B. Tech in Electronics and Computer Engineering

1. (a) Mission of the Department

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

1. (b) Program Educational Objectives (PEO)

The Program Educational Objectives for the Electronics and Computer Engineering program describe accomplishments that graduates are expected to attain within five years after graduation. Graduates within 5 years of graduation will / should demonstrate:

PEO – 1	Expertise using their mathematical and scientific knowledge to solve emerging real-world problems, design and create novel products and solutions related to Electronics and Computer System Design that are technically sound, economically feasible and socially acceptable.
PEO – 2	Broad knowledge to establish themselves as creative practicing professionals, locally and globally, in technical/managerial roles ranging from design, development, problem solving to production support in software industries and R&D sectors.
PEO – 3	Communication skills (in both written and oral forms) and critical reasoning skills in bridging the divide between advanced technology and end users in the practice of Electronics and Computer Engineering.
PEO – 4	Sustained learning and adapting to a constantly changing field through graduate work, professional development, self-study and collaborative activities.
PEO – 5	Leadership and initiative to ethically advance professional and organizational goals, facilitate the achievements of others, and obtain substantive results.
PEO – 6	Ability to work productively as individuals and in groups (teamwork) of diverse cultural and multidisciplinary backgrounds.

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

	Mission Stmt. - 1	Mission Stmt. - 2	Mission Stmt. – 3
PEO - 1	L	M	H
PEO - 2	H	L	H
PEO - 3	L	L	M
PEO - 4	M	L	M
PEO - 5	L	H	H
PEO - 6	H	H	H

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

1. (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	Intelligent Computing Systems	Project Management Techniques	New technologies in information and Communication
PEO - 1	H		H			H	M	H			H		H		H
PEO - 2		H	M	H	M								M		M
PEO - 3					L			M		H				M	
PEO - 4												H	L		
PEO - 5						L			M					M	
PEO - 6						M			H					H	L

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

Program Specific Outcomes (PSO)

Graduates of baccalaureate degree program in Electronics and Computer Engineering must demonstrate knowledge and hands-on competence in the ability to:

PSO – 1	Specify, design, develop, test and manage reliable and efficient hardware and software products appropriate for an organization for intelligent computing systems.
PSO – 2	Apply project management techniques andappropriate methodologies to help an individual or organization achieve its goals, objectives and needs.
PSO – 3	Anticipate the changing direction of Information & Communication Technology, and evaluate and communicate the likely utility of new technologies to an individual or organization.

1. (e) Program Structure - B.Tech in Electronics and Computer Engineering

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

Course Code	Course Title	Hours/ Week L	T	P	C
18LEH101J	English	2	0	2	3
18LEH102J	Chinese	2	0	2	3
18LEH103J	French				
18LEH104J	German				
18LEH105J	Japanese				
18LEH106J	Korean				
18PDH101L	General Aptitude	0	0	2	1
18PDH102T	Management Principles for Engineers	2	0	0	2
18PDH103T	Social Engineering	2	0	0	2
18PDH201L	Employability Skills & Practices	0	0	2	1
	Total Learning Credits				**12**

2. Basic Science Courses (B)

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

3. Engineering Science Courses (S)

Course Code	Course Title	Hours/ Week L	T	P	C
18MES101L	Engineering Graphics and Design	1	0	4	3
18EES101J	Basic Electrical and Electronics Engineering	3	1	2	5
18MES103L	Civil and Mechanical Engineering Workshop	1	0	4	3
18CSS101J	Programming for Problem Solving	3	0	4	5
18ECS301J	Applied Programing	2	0	2	3
	Total Learning Credits				**19**

4. Professional Core Courses (C)

Course Code	Course Title	Hours/ Week L	T	P	C
18ECC104T	Signals and Systems	**3**	**1**	**0**	**4**
18ECC211J	Solid State Semiconductor Devices	**3**	**0**	**2**	**4**
18ECC212J	Fundamentals of Computer System Design	3	0	2	4
18ECC201J	Analog Electronic Circuits	3	0	2	4
18CSC201J	Data Structures and Algorithms	3	0	2	4
18ECC202J	Linear Integrated Circuits	3	0	2	4
18CSC202J	Object Oriented Design and Programming	3	0	2	4
18CSC203J	Computer Organization and Architectures	3	0	2	4
18ECC311J	Microcontrollers and Interfacing	**3**	**0**	**2**	**4**
18CSC303J	Database Management Systems	3	0	2	4
18ECC312T	Hardware Interfacing and Networking	**3**	**0**	**0**	**3**
18ECC313J	Embedded Hardware and Operating systems	**3**	**0**	**2**	**4**
18ECC411J	FPGA based Embedded Systems	**3**	**0**	**2**	**4**
18ECC350T	Comprehension	0	1	0	1
	Total Learning Credits				**52**

