

B. Tech in Electronics and Communication Engineering (with Specialization in Cyber Physical System)

(a) Mission of the Department

Mission Stmt - 1	Build an educational process that is well suited to local needs as well as satisfies the national and international accreditation requirements
Mission Stmt – 2	Attract the qualified professionals and retain them by building an environment that fosters work freedom and empowerment.
Mission Stmt - 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 Stmt. - 1	Mission Stmt. - 2	Mission Stmt. – 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 must demonstrate knowledge and hands-on competence in the ability to:

PSO – 1	Analyze and verify the correctness of CPS implementations against system requirements and timing constraints.
PSO – 2	Design CPS requirements based on operating system and hardware architecture constraints.
PSO – 3	Implement specific software CPS using existing synthesis tools and analyze the functional behavior of CPS based on standard modeling formalisms.

(e) Program Structure for B.Tech in Electronics and Communication Engineering with Specialization in Cyber Physical System

1. Humanities & Social Sciences including Management Courses (H)					2. Basic Science Courses (B)						
Course Code	Course Title	Hours/ Week			C	Course Code	Course Title	Hours/ Week			C
		L	T	P				L	T	P	
18LEH101J	English	2	0	2	3	18PYB101J	Physics: Electromagnetic Theory, Quantum Mechanics, Waves and Optics	3	1	2	5
18LEH102J	Chinese					18CYB101J	Chemistry	3	1	2	5
18LEH103J	French					18MAB101T	Calculus and Linear Algebra	3	1	0	4
18LEH104J	German	2	0	2	3	18MAB102T	Advanced Calculus and Complex Analysis	3	1	0	4
18LEH105J	Japanese					18MAB201T	Transforms and Boundary Value Problems	3	1	0	4
18LEH106J	Korean					18MAB203T	Probability and Stochastic Process	3	1	0	4
18PDH101L	General Aptitude	0	0	2	1	18MAB302T	Discrete Mathematics for Engineers	3	1	0	4
18PDH102T	Management Principles for Engineers	2	0	0	2	18BTB101T	Biology	2	0	0	2
18PDH103J	Social Engineering	1	0	2	2		Total Learning Credits				32
18PDH201L	Employability Skills & Practices	0	0	2	1						
	Total Learning Credits				12						

3. Engineering Science Courses (S)					4. Professional Core Courses (C)						
Course Code	Course Title	Hours/ Week			C	Course Code	Course Title	Hours/ Week			C
		L	T	P				L	T	P	
18MES101L	Engineering Graphics and Design	1	0	4	3	18ECC102J	Electronic Devices	3	0	2	4
18EES101J	Basic Electrical and Electronics Engineering	3	1	2	5	18ECC103J	Digital Electronic Principles	3	0	2	4
18MES103L	Civil and Mechanical Engineering Workshop	1	0	4	3	18ECC104T	Signals and Systems	3	1	0	4
18CSS101J	Programming for Problem Solving	3	0	4	5	18ECC105T	Electromagnetics and Transmission Lines	3	0	0	3
18ECS201T	Control Systems	3	0	0	3	18ECC201J	Analog Electronic Circuits	3	0	2	4
	Total Learning Credits				19	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)					6. Open Elective Courses (O)						
Course Code	Course Title	Hours/ Week			C	Course Code	Course Title	Hours/ Week			C
		L	T	P				L	T	P	
	Professional Elective – 1	3	0	0	3		Open Elective – 1	3	0	0	3
	Professional Elective – 2	3	0	0	3		Open Elective – 2	3	0	0	3
	Professional Elective – 3	3	0	0	3		Open Elective – 3	3	0	0	3
	Professional Elective – 4	3	0	0	3		Open Elective – 4	3	0	0	3
	Professional Elective – 5	3	0	0	3		Total Learning Credits				12
	Professional Elective – 6	3	0	0	3						
	Total Learning Credits				18						

7. Project Work, Seminar, Internship In Industry / Higher Technical Institutions (P)					
Course Code	Course Title	Hours/Week			C
		L	T	P	
18ECP101L	Massive Open Online Course- I				
18ECP102L	Industrial Training - I	0	0	2	1
18ECP103L	Seminar – I				
18ECP104L	Massive Open Online Course- II				
18ECP105L	Industrial Training - II	0	0	2	1
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			C
		L	T	P	
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				
18GNM103L	NCC	0	0	2	0
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			C
		L	T	P	
18ECE250T	Principles of Cyber Physical System	3	0	0	3
18ECE251T	Embedded and Implanted Devices for Cyber Physical System	3	0	0	3
18ECE252T	Sensors and Actuators for Cyber Physical System	3	0	0	3
18ECE253T	Unsupervised Intelligence in Cyber Physical System	3	0	0	3
18ECE254T	Real Time Cyber Physical System	3	0	0	3
18ECE350T	Cyber Physical Interface and Automation	3	0	3	3
18ECE351T	High Performance Computing for Cyber Physical System	3	0	0	3
18ECE352T	Cyber Physical Control System	3	0	0	3
18ECE353T	Cyber Security	3	0	3	3
18ECE354T	Cloud and Distributed Systems for Cyber Physical System	3	0	0	3
18ECE355T	Design of Cyber Physical System	3	0	0	3
18ECE356T	Mobile Cyber Physical System	3	0	0	3

List of Open Elective Courses (O) Any 4 Courses					
Course Code	Course Title	Hours/Week			C
		L	T	P	
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 Cyber Physical System

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	
18ECE250T	Principles of Cyber Physical System	H	M	H	M	L	L	M	-	-	-	-	-	-	-	H	
18ECE251T	Embedded and Implanted Devices for Cyber Physical System	H	-	-	H	H	-	-	M	-	H	-	L	M	L	-	
18ECE252T	Sensors and Actuators for Cyber Physical System	H	-	H	M	-	-	L	-	-	-	-	H	-	M		
18ECE253T	Unsupervised Intelligence in Cyber Physical System	H	M	H	-	-	-	L	M	H	-	-	-	L	L	M	
18ECE254T	Real Time Cyber Physical System	H	M	H	-	-	-	-	M	H	-	-	-	H	L	-	
18ECE350T	Cyber Physical Interface and Automation	H	M	M	-	-	-	-	-	-	-	-	-	-	-	H	
18ECE351T	High Performance Computing for Cyber Physical System	H	-	M	H	-	-	-	-	-	-	-	-	M	-	M	
18ECE352T	Cyber Physical Control System	H	M	H	H	-	-	-	-	-	-	-	-	H	L	-	
18ECE353T	Cyber Security	H	M	H	H	-	-	M	-	-	M	-	-	H	L	-	
18ECE354T	Cloud and Distributed Systems for Cyber Physical System	H	M	H	-	H	-	-	-	-	-	-	L	H	L	-	
18ECE355T	Design of Cyber Physical System	H	-	M	-	-	H	H	L	L	-	-	M	L	L	-	
18ECE356T	Mobile Cyber Physical System	H	-	H	-	M	-	-	-	-	M	-	-	M	-	L	

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 Cyber Physical System

Semester - I					Semester - II						
Code	Course Title	Hours/Week			C	Code	Course Title	Hours/Week			C
		L	T	P				L	T	P	
18LEH102J-18LEH106J	Foreign Language (Chinese/ French/ German/ Japanese / Korean)	2	0	2	3	18LEH101J	English	2	0	2	3
18MAB101T	Calculus and Linear Algebra	3	1	0	4	18MAB102T	Advanced Calculus and Complex Analysis	3	1	0	4
18CYB101J	Chemistry	3	1	2	5	18PYB101J	Physics: Electromagnetic Theory, Quantum Mechanics, Waves and Optics	3	1	2	5
18CSS101J	Programming for Problem Solving	3	0	4	5	18MES101L	Engineering Graphics and Design	1	0	4	3
18MES103L	Civil and Mechanical Engineering Workshop	1	0	4	3	18EES101J	Basic Electrical and Electronics Engineering	3	1	2	5
18PDM101L	Professional Skills and Practices	0	0	2	0	18PDH101L	General Aptitude	0	0	2	1
18LEM102J	Value Education	1	0	1	0	18LEM101T	Constitution of India	1	0	0	0
18GNM102L	NCC / NSS / NSO	0	0	2	0	18GNM101L	Physical and Mental Health using Yoga	0	0	2	0
Total Learning Credits					20	Total Learning Credits					21
Semester - III					Semester - IV						
Code	Course Title	Hours/Week			C	Code	Course Title	Hours/Week			C
		L	T	P				L	T	P	
18MAB201T	Transforms and Boundary Value Problems	3	1	0	4	18MAB203T	Probability and Stochastic Process	3	1	0	4
18ECS201T	Control Systems	3	0	0	3	18BTB101T	Biology	2	0	0	2
18ECC102J	Electronic Devices	3	0	2	4	18ECC201J	Analog Electronic Circuits	3	0	2	4
18ECC103J	Digital Electronic Principles	3	0	2	4	18ECC202J	Linear Integrated Circuits	3	0	2	4
18ECC104T	Signals and Systems	3	1	0	4		Professional Elective-1	3	0	0	3
18ECC105T	Electromagnetics and Transmission Lines	3	0	0	3		Open Elective-1	3	0	0	3
18PDH103J	Social Engineering	1	0	2	2	18PDH102T	Management Principles for Engineers	2	0	0	2
18PDM201L	Competencies in Social Skills	0	0	2	0	18PDM202L	Critical and Creative Thinking Skills	0	0	2	0
18CYM101T	Environmental Science	1	0	0	0	Total Learning Credits					22
Total Learning Credits					24						
Semester - V					Semester - VI						
Code	Course Title	Hours/Week			C	Code	Course Title	Hours/Week			C
		L	T	P				L	T	P	
18MAB302T	Discrete Mathematics for Engineers	3	1	0	4	18ECC206J	VLSI Design	3	0	2	4
18ECC203J	Microprocessor, Microcontroller and Interfacing Techniques	3	0	2	4	18ECC302J	Microwave and Optical Communications	3	0	2	4
18ECC204J	Digital Signal Processing	3	0	2	4	18ECC303J	Computer Communication Networks	3	0	2	4
18ECC205J	Analog and Digital Communication	3	0	2	4	18ECC350T	Comprehension	0	1	0	1
	Professional Elective - 2	3	0	0	3		Professional Elective-3	3	0	0	3
	Open Elective - 2	3	0	0	3		Professional Elective-4	3	0	0	3
18ECP101L/18ECP102L/18ECP103L	Massive Open Online Course-I / Industrial Training-I / Seminar-I	0	0	2	1		Open Elective-3	3	0	0	3
18PDM301L	Analytical and Logical Thinking Skills	0	0	2	0	18ECP104L/18ECP105L/18ECP106L	Massive Open Online Course-II / Industrial Training-II / Seminar-II	0	0	2	1
18LEM110L	Indian Art Form	0	0	2	0	18PDH201L	Employability Skills and Practices	0	0	2	1
Total Learning Credits					23	18LEM109T	Indian Traditional Knowledge	1	0	0	0
						Total Learning Credits					24
Semester - VII					Semester - VIII						
Code	Course Title	Hours/Week			C	Code	Course Title	Hours/Week			C
		L	T	P				L	T	P	
18ECC301T	Wireless Communications	3	1	0	4	18ECP109L/18ECP110L	Project / Semester Internship	0	0	20	10
	Professional Elective-5	3	0	0	3	Total Learning Credits					10
	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						

B. Tech in Electronics and Communication Engineering
(with Specialization in Cyber Physical System)

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			Program Learning Outcomes (PLO)																																		
CLR-1 :	Learn about mathematical modeling techniques of mechanical and electrical systems			1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15																				
CLR-2 :	Impart knowledge about the transient and steady state error and analysis			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-3 :	Identify and analyze stability of a system in time domain using root locus technique																					H	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	H	-	-	
CLR-4 :	Know about different frequency domain analytical techniques																					H	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	H	-	-	
CLR-5 :	Acquire the knowledge of a controller for specific applications																					H	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	H	-	-	
CLR-6 :	Impart knowledge on controller tuning methods																					H	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	H	-	-	
Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:																																								
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", 5 th Edition, New Age, 2007	3. Gopal.M, "Control System Principles and Design", 2 nd Edition, TMH, 2002
	2. Benjamin C Kuo, "Automatic Control System", 9 th edition, John Wiley & Sons, 2010	4. Sivanandam and Deepa, "Control system Engineering using MATLAB", 2 nd 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.ani@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 Cyber Physical System)

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			Program Learning Outcomes (PLO)																		
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15				
CLR-1 :	Provide a basis for understanding semiconductor material, how a pn junction is formed and its principle of operation	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-2 :	Explain the importance of diode in electronic circuits by presenting appropriate diode applications				H	-	-	-	-	-	-	-	-	-	-	-	-	-	M	-	-	-	
CLR-3 :	Discuss the basic characteristics of several other types of diodes that are designed for specific applications				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	M	-	-	-
CLR-4 :	Describe the basic structure, operation and characteristics of BJT, and discuss its use as a switch and an amplifier.				H	-	-	-	-	-	-	-	-	-	-	-	-	-	M	-	-	-	
CLR-5 :	Describe the basic structure, operation and characteristics of MOSFET, and discuss its use as a switch and an amplifier.				H	-	-	-	-	-	-	-	-	-	-	-	-	-	M	-	L	-	
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				-	-	-	-	H	-	-	-	-	-	-	-	-	-	-	L	L	-	
Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:																						
CLO-1 :	Explain the operation, characteristics, parameters and specifications of semiconductor diodes and special diodes	1	60	70																			
CLO-2 :	Illustrate important applications of semiconductor diodes and special diodes.	2	60	70																			
CLO-3 :	Review bipolar transistor construction, operation, characteristics and parameters, as well as its application in amplification and switching.	1	60	70																			
CLO-4 :	Review field-effect transistor construction, operation, characteristics and parameters, as well as its application in amplification and switching.	1	60	70																			
CLO-5 :	Construct a circuit, then make functional measurements to understand the operating characteristics of the device / circuit.	3	70	75																			
CLO-6 :	Solve specific design problem, which after completion will be verified using modern engineering tools such as PSPICE.	2	70	75																			

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	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
	SLO-2					
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	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
	SLO-2					

Learning Resources	1. David A. Bell, <i>Electronic Devices and Circuits</i> , 5 th ed., Oxford University Press, 2015	5. Robert L. Boylestad, Louis Nashelsky, <i>Electronic Devices and Circuit Theory</i> , 11 th ed., Pearson Education, 2013
	2. Donald Neamen, <i>Electronic Circuits: Analysis and Design</i> , 3 rd ed., McGraw-Hill Education, 2011	6. Muhammad Rashid, <i>Microelectronic Circuits: Analysis & Design</i> , 2 nd ed., Cengage Learning, 2010
	3. Adel S. Sedra, Kenneth C. Smith, <i>Microelectronic Circuits: Theory and Applications</i> , OUP, 2014	7. Muhammed H Rashid, <i>Introduction to Pspice using OrCAD for circuits and electronics</i> , 3 rd ed., Pearson, 2004
	4. Thomas L. Floyd, <i>Electronic Devices</i> , 9 th ed., Pearson Education, 2013	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	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. 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)															
CLR-1 :	Understand binary codes, digital arithmetic operations and able to simplify Boolean logic expressions			1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
CLR-2 :	Describe how basic TTL and CMOS gates operate at the component level						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-3 :	Able to design simple combinational logics using basic gates and MSI circuits						H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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.						H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-5 :	Know how to implement logic circuits using PLDs.						-	M	H	-	H	-	-	-	-	-	-	-	-	-	-	-
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						-	M	H	-	L	-	-	-	-	-	-	-	-	-	-	-

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:			Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)																
CLO-1 :	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	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
	SLO-2					
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	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
	SLO-2	Problems on Karnaugh map simplification	Fan-out	Code converters	Synchronous (Clocked) sequential circuits	Design of combinational circuits using PLD's
S-11	SLO-1	Problems on Karnaugh map simplification	Propagation Delay	Magnitude comparators	Synchronous (Clocked) sequential circuits	Design sequential circuits using PLD's
	SLO-2	Problems on Karnaugh map simplification	Power dissipation	Magnitude comparators	Synchronous (Clocked) sequential circuits	Design sequential circuits using PLD's
S-12	SLO-1	Quine McCluskey	Noise margin	Parity generators (Odd parity)	Analyze and design synchronous sequential circuits	Design sequential circuits using PLD's
	SLO-2	Tabulation method	Supply voltage levels	Parity generators (Even parity)	State reduction	Design sequential circuits using PLD's
S-13	SLO-1	Problems on Quine McCluskey or Tabulation method.	Operational voltage levels	Implementation of combinational logic by standard IC's.	State assignment	Design sequential circuits using PLD's
	SLO-2	Exercise problems using Tabulation method	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
S-14-15	SLO-1	Lab 3: Design and Implement 2-bit Magnitude Comparator using logic gates				
	SLO-2					

