	Data Science Jobs - Health and Human Services
	SLO-2					

Learning Resources	1. Shah, C,. A Hands-On Introduction to Data Science. Cambridge: Cambridge University Press,. 2020 2. Rafael A. Irizarry, Introduction to Data Science: Data Analysis and Prediction Algorithms with R, CRC Press, 2020.	3. Joel Grus,Data Science from Scratch: First Principles with Python, O'Reilly Media, 2015. 4. Hastie, T., Tibshirani, R., Friedman, J., The Elements of Statistical Learning, 2nd Edition, Springer, 2009. 5. Murphy, K, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Understand										
Level 2	Apply	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
	Analyze										
Level 3	Evaluate	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	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
1. Mr. Athif Shah, Chairman, Abe Semicondutor, abechennai@gmail.com	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu	1. Dr. S. Karthik, SRMIST
2. Dr. Madan Kumar Lakshmanan, Senior Scientist, CEERI, lmadank@gmail.com	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	

Course Code	18ECE272T	Course Name	STATISTICAL INFERENCE TECHNIQUES	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	NIL	Co-requisite Courses	NIL	Progressive Courses	NIL
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards		NIL	

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Identify the basic concept of random variable and function for engineering application			
CLR-2 :	Review of sampling Distributions			
CLR-3 :	Illustrate basic key process of estimation methods			
CLR-4 :	Formulate hypothesis test problem			
CLR-5 :	Interpret Hypothesis test for large and small samples			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Apply key basic concepts of random process for engineering problem	2	80	70		H			H	-	-	-			-		-	-	-
CLO-2 :	Design the sampling method based on Sampling Distributions and get inference	3	85	75	-	H	-	M	H	-	-	-					-	L	M
CLO-3 :	Apply basic methods for estimation for engineering problem and get inference	2	75	70	L	H	-	M	H	-	-	-					-	-	-
CLO-4 :	Employ hypothesis test for given engineering problem	3	85	80	L	H	-	H	-	-	-	-					M	-	-
CLO-5 :	Analyze Hypothesis test for large and small samples	3	85	75	-	H	-	H	M	-	-	-					-	-	H

Duration (hour)		Learning Unit / Module 1 Basic of random variable and function	Learning Unit / Module 2 Sampling Distributions	Learning Unit / Module 3 Introduction to Estimation theory	Learning Unit / Module 4 Fundamental on Hypothesis	Learning Unit / Module 5 Hypothesis tests
		9	9	9	9	9
S-1	SLO-1	Random Variable	Introduction, Sampling Distributions-	Point estimation	The Logic of Hypothesis	Large Sample Tests
	SLO-2	Examples for random variable		The logic of Estimation	Simple and Composite Hypotheses	Hypothesis Testing on Population Proportion
S-2	SLO-1	Examples for Discrete and Continuous random variables.	t-Sampling Distributions F-Sampling Distributions	Definition and Properties of an Estimator	Null and Alternative Hypotheses	Population Mean
	SLO-2	Elementary Properties of Random Variables				Population Variances Means
S-3	SLO-1	Discrete Random Variables	Chi square Sampling Distributions	Methods of Estimation	Type I and Type II Errors	Type II Error and Power of a Test
	SLO-2	Continuous Random Variables	Standard Error			
S-4	SLO-1	Cumulative Distribution Function (CDF),	Distributions of sample mean	Interval Estimation Definition of Confidence Interval	Critical Region	Small Sample Tests
	SLO-2	Density Function			Level of Significance	Hypothesis Testing on Population Mean
S-5	SLO-1	Expected value of a Random Variable	Difference between two sample means	Construction of Confidence Intervals for Population Mean	One-tailed tailed tests	Difference between Two Population Means
	SLO-2	Expectations of Functions of a Random Variable		Construction of Confidence Intervals for Population Mean	two-tailed tests	
S-6	SLO-1	Moments of a distribution	Sample proportion	Population Proportion	two-tailed tests	Ratio of Two Variances of Normally Distributed Populations and on Population Correlation
	SLO-2					
S-7	SLO-1	Moment Generating and Characteristic	difference between two sample	Differences between Two Population	P-value	Paired t-test

	SLO-2	*Functions*	*proportions*	*Proportions*	*Large and Small Samples*	*Tests on Independence of Attributes*
S-8	**SLO-1**	*Probability Generating Functions*	*Case study: Wireless Channel noise and fading distribution model*	*Variance of a Normally Distributed Population*	*Power of a Test*	*Homogeneity of Variances and of Correlations of Normally Distributed Populations, readings*
	SLO-2					
S-9	**SLO-1**	*Case Study: The received communication data as Random variable*	*The Analysis of Variance- ANOVA*	*Prediction estimate of demodulated data*	*Steps involved in Testing Statistical Hypothesis, readings*	*Simple Linear Regression and Correlation*
	SLO-2					

Learning Resources	1. *Johnson, R. A. and Gupta, C. B., Miller & Freund's Probability and Statistics for Engineers, Pearson Education, Asia, Eighth Edition, 2015.* 2. *Devore, J. L., Probability and Statistics for Engineering and the Sciences, 8th Edition, Cengage Learning, 2014.*	3. *Gupta, S.C., and Kapoor, V.K., Fundamentals of Mathematical Statistics, Sultan Chand and Sons, 11thEdition, 2019.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	30%	-	30%	-	30%	-	30%	-
	Understand										
Level 2	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
	Analyze										
Level 3	Evaluate	20%	-	30%	-	30%	-	30%	-	30%	-
	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
1. Mr. Athif Shah, Chairman, Abe Semicondutor, abechennai@gmail.com	*1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*1. Dr. Bhagwan Das/ Head-Centre for Statistics, SRMIST*
2. Dr. Madan Kumar Lakshmanan, Senior Scientist, CEERI, lmadank@gmail.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*2. Dr .P. Vijayakumar, Associate Professor, ECE, SRMIST*

Course Code	18ECE371T	Course Name	REGRESSION AND MULTIVARIATE DATA ANALYSIS	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	NIL	Co-requisite Courses	NIL	Progressive Courses	NIL
Course Offering Department	Electronics and Communication Engineering	Data Book/Codes/Standards	NIL		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLR-1 :	Describe the applications on discrete and continuous random variables.																		
CLR-2 :	Assess the applications of two dimensional random variables.																		
CLR-3 :	Learn how correlation and regression analysis can be used to develop an equation that estimates how two variables are related																		
CLR-4 :	Impart knowledge on the applications of correlations, regression analysis																		
CLR-5 :	Assess knowledge on the applications of multivariate statistical analysis																		
CLR-6 :	Assess the applications of factor analysis																		
Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:																		
CLO-1 :	Compare the fundamentals between discrete and continuous random variables.	3	85	80	M	H	L	-	-	-	-	-	M	L	-	H	-	-	-
CLO-2 :	Choose the model and analyze systems using two dimensional random variables.	3	85	80	M	H	-	M	M	-	-	-	M	-	-	H	-	-	-
CLO-3 :	Evaluate problems involving correlation and regression.	3	85	80	M	H	-	-	-	-	-	-	M	-	-	H	-	H	-
CLO-4 :	Interpret the characteristics of multiple correlation analysis	3	85	80	M	H	-	M	-	-	-	-	M	L	-	H	-	-	-
CLO-5 :	Evaluate problems on multivariate analysis	3	85	80	M	H	L	-	-	-	-	-	M	-	-	H	M	-	H
CLO-6 :	Choose and analyze the use of multi factor analysis.	3	85	80	M	H	-	-	-	-	-	-	M	-	-	H	-	-	-

Duration (hour)		Learning Unit / Module 1 Probability and Distributions	Learning Unit / Module 2 Random Variables	Learning Unit / Module 3 Regression and Correlation	Learning Unit / Module 4 Multivariate Analysis	Learning Unit / Module 5 Component and Factor Analysis
		12	12	12	12	12
S-1	SLO-1	Probability & axioms of probability – Concepts, conditional probability	Two dimensional random variables-Discrete case	Simple Linear regression	Multivariate analysis-Introduction	Principal component analysis
	SLO-2	One dimensional random variable: Discrete Case-Probability mass function	Probability function of(X,Y)-Marginal probability distribution	Simple Linear regression	Multivariate analysis	Objectives of principal components
S-2	SLO-1	Continuous random variable-Probability density function	Conditional probability distribution of(X,Y)	Regression lines and properties	Analysis of dependence and interdependence	Estimation of principal components
	SLO-2	Cumulative distribution function-properties	Problems on discrete random variables	Regression coefficients	Applications of Multivariate techniques	Estimation of principal components
S-3	SLO-1	Problems on one dimensional random variables	Continuous random variables-Joint PDF	Estimation using regression and correlation	Organization of data	Sample variation by principal components
	SLO-2	Expectation and Moments	Marginal Probability distributions	Applications of regression	Positive definite matrices and vectors	Principal component for covariance matrices
S-4	SLO-1	Characteristic function -properties	Conditional probability distribution of(X,Y)	Multiple regression	A square – root matrix	Large sample inferences
	SLO-2	Binomial distribution-moments	Problems on continuous two dimensional random variables	Multiple regression	Random vectors and matrices	Large sample inferences
S-5	SLO-1	Binomial distribution-Applications	Independent random variables	Problems on multiple regression	Applications of Random vectors and matrices	Controlling future values

	SLO-2	Poisson distribution-moments	Cumulative distribution function-properties of F(x,y)	Multiple correlation	Mean vectors and covariance matrices	Factor analysis model
S-6	SLO-1	Geometric distribution - moments	Expected values of two dimensional random variables	Multiple correlation	Mean vectors and covariance matrices	Factor analysis model
	SLO-2	Geometric distribution - Applications	Covariance	Problems on multiple correlation	Random samples and the expected values of the samples mean	The orthogonal factor model
S-7	SLO-1	Exponential distribution-moments	Correlation and properties	Applications of multiple correlation	Expected values of the samples mean and covariance matrix	Factor analysis and solution
	SLO-2	Exponential distribution-Applications	Correlation coefficient	Cauchy Schwartz inequality	Multivariate normal distribution	Methods of estimation
S-8	SLO-1	Normal Distribution-moments	Rank Correlation	Modeling techniques	Principal components	Exploratory factor analysis
	SLO-2	Normal Distribution-Applications	Functions of two dimensional random variables	Modeling techniques	Principal components	Factor rotation and factor scores
S-9	SLO-1	Case study: Communication channel	Case study :Received data estimation in Demodulators	Inferences about the population parameters: Case study with Communication data	Case Study Application of multivariate analysis on signal processing data	CaseStudy; Application of Factor Analysis in Communication Systems
	SLO-2	Case study: Communication channel	Case study :Received data estimation in Demodulators	Inferences about the population parameters : Case study with Communication data	Case Study Application of multivariate analysis on signal processing data	CaseStudy; Application of Factor Analysis in Communication Systems

Learning Resources

1. Johnson, R. A. and Gupta, C. B., Miller & Freund's Probability and Statistics for Engineers, Pearson Education, 8th Edition, 2015.
2. Devore, J. L., Probability and Statistics for Engineering and the Sciences, 8th Edition, Cengage Learning, 2014.
3. Gupta, S.C., and Kapoor, V.K., Fundamentals of Mathematical Statistics, Sultan Chand and Sons, 11th Edition, 2019.
4. Dallas E. Johnson, Applied Multivariate Methods for Data Analysis, Thomson and Duxbury press, 1998
5. Johnson, R.A., and Wichern, D.W., Applied Multivariate Statistical Analysis, Pearson Education, 6th Edition, 2013.
6. Theodore W. Anderson, An Introduction to Multivariate Statistical Analysis, 3rd Edition, Wiley, 2003
7. Hardle, Wolfgang Karl, Simar, Leopold, Applied Multivariate Statistical Analysis, Springer, 2015
8. *S. C. Gupta, V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand&Sons,11th Edition., 2015*
9. *VeerarajanT., Probability, Statistics and Random Processes with Queueing Theory and Queueing Networks,4th Edition, McGraw Hill Education, 2015*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50%weightage)								Final Examination(50%weightage)	
		CLA– 1 (10%)		CLA– 2(15%)		CLA– 3(15%)		CLA– 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level1	Remember / Understand	40%	-	30%	-	30%	-	30%	-	30%	-
Level2	Apply / Analyze	40%	-	40%	-	40%	-	40%	-	40%	-
Level3	Evaluate / Create	20%	-	30%	-	30%	-	30%	-	30%	-
	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
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2. Dr. Madan Kumar Lakshmanan, Senior Scientist, CEERI, lmadank@gmail.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*2. Dr. B. Baskaran, Head, Maths Dept, SRMIST-VDP*

Course Code	18ECE372J	Course Name	PYTHON FOR DATA SCIENCES	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

Pre-requisite Courses	NIL	Co-requisite Courses	NIL	Progressive Courses	NIL
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards		NIL	

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Understand the basic concept of variables, text, numericals, list and control statements.			
CLR-2 :	Familiarize the students with the python dictionary's, lists			
CLR-3 :	Using the python IDE, functions, file handling and exception handling			
CLR-4 :	Understanding Data analysis using Data wrangling method			
CLR-5 :	Using matplotlib, seaborn and pandas for Data Visualization			
CLR-6 :	Provide strong foundation on Machine Learning - Naive Bayes, Clustering, Regression			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Apply basic concept of python programming in IDE	1	80	70	H	M			L										
CLO-2 :	Working with Dictionaries, list, file handling and exception handling	2	90	80	M											M			
CLO-3 :	Demonstrate Data analysis using Data wrangling with various probability distributions	3	90	80		M	H	H	H									H	
CLO-4 :	Analyze data visualization using matplotlib, pandas, seaborn.	3	80	70		M	H	H	H							H			H
CLO-5 :	Optimize machine learning using Naive Bayes, K Nearest neighbours for any given dataset	3	90	80		M	H	H	H										H
CLO-6 :	Optimize machine learning using clustering and regression for any given dataset	3	90	80			M		H							H			H

Duration (hour)		Learning Unit / Module 1 *Python and Programming Fundamentals*	Learning Unit / Module 2 *Algorithms, Data Structures and Performance Analysis*	Learning Unit / Module *3* *Data Analysis*	Learning Unit / Module *4* *Data Visualization*	Learning Unit / Module *5* *Python for Machine Learning*
		12	12	12	12	12
S-1	SLO-1	Introduction to Python Programming	Dictionaries - Working with dictionaries	Data wrangling introduction,	An introduction to matplotlib	Naive Bayes - Spam filter
	SLO-2	Running a hello world Program	Looping through a Dictionary, Nesting	Subsetting a dataset	Basics, plot components	Implementation , Testing the model,
S-2	SLO-1	Variables and simple Data types	User Input function	Generating and seeding random numbers	Plotting with pandas, Relationship between variables	*K*- Nearest neighbours - The model
	SLO-2	Variables, Strings, numberrs	While loop with lists and dictionaries	Generating random numbers using probability distributions	Distributions, Counts and frequencies	The Iris Datasheet - example
S 3-4	SLO-1	Lab-1: Basic programs using python IDE	Lab-4: Python programming based on dictionaries	Lab-7: Generating random numbers usign probability distributions	Lab-10: Python programming using matplotlib	Lab-13: Case study for any given dataset
	SLO-2					
S-5	SLO-1	Introducing Lists, Changing, Adding and removing elements	Functions- Passing Arguments, Return Values	Grouping the data aggression	Pandas - subpackages - scatter matrix	The curse of Dimensionality
	SLO-2	Organizing a List, Looping through list	Passing a list, Passing an arbitrary number of arguments and storing functions in modules	Filtering, Transformation	Lag plots, Autocorrelation plots	Evaluating various results
S-6	SLO-1	Avoiding index errors when working with Lists and sample list programs	Classes - Creating and using a class	*Random sampling - introduction*	Bootstrap plots	Clustering - Grouping planets by orbit characteristics
	SLO-2	Avoid indentation errors	Working with classes and instances	*Method: Customer churn model*	Seaborn - advanced plotting	Elbow point method for determining k

S 7-8	SLO-1	Lab-2: Python Programs based on Tuples	Lab-5: Python programming based on functions	Lab-8: Programs based on Data aggression, Filtering and Transformation	Lab-11: Python programming using matplotlib - plotting with pandas	Lab-14: Model Practical Exam
	SLO-2					
S-9	SLO-1	*Tuples, Tuple programs*	*Inheritance - importing classes*	*Method: using sklearn*	*Distribution, Faceting*	*Linear regression - predicting the length of a year on a planet*
	SLO-2	*Control statements , If statements - elsif statement*	*Files and exceptions - Reading from a file*	*Method: using shuffle function*	*Formatting - Title and axes*	*Interpreting the linear regression equation*
S-10	SLO-1	*Control Statements - if statements with lists*	*Writing to a file*	*Concatenating and appending data*	*Customizing visualizations - Adding reference lines, shading regions*	*Making predictions, Evaluating regression results*
	SLO-2	Sample programs	*Storing data*	*Merging/Joining datasets*	Annotations, colors	*Sample Case Study*
S 11-12	SLO-1	*Lab-3:* Python Programs based on Control statements	*Lab-6: Python programming based on file handling and exception handling*	*Lab-9:* Programs based on appending / merging data	*Lab-12: python programming using seaborn*	*Lab-15: End-Semester Exam*
	SLO-2					

Learning Resources	1. *Eric Matthes, Python Crash Course, No starch Press, 2nd Edition 2019.* 2. *Kirthi Raman, Ashish Kumar, Martin Czygan, Phuong Vo.T.H,, Python: Data Analytics and Visualization", Packt Publishing, 2017.* 3. *Stefanie Molin, Hands on Data Analysis with Pandas, Packt Publishing, 2019.*	4. *Joel Grus, Data Science from Scratch, O'Reilly Media,Inc, 2019.* 5. *Jake Vander Plas, Python Data Science Handbook, O'Reilly Media, Inc, 2016.* 6. *Wes McKinney, Python for Data analysis, O'Reilly Media, Inc, 2017.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	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
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2. Dr. Madan Kumar Lakshmanan, Senior Scientist, CEERI, lmadank@gmail.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECE373T	Course Name	CLOUD AND DISTRIBUTED COMPUTING	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO 2: Project Management Techniques	PSO – 3: Analyze & Research
CLR-1 :	*Understand the fundamental ideas behind Cloud Computing, the evolution of the paradigm, its applicability; benefits, as well as current and future challenges.*																		
CLR-2 :	*Learn cloud enabling technologies, Virtualization concepts and Virtual Machines.*																		
CLR-3 :	*Explore distributed system models and computer clusters for scalable parallel computing.*																		
CLR-4 :	*Understand the concept of Software Defined Networking and Geo Distributed cloud Data centres.*																		
CLR-5 :	*Explore distributed cloud storage technologies and relevant distributed file systems, NoSQL databases and object storage.*																		
CLR-6 :	*Understand the fundamental ideas behind Cloud Computing, the evolution of the paradigm, its applicability; benefits, as well as current and future challenges.*																		
Course Learning Outcomes (CLO):	***At the end of this course, learners will be able to:***																		
CLO-1 :	*Explain the fundamental ideas behind cloud computing, cloud models and current trends.*	*1*	*80*	*70*	*H*	*M*	*-*	*-*	*L*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*
CLO-2 :	*Analyze the need for virtualization in a cloud environment and outline their role in enabling the cloud computing system model*	*2*	*90*	*80*	*M*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*M*	*-*	*-*	*-*
CLO-3 :	*Apply distributed system model and understand the design principles of computer clusters.*	*3*	*90*	*80*	*-*	*M*	*H*	*H*	*H*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*H*	*-*
CLO-4 :	*Study the evolution and of SDN, Geo distributed cloud and demonstrate their use in VL2,Google B4.*	*3*	*80*	*70*	*-*	*M*	*H*	*H*	*H*	*-*	*-*	*-*	*-*	*-*	*-*	*H*	*-*	*-*	*H*
CLO-5 :	*Illustrate the fundamental concepts of cloud storage and demonstrate their use in storage systems such as Amazon S3.*	*3*	*90*	*80*	*-*	*M*	*H*	*H*	*H*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*H*

Duration (hour))		Learning Unit / Module 1 Introduction to Cloud computing	Learning Unit / Module 2 Cloud enabling technologies and Virtual Machines	Learning Unit / Module 3 Distributed System Models and Computer Clusters for scalable parallel computing	Learning Unit / Module 4 SDN and Geo-distributed Cloud 9	Learning Unit / Module 5 Distributed Cloud Storage
		9	9	9	9	9
S-1	SLO-1	*Introduction to Cloud Computing: Why Clouds? What is a Cloud? What's new in today's Clouds?*	*Cloud enabling technologies- Broadband networks and Internet architecture*	*System Models for Distributed and Cloud Computing: Clusters of Cooperative computers Evolution of*	*Software Defined Network: Key ideas of SDN*	*Introduction to Cloud Data Storage*
	SLO-2	*Evolution of cloud computing*			*SDN,SDN challenges The evaluation of storage technology*	
S-2	SLO-1	*Cloud Computing: Basic Concepts and Terminology*	*Data Center Technology*	*Grid Computing Infrastructures*	*Multi-tenant Data Centers: The challenge*	*Storage Models*
	SLO-2	*Network-Centric Computing*				
S-3	SLO-1	*Goals and Benefits*	*Web Technology*	*Peer-to-Peer Network families*	*Network virtualization*	*Distributed File Systems Google File System*
	SLO-2	*Risks and Challenges*				
S-4	SLO-1	*Roles and Boundaries Cloud Characteristics*	*Virtualization Technology: What is virtualization?*	*Software Environments for Distributed Systems and clouds: Service-Oriented Architecture(SOA)*	*Case Study: VL2, NVP*	*Design of Key-Value Stores: Key-value Abstraction, Key-value/ NoSQL Data Model*
	SLO-2		*Benefits of virtualization*			
S-5	SLO-1	*Cloud Service Models*	*Virtual Machines (VM) : Why use a VM*	*Trends towards distributed operating systems*	*Geo-distributed Cloud Data Centers:*	*Cloud Databases (HBase, MongoDB, Cassandra)*

	SLO-2	*Cloud Deployment Models*	*How VMs work?*	*Parallel and distributed programming models*	*Inter-Data Center Networking*	
S-6	SLO-1 SLO-2	*Cloud Service Providers and the Cloud Ecosystem*	*Virtualization models: Bare metal And Hypervisor*	*Cluster Development trends*	*Data center interconnection techniques: MPLS, Google's B4*	*Data Storage for Online Transaction Processing Systems*
S-7	SLO-1 SLO-2	*Amazon Web Services(AWS), Google Clouds, Microsoft Azure Cloud*	*Full Virtualization and Para-virtualization*	*Design Objectives of Computer Clusters, Fundamental Cluster Design Issues*	*Data center interconnection techniques: Microsoft's Swan*	*Cloud Application Development*
S-8	SLO-1 SLO-2	*SLA Management in Cloud Computing: A Service Providers Perspective*	*Hardware Support for Virtualization*	*Design Principles of Computer Clusters-Single System Image features*	*Design of Zookeeper: Race condition, Deadlock, Coordination, , Zookeeper design goals*	*Introduction to Spark: Resilient Distributed Datasets (RDDs), RDD Operations,*
S-9	SLO-1 SLO-2	*Case Study on Open Source & Commercial Clouds: Eucalyptus, Open Stack, Aneka*	*Kernel level Virtualization*	*High availability through redundancy, fault-tolerant cluster configurations*	*Zookeeper applications: Katta, Yahoo! Message Broker*	*Case Study on Spark applications: API,*

Learning Resources	1. Dan C. Marinescu, Cloud Computing Theory and Practice, 2nd Edition, Elsevier Inc., 2018 2. Kai Hwang. Geoffrey C. Fox, Jack J. Dongarra, Distributed and Cloud Computing from parallel processing to the internet of things, Elsevier, 2012. 3. Thomas Erl, Zaigham Mahmood, and Richardo Puttini, Cloud Computing: Concepts, Technology & Architecture, Prentice Hall/ Pearson PTR, 4th Edition, 20 4. Rajkumar Buyya, James Broberg, Andrzej Go scinski, Cloud Computing Principles and Paradigms, Wiley Publications, 2017. 5. Arshdeep Bahga, Vijay Madisetti, "loud Computing: A Hands-On Approach, University Press, 2016,

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
Level 2	Apply Analyze	*40%*	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-
Level 3	Evaluate Create	*20%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
	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
1. Mr. Athif Shah, Chairman, Abe Semicondutor, abechennai@gmail.com	*1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*1. Dr. Krishnaveni, SRMIST*
2. Dr. Madan Kumar Lakshmanan, Senior Scientist, CEERI, lmadank@gmail.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*Dr. M. S.Vasanthi, SRMIST*

Course Code	18ECE374J	Course Name	DATA SIMULATION THROUGH R	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Understand High performance computing environment syntax and symantic and library of R environment			
CLR-2 :	Be able to select the type of simulation methods based on application and data sets			
CLR-3 :	Get acquainted with the bootstrap method for statistical processing			
CLR-4 :	Apply EM algorithm and smoothing			
CLR-5 :	Explore simulation models for complex systems			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Code using R programming	3	80	70	L	H	H	H	H	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Decide the appropriate simulation method and optimization technique	2	85	75	M	H	L	M	H	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Apply bootstrap and jack knife method for problem solving	2	75	70	M	H	M	M	H	-	-	-	-	-	-	-	-	H	-
CLO-4 :	Use EM algorithm for smoothing	3	85	80	M	H	L	H	M	-	-	-	-	-	-	-	M	-	-
CLO-5 :	Analyse Various Type of Simulation Model for Complex System	3	85	75	M	H	M	H	H	-	-	-	-	-	-	-	-	-	H