5. Professional Elective Courses (E)

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

6. Open Elective Courses (O)

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

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

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

8. Mandatory Courses (M)

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

List of Professional Elective Courses (E)
Any 6 Courses

Course Code	Course Title	Hours/ Week L	T	P	C
	Sub-Stream: Electronics Engineering				
18ECE211T	Electromagnetics and Antenna Theory	3	0	0	3
18ECE212T	Control Systems: Theory and Applications	3	0	0	3
18ECE311J	Applied Digital Signal Processing	2	0	2	3
18ECE312T	Wireless and Optical Sensors	3	0	0	3
18ECE313T	Digital Communication Systems	3	0	0	3
18ECE314T	Wireless Communication Networks	3	0	0	3
18ECE315T	ASIC Design	3	0	0	3
18ECE316T	Embedded Linux	3	0	0	3
18ECE206J	Advanced Digital System Design	2	0	2	3
18ECE224T	Cryptography and Network Security	3	0	0	3
18ECE243J	Digital Image and Video Processing	2	0	2	3
18ECE322T	Opto Electronics	3	0	0	3
	Sub-Stream: Computer Engineering				
18CSE392T	Machine Learning - I	3	0	0	3
18CSE449T	Data Analysis and Visualization	3	0	0	3
18CSE378T	Principles of Cloud Computing	3	0	0	3
18CSE390T	Computer Vision	3	0	0	3
18CSE355T	Data Mining and Analytics	3	0	0	3
18CSE484T	Deep Learning	3	0	0	3
18ECE231J	IoT System Design	2	0	2	3
18ECE331J	Multi-Core Architecture and Programming	2	0	2	3
18ECE332T	Principles of Artificial Intelligence	3	0	0	3
18ECE333T	Principles of Cyber-Physical Systems	3	0	0	3
18ECE334T	Hardware/Software Co-Design	3	0	0	3
18ECE335T	Introduction to Virtual Computing	3	0	0	3
18ECE336T	Mobile Computing	3	0	0	3
18ECE337T	Web of Things	3	0	0	3
18ECE338T	Quantum Computing	3	0	0	3

List of Open Elective Courses (O)
Any 4 Courses

Course Code	Course Title	Hours/ Week L	T	P	C
18ECO101T	Short-Range Wireless Communication	3	0	0	3
18ECO102J	Electronic Circuits & Systems	2	0	2	3
18ECO103T	Modern Wireless Communication Systems	3	0	0	3
18ECO104J	Audio and Speech Processing	2	0	2	3
18ECO105T	Underwater Acoustics	3	0	0	3
18ECO106J	PCB Design and Manufacturing	2	0	2	3
18ECO107T	Fiber Optics and Optoelectronics	3	0	0	3
18ECO108J	Embedded System Design using Arduino	2	0	2	3
18ECO109J	Embedded System Design using Raspberry Pi	2	0	2	3
18ECO110J	3D Printing Hardware and Software	2	0	2	3
18ECO131J	Virtual Instrumentation	2	0	2	3
18ECO132T	Analytical Instrumentation	3	0	0	3
18ECO133T	LOGIC and Distributed Control System	3	0	0	3
18ECO134T	Sensors and Transducers	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 B.Tech in Electronics and Computer Engineering