Learning Resources	1. Morris Mano M, Michael D. Ciletti, Digital Design with an Introduction to the Verilog HDL, 5 th ed., Pearson Education, 2014	4. Ronald J. Tocci, Digital System Principles and Applications, 10 th ed., Pearson Education, 2009
	2. Charles H Roth (Jr), Larry L. Kinney, Fundamentals of Logic Design, 5 th ed., Cengage Learning India Edition, 2010	5. Donald P Leach, Albert Paul Malvino, Goutam Saha, Digital Principles and Applications, 6 th ed., Tata-Mcgraw Hill, 2008
	3. Thomas L. Floyd, Digital Fundamentals, 10 th ed., Pearson Education, 2013	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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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			Program Learning Outcomes (PLO)																		
CLR-1:	Know about requirements of signal and system analysis in communication.	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15				
CLR-2:	Understand the analysis of Periodic and Aperiodic Continuous time Signals using Fourier series and transforms	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-3:	Educate about Continuous time system through Laplace transform and Convolution integral				H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CLR-4:	Understand the characterization of the Discrete time signals and system through DTFT, Convolution sum				-	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-5:	Understand the concept of Z-Transform for the analysis of DT system				-	H	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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				-	H	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	L
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				-	H	-	M	M	-	-	-	-	-	-	-	-	-	-	-	L	-	-

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	1	65	60
CLO-1:	Understand the various classifications of Signals and Systems	2	65	60
CLO-2:	Analyze Periodic and Aperiodic Continuous time Signals using Fourier series and Fourier Transform	2	65	60
CLO-3:	Analyze and characterize the Continuous time system through Laplace transform and Convolution integral.	2	65	60
CLO-4:	Analyze and characterize the Discrete time signals and system through DTFT, Convolution sum	2	65	60
CLO-5:	Analyze and characterize the Discrete time system using Z transform	2	65	60
CLO-6:	Apply the mathematical techniques used for continuous-time signal and discrete-time signal and system analysis	2	65	60

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, 2 nd ed., Pearson Education, 2015	5. John G. Proakis, Manolakis, Digital Signal Processing, Principles, Algorithms and Applications, 4 th ed., Pearson Education, 2007.
	2. P.Ramakrishna Rao, Shankar Prakriya, Signals & Systems, 2 nd ed., McGraw Hill Education, 2015	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/
	3. Simon Haykin, Barry Van Veen, Signals and Systems, 2 nd ed., John Wiley & Sons Inc., 2007	
	4. Lathi B.P, Linear Systems & Signals, 2 nd ed., Oxford Press, 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%	-
Level 2	Understand	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
	Apply	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
Level 3	Analyze										
	Evaluate										
	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. 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):		Learning			Program Learning Outcomes (PLO)															
CLR-1 :		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
The purpose of learning this course is to:																				
Gain knowledge on the basic concepts and insights of Electric field																				
Gain knowledge on the basic concepts and insights of Magnetic field and Emphasize the significance of Maxwell's equations.																				
Interpret the wave propagation in guided waveguide.																				
Acquire the fundamental knowledge on Transmission Line Theory.																				
Acquire the knowledge on transmission line parameter calculation and impedance matching concepts.																				
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):		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	
At the end of this course, learners will be able to:																				
Apply the concepts and knowledge to solve problems related to electric field.		2	60	60	M	H	-	-	-	-	-	-	-	-	-	-	-	-	-	L
Analyze the concepts of Magnetic field and Maxwell's equations in the real world application.		2	60	60	H	M	-	-	-	-	-	-	-	-	-	-	-	-	-	L
Translate the phenomenon of guided wave propagation and its mode of propagation.		1	60	60	H	M	-	-	-	-	-	-	-	-	-	-	-	-	-	L
Describe the importance of transmission line theory applicable to low frequency transmission lines.		1	60	60	M	H	-	-	-	-	-	-	-	-	-	-	-	-	-	L
Solve transmission line parameter and impedance matching through analytical and graphical methods.		2	60	60	M	H	-	-	-	-	-	-	-	-	-	-	-	-	-	M
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 P_{avg} and P_{total}	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 α_{TE} and α_{TE}	Problem discussion.	Additional smith chart problem solving.

Learning Resources	1. Matthew N. O. Sadiku., S. V. Kulkarni, Elements of Electromagnetics, 6 th ed., Oxford University Press, 2015	4. William H. Hayt, Jr., John A. Buck., Engineering Electromagnetics, 8 th ed., Tata McGraw-Hill 2012
	2. G. S. N. Raju, Electromagnetic Field Theory and Transmission Lines, Pearson Education, 2006	
	3. Nannapaneni Narayana Rao, Principles of Engineering Electromagnetics, 6 th ed., Pearson Education, 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. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranjani@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):		Learning			Program Learning Outcomes (PLO)														
The purpose of learning this course is to:		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1:	Understand the operation and design of BJT amplifier circuits for a given specification	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-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:																	
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 amplifiers & 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	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
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	Multi-stage 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

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

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%
Level 2	Understand	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 3	Apply	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Analyze	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Evaluate	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	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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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			Program Learning Outcomes (PLO)														
CLR-1:	Study the basic principles, configurations and practical limitations of op-amp			1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2:	Understand the various linear and non-linear applications of op-amp			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-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:																				
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	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
	SLO-2					
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	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
	SLO-2					

Learning Resources	1. Ramakant A. Gayakwad, Op-Amps and Linear Integrated Circuits, 4 th ed., Prentice Hall, 2000	6. LABORATORY MANUAL, Department of ECE, SRM University
	2. David A. Bell, Operational Amplifiers and Linear ICs, 3 rd ed., OUP, 2013	7. David A Bell, Laboratory Manual for Operational Amplifiers & Linear ICs, 2 nd ed., D.A. Bell, 2001
	3. Roy Choudhury, Shail Jain, Linear Integrated Circuits, 4 th ed., New Age International Publishers, 2014	8. David La Lond, Experiments in Principles of Electronic Devices and Circuits, Delmar Publishers, 1993
	4. Robert F. Coughlin, Frederick F. Driscoll, Operational-Amplifiers and Linear Integrated Circuits, 6 th ed., Prentice Hall, 2001	9. Muhammed H Rashid, Introduction to PSpice using OrCAD for circuits and electronics, 3 rd ed., Pearson, 2004
	5. Sergio Franco, Design with operational amplifier and analog integrated circuits, McGraw Hill, 1997	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	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
Level 2	Understand										
	Apply	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 3	Analyze										
	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.,

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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

	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
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

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	4. Kenneth.J.Ayala, "8051 Microcontroller Architecture, Programming and Applications", 3rd edition, Thomson, 2007
	2. MuhammadAli Mazidi and Janice GillispieMazidi, "The 8051 - Microcontroller and Embedded systems", 7th Edition, Pearson Education, 2011.	5. Subrataghoshal " 8051 Microcontroller Internals Instructions ,Programming And Interfacing",2nd edition Pearson 2010
	3. Doughlas.V.Hall, "Microprocessor and Interfacing : Programming and Hardware", 3rd edition, McGraw Hill, 2015	6. Yu-cheng Liu, Glenn A.Gibson, "Microcomputer systems: The 8086/8088 family-Architecture,programming and design",2nd edition, Prentice Hall of India,2007

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		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
Level 2	Understand	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 3	Apply	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Analyze										
	Evaluate										
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

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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	

	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	3. Sanjit Mitra, "Digital Signal Processing –A Computer Based Approach", McGraw Hill, India, 4th Edition, 2013.
	2. Alan V. Oppenheim, Ronald W. Schaffer, "Discrete-Time Signal Processing", Pearson Education, 1st edition, 2015	

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		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 %	

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INSTITUTE OF SCIENCE & TECHNOLOGY
(Deemed to be University w/s 3 of UCA, 1956)

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:			Learning			Program Learning Outcomes (PLO)															
CLR-1:	Introduce and Understand the need for modulation, various Amplitude modulators/demodulators, frequency modulators and demodulators	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
CLR-2:	Comprehend the radio transmitters and receivers using the modulators and demodulators and to analyze the noise performance	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-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:																					
CLO-1:	Understand the concepts of analog modulation and demodulation techniques	2	80	70	M	-	-	-	-	-	-	-	-	-	-	-	-	-	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
	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
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
	SLO-2	Double sideband Full carrier	FM transmitter: Direct Method	Pulse modulation systems, Sampling and quantization	Generation, Signal Space Diagram and detection of FSK
S-3	SLO-1	Double sideband Suppressed carrier	FM transmitter: Indirect Method	PCM systems	Probability of Error for FSK
	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
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
	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	<i>Super-heterodyne receiver- AM</i>	Differential PCM (DPCM)	Probability of Error for PSK	OFDM Communication
	SLO-2	Non-linear Modulation-Balanced Modulator	<i>Super-heterodyne receiver- AM</i>	Differential PCM (DPCM)	Probability of Error for PSK	OFDM Communication
S-8	SLO-1	Demodulation of AM waves : Linear diode detector	<i>Super-heterodyne receiver- FM</i>	Delta modulation (DM)	Generation, signal space diagram and detection of QPSK	Measures of Information
	SLO-2	Demodulation of AM waves : Linear diode detector	<i>Super-heterodyne receiver- FM</i>	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	<i>Sources of Noise</i>	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	<i>Sources of Noise</i>	Demodulation and detection process	Probability of Error for QPSK	Shannon's Channel capacity theorem
S-12	SLO-1	Generation of Narrowband FM	<i>Noise in AM (Envelope Detection),</i>	Maximum likelihood receiver structure, Matched filter receiver	Generation, signal space diagram and detection of $\pi/4$ QPSK	Linear block codes
	SLO-2	Generation of Narrowband FM	<i>Noise in AM (Envelope Detection),</i>	Maximum likelihood receiver structure, Matched filter receiver	Generation, signal space diagram and detection of $\pi/4$ QPSK	Linear block codes
S-13	SLO-1	Demodulation of FM : Foster seely discriminator	<i>Noise in FM</i>	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	<i>Threshold effect, Pre-emphasis and De-emphasis</i>	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	5. Taub & Schilling, "Principle of Communication Systems", McGraw Hill Inc, 2nd Edition, 2003.
	2. Singh. R. P & Sapre. S. D, "Communication Systems: Analog & Digital," 3rd edition, McGrawHill Education, Seventh Reprint, 2016.	6. John G. Proakis, "Digital Communication", McGraw Hill Inc, 5th Edition, 2008.
	3. Simon Haykin, "Communication Systems", John Wiley & Sons, 4th Edition, 20008.	7. B.P. Lathi, "Modern Digital and Analog Communication System", Oxford University Press, 3rd Edition, 2005.
	4. Bernard Sklar, "Digital Communication, Fundamentals and Application", Pearson Education Asia, 2nd Edition, 2001	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											
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		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 %		-	

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	SLO-2	Arithmetic Operators, Bitwise Operators, Reduction Operators, Logical Operators, Relational Operators, Shift Operators, Conditional Operator, Concatenation Operator, Expressions and Operands, Operator Precedence	Lab-3: Design using FSM and ASM charts		Lab-9: Design and Analysis of CMOS Inverter using HSPICE	Lab-12: Design and Analysis of 4-input 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	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
	SLO-2					
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	Lab-2: (a) Realization of digital circuits using behavioral modeling (b) Realization of MOS circuits using switch-level modeling	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
	SLO-2					

Learning Resources	<ol style="list-style-type: none"> 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, Addison-Wesley, 2011. 3. Wayne Wolf, "Modern VLSI Design: IP-based Design", 4th edition, PHI, 2009. 	<ol style="list-style-type: none"> 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
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		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 %	

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Course Designers		
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1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranj.ani@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. J. Manjula, SRMIST



SRM
INSTITUTE OF SCIENCE & TECHNOLOGY
(Deemed to be University w/s of UGC 1956)

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

Learning		
1	2	3
Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
2	75	60
2	75	60
2	75	60
2	75	60
2	75	60
2	75	60

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
H	-	-	-	-	-	-	-	-	-	-	M	M	-	L
H	H	H	H	-	-	-	-	-	-	-	-	M	M	-
H	H	H	-	-	-	-	-	-	-	-	-	-	-	H
H	H	-	-	-	-	-	-	-	-	-	-	-	-	H
H	-	-	-	-	-	-	-	-	-	-	M	M	-	L
H	H	H	H	M	-	-	-	-	M	-	M	M	-	H

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:
CLO-1 :	Acquire the knowledge of Wireless communication and basic cellular concepts
CLO-2 :	Understand the essential Radio wave propagation and mobile channel models
CLO-3 :	Familiarize about Various performance analysis of mobile communication system.
CLO-4 :	Attain the knowledge of Diversity and capacity concepts
CLO-5 :	Be familiar with the various standards of Mobile Communication Systems
CLO-6 :	Explore the various concepts of wireless communication, its design with respect to fading and link performance

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, full 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 omnidirectional antennas	Empirical model - Okumara			
S-5	SLO-1	Channel assignment strategies	Empirical 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	Empirical 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 Probability	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.	5. Andrea Goldsmith, "Wireless Communications", Cambridge University Press, Aug 2005
	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.	7. Lee W.C.Y., "Mobile Communications Engineering: Theory and Applications", McGraw Hill, New York, 2nd Edition, 1998
	4. Andreas.F.Molisch., "Wireless Communications", Wiley, 2nd Edition-2005, Reprint-2014	

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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1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumar.anuj@gmail.com	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu	1. Dr. Sandeep Kumar P, SRMIST
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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:
CLO-1 :	Acquire knowledge on the theory of microwave transmission, microwave generators and associated components.
CLO-2 :	Analyse microwave passive devices and components.
CLO-3 :	Understand microwave measurements and associated techniques with equipment
CLO-4 :	Familiarize with the fundamentals of light transmission through fiber
CLO-5 :	Design a basic optical communication system.
CLO-6 :	Understand the working principle of microwave components , Microwave measurements, optical sources, detector and fibers

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

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
H	-	-	L	-	-	-	-	-	-	-	-	-	-	L
H	M	H	H	-	-	-	-	-	-	-	-	-	L	M
H	M	H	M	-	-	-	-	-	-	-	-	M	-	H
H	H	-	M	-	-	-	-	-	-	-	-	L	-	L
H	H	-	H	-	-	-	-	-	-	-	-	M	-	M
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
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
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
S-4-5	SLO-1 SLO-2 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
S-6	SLO-1 SLO-2 Reflex Klystron oscillators	Magic Tee	Measurement of Frequency and Q factor	Optical Sources: Light source materials, LED Structures	Rise time budget
S-7	SLO-1 SLO-2 Magnetron oscillators	Microwave Circulators, Isolators	Insertion loss measurements	LED Characteristics	Overview of Analog links: Radio over Fiber;
S-8	SLO-1 SLO-2 Microwave Bipolar Transistors Field effect transistor	Attenuators and Phase Shifters	Attenuation measurements	Semiconductor Laser Diode, Laser Characteristics	Key link parameters

S-9-10	SLO-1 SLO-2	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
S-11	SLO-1 SLO-2	IMPATT, TRAPATT and Tunnel diode	Rectangular Waveguides	Measurement of Scattering parameters	Optical Detectors: PIN and APD photo detector	Multichannel System: Need for multiplexing Operational principles of WDM, DWDM
S-12	SLO-1 SLO-2	Gunn diode	Rectangular Waveguides	Measurement of Scattering parameters	Responsivity and efficiency of APD	WDM Components: Coupler/Splitter, Fabry Perot Filter
S-13	SLO-1 SLO-2	Gunn Oscillation modes	Power Dividers	Functioning details of Vector Network Analyzer; Signal Analyzer; Spectrum analyzers	Fiber attenuation and dispersion	WDM Components: Optical MEMS switches
S-14-15	SLO-1 SLO-2	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)

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. Sivarajan, Galen H.Sasaki "Optical Networks A practical perspective", 3rd edition, 2013
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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. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anil@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):	<i>The purpose of learning this course is to:</i>			Program Learning Outcomes (PLO)																	
CLR-1:	Introduce the basic concepts in the field of computer networks.			1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2:	Understand the functional aspects of OSI model architecture.			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-3:	Acquire knowledge of the Network Layer protocols			1	60	65	-	-	-	-	-	H	-	-	-	-	M	-	-	-	-
CLR-4:	Analyze the various issues and challenges of Transport Layer.			1	60	65	-	-	M	-	-	L	-	-	-	-	-	-	-	-	-
CLR-5:	Familiarize the various Application Layer Protocols.			2	65	65	-	-	H	-	-	L	M	-	-	-	-	-	-	-	-
CLR-6:	Utilize the networking concepts to analyze the performance of Routing protocols.			1	60	65	-	-	-	-	-	-	M	-	-	-	-	-	-	-	H
CLR-6:	Utilize the networking concepts to analyze the performance of Routing protocols.			2	60	65	-	-	-	L	-	-	-	-	-	-	M	-	-	-	H
Course Learning Outcomes (CLO):	<i>At the end of this course, learners will be able to:</i>																				
CLO-1:	Express the basic services and concepts related to internetworking.			1	60	65															
CLO-2:	Explain the basic OSI model architecture and its lower layer functions.			1	60	65															
CLO-3:	Illustrate the various Network Layer concepts, mechanisms and protocols.			2	65	65															
CLO-4:	Describe the services and techniques of Transport Layer.			1	60	65															
CLO-5:	Discuss the various services and protocols in Application Layer.			1	60	65															
CLO-6:	Analyze the various Networking concepts and Routing protocols.			2	60	65															