Duration (hour)		Learning Unit / Module 1 Introduction to R environment	Learning Unit / Module 2 Simulation methods	Learning Unit / Module 3 Bootstrap and jackknife method for statistical processing	Learning Unit / Module 4 EM algorithm and smoothing	Learning Unit / Module 5 Simulation Models
		12	12	12	12	12
S-1	SLO-1	R and High-Performance Computing	Introduction to simulation	The bootstrap method	The basic EM algorithm	Different kinds of simulation and software
	SLO-2		Simulation need and applications		The basic EM algorithm	
S-2	SLO-1	The R statistical environment	Selection of suitable simulation technique	Estimation of standard errors with bootstrapping	The EM algorithm by example of k-means clustering	Simulating data using complex models
	SLO-2			Estimation of standard errors with bootstrapping	The EM algorithm by example of k-means clustering	
S 3-4	SLO-1	Lab1: Installing and working in R	Lab4: Simulation of Real and Pseudo random numbers	Lab 7: Estimation of BER -examples	Lab10: The EM algorithm for the imputation of missing value.	Lab 13: Model-based simulation studies – Modulator example
	SLO-2					
S-5	SLO-1	Generic functions, Methods and Classes	Simulation of non-uniform distributed random variables	The parametric bootstrap	Smoothing Regression	Design-based simulation
	SLO-2	Methods and Classes		Estimating bias with bootstrap	Nonparametric Regression	
S-6	SLO-1	Data manipulation	Tests for random number generator	The jackknife method	Spline smoothing and density estimation	Inserting missing value.
	SLO-2	Data manipulation	Tests for random number generator	Cross-validation	local polynomial regression kernel smoothing	
S 7-8	SLO-1	Lab 2: Data Manipulation examples	Lab5: non-uniform distributed random variables examples from demodulator data	Lab 8: Estimating bias: jackknife method	Lab 11: Spline smoothing examples	Lab: 14: Study of dynamic system
	SLO-2					
S-9	SLO-1	High performance computing	Monte Carlo Methods for Optimization Problems	The bootstrap in regression analysis	selecting tuning parameters by cross-validation	Agent-Based Models

	SLO-2	*Visualizing information*		*Numerical Examples*	*selecting tuning parameters by cross-validation*	
S-10	**SLO-1**	*Machine numbers*	*Numerical optimizations.*	*Bootstrapping in time series*	*Graphical aspects of smoothing.*	*Dynamic system in ecological modeling*
	SLO-2	*Rounding problems*	*stochastic optimizations.*	*Numerical Examples*	*Graphical aspects of smoothing.*	
S 11-12	**SLO-1**	*Lab:3- Examples on Machine numbers and rounding*	*Lab 6: stochastic optimization examples*	*Lab 9: Monte carlo test - examples*	*Lab: 12: Smoothing examples with Communication data*	*Lab: 15: Examination*
	SLO-2					

Learning Resources	1. Mathias Tepml, Simulation for Data Science with R, Packt Publishing House, 2016. 2. Christian P. Robert and George Casella, Introduction to Monte Carlo Methods with R, Springer, 2010

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	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
1. Mr. Athif Shah, Chairman, Abe Semicondutor, abechennai@gmail.com	*1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*1. Dr. Bhagwan Das, Head, Centre for Statistics, SRMIST*
2. Dr. Madan Kumar Lakshmanan, Senior Scientist, CEERI, lmadank@gmail.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECE471T	Course Name	DATA SCIENCE FOR COMMUNICATION NETWORKS	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	NIL	Co-requisite Courses	NIL	Progressive Courses	NIL
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	NIL		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*To provide basic concepts of Data Science*
CLR-2:	*To provide understanding of different data sources in various communication networks*
CLR-3:	*To emphasis on data visualization and different learning paradigms for communication networks*
CLR-4:	*To understand the various data science problems in wireless communication networks*
CLR-5:	*Learn and Understand the applications of data science in Telecom Industry*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1:	*Understand the concepts of Data Science*	2	80	85	H	-	-	-	-	-	-	-	-	-	-	-	M		
CLO-2:	*Classify the various data sources needed in communication networks*	2	75	80	H	M	-	-	H	-	-	-	-	-	-	-	H	L	H
CLO-3:	*Apply data visualization and different learning paradigms necessary for different applications*	2	85	80	H	H	-	-	H	-	-	-	-	-	-	-	H	M	H
CLO-4:	*Analyze various data science problems in communication networks*	3	80	75	H	H	-	-	H	-	-	-	-	-	-	-	H	H	H
CLO-5:	*Explore and Analyze various applications of data science in Telecom Industry*	3	75	85	H	H	-	H	H	-	-	-	-	-	-	-	H	M	H

Duration (hour)		*Learning Unit / Module 1* Overview of Data Science	*Learning Unit / Module 2* Data Source and necessities for Large Scale Communication Networks	*Learning Unit / Module 3* Data Visualization and Learning Paradigms	*Learning Unit / Module 4* Types of Data Science Problems in Wireless Networks	*Learning Unit / Module 5* Application of Data Science in Telecom Industry
		9	9	9	9	9
S-1	SLO-1	*Introduction to Data Science*	*Data Sources of Internet Service Providers: Telephony call record details, IP traffic flow records generated by routers, Protocol transitions*	Data Visualization: Design principles	Introduction to various data science problem in wireless networks	ISP Network: Structure of large ISP Networks, Measuring the ISP network, Challenges of ISP data analysis , Traffic Flow Management.
	SLO-2	*Causality and Experiments*				
S-2	SLO-1	*Data Preprocessing: Data cleaning, Data reduction, Data transformation, Data discretization*	*Data Sources of Mobile Communication Networks: Subscriber-related data, Network-related data, Application data*	Design principles for data visualization	Introduction to Regression - Linear Regression	*Application of data science in Telecommunication – Personalized Services - Customer Behaviour, Customer Demographics*
	SLO-2					
S-3	SLO-1	*Visualization and Graphing: Visualizing Categorical Distributions, Visualizing Numerical Distributions*	*Vehicular networks: Traffic Flow data, Public safety/security data, Vehicular safety warning messages,*	*Human perception of data*	Non-linear Regression	Network Management and Optimization, Social Media and Sentiment Analysis; Location-Based Initiatives
	SLO-2				Logistics Regression	
S-4	SLO-1	Overlaid Graphs, plots	*Ride quality monitoring information, Location-aware social network information*	*Effective interpretation with data*	Classification – Neural Networks	Customer Churn Prevention.
	SLO-2	Summary statistics of exploratory data analysis			Deep Learning	
S-5	SLO-1	*Randomness*	*Mobile Social Networks: Service Provider-related data, User related data.*	Modern visualization tools and techniques.	Support Vector Machine (SVM)	Application of data science in Telecom Industry - Customer Experience, Customer Segmentation, Product Development, Real-time Analytics
	SLO-2	Probability				
S-6	SLO-1	*Introduction to Statistics*	*Security and Privacy Concerns of data – Security in data acquisition, privacy and security in data storage,*	*Overview of Types of Learning Paradigms for Data Science*	k-Nearest Neighbour (k-NN)	Customer Sentiment Analysis., Fraud detection, Predictive analytics
	SLO-2	*Learning Curve*				Lifetime Value Prediction, Product

						Development
S-7	SLO-1	Sampling	Data Privacy and Challenges of data privacy	Data Mining vs. Machine Learning	Clustering	Price Optimization
	SLO-2	Sampling means and Sampling Sizes				Capacity management
S-8	SLO-1	Technical elements of the Data Science, Analytics Toolkit, Components of the analytics toolkit	Privacy in data analytics	Supervised vs. Unsupervised vs. Semi-Supervised Learning;	Anomaly Detection	Data integrity management
	SLO-2					Propensity profiling management
S-9	SLO-1	Applications of Data Science	Data policies for maintaining the privacy of data	Offline vs. Online vs. Active Learning.	Summarization	offer performance management.
	SLO-2					

Learning Resources	1. Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012. 2. Miroslav Kubat, An Introduction to Machine Learning, Springer, 2012 3. Larry L Peterson & Bruce S Davie, Computer Networks –A Systems Approac", Morgan Koufmann, Elsevier, 5th Edition, 2012.	4. Adi Adhikari and John DeNero, "omputational and Inferential Thinking: The Foundations of Data Science, GitBook, 2019. 5. Srinivasa, K.G., G M, Siddesh, H., Srinidhi, "etwork Data Analytics: A Hands-On Approach for Application Development" Springer, 2018. 6. Kolaczyk, Eric D., Statistical Analysis of Network Data: Methods and Models, Springer, 2009.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Understand										
Level 2	Apply	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
	Analyze										
Level 3	Evaluate	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	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

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Dr. Madan Kumar Lakshmanan, Senior Scientist, CEERI, lmadank@gmail.com	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	

Course Code	18ECE472T	Course Name	DATA BASE MANAGEMENT SYSTEMS	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	NIL	Co-requisite Courses	NIL	Progressive Courses	NIL
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	NIL		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Understand the fundamentals of Database Management Systems, Architecture and Languages			
CLR-2 :	Conceive the database design process through ER Model and Relational Model			
CLR-3 :	Design Logical Database Schema and mapping it to implementation level schema through Database Language Features			
CLR-4 :	Familiarize queries using Structure Query Language (SQL) and PL/SQL			
CLR-5 :	Familiarize the Improvement of the database design using normalization criteria and optimize queries			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Acquire the knowledge on DBMS Architecture and Languages	1	80	70	H	M	L	L	-	-	-	-	L	L	L	H	-	-	-
CLO-2 :	Apply the fundamentals of data models to model an application's data requirements using conceptual modeling tools like ER diagrams	3	85	75	H	H	H	H	H	-	-	-	H	H	H	H	-	-	H
CLO-3 :	Apply the method to convert the ER model to a database schemas based on the conceptual relational model	3	75	70	H	H	H	H	H	-	-	-	H	H	H	H	-	-	M
CLO-4 :	Apply the knowledge to create, store and retrieve data using Structure Query Language (SQL) and PL/SQL	3	85	80	H	H	H	H	H	-	-	-	H	H	H	H	H	-	-
CLO-5 :	Acquire the knowledge on DBMS Architecture and Languages	2	85	75	H	H	L	M	L	-	-	-	M	M	M	L	H	-	-

Duration (hour)		Learning Unit / Module 1 Database system overview	Learning Unit / Module 2 Entity Relation model	Learning Unit / Module 3 Query and exceptional handling	Learning Unit / Module 4 Relational Algebra and Dependency	Learning Unit / Module 5 Concurrency control
		9	9	9	9	9
S-1	SLO-1	What is Database Management System?	Database Design	Basics of SQL-DDL, DML, DCL	Relational Algebra – Fundamental Operators	Transaction concepts
	SLO-2	Advantage of DBMS over File Processing System	Design process	TCL Structure Creation, alternation	Relational Algebra – syntax	Properties of transactions
S-2	SLO-1	Introduction and applications of DBMS	Entity Relation Model	Defining Constraints-Primary Key, Foreign Key,	Relational algebra queries	Serializability of transactions,
	SLO-2	Purpose of database system		Unique, not null, check, IN operator	Tuple relational calculus	Testing for serializability, System recovery,
S-3	SLO-1	Views of data	ER diagram	Functions-aggregation functions	Pitfalls in Relational database, Decomposing bad schema	Concurrency control
	SLO-2	Data Abstraction			Functional Dependency – definition, trivial and non-trivial FD	
S-4	SLO-1	Database system Architecture	Keys , Attributes and Constraints	Sub Queries, correlated sub queries	closure of FD set , closure of attributes	Two- Phase Commit protocol, Recovery and Atomicity
	SLO-2				irreducible set of FD	
S-5	SLO-1	The evolution of Data Models	Mapping Cardinality	Nested Queries, Views	Normalization – 1Nf	Log-based recovery
	SLO-2			Nested Queries Types	2NF, 3NF	
S-6	SLO-1	Degrees of Data Abstraction	Extended ER - Generalization,	Transaction Control Commands	Decomposition using FD- dependency	Concurrent executions of transactions and
	SLO-2		Specialization and Aggregation		preservation,	Related problems
S-7	SLO-1	Database Users and DBA	ER Diagram Issues	PL/SQL Concepts- Cursors	BCNF	Locking mechanism, solution to

	SLO-2		*Weak Entity*			*concurrency related problems*
S-8	**SLO-1**	*Database Languages*	*Relational Model*	*Stored Procedure, Functions Triggers and Exceptional Handling*	*Multi- valued dependency,*	*Deadlock*
	SLO-2				*4NF*	
S-9	**SLO-1**	*Database Users*	*Conversion of ER to Relational Table*	*Query Processing*	*Join dependency and 5NF*	*Two-phase locking protocol,*
	SLO-2	*Database Administrators*				*Isolation, Intent locking*

Learning Resources	1. *Abraham Silberschatz, Henry F. Korth, S. Sudharshan, Database System Concepts, 6th Edition, Tata McGraw Hill,2011.* 2. *Ramez Elmasri, Shamkant B. Navathe, Fundamentals of Database Systems, 6th Edition, Pearson Education, 2011.* 3. *CJ Date, A Kannan, S Swamynathan, An Introduction to Database Systems, 8th Edition, Pearson Education, 2006.*	4. *Rajesh Narang, Database Management Systems, 2nd Edition, PHI Learning Private Limited, 2011.* 5. *Martin Gruber, Understanding SQL, Sybex,1990* 6. *Sharad Maheshwari, Introduction to SQLand PL/SQL,2nd Edition, Laxmi Publications, 2016.* 7. *Raghurama Krishnan, Johannes Gehrke, Database Management Systems,3rd Edition, McGraw Hill Education, 2003.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	30%	-	30%	-	30%	-	30%	-
	Understand										
Level 2	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
	Analyze										
Level 3	Evaluate	20%	-	30%	-	30%	-	30%	-	30%	-
	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.,

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2. Dr. Madan Kumar Lakshmanan, Senior Scientist, CEERI, lmadank@gmail.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECE473T	Course Name	DATA SECURITY	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	NIL	Co-requisite Courses	NIL	Progressive Courses	NIL
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards		NIL	

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis; Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLR-1 :	Explaining the key security requirements aligning with type of threats and vulnerabilities that attack the security of information or database systems.																		
CLR-2 :	Presenting symmetric and asymmetric cryptographic systems and covering most important parts of cryptology through introducing many cryptography techniques and algorithms																		
CLR-3 :	Describing the most important advance encryption theories aligning with the number theories that necessary as requirements.																		
CLR-4 :	Explaining the hash function as an application of cryptography aligning with the concept of message integrity and digital signature authentication.																		
CLR-5 :	Understand the issues involved in using asymmetric encryption to distribute symmetric keys.																		
CLR-6 :	To deal with different general purpose and application specific security Protocols and Techniques																		
Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:																		
CLO-1 :	Presenting the most important key security requirements that required for any security systems generally and specifically	1	85	65	M	-	-	-	-	-	-	-	-	-	-	M	L		
CLO-2 :	Utilizing and code developing for encryption algorithms that required to achieve confidentiality key security	1	85	65	H	-	M	M	L	-	-	-	-	-	-	L	H	H	H
CLO-3 :	Building an appropriate encrypting system that designed for specific key size and message length.	2,3	85	65	M		H	H	H	-	-	-	-	-	-	L	H	M	H
CLO-4 :	Investigating the suitability of a hash function for verifying the message integrity and digital signature authentication	2	75	65	H	H	H	H	H	-	-	-	-	-	-	L	H	H	H
CLO-5 :	Appreciate the role of distributed symmetric key in improving the asymmetric encryption systems	3,4	85	65	L	H	H	H	H	-	-	-	-	-	-	L	H	M	H
CLO-6 :	To study various aspects of Network Security, Web based Attacks, Services and Mechanisms.	3,4	85	65	L	H	H	H	H	-	-	-	-	-	-	-	H	H	H

Duration (hour)		Learning Unit / Module 1 Security services and Mechanisms	Learning Unit / Module 2 Block Ciphers	Learning Unit / Module 3 Public Key algorithms	Learning Unit / Module 4 Data security over internet	Learning Unit / Module 5 Web based attacks
		9	9	9	9	9
S-1	SLO-1	Introduction	Advanced block ciphers– introduction	Public key cryptosystems & message authentication - introduction	Data security over Internet - introduction	Web based attacks and security – introduction
	SLO-2					
S-2	SLO-1	Security Services	Block cipher modes operation	RSA algorithm	Kerbros version 4	Intrusion Detection
	SLO-2					
S-3	SLO-1	Security Mechanisms	IDEA	Diffie Hellmen Key Exchange	Kerbros version 5	Viruses and countermeasure
	SLO-2					
S-4	SLO-1	Security attacks	BlowFish	Message Authentication codes	X.509 certificate	Firewall Types and Configurations
	SLO-2					
S-5	SLO-1	Network Security Model	RC5	HASH function	Public key certificate format	Structured Query Language (SQL) Injection and its Types
	SLO-2					
S-6	SLO-1	Classical Encryption Techniques	CAST-128	Principle of MD5	PGP	Cross-site scripting (XSS), Document Object Model(DOM) Based Attacks
	SLO-2					
S-7	SLO-1	Substitution ciphers	Block ciphers, Advanced Encryption Standard (Structure)	SHA-1	IPSec	Session Hijacking, Cookie Guessing Attacks,
	SLO-2					

S-8	***SLO-1***	*Transposition ciphers*	*Block ciphers, Advanced Encryption Standard (Transformation function and key expansion)*	*HMAC algorithms*	*SSL*	*Cookie Discovery attacks, Cookie Setting Attacks*
	SLO-2					
S-9	***SLO-1***	*Data Encryption Standard (DES)*	*Key Distribution.*	*Digital Signature algorithm*	*SET*	*Phishing Attacks, denial-of-service attacks*
	SLO-2					

Learning Resources	1. *William Stallings, Cryptography and Network Security: Principles and Practice, 7th Edition, Pearson, 2016* 2. *Hans Delfs & Helmut Knebl, Introduction to Cryptography: Principles and Applications, 3rd Edition.Springer, 2015*	3. *Charlie Kaufman, Radio Perlman and Mike Speciner, Network Security, 2nd Edition, Prentice Hall of India, 2003* 4. *Othmar Kyas, Internet Security, International Thomson Publishing Inc.1997.* 5. *Bryan Sullivan, Vincent Liu, Web Application Security, A Beginner's Guide, 1st Edition, McGraw:Hill, 2012.,*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	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
1. Mr. Athif Shah, Chairman, Abe Semicondutor, abechennai@gmail.com	*1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*Dr. J. Anita Christaline, SRM IST*
2. Dr. Madan Kumar Lakshmanan, Senior Scientist, CEERI, lmadank@gmail.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECE332T	Course Name	PRINCIPLES OF ARTIFICIAL INTELLIGENCE	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	NIL	Co-requisite Courses	NIL	Progressive Courses	NIL
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	NIL		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Gain insight to Artificial Intelligence and agents			
CLR-2 :	Acquire knowledge about various searching strategies			
CLR-3 :	Create inference rules using predicate and first order logic			
CLR-4 :	Analyze the various planning strategies			
CLR-5 :	Appreciate the mathematical foundations in dealing uncertainty			
CLR-6 :	Utilize the concepts of AI in image processing and robotics			

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
					Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Obtain knowledge about artificial intelligence				H	-	-	-	-	-	-	-	-	-	-	-	L	L	L
CLO-2 :	Apply the searching strategies	2	85	80	H	H	-	-	-	-	-	-	-	-	-	-	M	L	M-
CLO-3 :	Formulate inference rules for given problem		3	80	75	H	H	H	-	-	-	-	-	-	-	-	-	M	L	M
CLO-4 :	Create appropriate solution plan using AI for real time problems		3	80	75	H	H	-	-	-	-	-	-	-	-	-	-	M	M	M
CLO-5 :	Handle uncertainty using mathematical axioms		3	75	70	H	-	H	-	-	-	-	-	-	-	-	-	H	M	H
CLO-6 :	Apply the concepts of image processing and robotics in the perspective of Artificial intelligence		2	80	75	H	H	H	H	-	-	-	-	-	-	-	-	H	M	H

Duration (hour)		Learning Unit / Module 1 AI- Search Techniques	Learning Unit / Module 2 Knowledge Representation Schemes	Learning Unit / Module 3 Planning	Learning Unit / Module 4 Probability Based Approaches	Learning Unit / Module 5 Advanced AI
		9	9	9	9	9
S-1	SLO-1	Introduction to Artificial Intelligence (AI)	Knowledge representation	Planning problem	Uncertainty, handling uncertainty, making rational decisions	Perception: introduction
	SLO-2	Evolution and foundations of AI	Issues in knowledge representation	Expressiveness and extensions	Design for decision theoretic agent	Perception: image formation
S-2	SLO-1	Problems, problem spaces and search	Propositional logic: Introduction and semantics	Components of planning	Basic probability notations	Edge detection in images
	SLO-2	Issues in design of search problems	Propositional logic: reasoning patterns	Goal stack planning	Axioms of probability	Image segmentation
S-3	SLO-1	Intelligent agents and environment	Inferences from propositional logic: Back tracking algorithm	Planning with search space tree: forward state planning	Independence	Extracting 3D information: motion, binocular stereopsis
	SLO-2	Good behavior of agents	Inferences from propositional logic: Local search algorithm	Planning with search space tree: Backward state planning	Bayes rule	Extracting 3D information: texture, shading and contour
S-4	SLO-1	Nature of environments	Agents based on propositional logic: Finding pits and wumpuses, tracking	Partial order planning	Semantics in Bayesian networks	Brightness based object recognition
	SLO-2	Structure of agents	Agents based on propositional logic: circuit based agents	Solving problems	Representations of conditional distributions	Feature and pose basedobject recognition
S-5	SLO-1	Problem solving by searching: Problem solving agents	First order logic: syntax and semantics, assertions and queries	Planning using graphs	Exact inferences in Bayesian networks	Vision for manipulation
	SLO-2	Problem solving by uninformed searching	First order logic: knowledge engineering	Planning using propositional logic	Approximate inferences in Bayesian networks	Vision for navigation
S-6	SLO-1	Problem solving by informed searching	Inferences in first order logic, forward	Hierarchical task network planning	Filtering and prediction in temporal	Robotics : introduction

			chaining		methods	
	SLO-2	Memory bounded heuristic searching	Solving problems	Modifying the planner	Smoothing and likelihood in temporal methods	Hardware and perception
S-7	SLO-1	*Heuristic function*	*Backward chaining, resolution*	*Conditional planning in fully observable environments*	*Hidden Markov model*	*Movement plan: configuration space, cell decomposition method*
	SLO-2	*Local search algorithms and optimizations :Hil climbing, Simulated annealing*	*Solving problems*	*Conditional planning in partially observable environments*	*Simplified matrix algorithms*	*Movement plan: skeletonization method*
S-8	SLO-1	*Local search algorithms and optimizations: Local beam search, Genetic algorithms*	*Knowledge representation: Ontological engineering*	*Monitoring and re planning*	*Kalman filters*	*Planning uncertain movements*
	SLO-2	*Searching in continuous space*	*Categories and objects*	*Continuous planning*	*One dimensional example*	*Controls in uncertain movements*
S-9	SLO-1	*Online search agents and unknown environments: problems and agents*	*Actions, situations and events*	*Multi agent planning*	*Dynamic Bayesian network*	*Software architectures for robotics*
	SLO-2	*Online search agents and unknown environments: local search and learning*	*Mental events and objects*	*Coordination in multi agent planning*	*Approximate and exact inferences in dynamic Bayesian network*	*Programming languages for robotics*

Learning Resources	*1. Stuart Russel, Peter Norwig, Artificial Intelligence, A modern approach, 4th Edition, Pearson, 2018.* *2. Eliane Rich, Kevin Knight, Shivashankar B. Nair, Artificial Intelligence, 3rd Edition, Tata Mc Graw Hill Publishing Company, 1991.*	*3. Patrick Henry Winston, Artificial Intelligence, 3rd Edition, Addison Wesley, 2011.* *4. Deepak Khemani, Artificial Intelligence, Tata Mc Graw Hill Education 2013.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*40%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
	Understand										
Level 2	Apply	*40%*	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-
	Analyse										
Level 3	Evaluate	*20%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
	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. Jagatheeeswaran, Head, Auxolabs, jagatheeswarans.iot@auxolabs.in	*Dr. Chitrakda, Anna University, au.chitra@gmail.com*	Dr. Pushpalatha, Professor/CSE, SRMIST

Course Code	18ECE339T	Course Name	DATA ANALYSIS AND VISUALIZATION	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	NIL	Co-requisite Courses	NIL	Progressive Courses	NIL
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards		NIL	

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Obtain knowledge in handling data
CLR-2 :	Learn the various statistical techniques in data handling
CLR-3 :	Know the various regression and classification techniques
CLR-4 :	Identify various data sources and dealing with messy date
CLR-5 :	Create insights to art of visualization
CLR-6 :	Knowing the impact of visual effects

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Handle univariate and multivariate data	2	80	75	H	H	-	H	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Appreciate the statistical inferences from data	3	80	75	H	H	-	H	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Learn the regression and classification techniques	2	85	80	H	H	-	H	-	-	-	-	-	-	-	-	M	-	-
CLO-4 :	Dealing data from multiple sources and dealing messy data	2	85	80	H	H	-	H	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	Gain insight about visualizations	1	90	85	H	-	H	-	H	-	-	-	-	-	-	-	-	H	-
CLO-6 :	Appreciate the various visual effects	1	90	85	H	H	H	-	H	-	[-	-	-	-	-	-	-	-	H