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	Intelligent Computing Systems	Project Management Techniques	New technologies in information and Communication
18MAB201T	Transforms and boundary value problems	L		M	M					M				H		
18MAB203T	Probability and stochastic process	L														
18MAB302T	Discrete Mathematics for Engineers	L														
18ECS301J	Applied Programing	M		H	M									H		M
18ECC211J	Solid State Semiconductor Devices	M	M	H					M	H				L	L	M
18ECC212J	Fundamentals of Computer System Design	H	M	H					M	H				H	L	
18ECC104T	Signals and Systems	H	H	M												H
18ECC201J	Analog Electronic Circuits	H		M	H									M		M
18CSC201J	Data Structures and Algorithms	M	L	H	H									H	L	
18ECC202J	Linear Integrated Circuits	M	L	H	H									H	L	
18CSC202J	Object Oriented Design and Programming	M	M	H		H							L	H	L	
18CSC203J	Computer Organization and Architectures	M	L	H	H	H	M	L							L	H
18ECC311J	Microcontrollers and Interfacing	H	L	H	H	H			H	M			M	H	L	
18CSC303J	Database Management Systems	M				M										
18ECC312T	Hardware Interfacing and Networking	M					L	H	M					L		M
18ECC313J	Embedded Hardware and Operating systems	H	L	H		M			L	L				L	L	
18ECC411J	FPGA based Embedded Systems	H		M			H	H	L	L			M	L	L	
18ECC350T	Comprehension	M	H	H	L	L	L	L	L	L	L	L	L	M	L	M
18ECP101L	MOOC / Industrial Training / Seminar – 1	M					M	L			H		H		M	
18ECP102L	MOOC / Industrial Training / Seminar – 2	M					M	L			H		H		M	
18ECP103L	Project (Phase-I) / Internship (3-4 weeks)	M	M	H	H	M	H	H	L	H	H	H	H	H	H	M
18ECP103L	Project (Phase-II) / Semester Internship	M	M	H	H	M	H	H	L	H	H	H	H	H	H	M
18ECE211T	Electromagnetics and Antenna Theory	H	H	H	M								M			
18ECE212T	Control Systems: Theory and Applications	H	H	H	H	H							H	H		
18ECE311J	Applied Digital Signal Processing	H	H	L	M	L					L		H	H		H
18ECE312T	Wireless and Optical Sensors	H	H											M	M	M
18ECE313T	Digital Communication Systems	H	H	H	H										M	
18ECE314T	Wireless Communication Networks	H	H	H	H										M	
18ECE315T	ASIC Design	M		H	M	H										
18ECE316T	Embedded Linux	L	H	H												H
18ECE231J	IoT System Design	M	M	H		M									M	M
18ECE331J	Multi-Core Architecture and Programming	H		M	M									M		H
18ECE332T	Principles of Artificial Intelligence	H	H	H										M	L	M
18ECE333T	Principles of Cyber-Physical Systems	H		H					H	H	H			H		H
18ECE334T	Hardware/Software Co-Design	H	H	M	H	H								H		
18ECE335T	Introduction to Virtual Computing	H		H		H								H		H
18ECE336T	Mobile Computing	H		H										M	L	H
18ECE337T	Web of Things	H	H		H	H								H		H
18ECE338T	Quantum Computing	H	H		H									H	L	H
18ECE206J	Advanced Digital System Design	M	M	H		M									M	M
18ECE224T	Cryptography and Network Security	H		M	M									M		H
18ECE243J	Digital Image and Video Processing	H	H	H										M	L	M
18ECE322T	Opto Electronics	H		H					H	H	H			H		H
18CSE392T	Machine Learning - I	H	H	M	H	H								H		
18CSE449T	Data Analysis and Visualization	H		H		H								H		H

18CSE378T	Principles of Cloud Computing	M	M	H		M									M	M
18CSE390T	Computer Vision	M	M	H		M									M	M
18CSE355T	Data Mining and Analytics	H		M	M									M		H
18CSE484T	Deep Learning	H	H	H										M	L	M

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

1. (g) Implementation Plan - B. Tech in Electronics and Computer Engineering

Semester - I

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

Semester – II

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

Semester - III

Code	Course Title	Hours/ Week L	T	P	C
18MAB201T	Transforms and Boundary Value Problems	3	1	0	4
18ECC104T	Signals and Systems	3	1	0	4
18ECC211J	Solid State Semiconductor Devices	3	0	2	4
18ECC212J	Fundamentals of Computer System Design	3	0	2	4
18CSC202J	Object Oriented Design and Programming	3	0	2	4
18PDH103T	Social Engineering	2	0	0	2
18PDM201L	Competencies in Social Skills	0	0	2	0
18PDM203L	Entrepreneurial Skill Development				
18CYM101T	Environmental Science	1	0	0	0
Total Learning Credits					22