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, 5 th Edition Reprint, 2014.	3. William Stallings, "Data & Computer Communication", Pearson Education India, 10 th Edition, 2014.
	2. Andrew S.Tanenbaum, "Computer Networks", Pearson Education India, 5 th Edition, 2013.	4. James F. Kurose, Keith W. Ross, "Computer Networking: A Top-Down Approach Featuring the Internet", Pearson Education, 6 th 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 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.,

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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	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):	<i>The purpose of learning this course is to:</i>	Learning	Program Learning Outcomes (PLO)																
CLR-1:	<i>Acquire skills to solve real world problems in Analog and Digital Electronics (Discrete & IC)</i>	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2:	<i>Acquire skills to solve real world problems in Analog and Digital Communication</i>	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
CLR-3:	<i>Acquire skills to solve real world problems in Signals & Systems, and DSP</i>																		
CLR-4:	<i>Acquire skills to solve real world problems in Microprocessors & Microcontrollers, and VLSI Design</i>																		
CLR-5:	<i>Acquire skills to solve real world problems in Electromagnetics and Transmission Lines</i>																		
CLR-6:	<i>Acquire skills to solve real world problems in Microwave and Optical Communications</i>																		

Course Learning Outcomes (CLO):	<i>At the end of this course, learners will be able to:</i>	Learning	Program Learning Outcomes (PLO)																
CLO-1:	<i>Practice and gain confidence and competence to solve problems in Analog and Digital Electronics (Discrete & IC)</i>	3	85	80	H	H	H	L	L	L	L	L	L	L	L	L	M	L	M
CLO-2:	<i>Practice and gain confidence and competence to solve problems in Analog and Digital Communication</i>	3	85	80	H	H	M	L	L	L	L	L	L	L	L	L	M	M	M
CLO-3:	<i>Practice and gain confidence and competence to solve problems in Signals & Systems, and DSP</i>	3	85	80	H	H	M	L	L	L	L	L	L	L	L	L	M	L	M
CLO-4:	<i>Practice and gain confidence and competence to solve problems in Microprocessors & Microcontrollers, and VLSI Design</i>	3	85	80	H	H	M	L	L	L	L	L	L	L	L	L	M	M	M
CLO-5:	<i>Practice and gain confidence and competence to solve problems in Electromagnetics and Transmission Lines</i>	3	85	80	H	H	H	L	L	L	L	L	L	L	L	L	M	L	M
CLO-6:	<i>Practice and gain confidence and competence to solve problems in Microwave and Optical Communications</i>	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
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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%
Level 2	Apply	-	40%	-	40%	-	40%	-	40%	-	40%
Level 3	Analyze	-	40%	-	40%	-	40%	-	40%	-	40%
	Evaluate	-	20%	-	30%	-	30%	-	30%	-	30%
	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.ani@gmail.com	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu	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	Dr. V. Nithya, SRMIST



SRM
 INSTITUTE OF SCIENCE & TECHNOLOGY
 (Deemed to be University u/s 3 of UGC Act, 1956)

B. Tech in Electronics and Communication Engineering
(with specialization in Cyber Physical System)

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	18ECE250T	Course Name	PRINCIPLES OF CYBER PHYSICAL SYSTEM	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18MAB101T	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:			Program Learning Outcomes (PLO)																				
CLR-1 :	Obtain cyber physical systems fundamentals and principles knowledge as building blocks to promote further design and implementation of more complex real time systems.			1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
CLR-2 :	Understand cyber physical systems design for synchronous model with specific case study for arm processor.			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			
CLR-3 :	In what way cyber physical systems are crucial for the optimal performance of asynchronous model.						H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-4 :	Comprehend the cyber physical systems design and implementation in dynamical models.						H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-5 :	Hybridization of cyber physical systems which will help the students to anticipate upcoming technologies.						-	M	H	-	H	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-6 :	Gain overall understand of the cyber physical systems for that will suit practical, engineering and industrial needs.						-	M	H	-	H	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-6 :	Gain overall understand of the cyber physical systems for that will suit practical, engineering and industrial needs.						-	M	H	-	H	-	-	-	-	-	H	-	-	-	M	-	-	L

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:			1	90	75	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-1 :	Understand the basics of cyber physical systems.			1	80	70	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Design synchronous models for Real Time applications.			2,3	90	75	-	M	H	-	H	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Design Asynchronous models for Real Time applications.			2,3	90	75	-	M	H	-	H	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Develop Deep Understanding on selection of hardware and software's for designing dynamical systems.			2	80	75	-	M	H	-	L	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	Come up with cost effective, reliable, robust and feasible designs for real world problems.			2	90	75	-	M	H	-	H	-	-	-	H	-	-	-	M	-	-	L
CLO-6 :	Design and implement cyber physical system and address the problems and limitations for real world problems.			2	90	75	-	M	H	-	H	-	-	-	H	-	-	-	M	-	-	L

DURATION (HOUR)	INTRODUCTION TO CYBER PHYSICAL SYSTEMS	SYNCHRONOUS MODEL	ASYNCHRONOUS MODEL	DYNAMICAL SYSTEM	HYBRID SYSTEMS	
S-1	SLO-1	Introduction To Cyber-Physical Systems	Reactive Components	Asynchronous Process	Continuous Time Model	Hybrid Dynamical Model
	SLO-2	Cyber-Physical Systems Design Recommendations.	Variables, Valuations, And Expression	States, Internal Actions	Continuously Evolving Inputs And Outputs	Hybrid Process, Process Composition
S-2	SLO-1	Cyber-Physical System Requirements	Execution, Extended-State Machines	Executions, Extended State Machines	Continuously Evolving Inputs And Outputs	Zeno Behavior
	SLO-2	Requirements Engineering	Properties Of Components	Operation On Process	Models With Disturbance	Stability
S-3	SLO-1	Interoperability	Finite State Components	Asynchronous Design Primitives	Composing Components Stability	Designing Hybrid Systems
	SLO-2	Real Time System	Combinational Components	Blocking Vs Non-Blocking Synchronization	Composing Components Stability	Automated Guided Vehicle
S-4	SLO-1	GPU Computing	Event-Triggered Components	Deadlocks	Linear Systems Linearity	Automated Guided Vehicle
	SLO-2	Internet Of Things (IOT)	Nondeterministic Components	Deadlocks	Linear Systems Linearity	Obstacle Avoidance With Multi Robot Coordination
S-5	SLO-1	Internet Of Things (IOT)	Input Enabled Components	Shared Memory	Solutions Of Linear Differential Equations Stability	Obstacle Avoidance With Multi Robot Coordination
	SLO-2	Radio Frequency Identification Technology	Task Graphs And Await Dependencies	Fairness Assumptions	Solutions Of Linear Differential Equations Stability	Multi Hop Control Networks
S-6	SLO-1	Wireless Sensor Networks Technology	Composing Components	Asynchronous Coordination Protocols	Designing Controllers	Multi Hop Control Networks
	SLO-2	Powerline Communication	Block Diagrams Input / Output Variable Renaming	Asynchronous Coordination Protocols	Open Loop Vs Feedback Controller	Linear Hybrid Automata
S-7	SLO-1	Smart Cities And Internet Of Everything	Parallel Composition	Leader Election	Stabilizing Controller	Example Pursuit Game

	SLO-2	<i>Ubiquitous Computing Fundamentals</i>	<i>Output Hiding</i>	<i>Reliable Transmission</i>	<i>Stabilizing Controller</i>	<i>Example Pursuit Game</i>
S-8	SLO-1	<i>Core Properties Of Ubiquitous Computing</i>	<i>Synchronous Designs</i>	<i>Wait Free Consensus</i>	<i>PID Controllers</i>	<i>Formal Model</i>
	SLO-2	<i>Smart Devices: Components And Services</i>	<i>Synchronous Circuits</i>	<i>Safety Specifications</i>	<i>Analysis Techniques</i>	<i>Symbolic Reachability Analysis</i>
S-9	SLO-1	<i>Autonomous Systems In Ubiquitous Computing</i>	<i>Cruise Control Systems</i>	<i>Invariants Of Transition Systems</i>	<i>Numerical Solutions</i>	<i>Timed Automata</i>
	SLO-2	<i>CASE STUDY: Cyber Physical Vehicle Tracking System</i>	<i>Synchronous Networks</i>	<i>Safety Monitors</i>	<i>Barrier Certificates</i>	<i>Model Of Timed Automata</i>

Learning Resources	1. Rajeev Alur, Principles Of Cyber Physical Systems, 1 st Edition, MITPress 2015.	2. Raj Rajkumar , "Cyber Physical Systems," 2 nd Edition, Elsevier 2015
		3. Edward D Lamie, "Computing Fundamentals Of Cyber Physical Systems " , 2 nd Edition, Newnes Elsevier Publication.

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%	-
Level 2	Understand	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Apply	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
Level 3	Analyze	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Evaluate	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Create	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Total	100 %		100 %		100 %		100 %		100 %	

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Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Athif Shah, Chairman, Abe Semiconductor, abechennai@gmail.com	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu	1. Dr. Vivek Maik, SRMIST
2. Dr. Madan Kumar Lakshmanan, Senior Scientist, CEERI, Imadank@gmail.com	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	

Course Code	18ECE251T	Course Name	EMBEDDED AND IMPLANTED DEVICES FOR CYBER PHYSICAL SYSTEM	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18EES101J	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:			Program Learning Outcomes (PLO)																																				
CLR-1:	Understand the various embedded processors and memory architecture	Learning			1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15																		
CLR-2:	Identify suitable hardware and software available to develop a CPS	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																					
CLR-3:	Study the multitasking and threading techniques for embedded processors																			L	M	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CLR-4:	Analyze the implementation scheme of implantable CPS for health care application																			L	M	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-5:	Use Cyber physical systems for energy management																			L	M	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-6:	Develop framework to put Human in CPS loop																			L	M	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
																				3	70	70	-	-	H	-	M	-	-	-	M	-	-	M	H	L	-	-	-	-

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:			
CLO-1:	Identify suitable embedded processor and memory for cyber physical system applications	2,3	70	70
CLO-2:	Select optimal hardware and software for cyber physical system model	2,3	70	70
CLO-3:	Efficiently use the embedded processor resources	2,3	70	70
CLO-4:	Develop implantable CPS model for health care application.	2,3	70	70
CLO-5:	Develop implantable CPS model for various real world problems.	2,3	70	70
CLO-6:	Understand the realistic constraints to put concepts of Human in CPS loop in real time applications	3	90	80

Duration (hour)	EMBEDDED PROCESSORS	INPUT AND OUTPUT HARDWARE AND SOFTWARE	MULTITASKING AND SCHEDULING	IMPLANTED CYBER-PHYSICAL SYSTEMS	HUMAN-IN-THE-LOOP CYBER-PHYSICAL SYSTEMS
S-1	SLO-1	Processors - Generalized Architecture	Hardware - Pulse Width Modulation,	Multitasking -Threads, Creating Threads,	Medical Cyber-Physical Systems - System Description And Operational Scenarios,
	SLO-2			Implementing Threads	Virtual Medical Devices
S-2	SLO-1	Processors – Speed	General-Purpose Digital I/O	Mutual Exclusion, Deadlock	Clinical Scenarios, Key Design Drivers And Quality
	SLO-2	Processors –Computational Power	General-Purpose Digital I/O	Memory Consistency Models	Attributes, Trends
S-3	SLO-1	Microcontrollers - Architecture	Serial Interfaces	The Problem With Threads	Quality Attributes
	SLO-2	Microcontrollers		Processes And Message Passing	Challenges Of The MCPS Domain
S-4	SLO-1	DSP Processors- Architecture	Parallel Interfaces	Scheduling - Basics Of Scheduling	On-Demand Medical Devices
	SLO-2	DSP Processors- Features		Scheduling Decisions	Assured Safety,
S-5	SLO-1	Programmable Logic Controllers - Architecture	Buses	Task Models,	Smart Alarms And Clinical Decision Support Systems
	SLO-2	Programmable Logic Controllers- Features		Comparing Schedulers	Closed-Loop System
S-6	SLO-1	Graphics Processors Architecture	Software - Sequential Software In A Concurrent World	Implementation Of A Scheduler	Energy Cyber-Physical Systems - System Description
	SLO-2	Graphics Processors Architecture		Rate Monotonic Scheduling	Operational Scenarios
S-7	SLO-1	Parallelism, Pipelining,	Interrupts	Earliest Deadline First, Scheduling	Architecture
	SLO-2	Instruction-Level Parallelism	Exceptions	Mutual Exclusion	

S-8	SLO-1	Multicore Architectures	Timers	Priority Inversion, Priority Inheritance Protocol	Cyber Paradigm For Sustainable Sees	Social Networking
	SLO-2	Multicore Architectures	Atomicity	Priority Ceiling Protocol		Social Networking
S-9	SLO-1	Memory Architectures - Memory Technologies	Interrupt Controllers	Multiprocessor Scheduling	Practitioners' Implications	The Sample App's Base Architecture
	SLO-2	Memory Hierarchy, Memory Models	Modeling Interrupts	Scheduling Anomalies		

Learning Resources	<ol style="list-style-type: none"> 1. E. A. Lee And S. A. Seshia, Introduction To Embedded Systems - A Cyber-Physical Systems Approach, Second Edition, Mit Press, 2017. 2. Houbing Song Danda Rawat Sabina Jeschke Christian Brecher, Cyber-Physical Systems Foundations, Principles And Applications, , 1st Edition, Academic Press, 2016 3. Raj Rajkumar, Dionisio De Niz, Mark Klein, Cyber-Physical Systems, Pearson Education, Inc.2017, 4. David Nunes, Jorge Sá Silva, Fernando Boavida, A Practical Introduction To Human-In-The-Loop Cyber-Physical Systems, Johnwiley & Sons Ltd, 2018. 	<ol style="list-style-type: none"> 5. Raj Kamal, Internet Of Things, Mcgraw Hill Education; First Edition, 2017. 6. Edward Ashford Lee, Sanjit Arunkumar Seshia, Introduction To Embedded Systems - A Cyber Physical Systems Approach - Second Edition, Lulu Enterprises Incorporated, 2014 7. Hamid R. Arabia, Leonidas Deligiannidis, Fernando G. Tinetti, Embedded Systems, Cyber-Physical Systems, And Applications, The 2017 Worldcomp International Conference Proceedings, Csrea, 2018
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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
Dr. Vinay Kumar Gupta, National Physical Laboratory, guptavinay@nplindia.org	Prof.C. Vijayan, IITM, Chennai, cvijayan@iitm.ac.in	Dr. P. Eswaran, SRMIST
	Prof. S. Balakumar, Univ of Madras, balakumar@unom.ac.in	Mr. A V M Manikandan, SRMIST

Course Code	18ECE252T	Course Name	SENSORS AND ACTUATORS FOR CYBER PHYSICAL SYSTEM	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18EES101J	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:			Learning			Program Learning Outcomes (PLO)														
CLR-1:	Learn sensor basic working			1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2:	Understand sensor design for embedded applications			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
CLR-3:	Design optimal real time models and learn the uncertainties																				
CLR-4:	Understand the Interface of Sensor System Design And Implementation																				
CLR-5:	Develop Deep Understanding On Sensor Materials and Technologies																				
CLR-6:	Understand about industry grade sensors and applications																				
CLR-6:	Understand about industry grade sensors and applications																				

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:			1	60	70	-	H	-	-	L	-	-	-	-	-	-	-	-	-	-	-
CLO-1:	Understand the working, classification and design of systems with sensors			2	60	70	M	-	-	-	-	-	-	-	-	-	-	M	-	-	-	-
CLO-2:	Design multi sensor cyber physical system for real world applications			3	60	70	-	M	H	-	H	-	-	-	-	-	-	-	-	-	-	L
CLO-3:	Implement different practical real time systems with minimal supervision			1	60	70	-	M	-	-	-	-	-	-	-	-	-	H	-	-	-	-
CLO-4:	Develop Deep Understanding on selection of hardware and software's for designing systems			3	60	70	-	M	M	-	H	-	-	-	-	H	-	-	-	-	-	H
CLO-5:	Come up with cost effective, reliable, robust and feasible designs for real world problems			3	60	70	-	-	M	-	H	-	-	-	-	-	-	H	L	-	-	M
CLO-6:	Design and implement real time systems and address the problems and limitations			3	60	70	-	-	M	-	H	-	-	-	-	-	-	H	L	-	-	M