Duration (hour)		Learning Unit / Module 1 Data 9	Learning Unit / Module 2 Regression models 9	Learning Unit / Module 3 Relational databases 9	Learning Unit / Module 4 Data visualization considerations 9	Learning Unit / Module 5 Data Layouts 9
S-1	SLO-1	Shape of data : Univariate data, Frequency distributions	Predicting continuous variables: linear models	Data sources	Classification of visualization: complexity	Positioning: layout
	SLO-2	Measures of central tendency, Spread	Linear regression	Relational databases	Inforgraphics vs data visualization	Positioning: axes
S-2	SLO-1	Population, sampling and estimation	Multiple regression	SQL	Exploration vs explanation	Placement and proximity: Semantic distance and relative proximity, absolute placement
	SLO-2	Probability distributions	Regression with a non binary predictor	JSON	Information vs persuasive vs visual art	Representation of physical space
S-3	SLO-1	Multivariate data: Relationships between single categorical and single continuous variable	Kitchen sink regression	XML	Looking data as designer	Logical and physical relationships
	SLO-2	Relationships between two categorical variables	The bias variance trade off: Cross validation	Other data formats	Role of designer	Patterns and grouped objects
S-4	SLO-1	Relationship between two continuous variables	Striking a balance	Handling data from online repositories	Looking data as reader	Patterns of organizations: Graphs, layouts
	SLO-2	Covariance	Linear regression diagnostics	Dealing messy data	Creation of visualization for other people	Axis styles
S-5	SLO-1	Correlation coefficients	Second, third and fourth anscombe relationship	Analysis with messy data: Types	Contextual considerations	Using circles and circular layouts
	SLO-2	Comparing multiple correlations	Advancements	Unsophisticated methods for dealing	Context of use	Applying encodings: Color

				missing data: Complete case analysis, Pairwise deletion		
S-6	SLO-1	Probability: Basics	Predicting categorical variables: k nearest neighbors	Unsophisticated methods for dealing missing data: Mean substitution, Hot deck imputation	The goal and supporting data	Leverage Common color
	SLO-2	A tale of two interpretations	Confusion matrix	Unsophisticated methods for dealing missing data: Regression imputation, Stochastic regression imputation	Knowledge before structure	Cognitive interference and Stroop test
S-7	*SLO-1*	Sampling from distributions	Logistic regression	*Multiple imputation*	Choosing appropriate visual encodings: natural order, distinct values, redundant encoding	*Color theory*
	SLO-2	Binomial distribution	Role of sigmoid function	*Analysis with sanitized data*		*Sizes: Conveying size*
S-8	*SLO-1*	*Problems in binomial distribution*	Decision trees	*Checking for out of bounds and data type*	*Defaults vs innovative formats, Readers context*	*Size: Comparing size*
	SLO-2	*Normal distribution*	Random forests	*Checking for unexpected categories, outliers, typographical errors.*	*Compatibility with reality, Patterns and consistency*	*Text and typography*
S-9	*SLO-1*	*Problems in normal distribution*	*Choosing a classifier: vertical and diagonal boundary*	*Checking unlikely data*	*Selecting structures: Comparisons, bad structures*	*Shapes and lines*
	SLO-2	*Three sigma rule and using z tables*	*Choosing a classifier: crescent and circular boundary*	*Other messiness*	*Abused structure and simplicity in designing*	*Keys Vs direct labeling of data points*

Learning Resources	1. *Tony Fischetti, Data Analysis with R, Packt publishing, 2015.* 2. *Noab Iliinsky, Julie Steele, Designing data visualizations, O' Reilly publishers, 2011.*	3. *Trevor Hastie, Robery Tibshirani, Jerome Friesman, The Elements of Statistical Learning, Data mining, Inference and prediction, 2nd Edition, Springer, 2010.* 4. *Charles D. Hansen and Chris R. Johnson, Visualization Handbook, Academic Press, 2004.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*40%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
	Understand										
Level 2	Apply	*40%*	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
	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.Baraneedhara Karthikeyan, Director, Skylim Infotech Pvt Ptd	*Dr. Bhuvaneshwari, Professor, MIT, Anna University, Chennai*	*Dr. Revathi Venkataraman, Professor/ CSE Dept, SRMIST*

Course Code	18CSE392T	Course Name	MACHINE LEARNING - I	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	NIL	Co-requisite Courses	NIL	Progressive Courses	NIL
Course Offering Department	Computer Science Engineering	Data Book / Codes/Standards	NIL		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	To provide basic concepts of machine learning
CLR-2 :	To provide deeper understanding of various tools and techniques for Machine learning Algorithms and outputs
CLR-3 :	Understand and Implement the major classification techniques
CLR-4 :	Understand and Implement the various Clustering Methods
CLR-5 :	Learn and Understand the Tree based machine Learning Algorithms

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	Understand the concepts of machine learning	2	80	85	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Learn and understand machine tools and libraries of machine learning	2	75	80	H	H	H	-	H	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Learn and understand the linear learning models and classification in machine learning	2	85	80	H	H	-	-	H	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Understand the clustering techniques and their utilization in machine learning	2	80	75	H	H	-	-	H	-	-	-	-	-	-	-	-	-	-
CLO-5 :	Study the tree based machine learning techniques and to appreciate their capability	2	75	85	H	H	-	H	H	-	-	-	-	-	-	-	-	-	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Machine Learning: What and Why?	Platform for machine learning	Ridge Regression	Measuring (dis)similarity	Decision tree representation
	SLO-2	Types of Machine Learning	Machine learning python libraries		Evaluating output of clustering methods	
S-2	SLO-1	Supervised Learning	Scikit-learn	Maximum likeliwood estimation (least squares)	Spectral clustering	Basic decision tree learning algorithm
	SLO-2	Unsupervised Learning	training data – testing data – validation data		Hierarchical clustering	
S-3	SLO-1	Reinforcement learning	k-fold cross validation	principal component analysis	Agglomerative clustering	Inductive bias in decision tree
	SLO-2	The Curse of dimensionality	Features		Divisive clustering	
S-4	SLO-1	Over fitting and under fitting	Performance metrics	Bayesian classifier	Choosing the number of clusters	Decision tree construction
	SLO-2	linear regression	MSE, accuracy, confusion matrix, precision		Clustering datapoints and features	
S-5	SLO-1	Bias and Variance tradeoff	recall, F- score	Support vector machine	Bi-clustering	Issues in decision tree
	SLO-2	Testing – cross validation				
S-6	SLO-1	Regularization	Linear Regression with multiple variables	Support vector machine + kernels	Multi-view clustering	Classification and regression trees (CART)
	SLO-2	Learning Curve				
S-7	SLO-1	Classification	Logistic Regression	Multi class classification	K-Means clustering	Random Forest
	SLO-2	Error and noise				Random Forest with scikit-learn
S-8	SLO-1	Parametric vs. non-parametric models	spam filtering with logistic regression	K nearest neighbour classification	K-meloids clustering	Multivariate adaptive regression trees (MART)
	SLO-2					Introduction to Artificial Neural Networks
S-9	SLO-1	Linear Algebra for machine learning	Naive Bayes with scikit-learn	Application: face recognition with PCA	Application: image segmentation using K-means clustering	Perceptron learning
	SLO-2					

Learning Resources	1. *Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.* 2. *Ethem Alpaydin, "Introduction to Machine Learning", Prentice Hall of India, 2005* 3. *Tom Mitchell, "Machine Learning", McGraw-Hill, 1997.*	4. *Sebastian Raschka, Vahid Mirjilili,"Python Machine Learning and deep learning", 2nd edition, kindle book, 2018* 5. *Carol Quadros,"Machine Learning with python, scikit-learn and Tensorflow", Packet Publishing, 2018.* 6. *Gavin Hackeling," Machine Learning with scikit-learn", Packet publishing, O'Reily, 2018.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	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
Dr.Anbu Rathinavel, Chief Design Officer, Design Intellect	*Dr.Virajkumar, Professor, PES University*	1. *Dr. G. Vadivu, SRMIST* 2. *Dr. Usha Kiruthika, SRMIST* 3. *Mr. S. Joseph James, SRMIST*

Course Code	18CSE391T	Course Name	BIG DATA TOOLS AND TECHNIQUES	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Gain knowledge about the various tools and techniques used in big data analytics			
CLR-2 :	Learn the fundamentals of Hadoop and the related technologies			
CLR-3 :	Understand the basics of development of applications using MapReduce, HDFS, YARN			
CLR-4 :	Learn the basics of Pig, Hive and Sqoop			
CLR-5 :	Learn the basics of Apache Spark, Flink and understand the importance of NoSQL databases			
CLR-6 :	Learn about Enterprise Data Science and data visualization tools			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)															
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research	
CLO-1 :	Use the various tools and techniques in big data analytics	2	80	75	H	H	-	H	-	-	-	-	-	-	-	-	-	M	-	
CLO-2 :	Apply Hadoop and related technologies to big data analytics	3	80	75	H	H	-	H	-	-	-	-	-	-	-	-	-	-	-	
CLO-3 :	Apply MapReduce, HDFS and YARN develop big data applications	2	85	80	H	H	-	H	-	-	-	-	-	-	-	-	M	-	-	
CLO-4 :	Develop applications using Pig, Hive and Sqoop	2	85	80	H	H	-	H	-	-	-	-	-	-	-	-	M	H	H	
CLO-5 :	Apply Apache Spark and Flink to applications and understand the importance of NoSQL databases	1	90	85	H	-	H	-	H	-	-	-	-	-	-	-	-	H	-	
CLO-6 :	Understand the applications of Enterprise Data Science and data visualization tools	1	90	85	H	H	H	-	H	-	[-	-	-	-	-	-	-	-	-	

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Overview of Big Data Analytics	MapReduce	Setting up a Hadoop cluster	Introducing Oozie	Enterprise Data Science Overview
	SLO-2	Introduction to data analytics and big data	Analyzing data with Unix tools and Hadoop	Cluster specification and setup	Introducing Oozie	Enterprise Data Science Overview
S-2	SLO-1	Big Data Mining	Scaling Out – Data Flow, Combiner Functions	Hadoop configuration	Apache Spark	Data Science Solutions in the enterprise
	SLO-2	Technical elements of the Big Data platform	Hadoop Streaming	YARN configuration	Apache Spark	Data Science Solutions in the enterprise
S-3	SLO-1	Analytics Toolkit, Components of the analytics toolkit	HDFS	Introduction to Pig	Limitations of Hadoop and overcoming the limitations	Enterprise data science – Machine Learning and AI
	SLO-2	Distributed and Parallel Computing for Big Data	HDFS	Installing and running pig	Core components and architecture of Spark	Enterprise Infrastructure solutions
S-4	SLO-1	Cloud computing and Big Data	Hadoop filesystems	Basics of Pig Latin	Introduction to Apache Flink	Visualizing Big Data
	SLO-2	Cloud computing and Big Data	Java Interface to Hadoop	Basics of Pig Latin	Installing Flink	Visualizing Big Data
S-5	SLO-1	In-Memory Computing Technology for Big Data	YARN	Introduction to Hive	Batch analytics using Flink	Using Python and R for visualization
	SLO-2	In-Memory Computing Technology for Big Data	Job Scheduling	Installing and running Hive	Batch analytics using Flink	Big Data Visualization Tools
S-6	SLO-1	Hadoop Ecosystem	Hadoop I/O	Introduction to HiveQL	Big Data Mining with NoSQL	Data Visualization with Tableau
	SLO-2	Hadoop Ecosystem	Hadoop I/O	Introduction to HiveQL	Big Data Mining with NoSQL	Data Visualization with Tableau

S-7	***SLO-1***	*The core modules of Hadoop*	*Data Integrity*	*Introduction to Zookeeper*	*Why NoSQL?*	*Case Studies: Hadoop*
	SLO-2	*The core modules of Hadoop*	*Compression*	*Installing and running Zookeeper*	*NoSQL databases*	*Case Studies: Hadoop*
S-8	***SLO-1***	*Introduction to Hadoop MapReduce*	*Serialization*	*The Zookeeper Service*	*Introduction to HBase*	*Case Studies: Spark*
	SLO-2	*Introduction to Hadoop MapReduce*	*File based Data Structures*	*Flume Architecture*	*Introduction to HBase*	*Case Studies: Spark*
S-9	***SLO-1***	*Introduction to Hadoop YARN*	*Developing a MapReduce Application*	*Introduction to Sqoop*	*Introduction to MongoDB, Cassandra*	*Case Studies: NoSQL*
	SLO-2	*Introduction to Hadoop YARN*	*Developing a MapReduce Application*	*Introduction to Sqoop*	*Introduction to MongoDB, Cassandra*	*Case Studies: NoSQL*

Learning Resources	1. *Tom White,Hadoop:The Definitive Guide,3rd Edition,O'Reilly,2012.* 2. *Sridhar Alla,Big Data Analytics with Hadoop3,Packt,2018.*	3. *Nataraj Dasgupta, Practical Big Data Analytics, Packt,2018.* 4. *DT Editorial Services, Big Data Black Book,2016.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*40 %*		*30 %*		*30 %*		*30 %*		*30%*	
	Understand										
Level 2	Apply	*40 %*		*40 %*		*40 %*		*40 %*		*40%*	
	Analyze										
Level 3	Evaluate	*20 %*		*30 %*		*30 %*		*30 %*		*30%*	
	Create										
	Total			100 %		100 %		100 %		100 %	

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr.Baraneedhara Karthikeyan, Director, Skylim Infotech Pvt Ptd	Dr. Bhuvaneshwari, Professor, MIT, Anna University, Chennai	Dr. Revathi Venkataraman, Professor/ CSE Dept, SRMIST

Course Code	18CSE355T	Course Name	DATA MINING AND ANALYTICS	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	NIL	Co-requisite Courses	NIL	Progressive Courses	NIL
Course Offering Department	Computer Science Engineering	Data Book / Codes/Standards		NIL	

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Understand the concepts of Data Mining
CLR-2 :	Familiarize with Association rule mining
CLR-3 :	Familiarize with various Classification algortihms
CLR-4 :	Understand the concepts of Cluster Analysis
CLR-5 :	Familiarize with Outlier analysis techniques
CLR-6 :	Familiarize with applications of Data mining in different domains

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)															
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3	
CLO-1 :	Gain knowledge about the concepts of Data Mining	2	80	85	H	H	-	H	-	-	-	-	-	-	-	-	-	M	-	
CLO-2 :	Understand and Apply Association rule mining techniques	2	75	80	H	H	-	H	-	-	-	-	-	-	-	-	-	-	-	
CLO-3 :	Understand and Apply various Classification algortihms	2	85	80	H	H	-	H	-	-	-	-	-	-	-	-	M	-	-	
CLO-4 :	Gain knowledge on the concepts of Cluster Analysis	2	80	75	H	H	-	H	-	-	-	-	-	-	-	-	M	H	H	
CLO-5 :	Gain knowledge on Outlier analysis techniques	2	75	85	H	-	H	-	H	-	-	-	-	-	-	-	-	H	-	
CLO-6 :	Understand the importance of applying Data mining concepts in different domains	2	80	85	H	H	-	H	-	[-	-	-	-	-	-	-				

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Why Data mining? What is Data mining ?	Mining frequent patterns: Basic concepts	Classification: Basic concepts	Cluster Analysis: Introduction	Outliers: Introduction
	SLO-2	Kinds of data meant for mining	Market Basket Analysis	General approach to Classification	Requirements and overview of different categories	Challenges of outlier detection
S-2	SLO-1	Kinds of patterns that can be mined	Frequent item sets, Closed item sets	Decision tree induction	Partitioning method: Introduction	Outlier detection methods: Introduction
	SLO-2	Applications suitable for data mining	Association rules-Introduction	Algorithm for Decision tree induction	k-means	Supervised and Semi-supervised methods
S-3	SLO-1	Issues in Data mining	Apriori algorithm-theoretical approach	Numerical example for Decision tree induction	k-medoids	Unsupervised methods
	SLO-2	Data objects and Attribute types	Apply Apriori algorithm on dataset-1	Attribute selection measure	Hierarchical method: Introduction	
S-4	SLO-1	Statistical descriptions of data	Apply Apriori algorithm on dataset-2	Tree pruning	Agglomerative vs. Divisive method	Statistical and Proximity based methods
	SLO-2		Generating Association rules from frequent item sets	Scalability and Decision tree induction	Distance measures in algorithmic methods	
S-5	SLO-1	Need for data preprocessing and data quality	Improving efficiency of Apriori	Bayes' Theorem	BIRCH technique	Statistical approaches
	SLO-2			Naïve Bayesian Classification		
S-6	SLO-1	Data cleaning	Pattern growth approach	IF-THEN rules for classification	DBSCAN technique	Statistical data mining
	SLO-2	Data integration		Rule extraction from a decision tree		
S-7	SLO-1	Data reduction	Mining frequent item sets using Vertical data format	Metrics for evaluating classifier performance	STING technique	Data mining and recommender systems
	SLO-2		Strong rules vs. weak rules	Cross validation		

S-8	***SLO-1***	*Data transformation*	*Association analysis to Correlation analysis*	*Bootstrap*	*CLIQUE technique*	*Data mining for financial data analysis*
	SLO-2			*Ensemble methods-Introduction*		
S-9	***SLO-1***	*Data cube and its usage*	*Comparison of pattern evaluation measures*	*Bagging and Boosting*	*Evaluation of clustering techniques*	*Data mining for Intrusion detection*
	SLO-2			*Random Forests: Introduction*		

Learning Resources	*1. Jiawei Han and Micheline Kamber, Data Mining: Concepts and Techniques", 3rd Edition, Morgan Kauffman Publishers, 2011.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember / Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply / Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate / Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	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
1. Mr. V. Selvakumar, Hexaware Technologies, selvakumarv@hexaware.com	*1. Dr.Latha Parthiba, Pondicherry University, lathaparthiban@yahoo.com*	*1. Mr.L.N.B.Srinivas, SRMIST*

Course Code	18CSE484T	Course Name	DEEP LEARNING	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	NIL	Co-requisite Courses	NIL	Progressive Courses	NIL
Course Offering Department	Computer Science Engineering	Data Book / Codes/Standards		NIL	

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Understand the concepts of Neural Networks and Deep Learning
CLR-2 :	Understand Deep neural network and layered learning approach
CLR-3 :	Study and understand CNN and RNN for deep learning
CLR-4 :	Learn and understand Auto Encoders and its applications
CLR-5 :	Understand concept of transfer learning and its applications with keras
CLR-6 :	Understand the concepts of Neural Networks and Deep Learning

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	Apply basic mathematical concepts in Deep Learning	2	80	85	H	L			H							H	H		M
CLO-2 :	Work with powerful framework for supervised learning	3	75	80	H	H			H							H	H	H	H
CLO-3 :	Deal with Convolution Neural Networks	2	85	80	H	H	H		H							H	H	H	H
CLO-4 :	Analyze various types efficient data encoders	2	80	75	H	H	-		H							H	H	H	H
CLO-5 :	Apply various network models in deep learning	3	75	85	H	H	H	H	H							H	H	H	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Historical trends in deep learning – Machine Learning basics	Introduction to Simple DNN	Convolution Neural Networks Introduction	Encoder	Deep Architectures in Vision
	SLO-2	Learning algorithms – Supervised and Unsupervised Training	Platform for Deep Learning	Convolution Operation	Decoder	AlexNet to ResNet
S-2	SLO-1	Linear Algebra for machine learning	Deep Learning Software Libraries	Motivation	Auto Encoders Introduction	Transfer Learning
	SLO-2	Testing - Cross Validation	Deep Feed Forward Networks Introduction	Pooling	Auto Encoders	
S-3	SLO-1	Dimensionality Reduction	Learning XOR	Normalization	Under Complete Auto Encoder	Siamese Networks
	SLO-2	Over fitting /Under Fitting	Gradient-Based Learning	Applications in Computer Vision - ImageNet	Regularized Auto Encoder	
S-4	SLO-1	Hyper parameters and validation sets	Various Activation Functions, ReLU, Sigmoid – Error Functions	Sequence Modelling –VGGNet, LeNet	Stochastic Auto Encoder	Metric Learning
	SLO-2	Estimators – Bias - Variance	Architecture Design	Recurrent Neural Networks	Denoising Auto Encoder	Ranking / Triplet Loss
S-5	SLO-1	Loss Function-- Regularization	Differentiation Algorithms	RNN topologies- Difficulty in Training RNN	Contractive Auto Encoder	RCNNs with keras
	SLO-2	Biological Neuron – Idea of Computational units	Regularization methods for Deep Learning		Auto Encoder Applications	
S-6	SLO-1	McCulloch-Pitts units and Thresholding logic	Early Stopping	Long Short Term Memory	Dimensionality Reduction and Classification using Auto encoders	CNN-RNN
	SLO-2	Linear Perceptron	Drop Out		Recommendation	
S-7	SLO-1	Perceptron Learning Algorithm	Difficulty of training deep neural networks	Bidirectional LSTMs	Optimization for Deep Learning-Optimizers –RMS prop for RNNs	Applications in captioning and Video tasks
	SLO-2	Convergence theorem for Perceptron				

		Learning Algorithm				
S-8	***SLO-1***	*Linear Separability*	*Greedy layer wise training*	*Bidirectional RNNs*	*SGD for CNNs*	*3D CNNs*
	SLO-2	*Multilayer perceptron –The first example of network with Keras code*				
S-9	***SLO-1***	*Back propagation*	*Optimization methods for Neural Networks-Adagrad, Adam*	*Application case study -Handwritten digits recognition using deep learning, LSTM with Keras – sentiment Analysis*	*Application case study – Image dimensionality reduction using encoders LSTM with Keras – sentiment Analysis*	*Application case study – Image recognition using RCNN and transfer learning*
	SLO-2					

Learning Resources	1. *Ian Goodfellow,Yoshua Bengio,Aaron Courville, DeepLearning, MITPress,2016.* 2. *Kevin P. Murphy, Machine Learning:AProbabilisticPerspective, MITPress,2012.* 3. *Raul Rojas, Neural Networks: A Systematic Introduction, 1996.*	4. *Christopher and M.Bishop,, Pattern Recognition and Machine Learning, Springer Science Business Media, 2006.* 5. *Jason Brownlee, Deep Learning with Python, ebook,2016.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	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
Dr. Anbu Rathinavel, Chief Design Officer, Design Intellect	*Dr. Virajkumar, Professor, PES University*	*1. Dr .E. Poovammal, CSE, SRMIST*
		2. Dr. G. Vadivu, CSE, SRMIST
		3. Mr. Joseph James, CSE, SRMIST

B. Tech in Electronics and Communication Engineering (with specialization in Data Science)

2018 Regulations

Open Elective Courses (O)

Department of Electronics and Communication Engineering
SRM Institute of Science and Technology
SRM Nagar, Kattankulathur – 603203, Kancheepuram District, Tamilnadu

Course Code	18ECO101T	Course Name	SHORT RANGE WIRELESS COMMUNICATION	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/ Standards		Nil	

Course Learning Rationale (CLR):	Understand the concept of Short range Wireless Communication
CLR-1 :	Overview of different modulation scheme and wireless system
CLR-2 :	To understand the various components used to implement a short-range radio system.
CLR-3 :	Analysis of the various kinds of transmitters and receivers used for Short range Wireless Communication.
CLR-4 :	To know about regulations and standards of ISM band communications
CLR-5 :	Design and analysis of short-range radio like UWB and Visible light.