Semester - IV

Code	Course Title	Hours/ Week L	T	P	C
18MAB203T	Probability and Stochastic Process	3	1	0	4
18BTB101T	Biology	2	0	0	2
18ECC201J	Analog Electronic Circuits	3	0	2	4
18CSC201J	Data Structures and Algorithms	3	0	2	4
	Professional Elective-1	3	0	0	3
	Open Elective-1	3	0	0	3
18PDH102T	Management Principles for Engineers	2	0	0	2
18PDM202L	Critical and Creative Thinking Skills	0	0	2	0
18PDM204L	Business Basics for Entrepreneurs				
Total Learning Credits					22

Semester - V

Code	Course Title	Hours/ Week L	T	P	C
18MAB302T	Discrete Mathematics for Engineers	3	1	0	4
18ECC202J	Linear Integrated Circuits	3	0	2	4
18CSC203J	Computer Organization and Architecture	3	0	2	4
18ECC311J	Microcontrollers and Interfacing	3	0	2	4
	Professional Elective – 2	3	0	0	3
	Open Elective – 2	3	0	0	3
18ECP101L	MOOC – 1	0	0	2	1
18ECP102L	Industrial Training - 1				
18ECP103L	Seminar – 1				
18PDM301L	Analytical and Logical Thinking Skills	0	0	2	0
18PDM303L	Entrepreneurship Management				
18LEM110L	Indian Art Form	0	0	2	0
Total Learning Credits					23

Semester - VI

Code	Course Title	Hours/ Week L	T	P	C
18ECS301J	Applied Programing	2	0	2	3
18ECC312T	Hardware Interfacing and Networking	3	0	0	3
18ECC313J	Embedded Hardware and Operating systems	3	0	2	4
18ECC350T	Comprehension	0	1	0	1
	Professional Elective-3	3	0	0	3
	Professional Elective-4	3	0	0	3
	Open Elective-3	3	0	0	3
18ECP104L	MOOC - 2	0	0	2	1
18ECP105L	Industrial Training - 2				
18ECP106L	Seminar – 2				
18PDH201L	Employability Skills and Practices	0	0	2	1
18LEM109T	Indian Traditional Knowledge	1	0	0	0
Total Learning Credits					22

Semester - VII

Code	Course Title	Hours/ Week L	T	P	C
18CSC303J	Database Management Systems	3	0	2	4
18ECC411J	FPGA based Embedded Systems	3	0	2	4
	Professional Elective-5	3	0	0	3
	Professional Elective-6	3	0	0	3
	Open Elective-4	3	0	0	3
18ECP107L	Minor Project	0	0	6	3
18ECP108L	Internship (4-5 weeks)				
Total Learning Credits					20

Semester - VIII

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

B. Tech in Electronics and Computer Engineering

2018 Regulations

SYLLABUS

Semester III to VIII

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

B. Tech in Electronics and Computer Engineering

2018 Regulations

Basic Sciences and Engineering Sciences Courses

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

Course Code	18MAB201 T	Course Name	TRANSFORMS AND BOUNDARY VALUE PROBLEMS	Course Category	BS	Basic Sciences	L	T	P	C
							3	1	0	4

Pre-requisite Courses	18MAB101T,18MAB102T	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mathematics	Data Book / Codes/Standards	nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Application of Partial differential equations in problems of Science and Engineering
CLR-2 :	To apply the concept of Fourier series in problems of science and Engineering.
CLR-3 :	To Apply the concept of Partial differential equation and boundary value problems in Science and Engineering
CLR-4 :	To apply the concepts of Fourier Transforms problems in Science and Engineering
CLR-5 :	To study Z-Transforms and its applications in Science and Engineering

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	Apply the Knowledge of Partial differential equation in problems involving Science and Engineering	2	85	80	L		L						M	L		H			
CLO-2 :	Gain familiarity in the knowledge of Fourier series and apply them to the problems involving Science and Engineering	2	85	80	L			M	M										
CLO-3 :	Gain knowledge in solution of Partial Differential Equations and boundary value problems and its applications in engineering problems	2	85	80		M							M			H			
CLO-4 :	To gain the knowledge of Fourier Transform and apply them in the problems involving Science and Engineering	2	85	80	L	M		M					M			H			
CLO-5 :	Gain the knowledge of Z-Transforms and its applications and apply in the problems involving Science and Engineering	2	85	80		M	L						M	L		H			