DURATION (HOUR)	SENSOR BASIC BLOCKS	OPTICAL COMPONENTS OF SENSOR	HUMAN DETECTORS	CHEMICAL AND BIOLOGICAL SENSORS	MATERIALS AND TECHNOLOGIES
S-1	SLO-1 Data Acquisition	Energy Of Light Quanta	Ultrasonic Detectors	Chemical Sensors	Silicon As Sensing Material
	SLO-2 Sensors, Signals, And Systems	Light Polarization	Microwave Motion Detectors	Bio Chemical Sensors	Plastics
S-2	SLO-1 Sensor Classification	Light Scattering	Microwave Motion Detectors	Chemical Sensor Characteristics	Metals, Ceramics
	SLO-2 Units Of Measurements	Geometrical Optics	Ground Penetrating Radars	Selectivity And Sensitivity	Simple And Fraden Model Ceramics
S-3	SLO-1 Transfer Functions	Radiometry	Linear Optical Sensors	Electrical And Electrochemical Sensors	Steinhart And Hart Model Ceramics
	SLO-2 Mathematical Models, Functional Approximations	Photometry	Capacitive Occupancy Detectors	Electrode Systems	Structured Glass, Optical Glass
S-4	SLO-1 Linear Regression, Polynomial Approximations	Windows	Triboelectric Detectors	Potentiometric Sensors	Nano Materials
	SLO-2 Sensitivity, Piecewise Linear Approximation	Mirrors Coated And Prismatic	Optoelectronic Motion Detectors - Structure	Conductometric Sensors	Surface Processing, Spin Casting
S-5	SLO-1 Spline Interpolation,	Lenses – Curved Surface Lenses	Optoelectronic Motion Detectors - Distortion	Metal Oxide Semiconductor (MOS) Chemical Sensors	Vacuum Deposition
	SLO-2 Multidimensional Transfer Functions	Lenses – Fresnel Lenses	Optoelectronic Motion Detectors - Efficiency	Elastomer Chemiresistors	Sputtering
S-6	SLO-1 Calibration,	Lenses – Flat Nano Lenses	Optical Presence Sensors	Chemical Capacitive Sensors, Chem FET	Chemical Vapor Deposition (CVD)
	SLO-2 Computation Of Parameters	Fiber Optics And Waveguides	Pressure-Gradient Sensors	Photoionization Detectors	Electroplating
S-7	SLO-1 Computation Of A Stimulus	Optical Efficiency	Gesture Sensing (3-D Pointing)	Physical Transducers, Acoustic Wave Devices	MEMS Technologies

	SLO-2	Use Of A Analytical Equation	Lensing Effect	Gesture Sensing (3-D Pointing)	Micro Cantilevers, Spectrometers	Photolithography
S-8	SLO-1	Use Of Linear Piecewise Approximation	Concentrators	Tactile Sensors	Optical Transducers And Radiometric Selectivity	Silicon Micromachining
	SLO-2	Iterative Computation Of Stimulus	Coatings For Thermal Absorption	Tactile Sensors	Color Change Sensors	Micromachining Of Bridges And Cantilevers
S-9	SLO-1	CASE STUDY: Sensors For Mobile Communication Devices - Requirements	Anti Reflective Coating	CASE STUDY: Ionizing Radiation Detectors	Multi Sensor Arrays	Lift Off, Wafer Bonding
	SLO-2	CASE STUDY: Sensors For Mobile Communication Devices - Integration	CASE STUDY: Energy Harvesting	CASE STUDY: Ionizing Radiation Detectors	Electronics Noses And Tongues	LIGA In Wafer Bonding

Learning Resources	1. Phillip A. Laplante , "Handbook Of Modern Sensors – Physics Design And Applications" , 5 th Edition, Springer Publication, 2015.	2. Xiacong Fan, "Real-Time Embedded Systems," 2 nd Edition, Elsevier 2015.
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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 %	

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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. Krishnaveni, SRMIST

Course Code	18ECE253T	Course Name	UNSUPERVISED INTELLIGENCE IN CYBER PHYSICAL SYSTEM	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18MAB101T	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:			Learning			Program Learning Outcomes (PLO)																																
CLR-1:	Learning of unsupervised intelligence algorithms in cyber physical system			1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15																		
CLR-2:	Understand the working of model based reinforcement learning			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																		
CLR-3:	Learn with case study about reinforcement learning																					H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-4:	Use of python programming for reinforcement learning																					-	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-5:	Unsupervised learning using SCIKIT learner, tensor flow and KERAS																					-	M	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	H
CLR-6:	Gain overall understand of the cyber intelligent systems for real world applications																					-	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-6:	Gain overall understand of the cyber intelligent systems for real world applications																					-	M	-	-	-	-	-	-	-	-	-	-	-	-	-	M	-	-

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:			1	80	70	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-1:	Ability to understand reinforcement learning and its use for intelligence			1	75	70	-	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2:	Able to design intelligent systems using cyber security standards			3	75	70	-	M	H	-	-	-	-	-	-	-	-	-	-	-	-	H
CLO-3:	Implement different practical self learning systems with minimal supervision			3	75	70	-	M	H	-	-	-	-	-	-	-	-	-	-	-	-	H
CLO-4:	Develop deep reinforcement learning for designing cyber physical system			1	70	70	-	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5:	Come up with cost effective, reliable, robust and feasible designs for real world problems			2	70	70	-	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-6:	Design and implement real time systems and address the problems and limitations																					

DURATION (HOUR)	REINFORCEMENT LEARNING AND CPS	MODEL BASED REINFORCEMENT LEARNING	DEEP REINFORCEMENT LEARNING & CASE STUDY	PYTHON PROGRAMMING FOR REINFORCEMENT LEARNING	UNSUPERVISED LEARNING USING SCIKIT-LEARNER, TENSORFLOW AND KERAS	
S-1	SLO-1	Overview Of Reinforcement Learning	Model Based Reinforcement Learning Introduction	Deep Reinforcement Learning Introduction	Introduction To Reinforcement Learning Using Python	Unsupervised Learning Using Scikit-Learn
	SLO-2	Comparison Of Different Reinforcement Learning Methods	Model Free Reinforcement Learning	Deep Reinforcement Learning Examples	Introduction To Reinforcement Learning Using Python	Dimensionality Reduction
S-2	SLO-1	Examples Of Different Reinforcement Learning Methods	Model Based Reinforcement Learning Principles,	Deep Reinforcement Learning Working Principles	Introduction To Reinforcement Learning Libraries Used	The Motivation For Dimensionality Reduction
	SLO-2	Applications Of Different Reinforcement Learning Methods	Working & Applications	Deep Reinforcement Learning Mathematical Modeling	Introduction To Reinforcement Learning Set Up Of Tools	Dimensionality Reduction Algorithms
S-3	SLO-1	History Of Reinforcement Learning	Dynamic Programming	Deep Reinforcement Learning Value Function	Elements Of Reinforcement Learning	Principal Component Analysis
	SLO-2	History Of Reinforcement Learning	Dynamic Programming Principles & Applications	Deep Reinforcement Learning Value Function Tools	Agent Environment Interface	Singular Value Decomposition
S-4	SLO-1	Simulation Tool Kits For Reinforcement Learning	Partially Observable Markov Decision Process	Deep Reinforcement Learning Value Policy Tools	Types Of Reinforcement Environment	Dictionary Learning
	SLO-2	Simulation Tool Kit For Reinforcement Learning	Partially Observable Markov Decision Process - Architecture	Reinforcement Learning For Cyber Security	Reinforcement Environment Platforms	Independent Component Analysis
S-5	SLO-1	Overview Of Cyber Physical System	Partially Observable Markov Decision Process – Working & Applications	Reinforcement Learning For Cyber Security – Examples	Reinforcement Environment Platform Call Function	Unsupervised Learning Using Tensor Flow
	SLO-2	Examples Of Cyber Physical Systems	Continuous Observable Markov Decision Process – Working & Applications	Reinforcement Learning For Cyber Security – Architectures	Getting Started With OPENAI And TENSORFLOW	Keras- Auto Encoders

S-6	SLO-1	Cyber Security-Introduction	Continuous Observable Markov Decision Process – Working & Applications	Reinforcement Learning For Cyber Security – Architectures	Setting Up Your Machine For OPEN AI And TENSOR FLOW	Auto Encoder: The Encoder And The Decoder
	SLO-2	Cyber Security Examples	Continuous Observable Markov Decision Process – Working & Applications	Reinforcement Learning For Cyber Security – System Function	OPENAI Gym, OPENAI Universe	Under Complete Auto Encoders
S-7	SLO-1	Cyber Security Standards	Reinforcement Learning Predication Analysis	CASE STUDY: Online Cyber Attack Detection In Smart Grid –Introduction	TENSORFLOW	Over Complete Auto Encoders
	SLO-2	Reinforcement Learning Problems	Reinforcement Learning Predication Analysis	CASE STUDY: Online Cyber Attack Detection In Smart Grid –Application	The Markov Chain And Markov Process	Dense Vs. Sparse Autoencoders
S-8	SLO-1	Multi Armed Bandit Problem	Reinforcement Learning Control Methods	CASE STUDY: Online Cyber Attack Detection In Smart Grid –System Design	Markov Decision Process	Denosing Autoencoder
	SLO-2	Contextual Bandit Problem	Reinforcement Learning Advanced Algorithm	CASE STUDY: Online Cyber Attack Detection In Smart Grid –Working Principle	The Bellman Equation	Variational Autoencoder
S-9	SLO-1	Contextual Bandit Problem	Reinforcement Learning Advanced Algorithm Examples	CASE STUDY: Online Cyber Attack Detection In Smart Grid –System Model	Optimality, Solving The Bellman Equation	Hands-On With Autoencoder
	SLO-2	Reinforce Learning Problem	Reinforcement Learning Advanced Algorithm Applications	CASE STUDY: Online Cyber Attack Detection In Smart Grid –State Estimation	Optimality, Solving The Bellman Equation	Hands-On With Autoencoder

Learning Resources	1	Chong Li, Meikang Qiu, Reinforcement Learning for Cyber-Physical Systems and Cybersecurity Case Studies, 1st Edition, CRC Press.	2.	Sudharsan Ravichandiran, Hands-On Reinforcement Learning with Python, 2 nd Edition, Packet Publishing, 2018.
			3.	Ankur A. Patel, Hands-On Unsupervised Learning Using Python, 1 st Edition, O'Reilly Media, Inc., March 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 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, abechnal@gmail.com	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu	1. Dr. P. Vijaya Kumar, SRMIST
2. Dr. Madan Kumar Lakshmanan, Senior Scientist, CEERI, lmadank@gmail.com	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	

S-6	SLO-1	System Programming Language C/C++	Real-Time Scheduling: Sporadic Server	Data Management Activities	Introduction To Software Engineering	Towards Cognitive Prostheses, Challenges And Opportunities
	SLO-2	System Programming Language C/C++	Real-Time Scheduling: Sporadic Server	Data Management Activities	Introduction To Software Engineering	Mobile Wsn-Cps Applications
S-7	SLO-1	Build Target Images	Resource Sharing: Shared Variables	Cyber-Physical Cloud Computing: Opportunities And Challenges	V-Model	Smart Space Systems
	SLO-2	Build Target Images	Shared Memory	Cyber-Physical Cloud Computing: Opportunities And Challenges	Agile Software Development Methodology	Emergency Response Systems
S-8	SLO-1	CASE STUDY: Building A QNX Image	Semaphore	Design Challenges And Issues For Routing In WSN Within The Context Of CPS	Comparison Of The V-Model And The Agile Software Development Methodology	Human Activity Inference
	SLO-2	Transfer Executable File Object To Target	Semaphore	Routing Protocols In Wsns For Cpss	Requirements In Software Design In Cyber-Physical Systems	Smart Factory
S-9	SLO-1	Integrated Testing On Target	Mutex	Future Directions Of Routing Protocols In WSN For CPS	Requirements In Software Design In Cyber-Physical Systems	CASE STUDY: Cyber-Physical Vehicle Tracking System
	SLO-2	System Production	Condition Variable	Case Study: Wsn-Cps Applications	Maritime Area Case Studies	Case Study: Cyber-Physical Vehicle Tracking System

Learning Resources	1. Kuodi Jain-Real Time Sysytems , 1st edition, Intech Open Publishing, 2015.	3. Sherali Zeadally and Nafaa` Jabeur- Cyber-Physical System Design with Sensor Networking Technologies, 1 st Edition, IEEE Design & Test, 2017.
	2. Xiaocong Fan- Real-Time Embedded Systems Design Principles and Engineering Practices, 1 st Edition, Newnes Publications, 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 %	

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

Course Code	18ECE350T	Course Name	CYBER PHYSICAL INTERFACE AND AUTOMATION	Course Category	E	Professional Elective			
						L	T	P	C
						3	0	0	3

Pre-requisite Courses	18ECE251T	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:	Learning			Program Learning Outcomes (PLO)															
CLR-1:	Study the cyber physical systems built-on Wireless sensor networks	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
CLR-2:	Learn the synthesis for cyber physical systems	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	
CLR-3:	Gain knowledge on security features of cyber physical systems																			
CLR-4:	Analyse the real-time scheduling for cyber physical systems																			
CLR-5:	Enhance the scientific computing skills on medical cyber physical systems																			
CLR-6:	Develop Cyber physical systems for interfacing and automation																			
CLR-6:	Develop Cyber physical systems for interfacing and automation																			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
CLO-1:	Appreciate the features of localization of wireless sensor networks using CPS	3	80	70	L	H	-	H	L	-	-	-	L	L	-	H	-	-	-
CLO-2:	Synthesize the feedback control systems for CPS	3	85	75	M	H	L	M	L	-	-	-	M	L	-	H	-	-	-
CLO-3:	Analyse security issues in CPS	3	75	70	M	H	M	H	L	-	-	-	M	L	-	H	-	-	-
CLO-4:	Design the real time scheduling algorithms for CPS	3	85	80	M	H	M	H	L	-	-	-	M	L	-	H	-	-	-
CLO-5:	Apply the automated concepts in medical CPS.	3	85	75	H	H	M	H	L	-	-	-	M	L	-	H	-	-	-
CLO-6:	Implement basic applications with automation	3	80	70	L	H	-	H	L	-	-	-	L	L	-	H	-	-	-

Duration (hour)	CYBER-PHYSICAL SYSTEMS BUILT ON WIRELESS SENSOR NETWORKS	SYNTHESIS FOR CYBER-PHYSICAL SYSTEMS	SECURITY OF CYBER-PHYSICAL SYSTEMS	REAL-TIME SCHEDULING FOR CYBER-PHYSICAL SYSTEMS	MEDICAL CYBER-PHYSICAL SYSTEMS
S-1	SLO-1	Introduction And Motivation	Introduction	Introduction	Introduction
	SLO-2	Medium Access Control	Introduction	Introduction	Virtual Medical Devices
S-2	SLO-1	System Description And Operational Scenarios	Basic Techniques	Basic Techniques	System Description And Operational Scenarios
	SLO-2	Routing	Preliminaries	Discrete Verification	Clinical Scenarios
S-3	SLO-1	Node Localization	Problem Definition	Cyber Security Requirements	Key Design Drivers And Quality Attributes
	SLO-2	Clock Synchronization			Trends
S-4	SLO-1	Power Management	Solving The Synthesis Problem	Attack Model	Advanced Techniques
	SLO-2		Construction Of Symbolic Models		
S-5	SLO-1	Key Design Drivers And Quality Attributes	Controller Timing	Countermeasures	Multiprocessor/Multicore Scheduling
	SLO-2	Physically Aware	Control Design For Resource Efficiency		
S-6	SLO-1	Real-Time Aware	Advanced Techniques	Advanced Techniques	Accommodating Variability And Uncertainty
	SLO-2	Runtime Validation Aware	Construction Of Symbolic Models		
S-7	SLO-1	Security Aware	Continuous-Time Controllers	Hybrid Verification	Managing Other Resources
					Practitioners' Implications

	SLO-2		Software Tools			MCPS Developer Perspective
S-8	SLO-1	Practitioners' Implications	Reducing The Computation Time	System Theoretic Approaches	Rhythmic Tasks Scheduling	MCPS Administrator Perspective
	SLO-2		Analysis And Simulation Of Feedback Control Systems			MCPS User Perspective
S-9	SLO-1	Summary And Open Challenges	Summary And Open Challenges	Summary And Open Challenges	Summary And Open Challenges	Summary And Open Challenges
	SLO-2					

Learning Resources	1. Rajeev Alur, Principles of Cyber Physical Systems, 1 st Edition, MIT Press 2015.	2. Raj Rajkumar, "Cyber Physical Systems," 2 nd Edition, Elsevier 2015
		3. Edward D Lamie, "Computing Fundamentals Of Cyber Physical Systems", 2 nd Edition, Newnes Elsevier Publication.