Course Learning Outcomes (CLO):	The purpose of this course is to introduce practically all aspects of radio communication including wave propagation, antennas, transmitters, receivers, design principles, telecommunication regulations	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	To cover the various forms of signals used for information transmission and modulation, and overall wireless system properties.	2	80	70	L	-	-	-	-	-	-	-	-	-	-	-	-	H	-
CLO-2 :	To present various component types that can be used to implement a short-range radio system.	2	85	75	-	-	M	L	-	-	-	-	-	-	-	-	H	-	-
CLO-3 :	To describe the various kinds of transmitters and receivers.	2	75	70	-	-	H	M	-	-	-	-	-	-	-	-	-	H	-
CLO-4 :	To covers regulations and standards of ISM band communications	2	85	80	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-5 :	To covers some of the most important new developments in short-range radio like UWB and Visible light.	2	85	75	-	-	L	M	-	-	-	-	-	-	-	-	-	-	H

Duration (hour)		Wireless Systems	Baseband Coding basics	RF transceivers	Wireless standards	Optical wireless Technologies
		9	9	9	9	9
S-1	SLO-1	Introduction to wireless systems	Types of Antennas-Dipole, groundplane, loop	RF Receivers- Introduction	Technical Background to the WPAN Concept - Regulation and Standardization Issues	Fundamentals of UROOF Technologies
	SLO-2	Reasons for the Spread of Wireless Applications	Helical, Patch antennas	RF Source-Frequency control	European Consortium: Overview	Conversion from RF to Optical Domain
S-2	SLO-1	Characteristics of Short-range Radio	Antenna Characteristics-Impedence, directivity and gain, Effective area	Modulation types	Millimeter-Wave Applications and Services - PAN scenarios in the IST Magnet project	Conversion from Optical to RF Domain
	SLO-2	Wireless Applications	Polarization, Bandwidth, Antenna factor	Amplifiers	Typical LDR services connected to the IST-FP6 MAGNET project	Optical Microwave Mixing Used for UWB Over Systems
S-3	SLO-1	Elements of Wireless Communication Systems-Transmitter	Baseband Data Format and Protocol - Radio Communication Link Diagram	Impedance matching in transmitter and receivers	Frequency Regulation and Standardization Issues - Optional UM4 usage models issued from the IEEE802.15.3c TG	Integrated UROOF Transceiver (IUT)
	SLO-2	Elements of Wireless Communication Systems-Receiver	Code Hopping	Filtering	Flexible antenna gain, 60 GHz regulation status for wireless transmissions.	Mixed Wireless-wired UROOF Channel, Carrier-to-noise Ratio
S-4	SLO-1	Wireless Local Area Networks (WLAN)-WIFI	Baseband Coding-Digital systems	SAW band pass filter matching	Channel Propagation Characterization and Modeling- 60 GHz Propagation Measurements	Laser and Photodetector Noise Baseline,
	SLO-2	Network Architecture	Wireless Microphone System	Tuned Radio Frequency (TRF)	Propagation Channel Characterization	Clipping Distortion Implication , Latency
S-5	SLO-1	Bluetooth Transceiver	RF Frequency and Bandwidth-factors	ASH Receiver	Multipath Propagation Modeling	Modelling the Propagation through the Fibre

	SLO-2	*Bluetooth Modes*	*Propagation characteristics*	*Super regenerative Receiver –Block diagram*	*France Telecom Propagation Channel Models*	*Analysis of UWB Technologies for UROOF- Comparing UWB Technologies for Radio-over- fibre*
S-6	**SLO-1**	*Zigbee Architecture, Frame Structure*	*Modulation types*	*Super regenerative Receiver – Operation*	*MSK-Based System for LOS Gb/s Communications*	*MB-OFDM Over Multimode Fibre*
	SLO-2	*Applications and conflicts*	*Modulation for digital event communication*	*Super heterodyne Receiver-Block diagram*	*System architecture for an MSK-based system to operate in a LOS channel.*	*All-optical Generation of Ultra-wideband Impulse Radio*
S-7	**SLO-1**	*Ultra-wideband Technology-Bit Sequence detection*	*Continuous Digital Communication*	*Super heterodyne Receiver- Operation*	*OFDM-Based System for NLOS Gb/s Communications*	*Operation Principles and Theoretical Approach*
	SLO-2	*UWB Block Diagram*	*Advanced Digital Modulation*	*Direct Conversion Receiver- Block diagram*	*System architecture for an OFDM-based system to operate in a NLOS channel.*	*VLC Link –Transmitter*
S-8	**SLO-1**	*Wireless Modules-Japan,UK,USA*	*Spread Spectrum-DHSS*	*Direct Conversion Receiver- Operation*	*System Design Aspects-Channel Plan*	*The VLC Channel*
	SLO-2	*Wireless Modules-Austria, Honeywell, Norway*	*Spread Spectrum-FHSS*	*Digital Receivers-Software radio*	*60 GHz Channel Characteristics, Baseband Modulation: OFDM versus Single Carrier*	*Receiver, Modulation*
S-9	**SLO-1**	*FCC Regulations-Terms and definitions*	*RFID-transceiver*	*Software radio operation*	*60 GHz Analog Front-End Architectures*	*Potential Applications*
	SLO-2	*Nomenclature for defining Emission, modulation and transmission*	*Design issues for RFID*	*Repeaters*	*Multiple Antenna Technologies*	*Challenges*

Learning Resources

1. Alan Bensky, "Short range Wireless Communications-Fundamentals of RF system design and Applications", Elsevier Inc, 2004
2. Antti V. Raisanen, Arto Lehto, "Radio engineering for wireless communication and sensor applications", Artech House, 2003
3. Rolf Kraemer and Marcos Katz, "Short-range wireless communications emerging technologies and applications", Wiley WWRF series, March 2009
4. Shlomi Arnon, John Barry, George Karagiannidis, Robert Schober, Murat Uysal, "Advanced Optical Wireless Communication Systems" , Cambridge University Press, 2012

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember / Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply / Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate / Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	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
1. *Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com*	1. *Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*1. Dr. J. Subhashini, SRM IST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18EC0102J	Course Name	ELECTRONIC CIRCUITS AND SYSTEMS	Course Category	O	Open Elective	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/ Standards			

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Provide a basis for understanding semiconductor material, how a pn junction is formed and its principle of operation
CLR-2 :	Describe the basic structure, operation and characteristics of transistors BJTs and FETs, and discuss their use as a switch and an amplifier
CLR-3 :	Learn the basics of op-amp: the principle, operation, characteristics and fundamentally important circuits
CLR-4 :	Describe and analyze the basic operation of sinusoidal oscillators and use a 555 Timer in an oscillator application.
CLR-5 :	Learn the fundamentals of analog and digital communication, networking, radio transmission and mobile telephones
CLR-6 :	Encourage the learner to assemble and test real circuits in the laboratory

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	1	80	70	L	L	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification and switching.	1	80	70	L	L	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Identify different configurations of op-amp analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	1	80	70	L	L	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	1	80	70	L	L	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	Understand the basic concepts and techniques of telecommunication systems and networks	1	80	70	L	L	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	Understand how circuit behavior can be studied with a computer, using a circuit simulation software	2	90	80	-	-	H	-	H	-	-	-	-	L	-	M	L	-	-

		Learning Unit / Module 1 (12)	Learning Unit / Module 2 (12)	Learning Unit / Module 3 (12)	Learning Unit / Module 4 (12)	Learning Unit / Module 5 (12)
Duration (hour)		Active Discrete Components & Circuits – I	Active Discrete Components & Circuits – II	Linear Integrated Circuits	Oscillators and Timers	Telecommunications
S-1	SLO-1	Conduction in semiconductors	JFETs: Structure & Operation	Introduction to Op-amp	RC Phase-Shift oscillator Operation	Analog & Digital Communication: Stages in telecommunication systems
	SLO-2	Conduction in diodes	Characteristics & Parameters	Basic op-amp and its characteristics	& Design	Carriers and Modulation
S-2	SLO-1	Basic operation of PN junction diode	JFET Biasing (Voltage-Divider Biasing)	op-amp modes	Wein bridge Oscillator operation	Carriers and Modulation
	SLO-2	VI Characteristics of diode	CS-JFET Amplifier operation	parameters	& Design	Pulse Modulation
S-3	SLO-1					
	SLO-2	**Lab-1: VI Characteristics of PN Junction Diode**	**Lab-4: Design & Analysis of CE BJT Amplifier**	**Lab-7: Negative Feedback op-amp circuits**	**Lab-10: Analysis & Design of RC Oscillators**	**Lab-13: Demonstration of AM & FM**
S-4	SLO-1					
	SLO-2					
S-5	SLO-1	Applications of diode: HWR & FWR	MOSFETs: Structure	Op-amp circuits: Scale changer, adder, subtractor	LC oscillators operation: Hartley Oscillator	Pulse Modulation
	SLO-2	Clippers & Clampers	Operation	HWR & FWR	Colpitts Oscillator	Digital Transmission, Frequency Division MultiplexingTime Division Multiplexing
S-6	SLO-1	Basic operation of Zener diode and its VI characteristics	Characteristics	Clipper &Clamper	555 Timer IC: Basic Operation	Networks: RS-232, circuit switching

	SLO-2	*Zener diode as a voltage regulator*	*Parameters*	*Log & Antilog amplifiers*	*Astable Operation*	*Message switching, TCP/IP*
S-7	SLO-1					
	SLO-2	***Lab-2: VI Characteristics of Zener Diode***	***Lab-5: Design & Analysis of CS-JFET Amplifier***	***Lab-8: Op-amp Circuits-I***	***Lab-11: 555 Timer Operation & Applications***	***Lab-14: Demonstration of Pulse Modulation***
S-8	SLO-1					
	SLO-2					
S-9	SLO-1	*BJTs: Structure & Operation*	*MOSFET as an amplifier*	*Instrumentation amplifier*	*Monostable Operation*	*Radio Transmission: Electromagnetic Spectrum, ground waves, sky waves*
	SLO-2	*Characteristics & Parameters*	*MOSFET as a switch*	*Comparator*	*Applications of 555 Timer*	*antennas, directional transmissions,*
S-10	SLO-1	*CE BJT amplifier operation*	*MOSFET Biasing (Voltage-Divider Biasing)*	*Comparator applications*	*Applications of 555 Timer*	*Transmitters, Receivers*
	SLO-2	*Differential amplifier operation*	*CS-MOSFET amplifier operation*	*Schmitt trigger*	*Voltage-Controlled Oscillators*	*Mobile telephones*
S-11	SLO-1					
	SLO-2	***Lab-3: Applications of PN Junction diode and Zener diode***	***Lab-6: Design & Analysis of CS-MOSFET Amplifier***	***Lab-9: Op-amp Circuits-II***	***Lab-12: VCO Operation***	***Mini Project / Model Practical Examination***
S-12	SLO-1					
	SLO-2					

Learning Resources	1. *Owen Bishop, "Electronic Circuits and Systems", 4th edition, Elsevier, 2011.* 2. *Harry Kybett, Earl Boysen, "All New Electronics", 3rd edition, Wiley, 2008.*	3. *Paul Scherz, "Practical Electronics for Inventors", McGraw-Hill, 2000.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	Total	100 %		100 %		100 %		100 %		-	

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Mr. Anuj Kumar, Bombardier* Transportation, Ahmedabad, *kumaranuj.anil@gmail.com*	1. *Dr. Meenakshi, Professor* of ECE, CEG, Anna University, *meena68@annauniv.edu*	*1. Mr. Manikandan AVM, SRM IST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*2. Dr. Rajesh Agarwal, SRM IST*

Course Code	18ECO103T	Course Name	MODERN WIRELESS COMMUNICATION SYSTEM	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards		Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Learn to analyze the transmission of various wireless communication systems
CLR-2 :	Understand the fundamentals of various networks in wireless communication
CLR-3 :	Understand the techniques involved in personal communication services.
CLR-4 :	Introduce various wireless systems for 3G and future communication
CLR-5 :	Learn to analyze wireless networks for short range communication
CLR-6 :	Understand the Fundamentals, Techniques and Networks of Wireless Communication Systems

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)															
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Discuss the fundamentals of transmission in wireless systems	2,3	80	75	-	-	-	H	-	-	-	-	-	-	-	-	H		
CLO-2 :	Provide an overview of various approaches to communication networks	2,3	80	85	-	-	-	H	-	-	-	-	-	-	-	-	-	-	H
CLO-3 :	Study the numerous different-generation technologies with their individual pros and cons	2,3	85	85	-	-	-	H	-	-	-	-	-	-	-	-	M	-	H
CLO-4 :	Discuss about the principles of operation of the different access technologies like FDMA, TDMA, SDMA and CDMA and their pros and cons.	2,3	85	80	-	-	-	H	-	-	-	-	-	-	-	-	M	-	H
CLO-5 :	Learn about the various mobile data services and short range networks.	2,3	85	80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	H
CLO-6 :	Gain knowledge on *Fundamentals, Techniques and Networks of Wireless Communication Systems*	2,3	85	80	-	-	-	-	-	-	-	-	-	-	-	-	H	-	-

Duration (hour)		Transmission Fundamentals	Network Concepts	Personal Communication Services	3G and Beyond	Mobile Data Services and Short- Range Network
		9	9	9	9	9
S-1	SLO-1	*Cellphone Generations*	*Communication Networks*	*Personal communication Introduction, HSCSD, GPRS, D-AMPS, CDMA One, CDMA Two, Packet Data Systems*	*3G Introduction*	*Mobile Data Services Introduction Messaging, wireless web, WAP, site design Short-Range Wireless Networks: Unlicensed spectrum, WLANs, cordless telephony, IrDA, Bluetooth Smart Phones: Future phones, mobile OSs, smart phone applications.*
	SLO-2	*1G and 2G*	*LANs*	*GSM*	*IMT-2000 Introduction*	*Data Services*
S-2	SLO-1	*2.5G*	*MANs*	*GSM*	*IMT-2000*	*Messaging*
	SLO-2	*3G*	*WANs*	*HSCSD*	*IMT-2000*	*Wireless web*
S-3	SLO-1	*4G Transmission Introduction*	*Circuit switching*	*HSCSD*	*W-CDMA Introduction*	*WAP*
	SLO-2	*4G Transmission Fundamentals*	*Packet switching*	*GPRS*	*W-CDMA*	*Site design*
S-4	SLO-1	*Time domain concepts*	*ATM Cellular Networks Introduction*	*GPRS*	*CDMA 2000 Introduction*	*Short-Range Wireless Networks*

	SLO-2	*Frequency domain concepts*	*Cells*	*D-AMPS*	*EDGE*	*Unlicensed spectrum*
S 5-6	**SLO-1**	*Radio Media*	*Duplexing*	*D-AMPS*	*EDGE*	*WLANs*
	SLO-2					
S-7	**SLO-1**	*Analog Vs Digital*	*Multiplexing*	*CDMA Introduction*	*Wi-Fi Introduction*	*Cordless telephony*
	SLO-2	*Channel capacity*	*Voice coding*	*CDMA One*	*Wi-Fi*	*IrDA*
S-8	**SLO-1**	*Transmission media*	*Multiple Access Techniques: FDMA*	*CDMA One*	*WiMAX Introduction*	*Bluetooth Smart Phones*
	SLO-2	*Signaling Schemes*	*TDMA, SDMA*	*CDMA Two*	*WiMAX*	*Future phones*
S-9	**SLO-1**	*Carrier-based signaling,*	*CDMA*	*CDMA Two*	*OFDM*	*Mobile OSs*
	SLO-2	*Spread-spectrum signaling*	*Spectral efficiency*	*Packet Data Systems*	*MIMO*	*Smart phone applications*

Learning Resources	1. Simon Haykin, David Koilpillai, Michael Moher," Modern Wireless Communication", 1/e, Pearson Education, 2011 2. Rappaport T.S, "Wireless Communications: Principles and Practice", 2nd edition, Pearson education. 3. Andrea Goldsmith, "Wireless Communications", Cambridge University Press, Aug. 2005. 4. Andy Dornan, "The essential guide to wireless communications applications: from cellular systems to Wi-Fi", 2nd Edition, Prentice Hall, 2002	5. Ian F.Akyildiz, David M. Gutierrez Estevez, and Elias Chavarria Reyes, " The evolution of 4G cellular systems: LTE advanced", Physical communication, Volume 3, No. 4, pp. 217-298, Dec. 2010 6. William Stallings, " Wireless Communication & Networking", Pearson Education Asia, 2004 7. Andrea .F.Molisch, "Wireless communications", 2nd edition, Wiley Publications.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	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
1. *Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com*	1. *Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*1. Dr. Sabitha Gauni, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECO104J	Course Name	AUDIO AND SPEECH SIGNAL PROCESSING	Course Category	O	Open Elective	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Communication Engineering*	Data Book / Codes/Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*To explore about Speech signal processing*
CLR-2 :	*To explore about the human auditory system*
CLR-3 :	*Feature Extraction of Speech signal using Time characteristics*
CLR-4 :	*Frequency characteristics of Speech signal*
CLR-5 :	*Provide a foundation for developing applications in this field.*
CLR-6 :	*Understand the concept of speech processing both in time and frequency domain*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO – 1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze &Research
CLO-1 :	*Understand the functioning of the human vocal and auditory systems in terms of signal processing*	1	90	68	H		H		H				-	-	-	-	*M*	H	
CLO-2 :	*Analyze the function of feature extraction in speech and audio signal processing using Time Domain Characteristics*	2	85	67	H			H				M	-	-	-	-	*M*		*H*
CLO-3 :	*Understand the frequency characteristics of speech signal*	2	85	68	H		H			M		M	-	-	-	-		*H*	*H*
CLO-4 :	*Understand the Digital models for speech signal*	1&2	85	65	H		H	H					-	-	-	-	*H*	*M*	
CLO-5 :	*Understand the elements of music*	2&3	85	66			H		H			H	-	-	-	-	*H*		*H*
CLO-6:	*Understand Speech signal processing in time and frequency domain and their models.*	1,2,3	85	68	H		H			M		H	-	-	-	-		*M*	*M*

Duration (hour)		Learning Unit / Module 1 Basic Audio Processing	Learning Unit / Module 2 Human auditory system	Learning Unit / Module 3 Speech Signal Analysis in Time Domain	Learning Unit / Module 4 Speech Signal Analysis in Frequency Domain	Learning Unit / Module 5 Speech and Audio processing applications
		12	12	12	12	12
S-1	SLO-1	*Introduction to Digital audio*	*Human auditory system*	*Speech signal analysis*	*Short Time Fourier analysis*	*Introduction to Speech recognition*
	SLO-2	*Capturing and converting sound*	*Human auditory system*	*Speech signal analysis*	*Short Time Fourier analysis*	*Introduction to Speech recognition*
S-2	SLO-1	*Sampling of sound wave*	*simplified model of cochlea*	*Segmental, sub-segmental levels*	*Filter bank analysis*	*Complete system for an isolated word recognition with vector quantization /DTW*
	SLO-2	*Handling audio in MATLAB*	*simplified model of cochlea*	*Suprasegmental levels*	*Formant extraction and Pitch extraction*	*Complete system for an isolated word recognition with vector quantization /DTW*
S-3	SLO-1	***Lab 1: Read & write a speech signal, Record a speech signal, playback, convert into a wave file, plot the speech signal, and spectrogram plot.***	***Lab 4: Short-term energy of a speech signal***	***Lab 7: Estimation of pitch period using simplified inverse filter tracking (SIFT) algorithm***	***Lab 10: Phoneme-level segmentation of speech***	***Lab 13: Compute pitch period and fundamental frequency for speech signal***
	SLO-2					
S-4	SLO-1					
	SLO-2					
S-5	SLO-1	*Normalization*	*Sound pressure level and loudness*	*Time domain parameters of speech signal*	*Homomorphic speech analysis*	*Complete system for speaker identification, verification*
	SLO-2	*Audio processing*	*Sound pressure level and loudness*	*Time domain parameters of speech signal*	*Cepstral analysis of Speech*	*Introduction to speech enhancement*
S-6	SLO-1	*Segmentation*	*Sound intensity and Decibel sound levels*	*Methods for extracting the parameters Energy*	*Formant and Pitch Estimation*	*Introduction to speech enhancement*
	SLO-2	*Analysis of window sizing*	*Sound intensity and Decibel sound levels*	*Average ,Magnitude*	*Linear Predictive analysis of speech*	*Speech enhancement using spectral subtraction method*

S-7	SLO-1					
	SLO-2	***Lab 2: Convert into a wave file, plot the speech signal, and spectrogram plot***	***Lab 5: Short-time Fourier transform magnitude spectrum***	***Lab 8: Estimation of pitch period using harmonic product spectrum***	***Lab 11:To study the quantization and aliasing effect of speech signal***	***Lab 14: Short term speech analysis***
S-8	SLO-1					
	SLO-2					
S-9	SLO-1	*Visualization*	*Concept of critical band*	*Zero crossing Rate*	*Autocorrelation method, Covariance method*	*Introduction to Text to speech conversion*
	SLO-2	*Sound generation*	*Uniform filter bank , Non- uniform filter bank*	*Silence Discrimination using ZCR and energy*	*Solution of LPC equations*	*Introduction to Musical instrument classification*
S-10	SLO-1	*Speech production mechanism, Charistics of speech*	*Mel scale and bark scale,*	*Short Time Auto Correlation Function*	*Durbin's Recursive algorithm, Application of LPC parameters*	*Musical Information retrieval.*
	SLO-2	*Understanding of speech*	*Speech perception: vowel perception*	*Pitch period estimation using Auto Correlation Function*	*Pitch detection using LPC parameters, Formant analysis*	*Sample Programs*
S-11	SLO-1					
	SLO-2	***Lab 3:Cepstrum smoothed magnitude spectrum***	***Lab 6: (i)Linear prediction magnitude spectrum, (ii) (ii) Estimation of formant frequencies using linear prediction***	***Lab 9: Pitch and duration modification using time-domain pitch synchronous overlap and add (TD-PSOLA) method***	***Lab 12:: Speech signal to symbol transformation using wavesurfer***	***Lab 15: Study of Praat***
S-12	SLO-1					
	SLO-2					

Learning Resources	1. *Ian McLaughlin, "Applied Speech and Audio processing, with MATLAB examples", 1st Edition, Cambridge University Press, 2009* 2. *Ben Gold, Nelson Morgan, Dan Ellis, Wiley, "Speech and Audio Signal Processing: Processing and Perception of Speech and Music", 2nd Edition, John Wiley & Sons, 01-Nov-2011.*	3. *Rabiner,B.H.Juang, "Fundamentals of Speech Recognition", 2 nd Edition, Prentice-hall Signal Processing Series, April 1993* 4. *Ken Pohlmann, "Principles of Digital Audio", 6th Edition, McGraw-Hill, 2007* 5. *A.R.Jayan, "Speech and Audio Signal Processing", ISBN : 978-81-203-5256-8,* ***PHI Learning Pvt. Ltd, 2016.***

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (50% weightage)**								**Final Examination (50% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (15%)**		**CLA – 3 (15%)**		**CLA – 4 (10%)#**			
		Theory	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**	**Theory**	Practice
Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	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
1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*1. Dr. S. Dhanalakshmi, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*2. Mrs. K. Harisudha, SRMIST*

Course Code	18ECO105T	Course Name	UNDERWATER ACOUSTICS	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Communication Engineering*	Data Book / Codes/Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLR-1 :	*Understand what is Sound Navigation and Ranging (SONAR) and how it can be used in underwater applications.*																		
CLR-2 :	*Study about Ocean Acoustic Processing and sound wave propagation and analyze sea floor characteristics and ocean sounds.*																		
CLR-3 :	*Understand about Underwater reverberation and how types of noises affects the underwater acoustics signal data analysis.*																		
CLR-4 :	*Study about Acoustic transducers.*																		
CLR-5 :	*Know which transducers can be used for underwater applications.*																		
CLR-6 :	*Understand the basic theory and signal processing application for underwater communication and navigation.*																		
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*																		
CLO-1 :	*Acquire in-depth knowledge and analyze on Sound Navigation and Ranging (SONAR) equations and it characteristics.*	*L1*	*85*	*65*	M	-	-	-	-	-	-	-	-	-	-	M	L		
CLO-2 :	*Analyze Ocean Acoustic Processing and sound wave propagation.*	*L2*	*85*	*65*	M	H	H	H	H	-	-	-	-	-	-	L	H	H	H
CLO-3 :	*Acquire knowledge and analyze Underwater reverberation and various types of noises.*	*L1&L2*	*85*	*65*	M		H	H	H	-	-	-	-	-	-	L	H	M	H
CLO-4 :	*Acquire knowledge on working of underwater Acoustic transducers.*	*L1*	*85*	*65*	H	H	H	H	H	-	-	-	-	-	-	L	H	H	H
CLO-5 :	*Gain knowledge and apply SONAR concepts for underwater applications.*	*L1& L3*	*85*	*65*	L		H	H	-	-	-	-	-	-	-	L	H	M	H
CLO-6 :	*Understand the development and dynamics of underwater acoustic engineering*	*L2 &L3*	*85*	*65*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Duration (hour)		Learning Unit / Module 1 Sound Navigation and Ranging (SONAR)	Learning Unit / Module 2 Ocean Acoustic Processing and sound wave propagation	Learning Unit / Module 3 Reverberation and Noises	Learning Unit / Module 4 Acoustic Transduction	Learning Unit / Module 5 SONAR Application
		9	9	9	9	9
S-1	SLO-1	*Introduction to SONAR equation,*	*Processing ocean sound-Sampling rules*	*Reverberation-Scattering, back scattering strength and target strength*	*Piezoelectric transducer-Introduction*	*Echo sounder*
	SLO-2	*Source Intensity, Source Directivity*	*Spatial sampling and Temporal sampling*	*Surface and bottom scattering*	*Piezoelectric transducer-33-Mode longitudinal vibrator*	*Echo Sounder*
S-2	SLO-1	*Transmission loss*	*Filter operations-Finite Fourier transformation*	*Volume scattering, bottom scattering, reverberation target strength*	*Piezoelectric transducer-33-Mode longitudinal vibrator*	*Sub-bottom profiling*
	SLO-2	*Transmission loss*	*Filter operations-Time domain view of Band pass filtering. convolution operations, frequency domain*	*Calculation of reverberation for use in the sonar equation, Volume reverberation level*	*Electrostrictive transducers*	*Fishing sonars*
S-3	SLO-1	*Target Strength*	*Gated Signals-Dependence of Spectrum on ping carrier periodicity*	*Reverberation frequency spread and Doppler gain potential-Power spectral density of a CW pulse*	*Electrostrictive transducers*	*Side scan terrain mapping sonar*
	SLO-2	*Reflection Intensity Loss Coefficient*	*Power spectra of random signal-Signal having random characteristics, Spectral density,*	*Environmental frequency sampling*	*Magnetostrictive transducers*	*Side scan terrain mapping sonar*
S-4	SLO-1	*Sea-floor Loss,*	*Radom signal simulations-Intensity spectral density, Spectral smoothing*	*Frequency spreading due to transmitter and receiver motion*	*Magnetostrictive transducers*	*Acoustic positioning and navigation*
	SLO-2	*Sea-surface Loss*	*Matched filters and autocorrelation*	*Frequency spreading due to target, important observation with respect to reverberation*	*Electostatic Transducers*	*Acoustic positioning and navigation*

S-5	SLO-1	*Noise, Reverberation*	*Sounds in the oceans-natural physical sounds and biological sounds*	*Noise-Ambient noise models*	*Electostatic Transducers*	*3D Imaging Processing-data model*
	SLO-2	*Active and Passive Sonar Equations*	*Sound propagation in the ocean and underwater acoustic channel-Sound wave and vibration, velocity of sound*	*Ambient noise-seismic noise, ocean turbulence, shipping noise*	*Variable Reluctance Transducers*	*3D Imaging Processing-acquisition of 3D information*
S-6	SLO-1	*Passive Sonar Equations, Signal-to-Noise Ratio*	*Sound propagation in the ocean and underwater acoustic channel-Sound wave velocity of sound*	*Wave noise, thermal noise*	*Variable Reluctance Transducers*	*3D Imaging Processing-matrix approach and real time systems*
	SLO-2	*Signal Excess, Figure of Merit*	*Wave and ray theories of underwater sound fields*	*Rain noise, temporal variability of ambient noise, depth effects of noise*	*Moving coil transducers*	*3D Imaging Processing-Image representation, Acoustic image processing*
S-7	SLO-1	*Active SONAR target strength*	*Wave and ray theories of underwater sound fields*	*Under ice noise*	*Moving coil transducers*	*3D Imaging Processing-Segmentation and reconstruction of underwater tubular structures*
	SLO-2	*Active SONAR- reverberation, detection threshold*	*Wave and ray theories of underwater sound fields*	*Spatial coherence of ambient noise*	*Equivalent circuits-Basics Circuit Resonance*	*3D Imaging Processing-Segmentation and reconstruction of underwater tubular structures*
S-8	SLO-1	*Active Sonar Sources- Source Level, Cavitation*	*Sound absorption in sea water and its characteristics*	*Self-noise-Flow noise*	*Circuit Q and Bandwidth*	*Acoustic communication-Cross attributes of the received signal*
	SLO-2	*Near-Field Interactions Explosive Sources*	*Upper boundary of acoustic channel*	*Self-noise – Flow noise*	*Transducers as projectors-principle*	*Acoustic communication-channel transfer function*
S-9	SLO-1	*Physics of Shock Waves in Wate, Bubble Pulses*	*Lower boundary of acoustic channel and its characteristics*	*Self noise-turbulent noise coherence*	*Transducers as Hydrophones-principles of operations*	*Acoustic communication-combating multipath*
	SLO-2	*Pros and Cons of Explosive Charges, Parametric Acoustic Sources*	*sound field in shallow water*	*Self noise-strumming noise*	*Transducers as Hydrophones-simplified equivalent circuit*	*Acoustic communication-diversity reception, equalization*