		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
Duration (hour)		12	12	12	12	12
S-1	SLO-1	Formation of partial differential equation by eliminating arbitrary constants	Introduction of Fourier series - Dirichlet's conditions for existence of Fourier Series	Classification of second order partial differential equations	Introduction of Fourier Transforms	Introduction of Z- transform
	SLO-2	Formation of partial differential equation by eliminating two or more arbitrary constants	Fourier series –related problems in $(0,2\pi)$	Method of separation of variables	Fourier Transforms- problems	Z-transform- elementary properties
S-2	SLO-1	Formation of partial differential equation by eliminating	Fourier series –related problems in $(-\pi,\pi)$),	One dimensional Wave Equation and its possible solutions	Properties of Fourier transforms	Z-transform- change of scale property, shifting property

		arbitrary functions				
	SLO-2	Formationofpartial differential equation by eliminating two or more arbitrary functions	Change of interval Fourier series –related problems in (0,2l)	One dimensional Wave Equation-initial displacement with zero initial velocity- type 1 Algebraic function	Standard results of Fourier transforms	a^n , 1/n,1/(n+1)
S-3	**SLO-1**	Formation of partial differential equation by eliminating arbitrary functions of the form □ (*u*, *v*) □ 0	Fourier series –related problems in (-l,l)	One dimensional Wave Equation-initial displacement with zero initial velocity- type 2 Trigonometric function	Fourier Sine Transforms - problems	Z-transform of $1/n^2$, $1/(n+1)^2$
	SLO-2	Solution of first order	Fourier series –half range cosine series related problems $(0,\pi)$	One dimensional Wave Equation-initial displacement with zero initial velocity- type 3 – Midpoint of the string is displaced	Fourier Cosine Transforms - problems	Z-transform of $r^n \cos n\theta$
S-4	**SLO-1**	Problem solving using tutorial sheet 1	Problem solving using tutorial sheet 4	Problem solving using tutorial sheet 7	Problem solving using tutorial sheet 10	Problem solving using tutorial sheet 13
	SLO-2	Problem solving using tutorial sheet 1	Problem solving using tutorial sheet 4	Problem solving using tutorial sheet 7	Problem solving using tutorial sheet 10	Problem solving using tutorial sheet 13
S-5	**SLO-1**	Solution of first order nonlinear partial differential equations- standard type –II Clairaut's form	Fourier series –half range cosine series related problems (0, l)	One dimensional Wave Equation-initial displacement with non-zero initial velocity Type 1 Algebraic function	Properties of Fourier sine Transforms	Z-transform of $r^n \sin n\theta$
	SLO-2	Solution of first order nonlinear partial differential equations- standard type III F(z, p, q)=o	Fourier series –half range sine series related problems $(0,\pi)$,	One dimensional Wave Equation-initial displacement with non-zero initial velocity Type 2 Trigonometric function	Fourier sine Transforms	Initial value theorem
S-6	**SLO-1**	Solution of first order nonlinear partial differential equations- standard type-IV separation of variable f(x, p) = g(y, q)	Fourier series –half range sine series related problems (0, l)	Wave Equation-initial displacement with non-zero initial velocity Type 3 split function	Properties of Fourier cosine Transforms	Finial value theorem
	SLO-2	Lagrange's linear equation: Method of grouping	Parseval's Theorem (without proof)- related problems in Fourier series	One dimensional heat equation and its possible solutions	Fourier cosine Transforms applications	Inverse Z-transform- long division method
S-7	**SLO-1**	Lagrange's linear equation: Method of multipliers	Parseval's Theorem (without proof)- related problems in cosine series	One dimensional heat equation related problems	Convolution of two function	Inverse Z-transform, related problems, long division method
	SLO-2	More problems in Lagrange's linear equation: Method of multipliers	Parseval's Theorem (without proof)- related problems in sine series	One dimensional heat equation -Steady state conditions	Convolution Theorem	Inverse Z-transform, Partial fraction method
S-8	**SLO-1**	Problem solving using tutorial sheet 2	Problem solving using tutorial sheet 5	Problem solving using tutorial sheet 8	Problem solving using tutorial sheet 11	Problem solving using tutorial sheet 14
	SLO-2	Problem solving using tutorial sheet 2	Problem solving using tutorial sheet 5	Problem solving using tutorial sheet 8	Problem solving using tutorial sheet 11	Problem solving using tutorial sheet 14
S-9	**SLO-1**	Linear Homogeneous partial differential equations of second and higher order with constant coefficients- CF and PI Type 1: e^{ax+by}	Introduction to Harmonic Analysis	One dimensional heat equation -Steady state conditions more problems	Parseval's Identity for Fourier transform	Inverse Z-transform, Partial fraction method related problems
	SLO-2	PI Type2.: sin(ax+by) or cos(ax+by)	Harmonic Analysis for finding harmonic in $(0,2\pi)$	One dimensional heat equation -Steady state conditions with zero velocity	Parseval's Identity for Fourier sine & cosine transforms	Inverse Z-transform - residue theorem method
S-10	SLO-1		Harmonic Analysis for finding harmonic in	One dimensional heat equation -Steady state conditions with zero velocity more	Parseval's Identity for Fourier sine &	Inverse Z-transform - residue theorem