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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	SLO-2	Introduction To Porting Hpc Applications To Grids And Clouds -Applications And The Grid Infrastructure	Complex Description	Related Work, Statistical Resource Availability Characterizing, Root Cause Analysis Of Failures	Controllable Data Execution Model	Parameter Sensitive Analysis
S-5-6	SLO-1	Applications And Resource Management	Generating Simple Job Descriptions, Generating Complex Job Descriptions	Fitting Distribution to Empirical Availability Data, Availability Prediction, A Heuristics-Based Failure Probability Estimation, Life Cycle Of A Volunteer Peer	Design Of A Processor Core Customized For Stencil Computation-Introduction	Predicting Novel Interactions
	SLO-2					
S-7	SLO-1	Applications And Data Management	Complex Descriptions With Mutation, Scheduling Strategies	Failure Probability Estimation, Least Failure Probability Dispatch Policy	Related Work-Customizable Design And Processors, Micro Architecture, Stencil Computation	Overview Of Neural Network Accelerators
	SLO-2	The Simple API For Grid Applications (Saga)	Static Data Feeder Strategy, Dynamic Data Feeder Strategy	An Enhanced Workflow Management Mechanism, The Task Selection	Customization Design, Flow, Array Padding And Loop Tiling, BW Optimizations.	Architectures Of Hardware Accelerators – ASIC, GPU
S-8	SLO-1	Grid Applications And Data, Shared Data Access	Implementation, Scheduler	Evaluation Results, Baseline Policies	SIMD, DMA Stencil Computation and others	FPGA, Modern Storage Accelerator
	SLO-2	Data Topology, Data Volume	Description Generator, Description Repository Service	Time Dependent Schrödinger's Wave Equation, Performance Evaluation	Implementation	Parallel Programming Models
S-9	SLO-1	Porting And Programming Grid Applications	Simulation Results	Comparison With The Simple Redundant Task Dispatch Policy, Comparison With The Greedy Dispatch	Test Results	Middleware Of Neural Networks
	SLO-2	Grid Programming Models And Environments	Summary And Conclusion	Effects Of Window Size On The Process Time, Improvement Of The Performance By Identifying Worker Types	Introduction To Electro Migration Alleviation Techniques	Latest Developments

Learning Resources	1. Emmanuel Udoh, Cloud_grid and High performance computing Emerging Applications, 1 st Edition, IGI Global, 2011.	2. Chao Wang, High performance computing for Big Data Methodologies and Applications, 1 st Edition, Chapman & Hall Press Publications, 2020.
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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	18ECE352T	Course Name	CYBER PHYSICAL CONTROL SYSTEM	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18ECS201T, 18ECE252T	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:			Program Learning Outcomes (PLO)																																	
CLR-1:	Understand the basics and advanced concepts of control systems	Learning			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15																		
CLR-2:	Gain the knowledge of industrial controllers process and their instrumentation	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																		
CLR-3:	Comprehend basic symbology and process control elements and techniques																			H	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CLR-4:	be acquainted with Industrial standards and methods for calibration and controller tuning																			-	M	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-5:	Acquire knowledge on Control systems networking and cyber connections																			-	M	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-6:	Grasp significant knowledge on industrial control systems and networking standards																			-	M	H	-	-	-	-	-	-	-	-	-	-	-	M	-	H	-
CLR-6:	Grasp significant knowledge on industrial control systems and networking standards																			2	60	60	-	M	H	-	M	-	-	-	M	-	-	H	L	-	-

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:			
CLO-1:	Understand mathematical (state) equations of complex control systems and their stability	2	60	60
CLO-2:	Design optimal control process for industrial instrumentation	2	60	60
CLO-3:	Understand process control instrumentation and design various control flow diagrams	1	60	60
CLO-4:	Maintain Industrial standards and methods for calibration of industrial instrumentation	1	60	60
CLO-5:	Design PLC, SCADA, HART protocols and wireless interfacings	2	60	60
CLO-6:	Improve the standards of industrial instrumentation and networking protocols	2	60	60

Duration (hour)	CONTROL SYSTEMS BASICS AND BEYOND	INDUSTRIAL PROCESS TECHNIQUES AND INSTRUMENTATION	PROCESS-CONTROL METHODS	INDUSTRIAL STANDARDS AND METHODS FOR CALIBRATION AND CONTROLLER TUNING	CYBER SYSTEMS AND NETWORKING
S-1	SLO-1 Elements of Open- and Closed-Loop Systems	Need of Controllers	Batch Processes	Instrument Calibration and Controller Tuning	Programmable Logic Controller Basics
	SLO-2 Transfer function	Open-Loop Control	Batch Processes Control Requirements	Reasons for Performing Calibrations	Requirement of communication networks for PLC, PLC to Computer.
S-2	SLO-1 Continuous-time systems, and convolution	Closed-Loop Control	Types of Batch Processes	Calibration Preparation	Elements of SCADA system
	SLO-2 Impulse response and step response	Process Behavior	Continuous Processes	Standard Calibration Procedure	Discrete control, Analog control, Master Terminal Unit, Remote Terminal Unit, Operator interface
S-3	SLO-1 Feedback Control Systems	Selecting a Controller	Continuous Processes Control Requirements	Five-Point Calibration Procedure	Distributed Control System (DCS)
	SLO-2 Basic Characteristics of feedback control systems	On-Off Control	Measurement Devices (Sensors): Dynamic, Static	Process Calibrators	DCS Architectures, Local Control Unit
S-4	SLO-1 Stability, reference tracking	Continuous Control, Proportional Mode	Feedback Loop Interface Instruments	Sensor Calibration	HART communication protocol, communication modes
	SLO-2 Disturbance rejection, sensitivity and robustness	Integral Mode, Derivative Mode	Block diagram of a closed-loop automated system	Transmitter Calibration	Industrial Wireless Technologies
S-5	SLO-1 Typical control system structures for SISO, MISO, SIMO, and MIMO plants	Advanced Control Techniques	Transmitters, Transducers	Tuning the Controller	Wireless Architecture, Topologies
	SLO-2 State-space design	Cascade Control	Monitoring Instruments: Indicators, Alarms, Recorders	Trial-and-Error Tuning Method	Wireless Infrastructure in Industrial Control Systems,

S-6	SLO-1	State variables	Feed-Forward Control	Manipulation Devices (The Final Control Element): The Solenoid Valve, DC and AC Motors, The Control Valve	Ziegler-Nichols Tuning Methods	Self-Organizing Networks
	SLO-2	Solution of state equations	Ratio Control	Instrumentation Symbology	Ziegler-Nichols Continuous-Cycling Method	Wireless Standards
S-7	SLO-1	Eigenvalues and eigenvectors	Adaptive Control	General Instrument Symbols	Ziegler-Nichols Continuous-Cycling Method	Threats in Industrial Control Systems
	SLO-2	Jacobian linearization technique	Pneumatic Controllers	Tag Numbers	Ziegler-Nichols Reaction-Curve Tuning Method	Network Backbones: Hubs, Switches, Bridges, Gateways.
S-8	SLO-1	State transformations and diagonalisation	Panel-Mounted Controllers	Line Symbols	Ziegler-Nichols Reaction-Curve Tuning Method	Hierarchy of Industrial Networks
	SLO-2	Transformation to phase-variable canonical form	Personal Computers	Valve and Actuator Symbols	Controller Autotuning	Troubleshooting I/O Interfaces
S-9	SLO-1	Basics of Controllability and Observability	Programmable Logic Controllers	Reading a Single Loop	PID controller	Network Communication Standards
	SLO-2	Duality property. Stability	Distributed Control Systems (DCS)	Information Block	PID controller tuning rules	Fieldbus Networks

Learning Resources	1. Nagrath I.J and Gopal M, "Control Systems Engineering", New Age Publishers, 5 th Edition, 2009.	4. Bolton. W, "Programmable Logic Controllers" Fifth Edition, Elsevier Newnes, 2009.
	2. Cyber-security of SCADA and Other Industrial Control Systems, Editors: Colbert, Edward J. M., Kott, Alexander (Eds.) ISBN 978-3-319-32125-7	5. Michael Lucas, "Distributed Control Systems", Van Nostrand Reinhold Co., 1986.
	3. Frank Petruzella. D, "Programmable Logic Controllers", Tata McGraw Hill Third Edition, 2010.	6. Industrial Automated Systems: Instrumentation and Motion Control, Terry Bartelt, ISBN-13: 978-1-4354-8888-5

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 Semiconductor, abechnai@gmail.com	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu	1. Dr. Bandaru Ramakrishna, 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. Vivek Maik, SRMIST

Course Code	18ECE353T	Course Name	CYBER SECURITY	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18ECE250T	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:			Learning			Program Learning Outcomes (PLO)														
CLR-1:	Learn Cyber Security Concepts	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
CLR-2:	Understand the standards and protocols for cyber security	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		
CLR-3:	Design and understand cryptography and secure communications																				
CLR-4:	Understand security and privacy threats in computer networks																				
CLR-5:	Develop Deep Understanding On cyber crime issues and forensics																				
CLR-6:	Gain Overall Understand Of The cyber security for real world applications																				
CLR-6:	Gain Overall Understand Of The cyber security for real world applications																				

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:																			
CLO-1:	Ability to understand cyber security working and protocols	1	60	70	-	H	-	-	L	-	-	-	-	-	-	-	-	-	-	-
CLO-2:	Able to design secure systems using cyber security standards	2	60	70	M	-	-	-	-	-	-	-	-	-	-	M	-	-	-	-
CLO-3:	Implement different practical digital encrypted systems with minimal supervision	3	60	70	-	M	H	-	H	-	-	-	-	-	-	-	-	-	-	L
CLO-4:	Develop Deep Understanding on selection of hardware and software's for designing cyber physical system	1	60	70	-	M	-	-	-	-	-	-	-	-	-	H	-	-	-	-
CLO-5:	Come up with cost effective, reliable, robust and feasible designs for real world problems	3	60	70	-	M	M	-	H	-	-	-	-	H	-	-	-	-	-	H
CLO-6:	Design and implement real time systems and address the problems and limitations	3	60	70	-	-	M	-	H	-	-	-	-	-	-	H	L	-	-	M

DURATION (HOUR)	DIGITAL SECURITIES	ONLINE ANONYMITY	CRYPTOGRAPHY AND SECURE COMMUNICATION	CYBER CRIME ISSUES AND INVESTIGATION	DIGITAL FORENSICS
S-1	SLO-1	Introduction	Introduction To Cryptography	Unauthorized Access	Introduction To Digital Forensics,
	SLO-2	Types Of Cyber Attacks	Difference Between Encryption & Cryptography	Computer Intrusions,	Forensic Software And Hardware
S-2	SLO-1	Digital Privacy	Cryptographic Functions	White Collar Crimes,	Analysis And Advanced Tools,
	SLO-2	Online Tracking	Cryptographic Types	Viruses And Malicious Code,	Forensic Technology And Practices
S-3	SLO-1	Privacy Laws	Cryptographic Applications	Internet Hacking And Cracking,	Forensic Ballistics And Photography
	SLO-2	Malware - Definition And Working Principle	Cryptographic Systems Trust Models	Virus Attacks,	Face, Iris And Fingerprint Recognition
S-4	SLO-1	Hacking - Definition And Working Principle	Cryptographic Key Pair	Software Piracy, Intellectual Property	Audio Video Analysis,
	SLO-2	Pharming - Definition And Working Principle	Disk Encryption Using Windows Bitlocker	Mail Bombs, Exploitation	Windows System Forensics
S-5	SLO-1	Phishing - Definition And Working Principle	Disk Encryption Using Open Source Tools	Digital Laws And Legislation, Law Enforcement Roles And Responses,	Linux System Forensics,
	SLO-2	Ransomware- Definition And Working Principle	Multi Task Encryption Tools	Investigation Tools, E-Discovery	Comparison Between Windows & Linux System Forensics
S-6	SLO-1	Antivirus - Definition And Working Principle	Attacking Cryptographic Systems	EDRM Model, Digital Evidence Collection	WIFI Security (War-Driving)
	SLO-2	Other Security Solution	Countermeasures Against Cryptography Attacks	Evidence Preservation, E-Mail Investigation	Network Forensics,
S-7	SLO-1	Secure Online Browsing	Securing Data In Transit	E-Mail Tracking, Ip Tracking	Network Forensics - Application & Examples

	SLO-2	<i>Email Security</i>	<i>Connection Leak Testing</i>	<i>Cloud Storage Encryption</i>	<i>E-Mail Recovery,</i>	<i>Mobile Forensics</i>
S-8	SLO-1	<i>Social Engineering</i>	<i>Secure Search Engine</i>	<i>Encrypt DNS Traffic</i>	<i>Search And Seizure Of Computers,</i>	<i>Mobile Forensics – Application & Examples</i>
	SLO-2	<i>Secure WIFI Settings</i>	<i>Web Browser Privacy Configuration</i>	<i>Encrypt DNS Traffic For Email Communication</i>	<i>Recovering Deleted Evidences</i>	<i>Cloud Forensics.</i>
S-9	SLO-1	<i>Cloud Storage Security</i>	<i>Anonymous Payment</i>	<i>Attacking Cryptographic Systems</i>	<i>Password Cracking</i>	<i>Cloud Forensics Application & Examples</i>
	SLO-2	<i>IOT Security</i>	<i>Payment Security Measures</i>	<i>Securing Data In Transit</i>	<i>Recovering Hard Disk Data</i>	<i>Net Neutrality & Challenges Of Forensic Science</i>

Learning Resources	1. Digital Privacy and Security Using Windows: A Practical Guide By Nihad Hassan, Rami Hijazi, 1 st Edition, Apress Publications, 2017	2. Digital Forensics, DSCI - Nasscom, 2012. 3. Cyber Crime Investigation, DSCI - Nasscom, 2013.
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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. Dr. Madan Kumar Lakshmanan, Senior Scientist, CEERI, lmadank@gmail.com	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	

Course Code	18ECE354T	Course Name	CLOUD AND DISTRIBUTED SYSTEMS FOR CYBER PHYSICAL SYSTEM	Course Category	E	Professional Elective			L	T	P	C
									3	0	0	3

Pre-requisite Courses	18ECE254T	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:			Learning			Program Learning Outcomes (PLO)														
CLR-1 :	Understand the fundamental ideas behind cloud computing, the evolution of the paradigm, its applicability; Benefits, as well as current and future challenges.			1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	Learn cloud enabling technologies, virtualization concepts and virtual machines.			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
CLR-3 :	Explore distributed system models and computer clusters for scalable parallel computing.																				
CLR-4 :	Understand the concept of intelligent data in cloud and distributed computing.																				
CLR-5 :	Explore distributed cloud storage technologies and relevant distributed file systems.																				
CLR-6 :	Gain overall knowledge of cloud and distributed computing in real world applications.																				

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:			1,2	80	80	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-1 :	Explain the fundamental ideas behind cloud computing, cloud models and current trends.			1,2	80	80	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-2 :	Analyze the need for virtualization in a cloud environment and outline their role in enabling the cloud computing system Model.			1,2	85	80	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-3 :	Apply distributed system model and understand the design principles of computer clusters.			2,3	90	85	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-4 :	Know the use of computational methods associated with cloud and distributed computing.			2,3	90	85	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-5 :	Illustrate the fundamental concepts of distributed algorithms, standards and protocols.			1,2,3	80	80	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-6 :	Understand the state of the art trend in the cloud and distributed computing.			1,2,3	85	85	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-

Duration (Hour)	CLOUD COMPUTING	CLOUD TECHNOLOGY	DATA & INTELLIGENCE IN THE CLOUD	DISTRIBUTED COMPUTATIONS	DISTRIBUTED ALGORITHMS
S-1	SLO-1 What Is Cloud Computing	Introduction	Historic Review Of Database Storage Model	Distributed Computing Definition	Topology Abstraction And Overlays
	SLO-2 Cloud Computing Service Models	Web Technology – HTTP, HTML	Relational Is The New Hoover	Relation To Computer System Concepts	Classification Of Algorithms And Basic Concepts
S-2	SLO-1 Cloud Computing Deployment Models	Web Technology – XML, JSON	Database As A Service, Data Storage In The Cloud	Relation To Parallel Multiprocessor / Multicomputer Systems	Complexity Measure And Concepts
	SLO-2 Public Cloud – Definitions, Advantages	Web Technology – Javascript , AJAX	Backup Or Disaster Recovery	Message Passing Systems Versus Shared Memory Systems	Program Structure
S-3	SLO-1 Private Cloud – Definitions, Advantages	Model View Controller	Business Drivers For The Adoption Of Different Data Models	Primitives For Distributed Computations	Elementary Graph Algorithms
	SLO-2 Hybrid Cloud – Definitions, Advantages	Automatic Computing	Basically Available, Soft State, Eventually Consistent (BASE)	Synchronous Vs Asynchronous Executions	Synchronizers
S-4	SLO-1 Community Cloud – Definitions, Advantages	Virtualization – Application Virtualization	Column Oriented, Document Oriented And Key Value Stores	Design Issues And Challenges	Maximal Independent Set (MIS)
	SLO-2 Internal And External Factors For Choosing Cloud Model	Desktop Virtualization, Server Virtualization	Intelligence In The Cloud, Web 2.0	Selection And Coverage Of Topics	Connected Dominating Set
S-5	SLO-1 Legal Aspects Of Cloud Computing	Server Virtualization, Storage Virtualization	Relational Databases	A Distributed Program And Model Of Distributed Executions	Compact Routing Tables
	SLO-2 Privacy And Security In Cloud	Implementing Virtualization	Text Data, Natural Language Processing	Models Of Communication Networks	Leader Election