Learning Resources	6. Richard P HODGES, "Underwater Acoustics – Analysis, Design and Performance of SONAR", Wiley 1 edition2010, ISBN 978-0-470-68875- 7. Rodney F W Coates, "Underwater Acoustics Systems", Macmillan New Electronics,Wiley, 1st edition , 1990, ISBN 978-0-333-42542-8 8. Robert S H Istepanian and MilicaStojanovic, "Underwater Acoustic Digital Signal Processing and Communication Systems", Springer, 2002 edition, ISBN 978-1-4419-4882-3	9. Charles H Sherman, John L Butler, "Transducers and Arrays for Underwater Sound", Springer; 2nd edition, 2016, ISBN-10: 0-387-32940-4 ISBN-13: 978-0387-32940-6 10. Qihu Li, "Digital Sonar Design in underwater acoustics: Principles and applications", Springer, Zhejang University Press, 2012 11. Herman Medwin, Clarence S.Clay, "Fundamentals of Acoustical Oceanography", Academic Press, 1998.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	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
1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	***1. Dr. S. Dhanalakshmi, SRMIST***
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECO106J	Course Name	PCB DESIGN AND MANUFACTURING	Course Category	O	Open Elective	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/ Standards			

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Explore the terminologies of PCB design and Electronic components.
CLR-2 :	Understand the design and other consideration involved in PCB design
CLR-3 :	Understand the PCB design consideration for special application circuits
CLR-4 :	Design a PCB layout using CAD tool
CLR-5 :	Explore various PCB manufacturing techniques
CLR-6 :	

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Identify the various types of PCB and electronics components packaging	1	80	70	H			L											
CLO-2 :	Select suitable design and consider appropriate parameters involved in PCB design	1,2	80	70	M		L												
CLO-3 :	Apply the appropriate design rules in designing PCB for special application circuits	1,2	80	70	M			L											
CLO-4 :	Design and develop a PCB layout using CAD tool	1,2, 3	80	70	M			M	H										
CLO-5 :	Identify and select the required PCB manufacturing technology	1,2, 3	80	70	L				H										
CLO-6 :																			

		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
Duration (hour)		12	12	12	12	12
S-1	SLO-1	Nomenclature of a Printed Circuit Board	PCB Design Considerations - Important Design Elements	Design Rules for Analog Circuits	Schematic Capture - Introduction schematic capture tool	Image Transfer Techniques- Screen Printing, Pattern Transferring Techniques
	SLO-2	Classification of Printed Circuit Boards	PCB Design Considerations - Important Performance Parameters			
S-2	SLO-1	Manufacturing of basic PCB - Single-and Double-sided Plated Through-holes	PCB Design Considerations - Mechanical Design Considerations	Design Rules for Digital Circuits	Schematic Capture - Simulation of simple electronic circuit	Image Transfer Techniques- Printing Inks, Photo Printing, Laser Direct Imaging (LDI)
	SLO-2	Manufacturing of Multi-layer Boards - Flexible Boards, Challenges in modern PCB Design and Manufacture, PCB Standards	PCB Design Considerations - Mechanical Design Considerations		Schematic Capture - Schematic to layout transfer	Copper Clad Laminates - Properties of Laminates, Types of Laminates, Evaluation of Laminates
S-3	SLO-1	Study of electronic components- Passive electronic components	Design and analysis of RL and RC time constants. Schematic in CAD tool	Schematic and PCB Layout in CAD tool. **Regulated power supply design.- Full wave rectifier circuit design with fixed voltage regulator**	**PCB Layout Design of single digit pulse counter using PCB design tool.**	**Mini Project - PCB Layout Design of electronic turn ON/OFF timer using IC555 using PCB design tool.**
	SLO-2					
S-4	SLO-1					
	SLO-2					
S-5	SLO-1	Types, Symbols, Packaging shapes and terminal details of Electronic Components –Resistors, Thermistors Capacitors, Inductors	PCB Design Considerations - Electrical Design Considerations	Design Rules for High Frequency Circuits	PCB Layout Design - Conception Level Introduction	Etching Techniques – wet Etching chemicals
	SLO-2	Diodes, Light Emitting Diodes (LED), Photodiode,	PCB Design Considerations - Conductor Patterns, Component Placement Rules	Design Rules for Fast Pulse Circuits	PCB Layout Design - Specifying Parts, Packages and Pin Names, Libraries	Etching Techniques - Mechanical Etching
S-6	SLO-1	Transistors, Field-effect Transistors, Insulated Gate Bipolar Transistor (IGBT), Thyristor	Fabrication and Assembly Considerations	Design Rules for Microwave Circuits	PCB Layout Design - Checking foot prints of the components, Part list, Net list, Making Net list Files	PCB Assembly Process - Through-hole
S-7	SLO-1	Study of electronic components- active devices, analog and digital integrated	Design and analysis of RLC circuits. Schematic in CAD tool	Schematic and PCB Layout in CAD tool. **Regulated power supply design. -Full**	**PCB Design of single digit pulse counter: Schematic and PCB layout**	**Mini Project - Manufacture the PCB for electronic turn ON/OFF timer using**
	SLO-2					

S-8	**SLO-1**	*circuits (IC)*		***wave rectifier circuit design with fixed voltage regulator***	***using PCB design tool.***	***IC555and construct and test the designed circuit.***
	SLO-2					
S-9	**SLO-1**	*Digital Integrated Circuits, Random Access Memory*	*Environmental Factors, Cooling Requirements*	*Design Rules for High-density Interconnection Structures*	*PCB Layout Design - Mounting Holes, Adding Text, PCB Layout*	*PCB Assembly Process - Surface Mount, Mixed Technologies*
	SLO-2	*Read Only Memory*	*Packaging Density*			
S-10	**SLO-1**	*Microcontrollers, Surface Mount Devices*	*Layout Design*	*Electromagnetic Interference/Compatibility (EMI/EMC)*	*PCB Layout Design - DRC, Pattern Transfer, Layout printing*	*PCB Assembly Process - Soldering*
	SLO-2	*Transformer, Relays, Connectors*				
S-11	**SLO-1**	*Study of testing and measuring Instruments: Logic analyzer, spectrum analyzer, IC tester (Analog and Digital), LCR meters*	*PCB Layout Design - of RL, RC and RLC circuits*	*Schematic and PCB Layout in CAD tool.* ***Regulated power supply design. Full wave rectifier circuit design with fixed voltage regulator***	***Mini Project - PCB Layout Design of electronic turn ON/OFF timer using IC555 using PCB design tool.***	***Mini Project - Manufacture the PCB for electronic turn ON/OFF timer using IC555and construct and test the designed circuit.***
	SLO-2					
S-12	**SLO-1**					
	SLO-2					

Learning Resources

1. *Raghbir Singh Khandpur, "Printed Circuit Boards: Design, Fabrication, and Assembly" McGraw-Hill Electronic Engineering, 2006.*
2. *Charles A. Harpe, "High Performance Printed Circuit Boards", McGraw Hill Professional, 2000.*
3. *Bruce R. Archambeault, James Drewniak, "PCB Design for Real-World EMI Control", Volume 696 of The Springer International Series in Engineering and Computer Science, Springer Science & Business Media, 2013.*
4. *Kraig Mitzner, "Complete PCB Design Using OrCAD Capture and PCB Editor", Newnes/Elsevier, 2009.*
5. *Douglas Brooks "Signal Integrity Issues and Printed Circuit Board Design", Prentice Hall PTR, 2003.*
6. *Mark I. Montrose "Printed Circuit Board Design Techniques for EMC Compliance : A handbook for designers" Wiley, 2 Edition, 2015.*
7. *Esim open source tool : http://esim.fossee.in/*
8. *TINA/Orcad User manual*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember / Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply / Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate / Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		-	

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com*	1. *Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*1. Dr. P. Eswaran, SRM IST*
2. *Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com*	2. *Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECO107T	Course Name	FIBER OPTICS AND OPTOELECTRONICS	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards		Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Analyze the basic laws and theorems of light associated with the optical fiber communication and the classification of optical fibers			
CLR-2 :	Address concepts related to transmission characteristics such as attenuation and dispersion.			
CLR-3 :	Explore the fundamentals of optoelectronics display devices, Sources and Detectors			
CLR-4 :	Gain to information on Optical modulators and amplifiers			
CLR-5 :	Illustrate the integration methods available for optoelectronic circuits and devices			
CLR-6 :	Utilize the basic optical concepts applied in various engineering problems and identify appropriate solutions			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Review the basic theorems related to fiber optic communication, and attain knowledge of types of optical fibers	2	80	70	H	H	-	-	-	-	-	-	-	-	-	-	-		H
CLO-2 :	Understand the optical signal distortion factors in optical fiber communication	2	85	75	H	-	M	-	-	-	-	-	-	-	-	-	-	-	M
CLO-3 :	Familiarize the principle and operation of various display devices, light sources and detectors	2	75	70	H	M	M	-	-	-	-	-	-	-	-	-	-	-	L
CLO-4 :	Acquire knowledge of various optoelectronic modulators and amplifiers	2	85	80	H	-	M	-	-	-	-	-	-	-	-	-	-	-	H
CLO-5 :	Understand the various optoelectronic integrated circuits	2	85	75	H	-	M	L	-	-	-	-	-	-	-	-	-	-	L
CLO-6:	Acquire fundamental concepts related to optical communication and optoelectronic devices	2	80	75	H	M	M	L	-	-	-	-	-	-	-	-	-	-	H

Duration (hour)		Learning Unit / Module 1 Introduction to Optical Fibers	Learning Unit / Module 2 Transmission Characteristics of Optical Fibers	Learning Unit / Module 3 Display Devices, Light Sources and Detection Devices	Learning Unit / Module 4 Optoelectronic Modulators and Switching Devices	Learning Unit / Module 5 Optoelectronic Integrated Circuits
		9	9	9	9	9
S-1	SLO-1	Evolution of fiber optic system	Attenuation – Absorption, Attenuation units	Display devices – Photo luminescence	Analog and Digital Modulation	Optoelectronic integrated circuits - Introduction
	SLO-2	Elements of an optical fiber transmission link	Attenuation – Scattering losses	Cathode luminescence	Electro optic modulators – Electro optic effect – Longitudinal electro optic modulator	Need for Integration - Hybrid and Monolithic Integration
S-2	SLO-1	Elements of an optical fiber transmission link	Attenuation – Bending losses, microbending and macro bending losses	Electro luminescence	Electro optic modulators – Transverse electro optic modulator	Hybrid and Monolithic Integration
	SLO-2	Advantages of fiber optic system	Attenuation - Core cladding losses	Injection luminescence	Acousto optic modulators – Transmission type – Raman Nath modulator	Materials and processing of OEICs
S-3	SLO-1	Characteristics and behavior of light	Signal distortion in optical waveguides	Light source materials	Acousto optic modulators – Reflection type – Bragg modulator	Application of optoelectronic integrated circuits
	SLO-2	Total internal reflection	Types of dispersion-Intramodal and Intermodal dispersion	Surface emitting LEDs	Solving Problems	Slab and Strip Waveguides
S-4	SLO-1	Acceptance angle	Material dispersion	Edge emitting LEDs	Optical switching and logic devices – self-electro-optic-device	Integrated transmitters and receivers – Front end photo receivers
	SLO-2	Numerical aperture, Critical angle	Material dispersion, Waveguide dispersion	Quantum efficiency and LED power – Internal quantum efficiency derivation	Optical switching and logic devices – Bipolar controller modulator	Integrated transmitters and receivers – photoreceiver noise and bandwidth considerations
S-5	SLO-1	Solving Problems	Waveguide dispersion	Quantum efficiency and LED power –	Optical switching and logic devices-	Integrated transmitters and receivers –

				External quantum efficiency and total LED power	tunable threshold logic gate – Switching speed and energy.	PIN-HBT photoreceivers
	SLO-2	Solving Problems	Signal distortion in single mode fibers	Solving Problems	Optical Amplifiers – General applications of optical amplifiers	Integrated transmitters and receivers – OEIC transmitters – equivalent circuit for integrated receivers
S-6	SLO-1	Ray optics	Polarization mode dispersion	Semiconductor laser diode	Semiconductor optical amplifiers – Basic configuration	Integrated transmitters and receivers – Complex circuits and arrays
	SLO-2	Types of rays	Polarization mode dispersion, Intermodal dispersion	Modes and threshold condition	Semiconductor optical amplifiers – Optical gain - Limitations	Integrated transmitters and receivers - optical control and microwave oscillators
S-7	SLO-1	Optical fiber modes	Intermodal dispersion	Photo detection principle	Erbium doped fiber amplifiers – energy level diagram and amplification mechanism	Guided wave devices – Waveguide and couplers
	SLO-2	Optical fiber configurations	Solving Problems	PIN Photodiode	Erbium doped fiber amplifiers – EDFA configuration	Guided wave devices – Active guided wave devices
S-8	SLO-1	Single mode fibers	Solving Problems	PIN photodiode - Avalanche Photodiode	Solving Problems	Guided wave devices – Mach Zehnder Interferometers
	SLO-2	Multimode Fibers	Pulse Broadening in Graded Index Waveguides	Avalanche Photodiode	Solving Problems	Active couplers
S-9	SLO-1	Step Index Fibers	Mode Coupling	Noise mechanism in photodetectors	Fiber Raman Amplifiers – Configuration – Forward pumping	Active Couplers
	SLO-2	Graded Index Fibers	Design Optimization of Single Mode Fibers	Solving Problems	Fiber Raman Amplifiers – Backward pumping	Active Couplers

Learning Resources	1. Gerd Keiser, "Optical Fiber Communications", 5th Edition, McGraw Hill Education (India), 2015. 2. Khare R P, "Fiber Optics and Optoelectronics", Oxford University Press, 2014.	3. J. Wilson and J. Hawkes, "Optoelectronics – An Introduction", Prentice Hall, 1995. 4. Pallab Bhattacharya, "Semiconductor Optoelectronic Devices", Prentice Hall of India Pvt. Ltd, 2006.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
Level 2	Apply Analyze	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
Level 3	Evaluate Create	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	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
1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anij@gmail.com	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu	1. Dr. S. Sathiyan, SRMIST
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	

Course Code	18ECO108J	Course Name	EMBEDDED SYSTEM DESIGN USING ARDUINO	Course Category	O	Open elective courses	L	T	P	C
							2	0	2	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Get to know about ARDUINO hardware details and environment
CLR-2 :	To understand the core elements of ARDUINO programming language
CLR-3 :	Create insights to the concepts of serial communication
CLR-4 :	To use common input and output devices
CLR-5 :	Apply the ARDUINO programming into real time applications
CLR-6 :	

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	Learning 2 Expected Proficiency (%)	Learning 3 Expected Attainment (%)	PLO 1 Engineering Knowledge	PLO 2 Problem Analysis	PLO 3 Design & Development	PLO 4 Analysis, Design, Research	PLO 5 Modern Tool Usage	PLO 6 Society & Culture	PLO 7 Environment & Sustainability	PLO 8 Ethics	PLO 9 Individual & Team Work	PLO 10 Communication	PLO 11 Project Mgt. & Finance	PLO 12 Life Long Learning	PSO-1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Analyze the programming skill	2	80	70	H		-	-	-	-	-	-	-	-	-	-	-	H	H
CLO-2 :	Apply the real time data's into digital	2	85	75	H	H	H	H	H	-	-	-	H	-	H	-	-	H	H
CLO-3 :	Interact with almost many devices	2	75	70	H	-	H	H	H	-	-	-	H	-	H	-	H	H	-
CLO-4 :	Learn techniques to handle timer delays and IO devices	2	85	80	H	H	H	H	H	-	-	-	H	-	H	-	H	H	-
CLO-5 :	Use and modifying the existing libraries	2	85	75	H	-	H	H	H	-	-	-	H	-	H	-	H	H	-
CLO-6 :																			

Duration (hour)		12	12	12	12	12
S-1	SLO-1	Introduction to arduino platform	Introduction To Arduino C	Analog And Serial Communication	IO Programming	Case Studies
	SLO-2	Block diagram	Arduino C Data Types .	Introduction To Analog Communication	Introduction To Timer/Counters	Wireless Communication Using Zigbee
S-2	SLO-1	AT mega 328p architecture	Decision Making in C	Pulse Width Modulation	Introduction To Timer/Counters	Bluetooth
	SLO-2	AT mega 328p architecture	Decision Making in C	RS232	Timer programming	Robotics -Motor And Sensor
S 3-4	SLO-1	Lab 1 Getting Started With Adriano	Lab 4 -Sensor Interfacing For Temperature Monitoring	Lab 7: Actuators – Stepper Motor	Lab10:Interrupt Programming	Lab 13:Mini Project
	SLO-2	CCS And AVR Studio 7 Blinking Led	Lab 4 -Sensor Interfacing For Displacement Measurement	Lab 7: Actuators – Stepper Motor	Lab10:Interrupt Programming	Lab 13:Mini Project
S-5	SLO-1	Pin function	Program Loops in C	I2C	Timer programming	Security-RFID, Infrared
	SLO-2	Overview of main features-I/O ports	Functions in C	I2C	Timer programming	Security-RFID, Infrared
S-6	SLO-1	Features-timers,interrupts	Introduction to Pointers	I2C	Timer programming	Bio medical application
	SLO-2					
S 7-8	SLO-1	Lab 2 GPIO LED	Lab 5: PWM BASED SERVO MOTOR INTERFACING	Lab 8: DC MOTOR	Lab11:Watch Dog Timer	Lab14:Model Practical
	SLO-2	Switch Based Led Control	Lab 5: PWM Based Servo Motor Interfacing	Lab 8: DC MOTOR	Lab11:Watch Dog Timer	Lab14:Model Practical
S-9	SLO-1	Features-PWM,SERIAL PORT	Using Pointers Effectively	SPI Protocol	Interrupts	Bio medical application
	SLO-2	Features-ADC	Structures, Unions, and Data Storage	SPI Protocol	Interrupt programming	Bio medical application

S-10	**SLO-1**	*Introduction to Arduino IDE*	*Arduino Libraries*	*Interfacing with sensors*	*External interrupt*	*GPS Navigation*
	SLO-2	*Writing ,saving,compiling with IDE.*	*Arduino Libraries*	*Interfacing with sensors*	*External interrupt*	*GPS Navigation*
S11-12	**SLO-1**	*Lab 3:DISPLAY INTERFACE-7 SEGMENT*	*Lab 6:SERIAL COMMUNICATION*	*Lab 9: Repeat/Revision Of Experiments*	*Lab 12 : I2C*	*Lab:15 University Practical*
	SLO-2	*LCD 16x2 Matrix*	*Lab 6:Serial Communication*	*Lab 9: Repeat/Revision Of Experiments*	*Lab 12: I2C*	*Lab:15 University Practical*

Learning Resources	1. Michael-Margolis,Arduino-Cookbook., Revised edition, O'Reilly,1st edition, 2011 2. D.Dale.Wheat, Arduino.Internals, TIA publication, 5th edition, 2011	3. James M. Fiore, Embedded Controllers Using C and Arduino, ARDUINO open source community, 2018 4. Jack Purdum ,Beginning C for Arduino , Apress, 2012

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	Total	100 %		100 %		100 %		100 %		-	

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Mr. Anuj Kumar, Bombardier* Transportation, Ahmedabad, *kumaranuj.anii@gmail.com*	1. *Dr. Meenakshi, Professor* of ECE, CEG, Anna University, *meena68@annauniv.edu*	*1.Mrs. S. Suhasini,, SRM IST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECO109J	Course Name	EMBEDDED SYSTEM DESIGN USING RASPBERRY PI	Course Category	O	Open Elective	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards		Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Understanding the programing of python for Raspberry Pi
CLR-2 :	Applying python programming on GPIO and interfacing motors using Raspberry Pi
CLR-3 :	Applying python programming on GPIO switch and keyboard
CLR-4 :	Create insights to the concepts and programming of motion detection ,GPS programming, light sensor ,gas detection
CLR-5 :	Analyze and understand the working principle and data sheet of temperature sensor, gas sensor ,ADC, ultrasonic rangefinder, Acceleration and light sensor
CLR-6 :	Utilize the technology of node js ,cloud service and MQTT Protocol for moving sensor data to web

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)															
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Apply python for Raspberry Pi	2	80	70	H	H	-	-	H	-	-	-	-	-	-	-	H	-	-
CLO-2 :	Analyze data sheet and functioning of sensors	2	85	75	H	H	H	H	H	-	-	-	-	-	-	-	-	-	H
CLO-3 :	Apply python programming on GPIO of Raspberry Pi and interfacing of sensor	2	75	70	H	H	H	H	-	-	-	-	-	-	-	-	H	-	-
CLO-4 :	Apply python programming on GPIO of Raspberry Pi to interfacing of actuators	2	85	80	H	H	H	H	H	-	-	-	-	-	-	-	H	-	-
CLO-5 :	Apply python programming on GPIO of Raspberry Pi to interfacing input and display device	2	85	75	H	-	H	H	-	-	-	-	-	-	-	-	H	-	-
CLO-6 :	Apply technology of node js ,cloud service and MQTT Protocol for IOT application	2	80	70	H	-	H	-	H	-	-	-	-	-	-	-	-	-	H

Duration (hour)		Learning Unit / Module 1 Basic python programming	Learning Unit / Module 2 Programming interrupts –Motor control, switches and keyboard interface	Learning Unit / Module 3 Sensor interface and programming	Learning Unit / Module 4 Temperature sensor and display interface programming	Learning Unit / Module 5 Publishing sensor data on web service
		12	12	12	12	12
S-1	SLO-1	Python Basics- Editing Python Programs with IDLE, Variables, displaying Output, Reading User Input , Arithmetic, Creating Strings	Programming with Interrupts	Detecting Movement-PIR sensor	Measuring Temperature Using a Digital Sensor	publish sensor data on web service-building a home security dash board
	SLO-2	Concatenating (Joining) Strings, Converting Numbers to Strings, Converting Strings to Numbers ,Find the Length of a String, Find the Position of One String Inside Another, Extracting Part of a String, Replacing One String of Characters with Another Inside a String ,Converting a String to Upper- or Lowercase	Programming with Interrupts	Data sheet analysis of PIR sensor	Data sheet analysis Digital Temperature Sensor	publish sensor data on web service-building a home security dash board
S-2	SLO-1	Running Commands Conditionally, Comparing Values, Logical Operators,	Controlling GPIO Outputs Using a Web Interface	Adding GPS to the Raspberry Pi	Measuring Distance-ultrasonic rangefinder	MQTT Protocol
	SLO-2	Repeating Instructions an Exact Number of Times ,Repeating Instructions Until Some Condition Changes , Breaking Out of a Loop, Defining a Function in Python	Controlling GPIO Outputs Using a Web Interface	Data sheet analysis of GPS	Data sheet analysis ultrasonic rangefinder	MQTT Protocol- installation and setting account ,token creation ,reading sensor data and pushing to thingsboard

S-3-4	SLO-1	***Lab 1: Arithmetic and string***	***Lab 7: Programming on interrupts***	***Lab 13: Programming on PIR sensor***	***Lab 19: Programming on Digital Temperature Sensor***	***Lab 25: Publish sensor data on web service***
	SLO-2	***Lab 2: Loop***	***Lab 8: Programming on Web Interface***	***Lab 14: Programming on GPS***	***Lab 20: Programming on ultrasonic rangefinder***	***Lab 26: Publish sensor data on web service***
S-5	SLO-1	*Creating a List , Accessing Elements of a List, Find the Length of a List , Adding Elements to a List , Removing Elements from a List,*	*Controlling Servo Motors using PWM*	*Using Resistive Sensors*	*Logging to a USB Flash Drive*	*basic of java scripts –node.js*
	SLO-2	*Creating a List by Parsing a String, Iterating over a List, Enumerating a List, Sorting a List, Cutting Up a List. Applying a Function to a List*	*Controlling the Speed of a DC Motor*	*Measuring Light*	*Logging to a USB Flash Drive*	*Modules-HTML module*
S-6	SLO-1	*Creating a Dictionary ,Accessing a Dictionary, Removing Things from a Dictionary,*	*Controlling the Direction of a DC Motor*	*Detecting Methane*	*Using a Four-Digit LED Display*	*Modules –file –event*
	SLO-2	*Iterating over Dictionaries*	*Using a Unipolar Stepper Motor*	*Data sheet analysis of gas sensor*	*Displaying Messages on an I2C LED matrix with data sheet discussion*	*Modules –file –event*
S-7-8	SLO-1	***Lab 3: Program on list***	***Lab 9: Programming on Stepper Motor***	***Lab 15: Programming on light sensor***	***Lab 21: Programming on Four-Digit LED Display***	***Lab 27: Programming on node js HTML module***
	SLO-2	***Lab 4: Program on Dictionary***	***Lab 10: Programming on DC Motor***	***Lab 16: Programming on Gas sensor***	***Lab 22: Programming on I2C LED matrix***	***Lab 28: Programming on node js file and event module***
S-9	SLO-1	*Controlling Hardware-Connecting an LED-Controlling the Brightness of an LED*	*Using a Bipolar Stepper Motor*	*Measuring a Voltage using MCP3008 And data sheet of MCP3008*	*Displaying Messages on an Alphanumeric LCD*	*LED blinking using node.js*
	SLO-2	*a Buzzing Sound*	*Building a Simple Robot Rover*	*Using Resistive Sensors with an ADC*	*Displaying Messages on an Alphanumeric LCD*	*LED blinking using node.js*
S-10	SLO-1	*Switching a High-Power DC Device Using a Transistor*	*Digital Inputs-Connecting a Push Switch-Toggling with a Push Switch-Using a Two-Position Toggle or Slide Switch*	*Measuring Temperature with an ADC*	*Cloud service for IOT*	*building java script client using MQTT broker*
	SLO-2	*Switching a High-Power Device Using a Relay*	*Using a Rotary (Quadrature) Encoder and Using a Keypad*	*Measuring Acceleration and data sheet discussion of Acceleration sensor*	*Cloud service for IOT*	*building java script client using MQTT broker*
S-11, 12	SLO-1	***Lab 5: LED blinking and Brightness control***	***Lab 11: Programming on Switch***	***Lab 17: Programming on ADC***	***Lab 23: Programming on an Alphanumeric LCD***	***Lab 29: Programming on LED blinking using node.js***
	SLO-2	***Lab 6: Switching a High-Power DC Device***	***Lab 12: Programming on Keypad***	***Lab 18: Programming on Measuring Acceleration***	***Lab 24: Programming on an Alphanumeric LCD***	***Lab 30: Building java script client using MQTT broker***