		Type 3: PI of polynomial	(0,2l)	problems	cosine transforms applications	method-problems
	SLO-2	Type 4 Exponential shifting - e^{ax+by} f (x, y)	Harmonic Analysis for finding harmonic in periodic interval (0,T)	equation -Steady state conditions with zero velocity more related problems	Fourier Transforms Using Differentiation property	Convolution theorem (without proof)
S-11	SLO-1	Linear Homogeneous partial differential equations of second and higher order with constant coefficients type 5 General rule	Harmonic Analysis for finding cosine series	Steady state conditions and Non- zero boundary conditions- related problems	Solving integral equation	Convolution theorem applications
	SLO-2	Applications of Partial differential equations in Engineering	Harmonic Analysis for finding sine series	Steady state conditions and Non- zero boundary conditions- more related problems	Self reciprocal using Fourier Transform, sine and cosine transform	Solution of linear difference equations with constant coefficients using Z-transform
S-12	SLO-1	Problem solving using tutorial sheet 3	Problem solving using tutorial sheet 6	Problem solving using tutorial sheet 9	Problem solving using tutorial sheet 12	Problem solving using tutorial sheet 15
	SLO-2	Problem solving using tutorial sheet 3	Problem solving using tutorial sheet 6	Problem solving using tutorial sheet 9	Problem solving using tutorial sheet 12	Problem solving using tutorial sheet 15

Learning Resources

1. Erwin kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, 2006
2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 43rd Edition, 2015.
3. Veerarajan T., Transforms and Partial Differential Equations, Tata McGraw-Hill, New Delhi, 3rd edition,2012.
4. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 2010 3rd Edition.
5. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, for third semester , New Delhi. Reprint, 3rd edition,2014

	Level of Thinking	Continuous Assessment				Final Examination (50%)
		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					

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

Course Designers							
(a) Experts from Industry							
1	*Mr.V.Maheshwaran*	*CTS, Chennai*	*maheshwaranv@yahoo.com*				
(b) Experts from Higher Technical Institutions							
2	*Dr.K.C.Sivakumar*	*IIT, Madras*	*kcskumar@iitm.ac.in*	3	*Dr.Nanjundan*	*Bangalore University*	*nanzundan@gmail.com*
(b) Internal Experts							
4	*Dr.A.Govindarajan*	*SRMIST*	govindarajan.a@ktr.srmuniv.ac.in	5	Prof. Ganapathy Subramanian K S	SRMIST	ganapathysubramanian k@ktr.srmuniv.ac.in

Course Code	18MAB203T	Course Name	PROBABILITY AND STOCHASTIC PROCESS	Course Category	BS	Basic Sciences	L	T	P	C
							3	1	0	4

Pre-requisite Courses	18MAB201T	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mathematics	Data Book / Codes/Standards	nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Gain advanced and integrated understanding of the fundamentals between discrete and continuous random variables.
CLR-2 :	Gain knowledge on the applications of two dimensional random variables.
CLR-3 :	Describe the various modes of convergence of random variables and their implications.
CLR-4 :	Apply the specialized knowledge in random processes to solve practical engineering problems.
CLR-5 :	Understand how random variables and stochastic processes can be described and analyzed.

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	Apply the Knowledge of Partial differential equation in problems involving Science and Engineering	2	85	80	L		L						M	L		H			
CLO-2 :	Gain familiarity in the knowledge of Fourier series and apply them to the problems involving Science and Engineering	2	85	80	L			M	M										
CLO-3 :	Gain knowledge in solution of Partial Differential Equations and boundary value problems and its applications in engineering problems	2	85	80		M							M			H			
CLO-4 :	To gain the knowledge of Fourier Transform and apply them in the problems involving Science and Engineering	2	85	80	L	M		M					M			H			
CLO-5 :	Gain the knowledge of Z-Transforms and its applications and apply in the problems involving Science and Engineering	2	85	80		M	L						M	L		H			