S-6	SLO-1	The Ethical Dimension In Cloud	Hypervisor	Intelligent Searching, Search Engine Overview,	Global State Of The Distributed Systems	Challenges In Designing Distributed Graph Algorithms
	SLO-2	Social Aspects In The Cloud	Map Reduce	The Crawler, The Indexer, Ranking, Vector Space Model	Cuts Of The Distributed Computation	Object Replication Problems
S-7	SLO-1	Economic And Political Aspects	Map Reduce Example	Classification, Measuring Retrieval Performance	Past And Future Cones Of An Event	Message Ordering Paradigms
	SLO-2	Green Information Technology	Scaling With Map Reduce	Clustering, Web Structure Mining	Models Of Process Communications	Asynchronous Execution With Synchronous Communication
S-8	SLO-1	Cloud Economics	Server Failure, Programming Model Of Map Reduce	Enterprise Search, Multimedia Search, Collective Intelligence	Framework For A System Of Logical Time With Clocks	Synchronous Program Order On A Synchronous System
	SLO-2	Outsourced , Managed And Services In The Cloud	Apache Hadoop	Tagging, Recommendation And Collective Intelligence In The Enterprise	Scalar Time, Vector Time And Efficient Implementation Of Vector Clocks	Group Communication And Causal Order
S-9	SLO-1	Total Cost Of Ownership	A Brief History Of Hadoop	Personalization, Crowd Sourcing	Jard-Jourdans Adaptive Technique	Total Order And Multicast
	SLO-2	Categories Of Cost Efficiencies	Amazon Elastic Map Reduce	Text Visualization	Matrix And Virtual Time	Propagation Trees For Multicast

Learning Resources	1. Richard Hill, Laurie Hirsch, Peter Lake, And Siavash Moshiri, Guide To Cloud Computing And Practice, 2 nd Edition, Springer Verlag, 2013.	2. Ajay D Kshemkalyani And Mukesh Singhal, "Distributed Computing – Principles, Algorithms And Systems," 2 nd Edition, Cambridge University Press, 2008.
		3. Dan C. Marinescu, "Cloud Computing Theory And Practice", 2 nd Edition, Elsevier Press, 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 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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2. Dr. Madan Kumar Lakshmanan, Senior Scientist, CEERI, Imadank@gmail.com	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	2. Dr. Vivek Maik, SRMIST

Course Code	18ECE355T	Course Name	DESIGN OF CYBER PHYSICAL SYSTEM	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18ECE253T	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:			Learning			Program Learning Outcomes (PLO)																																		
CLR-1:	Able to understand the design of human in the loop cyber physical systems			1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15																				
CLR-2:	Design knowledge of energy cyber physical systems			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																				
CLR-3:	Learn how Symbolic synthesis for cyber physical systems works																					L	M	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CLR-4:	Design principles of Intelligent wireless sensor networks in cyber physical systems																					L	M	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-5:	Through simple hands on exercise learn and implement humans in the loop software																					L	M	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-6:	Learn overall procedural and functional steps involved in design of cyber physical systems																					L	M	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-6:	Learn overall procedural and functional steps involved in design of cyber physical systems																					3	70	70	-	-	H	-	M	-	-	-	M	-	-	M	H	L	-	-	-

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:			2,3	70	70	L	M	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-1:	Able to design the cyber physical systems with Industry 4.0 standards			2,3	70	70	L	M	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2:	Able to design wireless sensor systems using intelligent methods			2,3	70	70	L	M	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3:	Implement different practical cyber physical systems with minimal supervision			2,3	70	70	L	M	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-4:	Develop Deep Understanding on selection of hardware and software's for designing cyber physical system			2,3	70	70	L	M	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5:	Come up with cost effective, reliable, robust and feasible designs for real world problems			2,3	70	70	L	M	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-6:	Design and implement real time systems and address the problems and limitations			3	90	80	-	-	H	-	M	-	-	-	M	-	-	M	H	L	-	-	-

DURATION (HOUR)	HUMAN IN THE LOOP CYBER PHYSICAL SYSTEMS	ENERGY CYBER PHYSICAL SYSTEMS	SYMBOLIC SYNTHESIS FOR CYBER PHYSICAL SYSTEMS	INTELLIGENT WIRELESS SENSOR NETWORKS IN CYBER PHYSICAL SYSTEMS	HUMANS IN THE LOOP: A SIMPLE HANDS ON	
S-1	SLO-1	The Evolution Of Cyber Physical Systems	Introduction And Motivation	Symbolic Synthesis Introduction And Motivation	Intelligent Systems Motivation And Essentiality	A Sample Behavior Change Intervention App
	SLO-2	Humans As Elements In Cyber Physical Systems	System Description And Operational Scenarios	Basic Techniques Of Symbolic Synthesis	Wireless Sensor Networks	The Sample App's Base Architecture
S-2	SLO-1	Human Sensing And Virtual Communities	Key Design Drivers And Quality Attributes	Problem Definition And Solving The Synthesis Problem	Deployment Of Wireless Sensor Networks In Cyber Physical Systems	The Android App And Server Set Up
	SLO-2	Taxonomies For Human In The Loop CPS	Key Design Drivers And Quality Attributes	Problem Definition And Solving The Synthesis Problem	Deployment Of Wireless Sensor Networks In Cyber Physical Systems	Enhancing The Sample App With Human In The Loop Emotion Awareness
S-3	SLO-1	Humans As Set Of Sensors	Key System Principles	Asynchronous Design Primitives	Intelligent Wirelless Sensor Networks	Choosing A Machine Learning Technique
	SLO-2	Humans As Communication Nodes	Performance Objectives In Terms Of Architectural Design	Construction Of Symbolic Models	Comparison Between Wireless And Intelligent Wireless Sensor Networks	Implementing Emotion Awareness
S-4	SLO-1	State Inference And Human Nature	A Possible Way Forward Cyber Paradigm For Sustainable Socio Ecological Energy Systems	Construction Of Symbolic Models	Information Security And Cyber Physical Systems	Installing Android Studio
	SLO-2	Humans As Processing Nodes	Physics Based Composition Of CPS For An Socio Ecological Energy Systems	Advanced Techniques For Construction Of Symbolic Models	Attacks And Vulnerabilities In Cyber Physical System	Cloning The Android Project
S-5	SLO-1	Humans As Processing Nodes	Physics Based Composition Of CPS For An Socio Ecological Energy Systems	Advanced Techniques For Construction Of Symbolic Models	Attack Resilient Design	Deploying The Server Protocols
	SLO-2	Actuation In CPS	Dymonds Based Standards For CPS Of An Socio Ecological Energy Systems	Continuous Time Controllers And Software Tools	Attack Resilient Design Examples	Installing The Software And Cloning The Server's Project

S-6	SLO-1	Humans And Robots As Actuators	Dymonds Based Standards For CPS Of An Socio Ecological Energy Systems	Controller Timing And Control Design For Resource Efficiency	Example Application With Distinct Intelligence Level	Setting Up The Database And Deploying The Server On Tomcat
	SLO-2	Powerline Communication	Dymonds Based Standards For CPS Of An Socio Ecological Energy Systems	Computational Complexity And Time Reduction	Example Application With Smart Grid	Handling Emotions On The Server
S-7	SLO-1	Technologies For Supporting Humans In Loop CPS	Interaction Variable Based Automated Modeling And Control	Less Frequent Sampling And Event Based Control	Example Application With Smart Field Monitoring	Creating The Web Interface
	SLO-2	Technologies For Supporting Humans In Loop CPS	It Enabled Evolution Of Performance Objectives	Controller Software Structures	Example Application With Variant Smartness	Creating The Servers Background Thread
S-8	SLO-1	Human In Loop Application Examples	It Enabled Evolution Of Performance Objectives	And Sharing Of Computing Resources	CASE STUDY: Smart Space Systems	Processing Incoming Emotions
	SLO-2	Human In Loop Industry Examples	Distributed Optimization	Analysis And Simulation Of Feedback Control Systems	CASE STUDY: Smart Space Systems	Handling New Emotion Interferences
S-9	SLO-1	Human In Loop Healthcare Examples	Distributed Optimization	Analysis And Simulation Of Feedback Control Systems	CASE STUDY: Smart City Systems	Providing Positive Reinforcement
	SLO-2	Human In Loop Smartphone And Social Networking	Summary And Open Challenges	Analysis And Simulation Of Feedback Control Systems	CASE STUDY: Smart City Systems	Creating A Motivational Dialog Box

Learning Resources	1. David Nunes, Jorge Sa Silva, And Fernando Boavida, A Practical Introduction To Human-In-The-Loop Cyber Physical Systems, 1 st Edition, Wiley & IEEE PRESS, 2018.	2. Sherali Zeadally And Nafaa Jabeur, "Cyber Physical System Design With Sensor Networking Technologies," 1 st Edition IET Press, London, 2016.
		3. Raj Rajkumar, Dionisio De Niz, And Mark Klein, "Cyber Physical Systems" , 1 st Edition, Addison Wesley Publishers, 2017.

Learning Assessment											
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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 %	

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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	18ECE356T	Course Name	MOBILE CYBER PHYSICAL SYSTEM	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18ECE250T	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:			Learning			Program Learning Outcomes (PLO)																																	
CLR-1:	Learn Mobile Cyber Physical System Concepts			1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15																			
CLR-2:	Understand Mobile System Design For Embedded Applications			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																			
CLR-3:	Design and understand green cloud computing																					H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CLR-4:	Understand security and privacy threats in mobile networking																					-	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-5:	Develop Deep Understanding On IoT and ubiquitous computing																					-	M	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	H
CLR-6:	Gain Overall Understand Of The Real Time Systems For Industrial Applications																					-	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-6:	Gain Overall Understand Of The Real Time Systems For Industrial Applications																					-	M	-	-	-	-	-	-	-	-	-	-	-	-	-	M	-	-	-

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:			1	80	70	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-1:	Understand the architecture of mobile cyber physical system			1	75	70	-	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2:	Design Mobile Cloud computing communication systems			3	75	70	-	M	H	-	-	-	-	-	-	-	-	-	-	-	-	H
CLO-3:	Implement different practical real time systems with minimal supervision			3	75	70	-	M	H	-	-	-	-	-	-	-	-	-	-	-	-	H
CLO-4:	Develop Deep Understanding on selection of hardware and software's for designing mobile cyber physical systems			1	70	70	-	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5:	Come up with cost effective, reliable, robust and feasible designs for real world problems			2	70	70	-	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-6:	Design and implement real time systems and address the problems and limitations																					

DURATION (HOUR)	MOBILE CLOUD COMPUTING	GREEN CLOUD COMPUTING AND RESOURCE ALLOCATION	SECURITY AND PRIVACY THREATS	WEB SERVICES	IOT and UBIQUITOUS COMPUTING
S-1	SLO-1	Introduction, fundamental components	Green cloud computing	Features of security and privacy issues in mobile clouds	Introduction to service oriented architecture
	SLO-2	Mobile computing	Dimensions in algorithms of green clouds	Main security and privacy problems	Radio frequency identification technology
S-2	SLO-1	Wireless networks	Creating an algorithm for green clouds	Data over collection problems	Wireless sensor networks technology
	SLO-2	Main Techniques in Cloud Computing	Sample Energy Aware Scheduling Algorithm	Data / Privacy Control Problems	Sensor Technology
S-3	SLO-1	Mobile cloud computing architecture	Preemptable algorithm execution in mobile cloud systems	Trust management problems	Sensor networks
	SLO-2	Mobile cloud computing architecture	Structure of cloud resource allocation mechanisms	Multi tenancy problems	Wireless sensor networks
S-4	SLO-1	Hybrid cloud resource manager	Steps of cloud resource allocation mechanisms	Threat taxonomy	Powerline communication
	SLO-2	Manipulations of Cloud Resource Manager	Messaging Methods: Push Pull	Confidentiality, Integrity and Availability	IOT and Powerline Communication
S-5	SLO-1	Optimization Mechanisms of Hybrid Cloud Computing	Concept of Resource Allocation Model in Cloud Computing	Massive Data Mining	Ubiquitous Computing
	SLO-2	Security Challenges and Solutions in Mobile Clouds	Resource Allocation Algorithms in Cloud Computing	Attach Interfaces Auditability Forensics and Legal Issues	Ubiquitous Computing Properties
S-6	SLO-1	Security Challenges and Solutions in Mobile Clouds	Round Robin Algorithm	Threat Models Basic Concepts	Tagging Sensing and Controlling

	SLO-2	Optimization of Data Processing and Storage in Mobile Clouds	Round Robin Algorithm Example	Insider Threats – Service Side and Customer Side	Web Service Business Process Execution Language	Tagging Sensing and Controlling
S-7	SLO-1	Cloud computing performance	Cloud list scheduling algorithm	Outsider threats – attack methods and goals	Web service security and specifications	Autonomous systems in ubiquitous computing
	SLO-2	Two technical dimensions	Cloud list scheduling algorithm example	Crucial issues in outsider threats	Ws-security framework	Autonomous systems in ubiquitous computing
S-8	SLO-1	Basic task scheduling method	Min-min scheduling algorithm	Crucial security dimensions	Big data and service computing	Smart devices: components and services
	SLO-2	Basic task scheduling method	Min-min scheduling example	Infrastructure security	Overview of big data	CASE STUDY: Digital Manufacturing / Industry 4.0: The Hannover Centre For Production Engineering (Pzh) Approach.
S-9	SLO-1	Example of Evaluation Modelizations	CASE STUDY: Project Example on Green Cloud Computing and Resource Allocation	Network, Host and Application Layer	Big Data Processing	CASE STUDY: Digital Manufacturing / Industry 4.0: The Bosch Software Innovations Approach
	SLO-2	CASE STUDY: Calculate Total Execution Time on Mobile CPS project	CASE STUDY: Project Example on Green Cloud Computing and Resource Allocation	CASE STUDY: Mobile Data Security and Storage, Identity and Access Management	CASE STUDY: Phase Reconfigurable Shuffle Optimization	CASE STUDY: Digital Manufacturing / Industry 4.0: The US Digital Manufacturing and Design Innovation Institute Approach

Learning Resources	1. Meikang Kiu, "Mobile Cloud Computing – Models, Implementation And Security" 5 th Edition, CRC Press, 2015.	2. Dietmar P.F. Moller, "Computing Fundamentals In Cyber Physical Systems." 1 st Edition, Springer 2015 3. Edward D Lamie, "Real Time Embedded Multi Threading" , 2 nd Edition, Newnes Elsevier Publication, 2016.
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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 Semiconductor, abechnai@gmail.com	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu	1. Dr. Vivek Maik, SRMIST
2. Dr. Madan Kumar Lakshmanan, Senior Scientist, CEERI, lmadank@gmail.com	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	

B. Tech in Electronics and Communication Engineering
(with specialization in Cyber Physical System)

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
CLO-1 :	To cover the various forms of signals used for information transmission and modulation, and overall wireless system properties.
CLO-2 :	To present various component types that can be used to implement a short-range radio system.
CLO-3 :	To describe the various kinds of transmitters and receivers.
CLO-4 :	To covers regulations and standards of ISM band communications
CLO-5 :	To covers some of the most important new developments in short-range radio like UWB and Visible light.

Learning	Program Learning Outcomes (PLO)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Level of Thinking (Bloom)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Expected Proficiency (%)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Expected Attainment (%)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Engineering Knowledge	L	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Problem Analysis	-	-	M	L	-	-	-	-	-	-	-	-	-	H	-
Design & Development	-	-	H	M	-	-	-	-	-	-	-	-	-	H	-
Analysis, Design, Research	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
Modern Tool Usage	-	-	L	M	-	-	-	-	-	-	-	-	-	-	H
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	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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 UMa 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, Measurements				
	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

<ol style="list-style-type: none"> Alan Bensky, "Short range Wireless Communications-Fundamentals of RF system design and Applications", Elsevier Inc, 2004 Antti V. Raisanen, Arto Lehto, "Radio engineering for wireless communication and sensor applications", Artech House, 2003 	<ol style="list-style-type: none"> Rolf Kraemer and Marcos Katz, "Short-range wireless communications emerging technologies and applications", Wiley WWRP series, March 2009 Shlomi Arnon, John Barry, George Karagiannidis, Robert Schober, Murat Uysal, "Advanced Optical Wireless Communication Systems", Cambridge University Press, 2012
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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.ani@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:	Learning			Program Learning Outcomes (PLO)																	
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
CLR-1:	Provide a basis for understanding semiconductor material, how a pn junction is formed and its principle of operation	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-2:	Describe the basic structure, operation and characteristics of transistors BJTs and FETs, and discuss their use as a switch and an amplifier				L	L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-3:	Learn the basics of op-amp: the principle, operation, characteristics and fundamentally important circuits				L	L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-4:	Describe and analyze the basic operation of sinusoidal oscillators and use a 555 Timer in an oscillator application.				L	L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-5:	Learn the fundamentals of analog and digital communication, networking, radio transmission and mobile telephones				L	L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-6:	Encourage the learner to assemble and test real circuits in the laboratory				L	L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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	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
	SLO-2					
S-4	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					
S-5	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	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-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	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-2					
	SLO-2					

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

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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. Rajesh Agarwal, SRM IST

Course Code	18ECO103T	Course Name	MODERN WIRELESS COMMUNICATION SYSTEM	Course Category	0	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

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
2,3	80	75	-	-	-	H	-	-	-	-	-	-	-	-	H	-	-
2,3	80	85	-	-	-	H	-	-	-	-	-	-	-	-	-	-	H
2,3	85	85	-	-	-	H	-	-	-	-	-	-	-	-	M	-	H
2,3	85	80	-	-	-	H	-	-	-	-	-	-	-	-	M	-	H
2,3	85	80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	H
2,3	85	80	-	-	-	-	-	-	-	-	-	-	-	-	H	-	-

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:
CLO-1 :	Discuss the fundamentals of transmission in wireless systems
CLO-2 :	Provide an overview of various approaches to communication networks
CLO-3 :	Study the numerous different-generation technologies with their individual pros and cons
CLO-4 :	Discuss about the principles of operation of the different access technologies like FDMA, TDMA, SDMA and CDMA and their pros and cons.
CLO-5 :	Learn about the various mobile data services and short range networks.
CLO-6 :	Gain knowledge on Fundamentals, Techniques and Networks of Wireless Communication Systems

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	<ol style="list-style-type: none"> 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 Doman, "The essential guide to wireless communications applications: from cellular systems to Wi-Fi", 2nd Edition, Prentice Hall, 2002 	<ol style="list-style-type: none"> 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 Understand	30 %	-	30 %	-	30 %	-	30 %	-	30%	-
Level 2	Apply Analyze	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
Level 3	Evaluate Create	30 %	-	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, kumaranjani@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

Learning	Learning		
	1	2	3
Level of Thinking (Bloom)			
Expected Proficiency (%)	90	85	68
Expected Attainment (%)	68	67	68

	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															

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:
CLO-1 :	Understand the functioning of the human vocal and auditory systems in terms of signal processing
CLO-2 :	Analyze the function of feature extraction in speech and audio signal processing using Time Domain Characteristics
CLO-3 :	Understand the frequency characteristics of speech signal
CLO-4 :	Understand the Digital models for speech signal
CLO-5 :	Understand the elements of music
CLO-6 :	Understand Speech signal processing in time and frequency domain and their models.