Learning Resources	1. *Simon Monk, "Raspberry Pi Cookbook", O'Reilly Media, Inc, 2014.* 2. *Volker Ziemann, "A Hands-On Course in Sensors Using the Arduino and Raspberry Pi, CRC Press, 2018.*	3. *Colin Dow, "Internet of Thing: Programming Projects - Build modern IoT solutions with the Raspberry Pi 3 and Python", packtpub 2018.* 4. *https://thingsboard.io/docs/* 5. *https://www.w3schools.com/nodejs/nodejs_raspberrypi_blinking_led.asp*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	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
1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*1. Dr. P. Vijayakumar, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECO110J	Course Name	3D PRINTING HARDWARE AND SOFTWARE	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Communication Engineering*	**Data Book / Codes/Standards**		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Understand the tools available for 3D printing*
CLR-2 :	*Familiarize with 3D design software and hardware*
CLR-3 :	*Understand the 3D design criteria and its limitations.*
CLR-4 :	*Learn the contemporary technology available for 3D design and printing*
CLR-5 :	*Understand various post processing methods involved in 3D printing technology*
CLR-6 :	*Develop the skillset on 3D component design and development using contemporary commercial software and hardware available.*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	**Learning**			**Program Learning Outcomes (PLO)**															
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	*Apply the 3D printing tools for components design*	*1*	*80*	*60*	*M*				*M*										
CLO-2 :	*Able to optimistically select the 3D design software and hardware for the given problem*	*1*	*80*	*60*	*M*				*H*										
CLO-3 :	*Capability to solve 3D design components design problems*	*2*	*75*	*60*	*M*			*M*										*M*	
CLO-4 :	*Choose the contemporary technology available for 3D design and printing*	*3*	*80*	*60*			*M*											*M*	*L*
CLO-5 :	*Apply various post processing methods involved in 3D printing technology*	*2*	*80*	*60*		*H*													
CLO-6 :	*Ability to develop the skillset on 3D component design and development using contemporary commercial software and hardware available.*	*2*	*80*	*60*											*M*			*M*	

Duration (hour)		***Introductions to 3D design tools***	***Three-dimensional (3D) Modeling***	***3D Design Fundamentals and Projects***	***3D Printing and its Technologies***	***Post Processing - Product Visualization and Print Cleaning***
S-1	SLO-1	*Introduction to Maya GUI - Object creation workflow, Constructing object primitives to scale and with accuracy*	*An overview of CAD software packages - Introduction to Fusion 360 - Drawing based workflow, Drawing constraints - Surfacing operations.*	*The good, the bad, and the ugly of design*	*History of 3D printing - Overview of 3D Printing technologies*	*Workflows for printing*
	SLO-2					
S-2	SLO-1	*Duplication and arrayed duplication - Grid and point/vertex snapping*	*Moving Parts and Articulation Hinges - Ball and sockets*	*Prominent Designers*	*Selective Laser Sintering (SLS) Direct Metal Laser Sintering (DMLS)*	*Software and Drivers - Formats for Printing (SLA, OBJ, CAD, etc.)*
	SLO-2					
S 3-4	SLO-1	*Understanding NURBS: NURBS Surfaces advantages, Similarities and differences between NURBS and CAD drawings Curve and surface construction*	*Creating a part negative, Creating Text in Maya the proper way (NURBS Curves, surface lofts, conversion to polygon) Painterly tools (Sculpt Geometry Tool, etc.)*	*Franchises Success stories, Pop culture*	*Vacuum forming - Resin casting - Injection Molding - Terms and standards for injection molding systems*	*Post and Export Print Lab setup*
	SLO-2					
S-5	SLO-1	*Understanding 3D geometry - Modeling workflows for Polygons - Additive vs. Subtractive Tools - Mesh editing*	*Flexibility and elasticity, Locks, bolts, and fasteners Threading (taps and dies)*	*Early decision making criteria*	*Fused Deposition Modeling (FDM) - Stereolithography (SLA)*	*Cleanup and airtight modeling*
	SLO-2					
S-6	SLO-1	*Best Practices for constructing printable polygon meshes*	*Interfacing, support, and reinforcement*	*Knowing the product*	*Laminated Object Manufacturing (LOM) - Electron Beam Melting (EBM)*	*Loading models and arranging print stage*
	SLO-2	*Fundamental Structure - Combining, merging, and sewing up polygon meshes*				

S 7-8	SLO-1	*Best Practices for constructing printable polygon meshes - Fundamental Structure - Combining, merging, and sewing up polygon meshes*	*How the modeling software packages differ from CAD packages, Sketch/drawing based workflows, Similarities and differences between CAD and NURBS.*	*Brainstorming and critique in the early design phase Group critiques of in-progress projects*	*Printing Resolutions and Tolerances Materials Properties (Temperature, Flexibility, Strength, Brittleness)*	*Printing - Removing support material*
	SLO-2					
S-9	SLO-1	*Understanding two-manifold vs. non-manifold geometry*	*Form and function visualizing the assembly process*	*Early decision-making criteria Knowing the product Vision and Reality*	*3D Printing (3DP) – Selective laser melting (SLM)*	*Special topics – 3D Scanners and its types*
	SLO-2	*Exporting geometry - Laying out a simple model on a stage for print*				
S-10	SLO-1	*Hollow forms and the importance of reducing volume Cost of size, cost of volume, cost of detail, cost of time State table*	*Complex interactions and motorizations*	*Calculating the total cost Progress checks and group critiques of in-progress projects*	*Final cleanup and processing of files for printing*	*Reverse engineering, Concepts and its hardware and software*
	SLO-2					
S 11-12	SLO-1	*Clean and uniform topology, Illustrator, IGES, and other import/export pipelines*	*Broad overview of manufacturing techniques Molding, sculpting, lathing, lofting, welding, cutting, drilling, gluing, etc*	*Brainstorming and critique in the early design phase Group critiques of in-progress projects*	*Planning for injection molding - 3D Printing for injection molding*	*High speed machining*
	SLO-2					

Learning Resources	1. *Hod Lipson, Melba Kurman, Fabricated: The New World of 3D Printing, Wiley, 2013* 2. *Matthew Griffin, Design and Modeling for 3D Printing, Maker Media, Inc., 2013.* 3. *Rob Thompson, Manufacturing Processes for Design Professionals, Thames & Hudson; Reprint edition, 2007.* 4. *https://web.stanford.edu/class/me137/* 5. *SolidWorks Gallery: http://www.3dcontentcentral.com/default.aspx*	6. *3D Anatomy Models: http://lifesciencedb.jp/bp3d/?lng=en* 7. *AutoDesk Fusion360 HomePage: http://fusion360.autodesk.com* 8. *International Journal of Rapid Manufacturing* 9. *Academic Journals on 3D Printing* 10. *International Journal of Rapid Manufacturing*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	Total	100 %		100 %		100 %		100 %		-	

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com*	1. *Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	1. Mr. S. Karuppudaiyan, Mechanical, SRMIST
2. *Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com*	2. *Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	2. *Dr. P. Eswaran, SRMIST*

Course Code	18ECO121T	Course Name	BASIC BIOMEDICAL ENGINEERING	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering with specialization in Biomedical Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Analyze the scopes and roles of Biomedical Engineering			
CLR-2 :	Utilize biomedical instrumentation modules			
CLR-3 :	Utilize medical imaging principles and its applications			
CLR-4 :	Analyze the scope of biomechanics and its applications			
CLR-5 :	Utilize biomaterials and its applications			
CLR-6 :	Gain the knowledge about Biomedical Engineering			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)															
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1: Problem Solving at the interface of Engg. & Medicine	PSO-2: Design & Develop Medical Devices	PSO-3: multidisciplinary research for health care solu.	
CLO-1 :	Analyze the areas in which biomedical engineers can work	2	85	75	-	-	-	-	-	-	-	-	-	-	-	L	-	-	L	
CLO-2 :	Analyze the basic biomedical instrumentation unit	3	85	75	L	-	-	-	-	-	-	-	-	-	-	-	-	-	L	
CLO-3 :	Analyze basic medical imaging principles	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CLO-4 :	Apply the concepts of biomechanics on human body	3	85	75	L	-	-	-	-	-	-	-	-	-	-	-	-	-	L	
CLO-5 :	Identify domains where biomedical engineers can work	3	85	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CLO-6 :	Analyze the applications of Biomedical Engineer	3	85	75	M	-	-	-	-	-	-	-	-	-	-	L	-	-	L	

Duration (hour)		Introduction to Biomedical Engineering	Biomedical Instrumentation	Medical Imaging system	Biomechanics	Biomaterials
		9	9	9	9	9
S-1	SLO-1	Evolution of the modern health care system	Introduction: Bioinstrumentation	X-Ray production	Introduction: Principal Areas of Biomechanics	Biomaterials Introduction
	SLO-2	Modern Healthcare system	Basic Bioinstrumentation System	X-Ray Imaging principle	Fundamentals of biomechanics and qualitative analysis	Classification of Biomaterials
S-2	SLO-1	What is Biomedical Engineering	Physiological Systems of the body	Application of X-ray imaging	Kinematics of Human Body Models	Properties of Biomaterials: Mechanical
	SLO-2	Roles played by the Biomedical Engineers	Sources of Biomedical Signals	CT-Imaging principle	Kinetics of Human Body Models	Properties of Biomaterials: Chemical
S-3	SLO-1	Types of Biomedical Engineering	Origin of Bioelectric Signals	CT-Imaging Applications	Modelling of Bio systems	Properties of Biomaterials: Biological
	SLO-2	Surgical instruments and medical devices	Origin of Bioelectric Signals	MRI- Introduction	Tissue Biomechanics	Biomedical alloys and its medical applications- titanium
S-4	SLO-1	Biomaterials	Various Electrodes used for picking the biomedical signals	MRI Imaging principles	Modelling in Cellular Biomechanics	Biomedical alloys and its applications- Stainless steel, Cobalt-Chromium alloys
	SLO-2	Biomechanics	Various Electrodes used for picking the biomedical signals	MRI Imaging principles	Fluid mechanics	Introduction to ceramics
S-5	SLO-1	Tissue Engineering	ECG Introduction	MRI Imaging Applications	Mechanics of the musculoskeletal system impact	Alumina, Zirconia
	SLO-2	Neural Engineering	ECG system Block diagram and its uses	Ultrasound basics	Mechanics of Blood Vessels	Titanium, Hydroxyapatite
S-6	SLO-1	Telehealth	EEG Introduction	Ultrasound Imaging	Cardiac Biomechanics	Glass ceramics

	SLO-2	*Bio signal processing*	*EEG system Block diagram and its uses*	*Ultrasound Application*	*Biomechanics of Chest and Abdomen*	*Introduction to polymers*
S-7	**SLO-1**	*Medical Imaging*	*EMG Introduction*	*fMRI Imaging*	*Cochlear Mechanics*	*Types of polymers*
	SLO-2	*Computational modelling*	*EMG system Block diagram and its uses*	*fMRI Imaging Application*	*Dynamics of Human Body Models*	*Biodegradable polymers and its applications*
S-8	**SLO-1**	*BioMEMS*	*Cardiac pacemakers and its uses*	*PET- Imaging*	*Gait analysis*	*Composites and its applications*
	SLO-2	*Mobile POCT*	*Cardiac Defibrillators and its uses*	*PET Imaging Application*	*Biomechanics in physical education*	*Wound-Healing process*
S-9	**SLO-1**	*Professional Status of Biomedical Engineering*	*Patient Monitoring System Introduction*	*SPECT Imaging*	*Biomechanics in strength and conditioning*	*Biomaterials for artificial valve, Ear*
	SLO-2	*Professional Societies*	*Patient Monitoring System Block diagram and its uses*	*SPECT Imaging Application*	*Biomechanics in sports medicine and rehabilitation*	*Biomaterials for artificial Skin, Eye*

Learning Resources	1. *Anthony Y. K. Chan, Biomedical Device Technology: Principles and Design, Charles C Thomas publisher, 2008* 2. *R.S Khandpur, Handbook of Biomedical Instrumentation, 3rd ed., McGraw Hill, 2014* 3. *Joseph J. Carr, John M.Brown, Introduction to Biomedical Equipment Technology, 4th ed., Pearson, 2002*	4. *John Enderle, Joseph Bronzino, Introduction to Biomedical Engineering, Academic Press, 2011* 5. *Andrew R Webb, Introduction to Biomedical Imaging, Wiley-IEEE Press, 2003* 6. *Sujata V. Bhat, Biomaterials, 2nd ed., Alpha Science International, 2005*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	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
1. Sathyanarayanan J, Mindray Medical India Pvt Ltd, sathyanarayananjayagopal@mindray.com	*1.* Dr. S. Poonguzhali, Anna University, poongs@annauniv.edu	***1. Ms.** Oinam Robita Chanu**, SRMIST***
2. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anil@gmail.com	*2. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	***2. Dr. D. Kathirvelu, SRMIST***
3. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*3. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECO122T	Course Name	HOSPITAL INFORMATION SYSTEMS	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering with specialization in Biomedical Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Utilize the planning and organizational activities of Hospitals			
CLR-2 :	Analyze the concepts in clinical and diagnostic services			
CLR-3 :	Utilize the policies and procedures about support services and material management			
CLR-4 :	Utilize the features in staff and safety management in hospital			
CLR-5 :	Analyze the reporting system and recent advancement in hospital administration			
CLR-6 :	Apply all the advanced application the field of telemedicine			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1: Problem Solving at the interface of Engg. & Medicine	PSO-2: Design & Develop Medical Devices	PSO-3: multidisciplinary research for health care solu.
CLO-1 :	Analyze the role of hospitals and ensure proper healthcare delivery	2	85	75	L	-	-	-	-	M	-	-	-	-	-	-	L	-	-
CLO-2 :	Suggest appropriate technologies and services in clinical and diagnostic field	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	L	-	-
CLO-3 :	Analyze the supportive services and the use of proper material management	3	85	75	M	-	-	-	-	-	M	L	-	-	-	-	M	-	L
CLO-4 :	Identify objectives of staff management and ensure safety management in hospitals	3	85	75	M	-	-	-	-	-	-	L	-	-	-	L	L	-	-
CLO-5 :	Implement the advance technologies and effectively evaluate the healthcare information	3	85	75	L	-	-	-	-	M	-	L	L	-	-	-	L	L	L
CLO-6 :	Implement the various standards in hospital and healthcare services	3	85	75	L	-	-	-	-	M	-	-	-	-	-	-	L	-	-

Duration (hour)		Planning and designing of hospitals	Inpatient and Outpatient services	Material management services	Management services in hospitals	Patient record and advancement in healthcare services
		9	9	9	9	9
S-1	SLO-1	Hospital as a social system	Design and planning of emergency department	Pharmacy services- goals of hospital pharmacy services	Human resource management- Human resource development	Medical record management- Importance of medical record
	SLO-2	Primary health care and hospitals	Health information and counselling	Staff organization and divisions of hospital pharmacy services	Hospital staff skill development	Methods of record keeping
S-2	SLO-1	Hospital planning and design-Guiding principles in planning	Outpatient services –Types and functions of outpatient department	Benefits of formulatory system	Nursing management-Functions of nursing management	Electronic medical record-Benefits and drawbacks
	SLO-2	Regionalization of Hospital service	Physical features of outpatient department	Other services of hospital pharmacy	Nursing management- organizational structure	Record retention and disposal
S-3	SLO-1	Role of health promotion approach in hospitals	Ward/Indoor services-Components of the ward system	Transport services-Types of ambulance	Biomedical waste management- Types and Composition of Biomedical Waste	Office management -skills required by the office staff
	SLO-2	Health promoting hospital system	Design of special units	Communication and physical facilities of ambulance service	Categories of biomedical waste	Functions of office management
S-4	SLO-1	Healthy hospital environment	Operation theatre services-Planning and designing of Operation theatres	Staff transport services	Concept of total quality management	Operations research in hospitals-Phases of operation research
	SLO-2	Components of healthy hospital environment	Types of Operation theatres	Other transport services in hospitals	Types of approaches in quality management	Operations research in hospitals- Tools and techniques of operations research

S-5	**SLO-1**	*Creating manpower services*	*Policies and procedures of operation theatres*	*Medicolegal services- Steps for Medicolegal Examination*	*Quality assessment and management tools*	*Emerging health insurance – components of health insurance*
	SLO-2	*Hospital engineering: Key to efficient healthcare services*	*Assessing operation theatre utilisation*	*Problems faced by healthcare professionals in medicolegal service*	*Clinical audit*	*Emerging health insurance-Types of health insurance*
S-6	**SLO-1**	*Designing disabled friendly hospitals-Barriers faced and implications in Persons with disabilities*	*Clinical laboratory services-Introduction and role of laboratory medicine*	*Food safety in hospitals-Need of food safety*	*Quality improvement-Cause and effect method*	*Advantages and common problems of health insurance schemes*
	SLO-2	*Need for disabled-friendly health services*	*Testing procedure in clinical laboratory*	*Sources of food contamination*	*Pareto analysis*	*Role of health and hospital administrators in Health insurance*
S-7	**SLO-1**	*Barrier-Free Environment to Universal Design*	*Radio diagnosis and imaging services-Planning and equipments of radiology department*	*Materials management- Principles of material management*	*Failure mode and effect analysis*	*Telemedicine clinic –functions and classification of telemedicine*
	SLO-2	*Overcoming the barriers*	*Advancement in radiology service*	*Concepts of Inventory control*	*Triggers of quality improvement strategy in a hospital*	*Challenges for telemedicine*
S-8	**SLO-1**	*Energy conservation- Classification*	*Radiation oncology service-Radiotherapy facilities*	*Modern techniques for inventory control*	*Occupational safety-Roles and responsibilities*	*Growth of mobile phones and potential of mobile health*
	SLO-2	*Types of energy streams in hospitals*	*Nuclear medicine services-Categorization and nuclear medicine department*	*Integrated concept for materials management*	*Prevention of hazards specific to health sector*	*Mobile health and its applications*
S-9	**SLO-1**	*Need for energy conservation*	*Planning of nuclear medicine department*	*Purchase and procurement system-Essentials for procurement process*	*Hospital security-Physical security*	*Challenges in implementing information and Communication technology in healthcare*
	SLO-2	*Energy conservation opportunities in hospitals*	*Ancillary requirements*	*Purchase system*	*Organizational chart of security wing*	*Information and communication technology applications in healthcare*

Learning Resources	1. *SonuGoel, Anil Kumar Gupta, Amarjeet Singh, Hospital administration A problem- solving approach, 1st ed., Elsevier, 2014*	2. *Sakharkar B M, Principles of hospital administration and planning, 2nd ed., Jaypee Brothers Medical Publishers, 2009* 3. *Kunders G D, Hospitals: Facilities planning and management, 1st ed., Tata Mcgraw Hill, 2008*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember / Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply / Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate / Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	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
1. Sathyanarayanan J, Mindray Medical India Pvt Ltd, sathyanarayananjayagopal@mindray.com	*1.* Dr. S. Poonguzhali, Anna University, poongs@annauniv.edu	***1.** Dr. D. Ashokkumar**, SRMIST***
2. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anil@gmail.com	*2. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	***2. Mr. P. Muthu, SRMIST***
3. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*3. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECO123T	Course Name	BIOMEDICAL IMAGING	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering with specialization in Biomedical Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Utilize the working principle of X-ray imaging			
CLR-2 :	Analyze the principle behind tomographic imaging and the reconstruction techniques			
CLR-3 :	Interpret the theory behind nuclear medicine and utilize the working of imaging modalities in nuclear medicine			
CLR-4 :	Analyze the physics of ultrasound and the different imaging modes using ultrasound			
CLR-5 :	Utilize the physical principle of nuclear magnetic resonance and magnetic resonance image reconstruction			
CLR-6 :	The learner will be to gain knowledge in the working principle of imaging modalities using X-ray, computed tomography, nuclear medicine, ultrasound and magnetic resonance imaging.			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)															
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1: Problem Solving at the interface of Engg. & Medicine	PSO-2: Design & Develop Medical Devices	PSO-3: multidisciplinary research for health care solu.
CLO-1 :	Analyze the physics and principle behind the working of X-ray imaging	2	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-2 :	Identify the principle behind working of tomographic imaging and reconstruction procedures.	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-3 :	Analyze the working principle of nuclear medicine imaging modalities	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-4 :	Identify the physics of ultrasound and the modes of ultrasound imaging	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-5 :	Explain the physical principle of magnetic resonance imaging and the instrumental components involved in MR imaging	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-6 :	Understand the basic principle and working of medical Imaging systems	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-

Duration (hour)		X-ray	Computed Tomography	Ultrasound	Magnetic Resonance Imaging	Nuclear medicine
		9	9	9	9	9
S-1	SLO-1	General principles of Imaging with X-rays	Introduction: Tomographic Imaging	Characteristics of sound: Propagation, wavelength, frequency and speed	Principles of NMR Imaging	Radionuclide decay terms and relationship
	SLO-2	X-ray Production –X-ray source	Comparison between tomographic and planar imaging	Pressure, Intensity and dB scale	Free Induction decay	Nuclear transformation
S-2	SLO-1	X-ray tube current, tube output	Basic principle: Technique of producing CT images	Interaction of ultrasound with matter: Acoustic impedance, reflection, refraction	Excitation, Emission	Radionuclide production
	SLO-2	Beam intensity, X-ray Energy Spectrum	Contrast scale	Scattering, Attenuation	Relaxation times-T1 & T2	Radiopharmaceuticals
S-3	SLO-1	Coherent and Compton scattering	System components: first generation, second generation, third generation,	Transducers: Piezoelectric materials, resonance transducers	Spin echo technique	Radiation detection and measurement: types of detectors, Gas-filled detectors
	SLO-2	Photoelectric effect	Fourth, fifth and spiral/helical CT	Damping block, matching layer, Resolution	Spin echo contrast weighting	Scintillation detectors
S-4	SLO-1	Linear and Mass attenuation coefficient of X-rays in tissue	X-ray source, types of detectors	Transducer arrays	T1 weighted image	Semiconductor detectors
	SLO-2	Instrumentation for Planar X-ray Imaging: Collimators	Gantry and slip ring technology, Collimation and filtration	Multi-element linear array scanners	T2 weighted image	Pulse height spectroscopy
S-5	SLO-1	Antiscatter grids Intensifying screens	Processing system	Multi-linear and phased array	Gradient recalled sequence	Non-imaging detector applications

	SLO-2	*X-ray films*	*Iterative reconstruction, back projection reconstruction*	*Generation and detection of ultrasound*	*Proton density weighted images, pulse sequence for fast imaging*	*Counting statistics*
S-6	**SLO-1**	*Instrumentation for computed and digital radiography*	*Filtered back projection*	*Basic pulse echo apparatus: A-scan*	*Slice selection gradient*	*Nuclear imaging*
	SLO-2	*X-ray Image characteristics: Signal to Noise ratio*	*Helical /Spiral CT: Helical pitch*	*B-Mode*	*Frequency encode gradient*	*Anger scintillation camera*
S-7	**SLO-1**	*Spatial resolution, Contrast to Noise ratio*	*Basic reconstruction approaches*	*M-mode*	*Phase encode gradient*	*Basic principle :Emission computed tomography*
	SLO-2	*X-ray contrast agents, X-ray angiography*	*Slice sensitivity profile*	*Echocardiograph*	*2D spin echo data acquisition*	*Single photon emission computed tomography*
S-8	**SLO-1**	*X-ray Fluoroscopy*	*Multislice CT*	*Duplex scanner*	*Basic NMR components: Main magnet, RF transmitter/receiver*	*Positron emission tomography*
	SLO-2	*X-ray mammography*	*Detector configuration*	*Intravascular imaging*	*Body coils, gradient coils*	*Imaging techniques and scanner instrumentation*
S-9	**SLO-1**	*Dual energy Imaging*	*Measurement of X-ray dosage*	*Artefacts: Refraction, shadowing and enhancement*	*fMRI : Basic principle*	*Dual modality: PET/CT*
	SLO-2	*Abdominal X-ray scans*	*Methods for dose reduction*	*Reverberation*	*BOLD concept, MR spectroscopy*	*Working and applications*

Learning Resources	1. *R.S.Khandpur, Handbook of Biomedical instrumentation, 3rd ed., Tata McGraw Hill, 2014*	2. *Jerrold T. Bushberg, John M. Boone, The essential physics of medical imaging, 3rd ed., Lippincott Williams & Wilkins, 2011*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	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.,