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	
S-4	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	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
	SLO-2					
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	Lab 3: Cepstrum smoothed magnitude spectrum	Lab 6: (i) Linear prediction magnitude spectrum, (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
	SLO-2					
S-12	SLO-1					
	SLO-2					

Learning Resources	1. Ian McLaughlin, "Applied Speech and Audio processing, with MATLAB examples", 1 st Edition, Cambridge University Press, 2009	3. Rabiner, B.H. Juang, "Fundamentals of Speech Recognition", 2 nd Edition, Prentice-hall Signal Processing Series, April 1993
	2. Ben Gold, Nelson Morgan, Dan Ellis, Wiley, "Speech and Audio Signal Processing: Processing and Perception of Speech and Music", 2 nd Edition, John Wiley & Sons, 01-Nov-2011.	4. Ken Pohlmann, "Principles of Digital Audio", 6 th 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		
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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. Mrs. K. Harisudha, SRMIST

S-5	SLO-1	Noise, Reverberation	Sounds in the oceans-natural physical sounds and biological sounds	Noise-Ambient noise models	Electrostatic 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 Water, 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	1. Richard P HODGES, "Underwater Acoustics – Analysis, Design and Performance of SONAR", Wiley 1 edition 2010, ISBN 978-0-470-68875-	4. 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
	2. Rodney F W Coates, "Underwater Acoustics Systems", Macmillan New Electronics, Wiley, 1 st edition, 1990, ISBN 978-0-333-42542-8	5. Qihu Li, "Digital Sonar Design in underwater acoustics: Principles and applications", Springer, Zhejiang University Press, 2012
	3. Robert S H Istepanian and Milica Stojanovic, "Underwater Acoustic Digital Signal Processing and Communication Systems", Springer, 2002 edition, ISBN 978-1-4419-4882-3	6. 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.,

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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	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:			Program Learning Outcomes (PLO)																		
CLR-1 :	Explore the terminologies of PCB design and Electronic components.	1	2	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15				
CLR-2 :	Understand the design and other consideration involved in PCB design	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-3 :	Understand the PCB design consideration for special application circuits				H		L															
CLR-4 :	Design a PCB layout using CAD tool				M		L															
CLR-5 :	Explore various PCB manufacturing techniques				M		L			M	H											
CLR-6 :					L		L			H												

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:			
CLO-1 :	Identify the various types of PCB and electronics components packaging	1	80	70
CLO-2 :	Select suitable design and consider appropriate parameters involved in PCB design	1,2	80	70
CLO-3 :	Apply the appropriate design rules in designing PCB for special application circuits	1,2	80	70
CLO-4 :	Design and develop a PCB layout using CAD tool	1,2, 3	80	70
CLO-5 :	Identify and select the required PCB manufacturing technology	1,2, 3	80	70
CLO-6 :				

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	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.
S-4	SLO-2					
S-4	SLO-1					
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		Design and analysis of RLC circuits. Schematic in CAD tool	Schematic and PCB Layout in CAD tool.		Mini Project - Manufacture the PCB for electronic turn ON/OFF timer using
	SLO-2					

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

Learning Resources	1. Raghbir Singh Khandpur, "Printed Circuit Boards: Design, Fabrication, and Assembly" McGraw-Hill Electronic Engineering, 2006.	5. Douglas Brooks "Signal Integrity Issues and Printed Circuit Board Design", Prentice Hall PTR, 2003.
	2. Charles A. Harpe, "High Performance Printed Circuit Boards", McGraw Hill Professional, 2000.	6. Mark I. Montrose "Printed Circuit Board Design Techniques for EMC Compliance : A handbook for designers" Wiley, 2 Edition, 2015.
	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.	7. Esim open source tool : http://esim.fossee.in/
	4. Kraig Mitzner, "Complete PCB Design Using OrCAD Capture and PCB Editor", Newnes/Elsevier, 2009.	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.,

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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	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):		Learning			Program Learning Outcomes (PLO)																																	
CLR-1:		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15																			
Analyze the basic laws and theorems of light associated with the optical fiber communication and the classification of optical fibers		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-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):		Learning			Program Learning Outcomes (PLO)																																	
CLO-1:		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15																			
At the end of this course, learners will be able to:		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																				H	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CLO-2: Understand the optical signal distortion factors in optical fiber communication																				H	-	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	M
CLO-3: Familiarize the principle and operation of various display devices, light sources and detectors																				H	M	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	L
CLO-4: Acquire knowledge of various optoelectronic modulators and amplifiers																				H	-	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	H
CLO-5: Understand the various optoelectronic integrated circuits																				H	-	M	L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	L
CLO-6: Acquire fundamental concepts related to optical communication and optoelectronic devices		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 – External quantum efficiency and total LED power	Optical switching and logic devices-tunable threshold logic gate – Switching speed and energy.	Integrated transmitters and receivers – 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	<ol style="list-style-type: none"> Gerd Keiser, "Optical Fiber Communications", 5th Edition, McGraw Hill Education (India), 2015. Khare R P, "Fiber Optics and Optoelectronics", Oxford University Press, 2014. 	<ol style="list-style-type: none"> J. Wilson and J. Hawkes, "Optoelectronics – An Introduction", Prentice Hall, 1995. Pallab Bhattacharya, "Semiconductor Optoelectronic Devices", Prentice Hall of India Pvt. Ltd, 2006.
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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, kumaranj.ani@gmail.com	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu	1. Dr. S. Sathiyam, 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	0	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:			Learning			Program Learning Outcomes (PLO)															
CLR-1 :	CLR-2 :	CLR-3 :	CLR-4 :	CLR-5 :	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Get to know about ARDUINO hardware details and environment	To understand the core elements of ARDUINO programming language	Create insights to the concepts of serial communication	To use common input and output devices	Apply the ARDUINO programming into real time applications	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	
					2	80	70	H		-	-	-	-	-	-	-	-	-	-	-	-	H	H
					2	85	75	H	H	H	H	H	-	-	-	H	-	H	-	-	-	H	H
					2	75	70	H	-	H	H	H	-	-	-	H	-	H	-	-	H	H	-
					2	85	80	H	H	H	H	H	-	-	-	H	-	H	-	-	H	H	-
					2	85	75	H	-	H	H	H	-	-	-	H	-	H	-	-	H	H	-

Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:		
CLO-1 :	Analyze the programming skill	2	80	70
CLO-2 :	Apply the real time data's into digital	2	85	75
CLO-3 :	Interact with almost many devices	2	75	70
CLO-4 :	Learn techniques to handle timer delays and IO devices	2	85	80
CLO-5 :	Use and modifying the existing libraries	2	85	75
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,1 st 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
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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.,

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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	18ECO109J	Course Name	EMBEDDED SYSTEM DESIGN USING RASPBERRY PI	Course Category	0	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	Program Learning Outcomes (PLO)																
CLR-1 :	Understanding the programming of python for Raspberry Pi	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	Applying python programming on GPIO and interfacing motors using Raspberry Pi	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-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:																			
CLO-1 :	Apply python for Raspberry Pi	2	80	70	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.	3. Colin Dow, "Internet of Thing: Programming Projects - Build modern IoT solutions with the Raspberry Pi 3 and Python", packtpub 2018.
	2. Volker Ziemann, "A Hands-On Course in Sensors Using the Arduino and Raspberry Pi, CRC Press, 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	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	



SRM
 INSTITUTE OF SCIENCE & TECHNOLOGY
 (Deemed to be University u/s 3 of UGC Act, 1956)

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:	Learning			Program Learning Outcomes (PLO)															
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
CLR-1:	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:	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
	SLO-2				Workflows for printing
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)
	SLO-2				Software and Drivers - Formats for Printing (SLA, OBJ, CAD, etc.)
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
	SLO-2				Post and Export Print Lab setup
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)
	SLO-2				Cleanup and airtight modeling
S-6	SLO-1	Best Practices for constructing printable polygon meshes			Laminated Object Manufacturing (LOM) - Electron Beam Melting (EBM)
	SLO-2	Fundamental Structure - Combining, merging, and sewing up polygon meshes	Interfacing, support, and reinforcement	Knowing the product	Loading models and arranging print stage

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	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	State table				
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	6. 3D Anatomy Models: http://lifesciencedb.jp/bp3d/?lng=en
	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.	8. International Journal of Rapid Manufacturing
	4. https://web.stanford.edu/class/me137/	9. Academic Journals on 3D Printing
	5. SolidWorks Gallery: http://www.3dcontentcentral.com/default.aspx	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.ani@gmail.com	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meenak68@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			Program Learning Outcomes (PLO)																		
CLR-1 :	Analyze the scopes and roles of Biomedical Engineering			1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15				
CLR-2 :	Utilize biomedical instrumentation modules			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 Enron. & Medicine.	PSO-2: Design & Develop Medical Devices	PSO-3: multidisciplinary research for health care soln.				
CLR-3 :	Utilize medical imaging principles and its applications						-	-	-	-	-	-	-	-	-	-	-	-	-	-	L	-	-	L	
CLR-4 :	Analyze the scope of biomechanics and its applications						L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-5 :	Utilize biomaterials and its applications						M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-6 :	Gain the knowledge about Biomedical Engineering						L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-6 :	Gain the knowledge about Biomedical Engineering						M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	L	-	-	L
Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:			2	85	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
CLO-1 :	Analyze the areas in which biomedical engineers can work			3	85	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
CLO-2 :	Analyze the basic biomedical instrumentation unit			3	85	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
CLO-3 :	Analyze basic medical imaging principles			3	85	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
CLO-4 :	Apply the concepts of biomechanics on human body			3	85	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
CLO-5 :	Identify domains where biomedical engineers can work			3	85	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
CLO-6 :	Analyze the applications of Biomedical Engineer			3	85	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			

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	<ol style="list-style-type: none"> 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 	<ol style="list-style-type: none"> 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
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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		
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2. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.ani@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			Program Learning Outcomes (PLO)																		
CLR-1 :	Utilize the planning and organizational activities of Hospitals	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15				
CLR-2 :	Analyze the concepts in clinical and diagnostic services	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 soln				
CLR-3 :	Utilize the policies and procedures about support services and material management				L	-	-	-	-	M	-	-	-	-	-	-	-	-	-	L	-	-	
CLR-4 :	Utilize the features in staff and safety management in hospital				M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	L	-	-
CLR-5 :	Analyze the reporting system and recent advancement in hospital administration				M	-	-	-	-	-	-	M	-	-	L	-	-	-	-	-	L	-	L
CLR-6 :	Apply all the advanced application the field of telemedicine				L	-	-	-	-	-	-	M	-	-	L	L	-	-	-	-	L	L	L
CLR-6 :	Apply all the advanced application the field of telemedicine				L	-	-	-	-	-	-	M	-	-	-	-	-	-	-	-	L	-	-

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	2	85	75
CLO-1 :	Analyze the role of hospitals and ensure proper healthcare delivery	3	85	75
CLO-2 :	Suggest appropriate technologies and services in clinical and diagnostic field	3	85	75
CLO-3 :	Analyze the supportive services and the use of proper material management	3	85	75
CLO-4 :	Identify objectives of staff management and ensure safety management in hospitals	3	85	75
CLO-5 :	Implement the advance technologies and effectively evaluate the healthcare information	3	85	75
CLO-6 :	Implement the various standards in hospital and healthcare services	3	85	75

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 formulary 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/In-door 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, 1 st ed., Elsevier, 2014	2. Sakharkar B M, Principles of hospital administration and planning, 2 nd ed., Jaypee Brothers Medical Publishers, 2009 3. Kunders G D, Hospitals: Facilities planning and management, 1 st ed., Tata Mcgraw Hill, 2008
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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%	-
Level 2	Understand	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
	Apply	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
Level 3	Analyze	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Evaluate	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	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		
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2. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.ani@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			Program Learning Outcomes (PLO)																	
CLR-1:	Utilize the working principle of X-ray imaging	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
CLR-2:	Analyze the principle behind tomographic imaging and the reconstruction techniques	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 Elec. & Medicine	PSO-2: Design & Develop Medical Devices	PSO-3: multidisciplinary research for health care.			
CLR-3:	Interpret the theory behind nuclear medicine and utilize the working of imaging modalities in nuclear medicine				M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLR-4:	Analyze the physics of ultrasound and the different imaging modes using ultrasound				M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLR-5:	Utilize the physical principle of nuclear magnetic resonance and magnetic resonance image reconstruction				M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	M	-	-
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.				M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	M	-	-

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	2	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-1:	Analyze the physics and principle behind the working of X-ray imaging	3	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, 3 rd ed., Tata McGraw Hill, 2014	2. Jerrold T. Bushberg, John M. Boone, The essential physics of medical imaging, 3 rd ed., Lippincott Williams & Wilkins, 2011
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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 %	

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Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Sathyanarayanan J, Mindray Medical India Pvt Ltd, sathyanarayananjvagoopal@mindray.com	1. Dr. S. Poonguzhali, Anna University, poongs@annauniv.edu	1. Dr. T. Jayanthi, SRMIST
2. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.ani@gmail.com	2. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu	2. Dr. U. Snehalatha, 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):	<i>The purpose of learning this course is to:</i>	Learning	Program Learning Outcomes (PLO)																				
CLR-1 :	<i>Utilize the latest technology and device used for assisting human disability</i>	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15				
CLR-2 :	<i>Analyze various devices used for mobility</i>	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 Elec. & Medicine	PSO-2: Design & Develop Medical Devices	PSO-3: multidisciplinary research for health care soln.				
CLR-3 :	<i>Utilize the various assist device used for hearing</i>				M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	M	-	-	
CLR-4 :	<i>Utilize the various assist device used for vision</i>				M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	L	-	-
CLR-5 :	<i>Utilize the various assist device used in orthopaedic</i>				M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	M	L	-
CLR-6 :	<i>Analyze the working principles of cardiac assist devices and Artificial kidney</i>				M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	M	-	-

Course Learning Outcomes (CLO):	<i>At the end of this course, learners will be able to:</i>	2	85	75
CLO-1 :	<i>Comprehend the assistive technology (AT) used for mobility</i>	3	85	75
CLO-2 :	<i>Analyze the Assist technology used for hearing</i>	3	85	75
CLO-3 :	<i>Evaluate the Assist technology used for sensory impairment of vision</i>	3	85	75
CLO-4 :	<i>Evaluate the assist device used in orthopedic</i>	3	85	75
CLO-5 :	<i>Analyze the latest use of assist technology in health care</i>	3	85	75
CLO-6 :	<i>Design the prosthetic heart valves and pacemaker</i>	3	85	75

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

	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. <i>Advances in Bio-medical engineering and Medical physics</i> , 1 st ed., Vol. I, II, IV, <i>Interuniversity publications</i> , 1968.	6. Albert M.Cook, Webster J.G. <i>Therapeutic Medical Devices</i> , Prentice Hall Inc., 1982
	2. Marion. A. Hersh, Michael A. Johnson, <i>Assistive Technology for visually impaired and blind</i> , 1 st ed., Springer Science & Business Media, 2010	7. Gerr .M. Craddock <i>Assistive Technology-Shaping the future</i> , 1 st ed., IOS Press, 2003
	3. Kopff W.J. <i>Artificial Organs</i> , 1 st ed., John Wiley and Sons, 1976	8. Brownsell, Simon, et al., A systematic review of lifestyle monitoring technologies, <i>Journal of telemedicine and telecare</i> 17.4 (2011): 185-189
	4. Daniel Goldstein, Mehmet Oz, <i>Cardiac assist Devices</i> , Wiley, 2000	9. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph.D, Bronzino, <i>Clinical Engineering</i> , 1 st ed., CRC Press, 2010
	5. Kenneth J. Turner, <i>Advances in Home Care Technologies: Results of the match Project</i> , 1 st ed., Springer, 2011	10. Pascal Verdonck, <i>Advances in Biomedical Engineering</i> , 1 st 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%	-
Level 2	Understand	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
	Apply	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
Level 3	Analyze	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Evaluate	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	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. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.ani@gmail.com	2. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu	2. Dr. U. Snehalatha, 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	Program Learning Outcomes (PLO)																				
CLR-1 :	Utilize Quality, Quality control measures essential for an organization	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15				
CLR-2 :	Utilize the quality management principles and good management practices	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 soln.				
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				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-6 :	Implement the global standards in healthcare				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	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 soln.	
CLO-1 :	Analyze the underlying concepts of quality and quality control concepts of an organization	2	85	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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	4. Joseph J.Carr, Elements of Electronics Instrumentation and Measurement, 2 nd ed., Pearson Education, 2003
	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	