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2. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*2. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	***2. Dr. U. Snekhalatha, SRMIST***
3. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*3. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECO124T	Course Name	HUMAN ASSIST DEVICES	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering with specialization in Biomedical Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Utilize the latest technology and device used for assisting human disability			
CLR-2 :	Analyze various devices used for mobility			
CLR-3 :	Utilize the various assist device used for hearing			
CLR-4 :	Utilize the various assist device used for vision			
CLR-5 :	Utilize the various assist device used in orthopaedic			
CLR-6 :	Analyze the working principles of cardiac assist devices and Artificial kidney			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)															
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1: Problem Solving at the interface of Engg. & Medicine	PSO-2: Design & Develop Medical Devices	PSO-3: multidisciplinary research for health care solu.
CLO-1 :	Comprehend the assistive technology (AT) used for mobility	2	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-2 :	Analyze the Assist technology used for hearing	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	-	L	-
CLO-3 :	Evaluate the Assist technology used for sensory impairment of vision	3	85	75	-	-	-	-	-	-	-	-	-	-	-	-	-	L	-
CLO-4 :	Evaluate the assist device used in orthopedic	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	L	-
CLO-5 :	Analyze the latest use of assist technology in health care	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-6 :	Design the prosthetic heart valves and pacemaker	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Basic assessment and evaluation for mobility	Basic ear anatomy, Mechanism of hearing	Anatomy of eye	Anatomy of upper & lower extremities -	Basic Anatomy and physiology of heart.
	SLO-2	Basic assessment and evaluation for mobility	Common tests audiograms	Categories of visual impairment	Classification of amputation types	Cardiac assist devices
S-2	SLO-1	Manual wheelchairs	Air conduction, Bone conduction	Intraocular Devices	Prosthesis prescription	Intra-Aortic Balloon Pump (IABP),
	SLO-2	Electric power wheelchairs	Masking techniques,	Extraocular Devices	Hand and arm replacement	Prosthetic heart valves
S-3	SLO-1	Power assisted wheelchairs	SISI	Permanent Vision Restoration	Different types of models, externally powered limb prosthesis	Evaluation of prosthetic valve
	SLO-2	Wheel chair standards & tests -	Hearing aids principles	Non-Permanent Vision Restoration	Different types of models, externally powered limb prosthesis	Heart pacemaker
S-4	SLO-1	Wheel chair transportation	Drawbacks in the conventional unit	Voice Control Sound Control.	Foot orthosis	CABG
	SLO-2	Control systems, navigation in virtual space by wheelchairs	DSP based hearing aids	Sensor Technology Adapted for the Vision Impaired	Pediatric orthoses	Extracorporeal support
S-5	SLO-1	Wheel chair seating and pressure ulcers.	Cochlear Implants	Libraille	Wrist-hand orthosis	Vascular prosthesis
	SLO-2	EOG based voice controlled wheelchair	Internal Hearing Aid	GRAB	feedback in orthotic system	Vascular prosthesis
S-6	SLO-1	BCI based wheelchair	External Hearing Aid	mathematical Braille	Components of upper limb prosthesis	Artificial heart

	SLO-2	Fuzzy logic expert system for automatic tuning of myoelectric prostheses	Permanent Hearing Restoration	Blind mobility aids	Components of lower limb prosthesis	Intermittent positive pressure breathing (IPPB) type assistance for lungs
S-7	SLO-1	Intelligent prosthesis	Non-Permanent Hearing Restoration	Reading writing & graphics access,	Lower extremity- and upper extremity-orthoses	Dialysis for kidneys
	SLO-2	Intelligent prosthesis	Touch Tactile Haptic Technology	Orientation & navigation Aids	Lower extremity- and upper extremity-orthoses	Artificial Kidney
S-8	SLO-1	Future trends in assistive technology	Sound Coding Translation	Wearable Assistive Devices for the Blind	functional electrical stimulation	Haemodialysis
	SLO-2	virtual reality based training system for disabled children	Acoustic Transducers Hearing Quality	Wearable tactile display for the fingertip.	Sensory assist devices	Membrane dialysis
S-9	SLO-1	Information technology, telecommunications,	Electric Electronic Stimulation	Cortical implants	Sensory assist devices	Portable dialysis monitoring and functional parameter
	SLO-2	new media in assisting healthcare	Hearing Enhancement	Retinal implants	Slints – materials used	Latest use of assistive technology for chronic heart diseases and healthcare

Learning Resources

1. Levine S.N. Advances in Bio-medical engineering and Medical physics, 1st ed., Vol. I, II, IV, Interuniversity publications, 1968.
2. Marion. A. Hersh, Michael A. Johnson, Assistive Technology for visually impaired and blind, 1st ed., Springer Science & Business Media, 2010
3. Kopff W.J, Artificial Organs, 1st ed., John Wiley and Sons, 1976
4. Daniel Goldstein, Mehmet Oz, Cardiac assist Devices, Wiley, 2000
5. Kenneth J. Turner, Advances in Home Care Technologies: Results of the match Project, 1st ed., Springer, 2011
6. Albert M.Cook, Webster J.G, Therapeutic Medical Devices, Prentice Hall Inc.,1982
7. Gerr .M. Craddock Assistive Technology-Shaping the future, 1st ed., IOS Press, 2003
8. Brownsell, Simon, et al,. A systematic review of lifestyle monitoring technologies, Journal of telemedicine and telecare 17.4 (2011): 185-189
9. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph.D, Bronzino, Clinical Engineering, 1st ed., CRC Press, 2010
10. Pascal Verdonck, Advances in Biomedical Engineering, 1st ed., Elsevier, 2009

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Understand										
Level 2	Apply	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
	Analyze										
Level 3	Evaluate	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	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
1. Sathyanarayanan J, Mindray Medical India Pvt Ltd, sathyanarayananjayagopal@mindray.com	1. Dr. S. Poonguzhali, Anna University, poongs@annauniv.edu	**1. Mrs. Lakshmi Prabha, SRMIST**
2. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	2. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu	**2. Dr. U. Snekhalatha, SRMIST**
3. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	3. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	

Course Code	18ECO125T	Course Name	QUALITY CONTROL FOR BIOMEDICAL DEVICES	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering with specialization in Biomedical Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Utilize Quality, Quality control measures essential for an organization			
CLR-2 :	Utilize the quality management principles and good management practices			
CLR-3 :	Utilize the various quality control tools			
CLR-4 :	Utilize the various quality management tools			
CLR-5 :	Analyze the various standards applicable to healthcare globally and nationally			
CLR-6 :	Implement the global standards in healthcare			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)															
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1: Problem Solving at the interface of Engg. & Medicine	PSO-2: Design & Develop Medical Devices	PSO-3: multidisciplinary research for health care solu.
CLO-1 :	Analyze the underlying concepts of quality and quality control concepts of an organization	2	85	75	-	-	-	-	-	-	-	-	-	-	-	L	-	-	L
CLO-2 :	Evaluate the various quality management principles and good management practices	3	85	75	L	-	-	-	-	-	-	-	-	-	-	-	-	-	L
CLO-3 :	Evaluate various tools of quality control	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Analyze the various quality management tools	3	85	75	L	-	-	-	-	-	-	-	-	-	-	-	-	-	L
CLO-5 :	Analyze the various standards applicable to healthcare globally and nationally	3	85	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	Analyze the outcomes of implementing global standards	3	85	75	M	-	-	-	-	-	-	-	-	-	-	L	-	-	L

Duration (hour)		Introduction to quality	TQM principles	Statistical process control	TQM tools	Quality systems
		9	9	9	9	9
S-1	SLO-1	Definition of Quality	Customer satisfaction – Customer Perception of Quality	The seven tools of quality	Benchmarking	ISO 9000 Systems
	SLO-2	Dimensions of Quality	Customer Complaints	Cause-and-effect diagram	Reasons to Benchmark	ISO 9000 Systems
S-2	SLO-1	Quality Planning	Service Quality	Check sheet	Benchmarking Process	ISO 9000:2000 Quality System – Elements
	SLO-2	Quality Planning	Customer Retention	Check sheet	Benchmarking Process	ISO 9000:2000 Quality System – Elements
S-3	SLO-1	Quality costs	Employee Involvement	Control chart	Quality Function Deployment (QFD)	Need for Accreditation of hospitals
	SLO-2	Quality costs	Motivation	Control chart	Quality Function Deployment (QFD)	Need for Accreditation of hospitals
S-4	SLO-1	Basic concepts of Total Quality Management	Empowerment	Histogram	House of Quality	FDA Regulations
	SLO-2	Principles of TQM	Teams and Team Work	Histogram	House of Quality	FDA Regulations
S-5	SLO-1	Leadership – Concepts	Recognition and Reward	Pareto chart	QFD Process - Benefits	Joint Commission
	SLO-2	Role of Senior Management	Performance Appraisal	Pareto chart	QFD Process - Benefits	Joint Commission
S-6	SLO-1	Quality Council	Juran Trilogy	Scatter diagram	Total Productive Maintenance (TPM) – Concept	Regulatory Bodies of India

	SLO-2	*Quality Statements*	*Juran Trilogy*	*Scatter diagram*	*Total Productive Maintenance*	*Medical Council of India*
S-7	**SLO-1**	*Strategic Planning*	*PDSA Cycle*	*Stratification*	*Improvement Needs*	*Pharmacy Council Of India*
	SLO-2	*Strategic Planning*	*PDSA Cycle*	*Stratification*	*Improvement Needs*	*Pharmacy Council Of India*
S-8	**SLO-1**	*Deming Philosophy*	*Kaizen*	*Six sigma*	*FMEA*	*Indian Nursing Council*
	SLO-2	*Deming Philosophy*	*Kaizen*	*Six sigma*	*FMEA*	*Indian Nursing Council*
S-9	**SLO-1**	*Barriers to TQM Implementation*	*5S*	*Six sigma*	*Stages of FMEA*	*Dental Council of India*
	SLO-2	*Barriers to TQM Implementation*	*5S*	*Six sigma*	*Stages of FMEA*	*Homeopathy Central Council*

Learning Resources	1. *Rose J.E, Total Quality Management, Kogan Page Ltd., 1993* 2. *Cesar A. Cacere, Albert Zana,The Practise of clinical Engineering, Academic Press,1997* 3. *Greg Bounds, Beyond Total Quality Management-Toward the emerging paradigm, McGraw Hill, 2013*	4. *Joseph J.Carr, Elements of Electronics Instrumentation and Measurement, 2nd ed., Pearson Education, 2003* 5. *Jerrold T. Bushberg, John M. Boone, The essential physics of medical imaging, 3rd ed., Lippincott Williams & Wilkins, 2011*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	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
1. Sathyanarayanan J, Mindray Medical India Pvt Ltd, sathyanarayananjayagopal@mindray.com	*1.* Dr. S. Poonguzhali, Anna University, poongs@annauniv.edu	*1. Dr. D. Kathirvelu, SRMIST*
2. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*2. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*2. Dr. D. Ashok Kumar, SRMIST*
3. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*3. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECO126T	Course Name	SPORTS BIOMECHANICS	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18ECE267J	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1: Problem Solving at the interface of Engg. & Medicine	PSO-2: Design & Develop Medical Devices	PSO-3: multidisciplinary research for health care solu.
CLR-1 :	Understand the fundamental muscle action and locomotion in biomechanical point of view																		
CLR-2 :	Get an idea about the movement patterns and causes of movements																		
CLR-3 :	Understand the qualitative and quantitative analysis of sports movements																		
CLR-4 :	Acquire an idea about the basic concept of jumping & aerial movement and throwing & hitting																		
CLR-5 :	Get an idea about the injury prevention, rehabilitation and special Olympic sports																		
CLR-6 :	Get an overall idea about the applications of biomechanics in sports																		
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*																		
CLO-1 :	Illustrate the muscle action in sport and locomotion	1	80	70	M												L		
CLO-2 :	Analyze the movement patterns and its causes	1,2	80	70	M												M		
CLO-3 :	Describe the Qualitative and Quantitative analysis of sports movements	2	80	70	M												M		
CLO-4 :	Analyze the movement of action such as jumping, throwing, hitting and aerial movement	2	80	70			L										L	L	L
CLO-5 :	Identify the injury scenario and special Olympic sports	2	80	70													L	L	L
CLO-6 :	Outline the major concepts in sports biomechanics																		

Duration (hour)		Muscle Action in Sport and Exercise and locomotion- Biomechanical view	Movement patterns and its causes	Qualitative and Quantitative analysis of sports movements	Jumping and Aerial Movement, Throwing and Hitting	Injury Prevention, Rehabilitation and Special Olympic Sports
		9	9	9	9	9
S-1	SLO-1	Introduction to Biomechanics	Introduction to Movement patterns	Introduction to Analysis of Sport Movements	Introduction to Aerial movement	Mechanisms of Musculoskeletal Injury
	SLO-2	Applications of Biomechanics	Defining human movements	A structured analysis framework	Types of Aerial Movement - Rotation during flight, Motion of the mass centre	Musculoskeletal Loading During Landing
S-2	SLO-1	Neural Contributions to Changes in Muscle Strength	Fundamental movements-Walking, Running	Preparation stage	Types of Aerial Movement : Somersaulting, Twisting,	Sport-Related Spinal Injuries and their Prevention
	SLO-2	Mechanical Properties and Performance in Skeletal Muscles	Fundamental movements-Throwing, Jumping	Observation stage	Control of aerial movement	Sport-Related Spinal Injuries and their Prevention
S-3	SLO-1	Muscle-Tendon Architecture	qualitative and quantitative movement	Evaluation and diagnosis stage	Introduction : High Jump	Impact Propagation and its Effects on the Human Body
	SLO-2	Athletic Performance	Comparison of qualitative and quantitative movement analysis	Intervention stage – providing appropriate feedback	Techniques of Jumping - Skating, Springboard and Platform Diving	Impact Propagation and its Effects on the Human Body
S-4	SLO-1	Eccentric Muscle Action in Sport and Exercise	Movement patterns-geometry of motion	Identifying critical features of a movement	Determinants of Successful Ski-Jumping Performance	Neuromechanics of the Initial Phase of Eccentric Contraction
	SLO-2	Stretch–Shortening Cycle of Muscle Function	Fundamentals of movement	Identifying critical features of a movement	Determinants of Successful Ski-Jumping Performance	Induced Muscle Injury
S-5	SLO-1	Biomechanical Foundations of Strength	Linear motion and the centre of mass	The use of videography in recording sports	Principles of Throwing	Manual Wheelchair Propulsion

				movements		
	SLO-2	Power Training	The geometry of angular motion and the coordination of joint rotations	The use of videography in recording sports movements	The Flight of Sports Projectiles	
S-6	SLO-1	Factors Affecting Preferred Rates of Movement in Cyclic Activities	Forces in sport	Recording the movement	Javelin Throwing: an Approach to Performance Development	Sports after Amputation
	SLO-2	The Dynamics of Running	Combinations of forces on the sports performer	Experimental procedures -Two dimensional videography		
S-7	SLO-1	Resistive Forces in Swimming	Momentum and the laws of linear motion	Experimental procedures -Three dimensional videography	Shot Putting	Biomechanics of Dance
	SLO-2	Propulsive Forces in Swimming	Force–time graphs as movement patterns	Data processing	Hammer Throwing: Problems and Prospects	
S-8	SLO-1	Performance-Determining Factors in Speed Skating	Determination of the centre of mass of the human body	Projectile motion	Hammer Throwing: Problems and Prospects	Biomechanics of Martial arts
	SLO-2	Cross-Country Skiing: Technique	Fundamentals of angular kinetics and Generation and control of angular momentum	Linear velocities and accelerations caused by rotation	Hitting	
S-9	SLO-1	Cross-Country Skiing: Equipment	Measurement of force	Rotation in three-dimensional space	Kicking	Biomechancis of YOGA
	SLO-2	Factors Affecting Performance	Measurement of pressure	Rotation in three-dimensional space	Simple concept problems	

Learning Resources	1. Susan J Hall, "Basic Biomechanics", McGraw-Hill Higher Education, 7th edition, 2014 2. Vladimir M. Zatsiorsky, Biomechanics in Sports: Performance Enhancement and Injury Prevention, 1st ed., Blackwell Science Ltd, 2000	3. Jules Mitchell,"Yoga Biomechanics", 1 edition , Handspring Publishing Limited ,2018 4. Roger Bartlett, Introduction to Sports Biomechanics: Analysing Human Movement Patterns, 2nd ed., Routledge, 2007

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40 %	-	40 %	-	40 %	-	30 %	-	30%	-
	Understand										
Level 2	Apply	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
	Analyze										
Level 3	Evaluate	20 %	-	20 %	-	20 %	-	30 %	-	30%	-
	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
1. Sathyanarayanan J, Mindray Medical India Pvt Ltd, sathyanarayananjayagopal@mindray.com	1. Dr. S. Poonguzhali, Anna University, poongs@annauniv.edu	1. Ms. Oinam Robita Chanu, SRMIST
2. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	2. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu	2. Dr .D. Ashok kumar, SRMIST
. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	3. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	

Course Code	18ECO131J	Course Name	VIRTUAL INSTRUMENTATION	Course Category	O	Open Elective	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Study the concepts of Virtual instrumentation and to learn the programming concepts in VI.			
CLR-2 :	Study about the various real time data acquisition methods.			
CLR-3 :	Study about the various Instrument Interfacing concepts.			
CLR-4 :	To study the programming techniques for various control techniques using VI software			
CLR-5 :	To study various analysis tools for Process control applications.			
CLR-6 :	To study various real time measurement systems			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO 1: Automatic control for continous & discrete systems	PSO-2: Utilize PLC & DCS for control of systems	PSO-3: Effective management skills
CLO-1 :	An ability to understand the purpose of virtual instrumentation and understand the construction of VI	1,2	80	70	H												H		
CLO-2 :	An ability to understand and apply various data acquisition methods.	2	85	75	H												H	H	
CLO-3 :	An ability to understand and implement the available interfacing instruments	2	75	70	H	H	H	H	H								H	H	H
CLO-4 :	An ability to understand and implement various control techniques using VI software	2,3	85	80	H	H	H	H	H								H		H
CLO-5 :	An ability to understand and develop a program foran engineering application.	2,3	85	75	H	H	H	H	H				H	H	H	H	H	H	
CLO-6 :	An ability to understand and implement various measurement systems	2,3	80	70	H	H	H	H	H				H	H	H	H	H	H	

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		12	12	12	12	12
S-1	SLO-1	Historical perspective, Need of VI, Advantages of VI, Virtual Instruments versus Traditional Instruments	A/D Converters, Organization of the DAQ VI system -	Introduction to PC Buses	Introduction to Non continuous controllers in LabVIEW	PC based digital storage oscilloscope
	SLO-2	Review of software in Virtual Instrumentation ,Software environment Architecture of VI, Introduction to the block diagram and Front panel Pallets	D/A Converters, Types of D/A	Local Buses-ISA, PCI,	Introduction to continuous controllers in LabVIEW	Sensor Technology
S-2	SLO-1	Creating and saving a VI, Front Panel Tool Bar, Block diagram Tool Bar, Palettes	plug-in Analog Input/output cards - Digital Input and Output Cards,	RS232, RS422	Design of ON/OFF controller	Applications of sensor Technology
	SLO-2	Creating sub VI, Creating an ICON, Building a connector pane, Displaying VI'S, Placing and Saving Sub VI'S on block diagram, Example of full adder circuit using half adder circuit	Organization of the DAQ VI system -	RS485	Proportional controller for a mathematically described processes using VI software	Signal processing Techniques
S-3	SLO-1	**Lab-1:** Front Panel controls and Indicator	**Lab-12:** Measurement of diode I-V characteristics using LabVIEW	**Lab-17:** Load cell Data acquisition using RS232	**Lab-22:** On-off temperature controller using LabVIEW	**Lab-28:** Design of DSO
	SLO-2	**Lab-2:** Verification of Arithmetic Operations				
S-4	SLO-1	**Lab-3:** Verification of Half Adder	**Lab-13:** Temperature measurement using LabVIEW and DAQ hardware.		**Lab-23:** Continuous Control of temperature using LabVIEW	**Lab-29:** Analysis of different signal Filters using LabVIEW
	SLO-2	**Lab-4:** Verification of Full adder.				
S-5	SLO-1	Loops-For Loop,	Opto Isolation need	Interface Buses-USB,PXI	Modeling of level process	Spectrum Analyzer

	SLO-2	*While Loop*	*Performing analog input and analog output*	*VXI,*	*Basic control of level process in LabVIEW*	*Waveform Generator*
S-6	**SLO-1**	*Arrays,*	*Scanning multiple analog channels*	*SCXI*	*Modeling of Reactor Processes*	*Data visualization from multiple locations*
	SLO-2	*Clusters, plotting data*	*Issues involved in selection of Data acquisition cards*	*PCMCIA*	*Basic control of Reactor process in LabVIEW*	*Distributed monitoring and control*
S-7	**SLO-1**	***Lab-5:** Program to find Addition of First n natural numbers using for loop*	***Lab-14:** Flow measurement in water using LabVEW and DAQ hardware*	***Lab-18:** DC motor control using VXI*	***Lab-24:** On-off Level controller using LabVIEW*	***Lab-30:** Real time spectrum analysis using LabVIEW*
	SLO-2	***Lab-6:** Program to find Addition of First n odd numbers using while loop.*				
S-8	**SLO-1**	***Lab-7:** Implementation of Array functions.*		***Lab-19:** GPIB with VISA functions*	***Lab-25:** Continuous Control of pressure controller using LabVIEW*	***Lab-31:** Arbitratory Waveform Generator using LabVIEW*
	SLO-2	***Lab-8:** Calculation of BMI using cluster*				
S-9	**SLO-1**	*Charts*	*Data acquisition modules with serial communication*	*Instrumentation Buses - Modbus and GPIB*	*Case studies on development of HMI in VI*	*Vision and Motion Control*
	SLO-2	*Graphs*	*Design of digital voltmeters with transducer input*	*Networked busses – ISO/OSI*	*Case studies on development of HMI in VI*	Examples on Integrating Measurement with vision and motion
S-10	**SLO-1**	*Case and Sequence Structures*	*Timers and Counters*	*Reference model,*	*Case studies on development of SCADA in VI*	NI Motion control
	SLO-2	*Formula nodes, String and File Input/Output.*	*Timers and Counters*	*Ethernet and TCP / IP Protocols*	*Case studies on development of SCADA in VI*	Speed control system
S-11	**SLO-1**	***Lab-9:** Monitoring of temperature using Charts and Graphs*	***Lab-15:** Design of digital voltmeters with transducer input using LabVIEW*	***Lab-20:** Online temperature control using LabVIEW using TCP/IP*	***Lab-26:** On-off pressure controller using LabVIEW*	***Lab-32:** Minor Project*
	SLO-2	***Lab-10:** Program for implementing Seven segment display*				
S-12	**SLO-1**	***Lab-11:** Program to perform Traffic light control*	***Lab-16:** Pressure measurement using LabVEW and DAQ hardware DAQ.*	***Lab-21:** Online temperature control using Web publishing tool*	***Lab-27:** Continuous Control of pressure controller using LabVIEW*	
	SLO-2					

Learning Resources	1. *Nadovich, C., Synthetic Instruments Concepts and Applications, Elsevier, 2005* 2. *Bitter, R., Mohiuddin, T. and Nawrocki, M., Labview Advanced Programming Techniques, 2nd ed., CRC Press, 2007* 3. *Gupta, S. and Gupta, J. P., PC Interfacing for Data Acquisition and Process Control", 2nd ed., Instrument Society of America, 1994*	4. *Jamal, R., Picklik, H., Labview – Applications and Solutions, National Instruments Release.* 5. *Johnson, G., Labview Graphical programming, McGraw-Hill, 1997* 6. *Wells, L.K., Travis, J., Labview for Everyone, Prentice Hall, 1997* 7. *Buchanan, W., Computer Busses, CRC Press, 2000*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	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
1. D. Karthikeyan, Controlsoft Engineering India Pvt Ltd, karthikeyan.d@controlsoftengg.in	*1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com*	*1. Dr. K. A. Sunitha, SRMIST*
2. V. Venkateswaran, Instrumentation Consultant, vvenkat99@gmail.com	*2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com*	*2. Mrs. A. Brindha, SRMIST*

Course Code	18ECO132T	Course Name	ANALYTICAL INSTRUMENTATION	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Understand the principle and theory of analytical instruments			
CLR-2 :	Understand the quantitative analysis of dissolved components			
CLR-3 :	Study the concept of separation science and its applications			
CLR-4 :	Study the various spectroscopic techniques and its instrumentation			
CLR-5 :	Identify and solve engineering problems associated with Radiation Techniques			
CLR-6 :	Understand the working of Analytical Instrument and their importance in industries			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO 1: Automatic control for continous & discrete systems	PSO-2: Utilize PLC & DCS for control of systems	PSO-3: Effective management skills
CLO-1 :	Apply the principles and theory of instrumental analysis	1,2	80	70	H	H	L	L	H	H	H						H	H	L
CLO-2 :	Apply the principles of various chemical analysis instruments in industries	1,2	85	75	H	H	L	L	H	H							H	H	L
CLO-3 :	Analyze and understand the operation of various radio chemical methods of analysis	1,2	75	70	H	H	L	L	H	H							H	H	L
CLO-4 :	To analyze and understand the operation of instruments based on optical properties	1,2	85	80	H	H	L	L	H	H							H	H	L
CLO-5 :	To identify and solve engineering problems associated with Radiation Techniques	1,2	85	75	H	H	L	L	H	H							H	H	L
CLO-6 :	To understand the working of analytical Instruments in industries	1,2	80	70	H	H	L	L	H	H							H	H	L

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		9	9	9	9	9
S-1	SLO-1	Introduction to Chemical instrumental analysis	Dissolved oxygen analyzer, Importance of measuring dissolved oxygen in Industry, Principle working	Chromatography, Importance, Basic working of Chromatography	Spectral methods of analysis- Properties or parameters of electromagnetic radiation	NMR spectrometers ,Importance and basic working of NMR Spectroscopy
	SLO-2	Spectral method of analysis	Working of Dissolved oxygen analyzer	Gas chromatography Instrumentation	Electromagnetic spectrum Types of spectrometers	Magnetic assembly, Probe unit, Instrument stabilization
S-2	SLO-1	Electro analytical and seperative methods	sodium analyzer, Importance of measuring sodium in Industry, Principle working	Basic parts of a gas chromatography	Beer's law UV-visible spectrophotometers Transmittance and absorbance	Types of NMR spectrometer, Minimal type
	SLO-2	Instrumental methods of analysis-basic components and their classification	Working of sodium analyzer	Carrier gas supply Sample injection system	Beer's law Application of beer's law	Multipurpose NMR,Wideline
S-3	SLO-1	Sampling systems	Silica analyzer, Importance of measuring Silica in Industry, Principle working	Chromatographic column, Selection of column	Derivations of beer's law	Applications of NMR Spectrometer
	SLO-2	Importance of Sampling system in chemical Industries and Safety aspects	Working of Silica Analyzer	Thermal compartment, Detection system, Recording system	Single beam and double beam instruments	Mass Spectrometers, Basic working and Importance
S-4	SLO-1	PH Measurement, Principle of PH measurement & Importance of PH measurement in Industries	Moisture measurement Importance of Moisture measurement	Liquid chromatography-Principles, types and applications	IR spectrophotometers Instruments of IR	Components of Mass Spectrometers
	SLO-2	Types of Electrodes, Reference Electrodes and types	Types of Moisture measurement	High pressure liquid chromatography	Types of IR Components required for three types of IR	Types of Mass spectrometers Magnetic Sector analyzer, Double focusing spectrometers
S-5	SLO-1	Secondary Electrodes and Types	Oxygen analyzer Methods of oxygen analyzers and importance	Instrumentation or basic component of HPLC	Instruments of dispersive instrument , IR Radiation Sources and types	Time of flight analyzers, Quadrupole Mass analyzers
	SLO-2	Indicator electrodes	Paramagnetic oxygen analyzer Electro analytical method	Solvent reservoir and its treatment system	Importance of Monochromators and types of Monochromators	Application of mass spectrophotometers