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
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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)																
CLR-1 :	Understand the fundamental muscle action and locomotion in biomechanical point of view			1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
CLR-2 :	Get an idea about the movement patterns and causes of movements			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 Econ. & Medicine	PSO-2: Design & Develop Medical Devices	PSO-3: multidisciplinary research for health care solu.		
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																
CLO-2 :	Analyze the movement patterns and its causes			1,2	80	70	M																
CLO-3 :	Describe the Qualitative and Quantitative analysis of sports movements			2	80	70	M																
CLO-4 :	Analyze the movement of action such as jumping, throwing, hitting and aerial movement			2	80	70			L														
CLO-5 :	Identify the injury scenario and special Olympic sports			2	80	70																	
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
	SLO-2	Applications of Biomechanics	Defining human movements	A structured analysis framework	Mechanisms of Musculoskeletal Injury
S-2	SLO-1	Neural Contributions to Changes in Muscle Strength	Fundamental movements-Walking, Running	Preparation stage	Musculoskeletal Loading During Landing
	SLO-2	Mechanical Properties and Performance in Skeletal Muscles	Fundamental movements-Throwing, Jumping	Observation stage	Sport-Related Spinal Injuries and their Prevention
S-3	SLO-1	Muscle-Tendon Architecture	qualitative and quantitative movement	Evaluation and diagnosis stage	Sport-Related Spinal Injuries and their Prevention
	SLO-2	Athletic Performance	Comparison of qualitative and quantitative movement analysis	Intervention stage – providing appropriate feedback	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	Techniques of Jumping - Skating, Springboard and Platform Diving
	SLO-2	Stretch-Shortening Cycle of Muscle Function	Fundamentals of movement	Identifying critical features of a movement	Determinants of Successful Ski-Jumping Performance
					Neuromechanics of the Initial Phase of Eccentric Contraction
					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 movements	Principles of Throwing	Manual Wheelchair Propulsion
	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	Biomechanics 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	3. Jules Mitchell, "Yoga Biomechanics", 1 edition, Handspring Publishing Limited, 2018
	2. Vladimir M. Zatsiorsky, Biomechanics in Sports: Performance Enhancement and Injury Prevention, 1st ed., Blackwell Science Ltd, 2000	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%	-
Level 2	Understand	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
	Apply	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
Level 3	Analyze	20 %	-	20 %	-	20 %	-	30 %	-	30%	-
	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.,

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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			Program Learning Outcomes (PLO)																			
CLR-1 :	Study the concepts of Virtual instrumentation and to learn the programming concepts in VI.			1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15					
CLR-2 :	Study about the various real time data acquisition methods.			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					
CLR-3 :	Study about the various Instrument Interfacing concepts.						H																			
CLR-4 :	To study the programming techniques for various control techniques using VI software						H	H	H	H	H															
CLR-5 :	To study various analysis tools for Process control applications.						H	H	H	H	H															
CLR-6 :	To study various real time measurement systems						H	H	H	H	H							H	H	H	H	H	H	H		
							2	85	75																	

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:																						
CLO-1 :	An ability to understand the purpose of virtual instrumentation and understand the construction of VI			1,2	80	70																	
CLO-2 :	An ability to understand and apply various data acquisition methods.			2	85	75																	
CLO-3 :	An ability to understand and implement the available interfacing instruments			2	75	70																	
CLO-4 :	An ability to understand and implement various control techniques using VI software			2,3	85	80																	
CLO-5 :	An ability to understand and develop a program for an engineering application.			2,3	85	75																	
CLO-6 :	An ability to understand and implement various measurement systems			2,3	80	70																	

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 Palettes	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 LabVIEW 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: Arbitrary 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 LabVIEW 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	4. Jamal, R., Picklik, H., Labview – Applications and Solutions, National Instruments Release.
	2. Bitter, R., Mohiuddin, T. and Nawrocki, M., Labview Advanced Programming Techniques, 2 nd ed., CRC Press, 2007	5. Johnson, G., Labview Graphical programming, McGraw-Hill, 1997
	3. Gupta, S. and Gupta, J. P., PC Interfacing for Data Acquisition and Process Control", 2 nd ed., Instrument Society of America, 1994	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	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
Level 2	Understand	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Analyze	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 3	Evaluate	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	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, prakait@rediffmail.com	1. Dr. K. A. Sunitha, SRMIST
2. V. Venkateswaran, Instrumentation Consultant, venkat99@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	Program Learning Outcomes (PLO)																				
CLR-1 :	Understand the principle and theory of analytical instruments	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15				
CLR-2 :	Understand the quantitative analysis of dissolved components	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				
CLR-3 :	Study the concept of separation science and its applications				H	H	L	L	H	H										H	H	L	
CLR-4 :	Study the various spectroscopic techniques and its instrumentation				H	H	L	L	H	H											H	H	L
CLR-5 :	Identify and solve engineering problems associated with Radiation Techniques				H	H	L	L	H	H											H	H	L
CLR-6 :	Understand the working of Analytical Instrument and their importance in industries				H	H	L	L	H	H											H	H	L
CLR-6 :	Understand the working of Analytical Instrument and their importance in industries				1,2	80	70	H	H	L	L	H	H								H	H	L

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	1,2	80	70	H	H	L	L	H	H								H	H	L
CLO-1 :	Apply the principles and theory of instrumental analysis	1,2	85	75	H	H	L	L	H	H								H	H	L
CLO-2 :	Apply the principles of various chemical analysis instruments in industries	1,2	75	70	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	85	80	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	75	H	H	L	L	H	H								H	H	L
CLO-5 :	To identify and solve engineering problems associated with Radiation Techniques	1,2	80	70	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	NO ₂ 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 ₂ S 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 ₂ S 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	<ol style="list-style-type: none"> 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 Rouessac "Chemical analysis Modern Instrumentation Methods and Techniques", John wiley & sons Ltd. 2007. 	<ol style="list-style-type: none"> 4. James W. Robinson, "Undergraduate Instrumental Analysis", Marcel Dekker., 2005. 5. Dwayne Heard, "Analytical Techniques for atmospheric measurement", Blackwell Publishing, 2006.
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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
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2. V. Venkateswaran, Instrumentation Consultant, venkat99@gmail.com	2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com	Mrs. A. Brindha, SRMIST

Course Code	18ECO133T	Course Name	SENSORS AND TRANSDUCERS			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 Instrumentation Engineering			Data Book / Codes/Standards	Nil

Course Learning Rationale (CLR):		The purpose of learning this course is to:			Program Learning Outcomes (PLO)															
CLR-1 :	Gain knowledge on classification, and characteristics of transducers	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
CLR-2 :	Acquire the knowledge of different types of inductive and capacitive sensors				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 PLO & DCS for control of systems	PSO-3: Effective management skills	
CLR-3 :	Acquire the knowledge of different types of thermal and radiation sensors				H	-	H	-	-	H	H	H	-	-	-	-	H	-	H	-
CLR-4 :	Acquire the knowledge of different types of magnetic sensors				H	-	-	H	-	H	-	-	-	H	H	-	-	H	-	-
CLR-5 :	Acquire the knowledge of different types of sensors measuring non-Electrical quantity				-	-	-	-	-	H	-	-	-	-	-	-	-	-	H	-
CLR-6 :	Locate the Applications of sensors in industries and home appliances				-	-	H	-	H	-	-	H	H	H	-	-	-	H	H	-

Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:		
CLO-1 :	To demonstrate the various types of basic sensors.	2,3	80	80
CLO-2 :	Understand the inductive and capacitive sensors which are used for measuring various parameters.	1,2	80	80
CLO-3 :	Understand the thermal and radiation sensors	1	80	80
CLO-4 :	Have an adequate knowledge on the various magnetic sensors	3	80	80
CLO-5 :	To demonstrate the various types of basic sensors measuring non electrical quantity	3	80	80
CLO-6 :	Select the right transducer for the given application	3	80	80

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.	Magnetostrictive 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 mounting.	Measurement of Vibration.
	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	<ol style="list-style-type: none"> 1. Patranabis, D., "Sensors and Transducers", 2nd Edition, Prentice Hall India Pvt. Ltd, 2010. 2. Doebelin, E.O., "Measurement Systems: Applications and Design", 6th Edition, Tata McGraw-Hill Book Co., 2011. 3. Bentley, J. P., "Principles of Measurement Systems", 4th Edition, Addison Wesley Longman Ltd., UK, 2004. 	<ol style="list-style-type: none"> 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.
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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, prakait@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:	Learning			Program Learning Outcomes (PLO)																	
CLR-1 :	Understand basic components of PLC	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
CLR-2 :	Understand the use of timers and counters in process automation	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			
CLR-3 :	Understand DCS architecture				H	M	L	-	-	-	-	-	-	M	-	M	L	M	L	M	L	M
CLR-4 :	Understand operator and engineering interface in DCS				H	H	H	H	H	-	L	-	H	M	L	L	H	H	H	H	H	H
CLR-5 :	Understand HART signal standard and Field bus				H	M	-	-	-	-	-	-	L	-	-	L	M	L	M	L	M	L
CLR-6 :	Understand Field bus signal standard.				H	H	-	H	-	-	-	-	H	M	-	L	H	L	M	L	M	L
CLR-6 :	Understand Field bus signal standard.				H	-	-	-	-	-	-	-	-	-	L	-	L	H	-	L	H	-

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
CLO-1 :	Select PLC based on I/O's	2,3	80	80	H	M	L	-	-	-	M	-	M	L	M	L			
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	L	M
CLO-5 :	Interpret industrial data communication modes	3	80	80	H	-	-	-	-	-	-	-	L	-	L	H	-	L	L
CLO-6 :	Gain knowledge on field bus	3	80	80	H	L	-	-	-	-	-	-	-	-	-	L	H	-	L

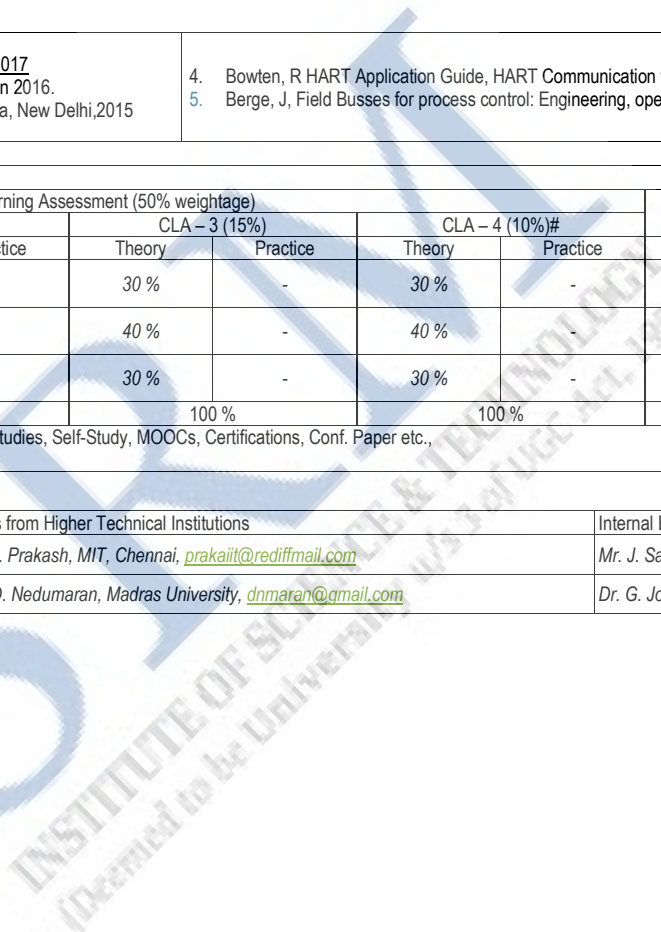
Duration (hour)	9	9	9	9	9
S-1	SLO-1 Programmable logic controllers	PLC Programming Languages	Evolution of DCS	Operator Interfaces Requirements	Introduction to HART
	SLO-2 PLC vs Computer	Ladder Diagram	Hybrid System Architecture	Process Monitoring	Evolution of Signal standard
S-2	SLO-1 Parts of a PLC	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 Comments: 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, <u>Programmable Logic Controller, Tata McGraw Hill Fifth Edition, 2017</u>	4. Bowten, R HART Application Guide, HART Communication foundation, 2015. 5. Berge, J, Field Busses for process control: Engineering, operation, maintenance, ISA press,2015
	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	

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, prakait@rediffmail.com	Mr. J. Sam Jeba Kumar, SRMIST
2. V. Venkateswaran, Instrumentation Consultant, venkat99@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:	Learning			Program Learning Outcomes (PLO)															
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
CLR-1 :	Understand the importance of micro system technology	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	
CLR-2 :	Learn the operating principle of various micro sensors and actuators	2,3	80%	80%	H	-	-	-	-	H	-	-	-	-	-	-	H	H	-	H
CLR-3 :	Impart the applications of various micro fabrication techniques	1,2	80%	80%	H	-	-	-	-	H	-	-	-	-	-	-	H	-	-	H
CLR-4 :	Understand the differences and need for microfabrication	1	80%	80%	H	-	-	H	-	H	-	-	-	-	-	-	H	H	-	H
CLR-5 :	Operate MEMS design tools to design simple micro devices	3	80%	80%	H	-	-	H	-	-	-	-	-	-	-	-	H	-	-	H
CLR-6 :	Understand recent developments and challenges in MEMS	3	80%	80%	H	-	-	H	-	-	-	-	-	-	-	-	H	H	-	H

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	
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", 22 nd reprint edition, Wiley & sons, 2015 2. M. Madou, "Fundamentals of Micro fabrication", Taylor and Francis group, 2002	3. Vardhan Gardener, "Micro sensors and smart devices", John Wiley & Sons, 2001 4. NPTEL link: https://nptel.ac.in/downloads/112108092/
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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%	-
Level 2	Understand	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
	Apply										
Level 3	Analyze	30 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Evaluate										
	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, prakait@rediffmail.com	1. Dr. A. Vimala Juliet, SRMIST
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 Cyber Physical System)

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

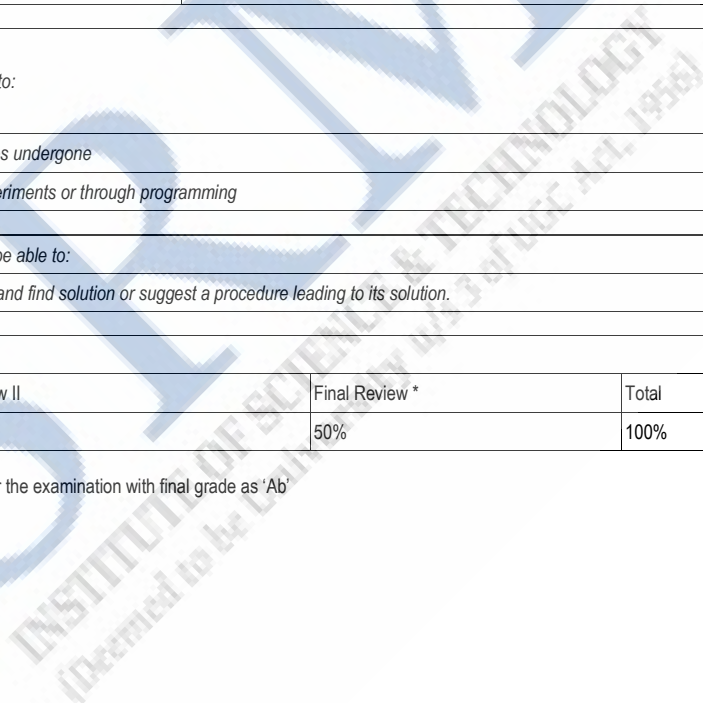
Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	As required for the project work		

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:
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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
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Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:
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CLO-1 :	Gain confidence to carry out supervisory, managerial, and design roles in an industrial context or research environment
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Learning Assessment			
Continuous Learning Assessment	Assessment tool	Final review	
	Weightage	Training Report 75%	Presentation* 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.
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Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:
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CLO-1 :	Carry out a self-study of an area of interest and communicate the same to others with clarity.
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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'



SRM
INSTITUTE OF SCIENCE & TECHNOLOGY
(Deemed to be University by UGC Act 1956)