S-6	**SLO-1**	pH meters direct reading type pH meter null detector type pH meter	CO monitor,Importance of measuring CO	Pumping system, Types of working systems and Importance	Samples And Sample Cells detectors	nuclear radiation detectors, importance of measurement
	SLO-2	ion selective electrodes Types of ion selective electrodes Glass membrane electrodes Liquid membrane electrodes Solid membrane Electrodes	Types of CO monitor	Pulse dampers	FTIR spectrometers, Main components Advantages, disadvantages	GM counter
S-7	**SLO-1**	Biosensors Features of Biosensor Block diagram of bio sensor	NO2 analyzer, Importance of NO_2 measurement	Sample injection system and types	Types of sources Selection factors	Working setup, advantages of GM Counter
	SLO-2	Applications of Biosensors in industries	Types of NO_2 measurement	Liquid chromatographic column working , Types of Column thermostats	Types of detectors Selection factors	proportional counter, Basic Principle
S-8	**SLO-1**	conductivity meters ,Importance in Chemical Industries	H_2S analyzer, Importance of H_2 S Measurement	Detection system types	atomic absorption spectrophotometer instruments for atomic absorption spectroscopy	Working setup, advantages of GM Counter
	SLO-2	Types of Conductivity meters	Types of H_2S measurement	Types of Recording system	radiation source chopper	solid state detectors, Basic Principle
S-9	**SLO-1**	Air pollution Monitoring Instruments	Dust and smoke measurement- dust measurement and Importance Types of dust measurement	Application of HPLC, Advantages of HPLC over gas chromatography	production of atomic vapor by flame, Parts by flame photometer Emission system	Working setup, advantages of Solid state detectors
	SLO-2	Estimation of Air pollution	Thermal analyzer , Importance of Thermal analyzers, Types of Thermal analyzer	Detectors types, Factors Influencing the Selection of Detectors	Monochromators And types, Types of Detectors and recording systems and their selection criteria	scintillation counter, Basic principle

Learning Resources	1. Khandpur. R.S, "Handbook of Analytical Instruments", Tata McGraw Hill publishing Co. Ltd., 2006 2. Bella. G, Liptak, "Process Measurement and analysis"., CRC press LLC.,2003. 3. Francis Rousseau and Annick Rouesssac "Chemical analysis Modern Instrumentation Methods and Techniques", John wiley & sons Ltd.2007.	4. James W.Robinson,"Undergraduate Instrumental Analysis", Marcel Dekker., 2005. 5. Dwayne Heard, "Analytical Techniques for atmospheric measurement", Blackwell Publishing, 2006.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
Level 2	Apply Analyze	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
Level 3	Evaluate Create	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	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
1. D. Karthikeyan, Controlsoft Engineering India Pvt Ltd, karthikeyan.d@controlsoftengg.in	1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com	Dr. K. A. Sunitha, SRMIST
2. V. Venkateswaran, Instrumentation Consultant, vvenkat99@gmail.com	2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com	Mrs. A. Brindha, SRMIST

Course Code	18ECO133T	**Course Name**	SENSORS AND TRANSDUCERS	**Course**	O	Open Elective	L	T	P	C

				Category			3	0	0	3

Pre-requisite Courses	*Nil*	**Co-requisite Courses**	*Nil*	**Progressive Courses**	*Nil*
Course Offering Department	*Electronics and Instrumentation Engineering*	**Data Book / Codes/Standards**		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Gain knowledge on classification, and characteristics of transducers*
CLR-2 :	*Acquire the knowledge of different types of inductive and capacitive sensors*
CLR-3 :	*Acquire the knowledge of different types of thermal and radiation sensors*
CLR-4 :	*Acquire the knowledge of different types of magnetic sensors*
CLR-5 :	*Acquire the knowledgeof different types of sensors measuring non-Electrical quantity*
CLR-6 :	*Locate the Applications of sensors in industries and home appliances*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	**Learning**			**Program Learning Outcomes (PLO)**														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO 1: Automatic control for continuous& discrete systems	PSO-2: Utilize PLC & DCS for control of systems	PSO-3: Effective management skills
CLO-1 :	*To demonstrate the various types of basic sensors.*	2,3	80	80	H	-	H	-	-	H	H	H	-	-	-	H	H	-	-
CLO-2 :	*Understand the inductive and capacitive sensors which are used for measuring various parameters.*	1,2	80	80	H	-	-	H	-	H	-	-	-	-	-	H	-	H	-
CLO-3 :	*Understand the thermal and radiation sensors*	1	80	80	-	-	-	-	-	H	-	-	H	H	-	-	H	-	-
CLO-4 :	*Have an adequate knowledge on the various magnetic sensors*	3	80	80	-	H	H	-	-	-	-	-	-	-	-	-	-	H	-
CLO-5 :	*To demonstrate the various types of basic sensors measuring non electrical quantity*	3	80	80	-	-	H	-	H	-	-	-	-	-	-	H	-	-	H
CLO-6 :	*Select the right transducer for the given application*	3	80	80	H	-	H	-	-	H	H	H	-	-	-	H	H	-	-

Duration (hour)		**9**	***9***	**9**	**9**	**9**
S-1	**SLO-1**	*Introduction to sensors/ transducers, Principles*	*Introduction to Inductive sensor*	*Thermal sensors: Introduction*	*Magnetic sensors: Introduction*	*Measurement of Non-Electrical quantity: Introduction*
	SLO-2	*Classification based on different criteria*	*Sensitivity and linearity of the sensor*	*Thermal Expansion type.*	*Villari effect*	*Flow Measurement – Introduction.*
S-2	**SLO-1**	*Characteristics of measurement systems*	*Transformer type transducer*	*Acoustics temperature sensors.*	*Wiedmann effect*	*Ultrasonic Flow Meters.*
	SLO-2	*Static characteristics Accuracy, Precision, Resolution, Sensitivity*	*Electromagnetic transducer*	*Thermo-emf sensor.*	*Hall effect*	*Hot Wire Anemometers.*
S-3	**SLO-1**	*Dynamic characteristics.*	*Magnetosrtictive transducer*	*Materials for thermos-emf sensors.*	*Construction,*	*Electromagnetic Flow meters.*
	SLO-2	*Environmental Parameters*	*Materials used in inductive sensor*	*Thermocouple construction*	*performance characteristics,*	*Principle and types.*
S-4	**SLO-1**	*Characterization and its type*	*Mutual Inductance change type*	*Types.*	*and its Application*	*Measurement of Displacement.*
	SLO-2	*Electrical characterization.*	*LVDT: Construction.*	*Thermo-sensors using semiconductor device*	*Introduction to smart sensors*	*Introduction and types.*
S-5	**SLO-1**	*Mechanical Characterization.*	*Material, input output relationship,*	*Pyroelectric thermal sensors*	*Film sensors: Introduction*	*Measurement of Velocity/ Speed.*
	SLO-2	*Thermal Characterization*	*Synchros-Construction*	*Introduction*	*Thick film sensors*	*Introduction and types.*
S-6	**SLO-1**	*Optical Characterization.*	*Capacitive sensor: Introduction*	*characteristics*	*Microelectromechanical systems*	*Measurement of Liquid Level.*
	SLO-2	*Errors and its classification.*	*Parallel plate capacitive sensor*	*Application*	*Micromachining.*	*Introduction and types.*
S-7	**SLO-1**	*Selection of transducers.*	*Variable thickness dielectric capacitive sensor*	*Radiation sensors.*	*Nano sensors*	*Measurement of Pressure.*
	SLO-2	*Introduction to mechanical sensors*	*Electrostatic transducer*	*Introduction*	*Applications: Industrial weighing systems: Link–lever mechanism.*	*Introduction and types.*
S-8	**SLO-1**	*Resistive potentiometer and types*	*Piezoelectric elements*	*Characteristics*	*Load cells – pneumatic, elastic and their*	*Measurement of Vibration.*

					mounting.	
	SLO-2	Strain gauge: Theory, type, design consideration, sensitivity.	Ultrasonic Sensors	Geiger counters	different designs of weighing systems.	Introduction and types.
S-9	SLO-1	Resistive transducer: RTD, materials used in RTD	Calculation of sensitivity.	Scintillation detectors	conveyors type.	Application of sensors in industries
	SLO-2	Thermistor: thermistor material, shape	Capacitor microphone, response characteristics	Application on radiation sensors	weighfeeder type.	Application of sensors in home appliances

Learning Resources	1. Patranabis, D., "Sensors and Transducers", 2nd Edition, Prentice Hall India Pvt. Ltd, 2010. 2. Doeblin, E.O., "Measurement Systems: Applications and Design", 6thEdition, Tata McGraw-Hill Book Co., 2011. 3. Bentley, J. P., "Principles of Measurement Systems", 4th Edition, Addison Wesley Longman Ltd., UK, 2004.	4. Murthy, D.V.S., "Transducers and Instrumentation", Prentice Hall of India Pvt. Ltd., New Delhi, 2010. 5. Neubert H.K.P., "Instrument Transducers – An Introduction to their performance and Design", Oxford University Press, Cambridge, 2003.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Understand										
Level 2	Apply	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
	Analyze										
Level 3	Evaluate	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	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
1. D. Karthikeyan, Controlsoft Engineering India Pvt Ltd, karthikeyan.d@controlsoftengg.in	1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com	Mrs. K. Vibha, SRMIST
2. V. Venkateswaran, Instrumentation Consultant, vvenkat99@gmail.com	2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com	Dr. G. Joselin Retna Kumar, SRMIST

Course Code	18ECO134T	Course Name	INDUSTRIAL AUTOMATION	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Understand basic components of PLC
CLR-2 :	Understand the use of timers and counters in process automation
CLR-3 :	Understand DCS architecture
CLR-4 :	Understand operator and engineering interface in DCS
CLR-5 :	Understand HART signal standard and Field bus
CLR-6 :	Understand Field bus signal standard.

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO 1: Automatic control for continous & discrete systems	PSO-2: Utilize PLC & DCS for control of systems	PSO-3: Effective management skills
CLO-1 :	Select PLC based on I/O's	2,3	80	80	H	M	L	-	-	-	-	-	M	-	M	L	M		M
CLO-2 :	Apply timers and counters in process automation	1,2	80	80	H	H	H	H	H	-	L	-	H	M	L	L	H	H	H
CLO-3 :	Select LCU based on application	1	80	80	H	M	-	-	-	-	-	-	L	-	-	L	M	L	M
CLO-4 :	Analyse data's in Operator displays	3	80	80	H	H	-	H	-	-	-	-	H	M	-	L	H	L	M
CLO-5 :	Interpret industrial data communication modes	3	80	80	H	-	-	-	-	-	-	-	-	L	-	L	H	-	L
CLO-6 :	Gain knowledge on field bus	3	80	80	H	L	-	-	-	-	-	-	-	-	-	L	H	-	L

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Programmable logic controllers	PLC Programming Languages	Evolution of DCS	Operator Interfaces Requirements	Introduction to HART
	SLO-2	PLC vs Computer	Ladder Diagram	Hybrid System Architecture	Process Monitoring	Evolution of Signal standard
S-2	SLO-1	Parts of a PLC	Functional block	Central Computer system Architecture	Process Control	HART Networks: Point-to-Point
	SLO-2	Architecture	Sequential Function Chart	DCS Architecture	Process Diagnostics	Multi-drop
S-3	SLO-1	PLC size and Application.	Instruction List	Comparison of Architecture	Process Record Keeping	Split range control valve
	SLO-2	Fixed and Modular I/O	Structured Text	Local Control Unit Architecture	Low Level Operator Interface	HART Field Controller Implementation
S-4	SLO-1	Discrete Input Modules	Wiring Diagram	Architectural Parameters	High Level Operator Interface	Hart Commends: Universal
	SLO-2	Discrete Output Modules	Ladder logic Program	Comparison Of LCU Architecture	Hardware Elements In The Operator Interface	Common Practice
S-5	SLO-1	Analog Input Modules	On-Delay Timer Instruction	LCU Language Requirements	Operator Input And Output Devices	Device Specific
	SLO-2	Analog Output Modules	Off-Delay Timer Instruction	Function Blocks	Operator Display Hierarchy	Wireless Hart
S-6	SLO-1	Special I/O Modules	Retentive Timer	Function Block Libraries	Plant-Level Display	Field Bus Basics
	SLO-2	High Speed Counter Module	Cascading Timer	Problem-Oriented Language	Area- Level Display	Field Bus Architecture
S-7	SLO-1	Power Supplies	Up-Counter	LCU Process Interfacing Issues	Group- Level Display	Field Bus Standard
	SLO-2	Isolators	Down-Counter	Security Requirements	Loop- Level Display	Field Bus Topology
S-8	SLO-1	Input/output Devices: Switches	Cascading Counters	Security Design Approach	Engineering Interface Requirements	H1 Field Bus
	SLO-2	sensors	Combining Counter And Timer Functions	On-Line Diagnostics	Requirement For Operator Interface Configuration	H2 Field Bus
S-9	SLO-1	Relays	Math Operation	Redundant Controller Design	Low Level Engineering Interface,	Interoperability
	SLO-2	Solenoid valve	Program	One-On-One, One-On-Many Redundancy	High Level Engineering Interfaces	Interchangeability

Learning Resources	1. Frank D. Petruzella, Programmable Logic Controller, Tata McGraw Hill Fifth Edition, 2017 2. Bolton. W, Programmable Logic Controllers, 6th Edition, Elsevier Newnes, Sixth Edition 2016. 3. Krishna Kant, Computer Based Industrial Control, Second edition, Prentice Hall of India, New Delhi,2015	4. Bowten, R HART Application Guide, HART Communication foundation, 2015. 5. Berge, J, Field Busses for process control: Engineering, operation, maintenance, ISA press,2015

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	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
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2. V. Venkateswaran, Instrumentation Consultant, vvenkat99@gmail.com	*2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com*	*Dr. G. Joselin Retna Kumar, SRMIST*

Course Code	18ECO135T	Course Name	FUNDAMENTALS OF MEMS	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Understand the importance of micro system technology
CLR-2 :	Learn the operating principle of various micro sensors and actuators
CLR-3 :	Impart the applications of various micro fabrication techniques
CLR-4 :	Understand the differences and need for microfabrication
CLR-5 :	Operate MEMS design tools to design simple micro devices
CLR-6 :	Understand recent developments and challenges in MEMS

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO 1: Automatic control for continuous& discrete systems	PSO-2: Utilize PLC & DCS for control of systems	PSO-3: Effective management skills
CLO-1 :	Appreciate the fundamental concepts in MEMS technology	2,3	80%	80%	H	-	-	-	-	H	-	-	-	-	-	H	H	-	H
CLO-2 :	Understand the fabrication and machining techniques of MEMS devices	1,2	80%	80%	H	-	-	-	-	H	-	-	-	-	-	H	-	-	H
CLO-3 :	Familiarize with the concepts of packaging of MEMS devices	1	80%	80%	H	-	-	H	-	H	-	-	-	-	-	H	H	-	H
CLO-4 :	Appreciate the significance of micro fabrication processes	3	80%	80%	H	-	-	H	-	-	-	-	-	-	-	H	-	-	H
CLO-5 :	Design and Simulate simple structures using MEMS software	3	80%	80%	H	-	H	H	H	-	-	H	H	-	-	H	H	-	H
CLO-6 :	Analyze recent trends and developments in MEMS technology	3	80%	80%	H	-	-	H	-	-	-	-	-	-	-	H	H	-	H

Duration (hour)		Introduction	Fabrication overview	Micromachining	Bonding & Sealing	Recent trends
		9	9	9	9	9
S-1	SLO-1	Introduction to MEMS and Brief recap of Macro devices	Introduction to Micro fabrication process	Introduction of micro machining(MMC) process	Introduction to MEMS packaging	Introduction to design tools and simulation
	SLO-2	Microelectronics and Micro systems	Significance of each technique	Significance of MMC	Challenges in packaging	FEM analysis
S-2	SLO-1	Scaling laws in geometry	Process Description of Photolithography	Bulk MMC process – merits and demerits	Different levels of Packaging	Design of a silicon die for a micro pressure sensor
	SLO-2	Silicon as ideal material and as substrate	Implementation of Photolithography	Sequence of steps	Die, device and system level	Simulation in software
S-3	SLO-1	Si wafer production	Process Description of CVD	Significance of Isotropic etching	Differences in IC packaging technology And MEMS packaging	Application of MEMS in automotive industry
	SLO-2	Cz process	Implementation, merits and demerits of CVD	Anisotropic etching		Airbag deployment
S-4	SLO-1	Sequential steps in wafer processing	Process Description of PVD	Surface MMC process	Die Preparation	Optical MEMS Application
	SLO-2		Implementation, merits and demerits of PVD	Sequence of steps	Plastic encapsulation and its significance	Micro mirrors
S-5	SLO-1	Chemical and mechanical properties of Si and compounds	Process Description, implementation of Ion implantation	Challenges in surface MMC	Types of wire bonding Thermo compression type	Micro fluidics Application
	SLO-2	Chemical and mechanical properties of Polymers, Quartz and GaAs	Oxidation process	Interfacial & Residual stresses	Thermo sonic, Ultra sonic type	Lab on chip module
S-6	SLO-1	Chemical, Biomedical type Micro sensors	Diffusion process	LIGA process- description merits and demerits	Types of surface bonding – Adhesive	IR and Gas sensing

	SLO-2	*Piezoelectric type of Micro sensors*	*Wet etching methods*	*Implementation*	*soldering, SOI type of bonding*	*Thermal sensors*
S-7	**SLO-1**	*Thermal, SMA, Piezoelectric actuators*	*Properties of etchants*	*Process Design-block diagram and description*	*Anodic bonding and lift off process*	*Micro power generation*
	SLO-2	*Electro static type Micro Actuators*	*Dry etching methods*	*Electro-mechanical design, Thermo-electric design*	*Precautions to be taken*	*Micro TEG*
S-8	**SLO-1**	*Micro devices- operation of Micro gears and micromotors*	*Production of plasma*	*CAD- block diagram description and implementation*	*Types of sealing- Micro shells, Hermetic sealing*	*Chemical sensors*
	SLO-2	*Micro devices –operation of Micro valves and pumps*	*Etch stop methods*		*Micro 'O' rings,Reactive seal*	*Micro humidity sensors*
S-9	**SLO-1**	*Case study*	*Case study*	*Case study*	*Selection of packaging materials*	*Micro pressure sensors*
	SLO-2				*Material requirements*	*Paper MEMS*

Learning Resources	1. *Tai-Ran Hsu, "MEMS and MICROSYSTEMS", 22nd reprint edition, Wiley & sons, 2015* 2. *M. Madou, "Fundamentals of Micro fabrication", Taylor and Francis group, 2002*	3. *VardhanGardener,"Micro sensors and smart devices", John Wiley & Sons,2001* 4. *NPTEL link:* https://nptel.ac.in/downloads/112108092/

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	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
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2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com*	*2. R.Bakiyalakshmi,SRMIST*

B. Tech in Electronics and Communication Engineering
(with specialization in Data Science)

2018 Regulations

Project Work, Seminar, Internship in Industry / Higher Technical Institutions (P)

Department of Electronics and Communication Engineering
SRM Institute of Science and Technology
SRM Nagar, Kattankulathur – 603203, Kancheepuram District, Tamilnadu

Course Code	18ECP109L / 18ECP110L	Course Name	PROJECT / SEMESTER INTERNSHIP	Course Category	P	*Project Work, Seminar, Internship In Industry / Higher Technical Institutions (P)*	L	T	P	C
							0	0	20	10

Pre-requisite Courses	*Nil*	Co-requisite Courses	Nil	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Communication Engineering*	**Data Book / Codes/Standards**	*As required for the project work*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*To prepare the student to gain major design and or research experience as applicable to the profession*
CLR-2 :	*Apply knowledge and skills acquired through earlier course work in the chosen project*
CLR-3 :	*Make conversant with the codes, standards , application software and equipment*
CLR-4 :	*Carry out the projects within multiple design constraints*
CLR-5 :	*Incorporate multidisciplinary components*
CLR-6:	*Acquire the skills of comprehensive report writing*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*
CLO-1 :	*Design a system / process or gain research insight into a defined problem as would be encountered in engineering practice taking into consideration its impact on global, economic, environmental and social context.*

Learning Assessment					
Continuous Learning Assessment	Assessment tool	Review I	Review II	Review III	Total
	Weightage	5%	20%	25%	50%
Final Evaluation	Assessment tool	Project Report	Viva Voce *		Total
	Weightage	20%	30%		50%

* Student has to be present for the viva voce for assessment. Otherwise it will be treated as non-appearance for the examination with final grade as 'Ab'

Course Code	18ECP107L	Course Name	MINOR PROJECT	Course Category	P	*Project Work, Seminar, Internship In Industry / Higher Technical Institutions (P)*	L	T	P	C
							0	0	6	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	Nil	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Communication Engineering*	**Data Book / Codes/Standards**	*As required for the project work*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Prepare the student to formulate an engineering problem within the domain of the courses undergone*
CLR-2 :	*Seek solution to the problem by applying codes / standards/ software or carrying out experiments or through programming*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*
CLO-1 :	*Identify a small part of major system or process, understand a problem associated with it and find solution or suggest a procedure leading to its solution.*

Learning Assessment					
Continuous Learning Assessment	Assessment tool	Review I	Review II	Final Review *	Total
	Weightage	20%	30%	50%	100%

* Student has to be present for final review for assessment. Otherwise it will be treated as non-appearance for the examination with final grade as 'Ab'

Course Code	18ECP101L / 18ECP104L	Course Name	MASSIVE OPEN ONLINE COURSE I / II	Course Category	P	*Project Work, Seminar, Internship In Industry / Higher Technical Institutions (P)*	L	T	P	C
							0	0	2	1

Pre-requisite Courses	*Nil*	Co-requisite Courses	Nil	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Communication Engineering*	Data Book / Codes/Standards	*As exposed to during the duration of training*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*
CLO-1 :	Apply the concepts, theories, laws, technologies learnt herein to provide engineering solutions.
CLO-2 :	Engage in independent and life-long learning
CLO-3 :	Solve the real world problems individually and in collaboration

Learning Assessment						
In-semester	Assessment tool	Quiz	Assignment	Non-proctored / Unsupervised Tests	Proctored / Supervised Test	Total
	Weightage	25%	25%	10%	40%	100%
End semester examination Weightage :						0%

Course Code	18ECP102L / 18ECP105L	Course Name	INDUSTRIAL TRAINING I / II	Course Category	P	*Project Work, Seminar, Internship In Industry / Higher Technical Institutions (P)*	L	T	P	C
							0	0	2	1

Pre-requisite Courses	*Nil*	Co-requisite Courses	Nil	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Communication Engineering*	**Data Book / Codes/Standards**	*As exposed to during the duration of training*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Provide an exposure to the students on the practical application of theoretical concepts in an industry or research institute*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*
CLO-1 :	*Gain confidence to carry out supervisory, managerial, and design roles in an industrial context.*

Learning Assessment			
Continuous Learning Assessment	Assessment tool	Final review	
	Weightage	Training Report	Presentation *
		75%	25%

* Student has to be present for the presentation for assessment. Otherwise it will be treated as non-appearance for the examination with final grade as 'Ab'

Course Code	18ECP108L	Course Name	INTERNSHIP	Course Category	P	*Project Work, Seminar, Internship In Industry / Higher Technical Institutions (P)*	L	T	P	C
							0	0	6	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	Nil	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Communication Engineering*	**Data Book / Codes/Standards**	*As exposed to during the duration of internship*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Provide an exposure to the students on the practical application of theoretical concepts in an industry or research institute and also to gain hands on experience in the context of design, production and maintenance*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*
CLO-1 :	*Gain confidence to carry out supervisory, managerial, and design roles in an industrial context or research environment*

Learning Assessment			
Continuous Learning Assessment	Assessment tool	Final review	
	Weightage	Training Report	Presentation*
		75%	25%

* Student has to be present for the presentation for assessment. Otherwise it will be treated as non-appearance for the examination with final grade as 'Ab'

Course Code	18ECP103L / 18ECP106L	Course Name	SEMINAR I / II	Course Category	P	*Project Work, Seminar, Internship In Industry / Higher Technical Institutions (P)*	L	T	P	C
							0	0	2	1

Pre-requisite Courses	*Nil*	Co-requisite Courses	Nil	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Communication Engineering*	**Data Book / Codes/Standards**	*As applicable*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Identify an area of interest within the program or a related one (multidisciplinary), carry out a literature survey on it, gain understanding and present the same before an audience.*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*
CLO-1 :	*Carry out a self-study of an area of interest and communicate the same to others with clarity.*

Learning Assessment			
Continuous Learning Assessment	Assessment tool	Presentation	
	Weightage	Presentation material	Presentation skills / ability to answer questions / understanding of the topic*
		60%	40%

* Student has to be present for the presentation for assessment. Otherwise it will be treated as non-appearance for the examination with final grade as 'Ab'