		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
Duration (hour)		12	12	12	12	12
S-1	SLO-1	One dimensional random variable: Discrete Case-Probability function, CDF	Two dimensional random variables-Discrete case	Limit theorems-- Markov's inequality	Random Processes- Introduction	Power spectral density function-properties
	SLO-2	Continuous random variable-Probability density function	Probability function of (X,Y)- Marginal probability distribution	Chebyshev's inequality	Classification of random processes	Proof of properties
S-2	SLO-1	Cumulative distribution function-properties	Conditional probability distribution of (X,Y)	Chebyshev's inequality	Distribution of the process	Problems on power spectral density function
	SLO-2	Problems on one dimensional random variables	Problems on discrete random variables	Chebyshev's inequality	Averages of the process	Problems on power spectral density function
S-3	SLO-1	Expectation, variance	Continuous random variables- Joint PDF	Chebyshev's inequality	Stationary ,SSS,WSS processes	Power density spectrum
	SLO-2	Moments-raw and central moments	Marginal Probability distributions	The weak law of large numbers	Problems on stationary and SSS processes	Problems based on power density spectrum
S-4	SLO-1	Problem solving using tutorial sheet 1	Problem solving using tutorial sheet 4	Problem solving using tutorial sheet 7	Problem solving using tutorial sheet 10	Problem solving using tutorial sheet 13
	SLO-2	Problem solving using tutorial sheet 1	Problem solving using tutorial sheet 4	Problem solving using tutorial sheet 7	Problem solving using tutorial sheet 10	Problem solving using tutorial sheet 13

S-5	SLO-1	Characteristic function - properties	Conditional probability distribution of (X,Y)	Central limit theorem	Problems on WSS process	Linear system with random inputs
	SLO-2	Characteristic function	Problems on continuous two dimensional random variables	Central limit theorem	Problems on WSS process	Representation of system in the form of convolution
S-6	SLO-1	Binomial distribution - moments	Independent random variables	Central limit theorem	Autocorrelation function - properties	Unit impulse response of the system
	SLO-2	Binomial distribution- Applications	Cumulative distribution function- properties of F(x,y)	Central limit theorem	Proof of properties	Properties
S-7	SLO-1	Poisson distribution- moments	Expected values of two dimensional random variables	The strong law of large numbers	Problems on autocorrelation function	Applications of unit impulse function
	SLO-2	Poisson distribution -Applications	Covariance and correlation	The strong law of large numbers	Application of autocorrelation function	Einstein Weiner- Khinchine Relationship
S-8	SLO-1	Problem solving using tutorial sheet 2	Problem solving using tutorial sheet 5	Problem solving using tutorial sheet 8	Problem solving using tutorial sheet 11	Problem solving using tutorial sheet 14
	SLO-2	Problem solving using tutorial sheet 2	Problem solving using tutorial sheet 5	Problem solving using tutorial sheet 8	Problem solving using tutorial sheet 11	Problem solving using tutorial sheet 14
S-9	SLO-1	Exponential distribution- moments	Conditional expected values	One sided Chebychev's inequality	Cross correlation- properties	Problems on Khinchine relationship
	SLO-2	Exponential distribution- Applications	Problems on uncorrelated random variables	Cauchy Schwartz inequality	Proof of properties	Cross power density spectrum- properties
S-10	SLO-1	Normal Distribution- moments	Functions of two dimensional random variables	Chernoff bounds	Problems on cross correlation function	Proof of properties
	SLO-2	Normal Distribution- Applications	Probability density functions of the type Z=XY	Chernoff bounds for the standard normal variate	Ergodicity	Cross power density spectrum- problems
S-11	SLO-1	Function of a random variable	Probability density functions of the type Z=X-Y	Chernoff bounds for the Poisson random variate	Mean ergodic process	Cross power density spectrum
	SLO-2	Function of a random variable	Probability density functions of the type Z=X/Y	Jenson's inequality	Mean ergodic theorem	Cross power density spectrum
S-12	SLO-1	Problem solving using tutorial sheet 3	Problem solving using tutorial sheet 6	Problem solving using tutorial sheet 9	Problem solving using tutorial sheet 12	Problem solving using tutorial sheet 15
	SLO-2	Applications of random variables in engineering	Application of two dimensional random variables in Engineering	Applications of Central limit Theorem in engineering	Applications of random process in engineering	Applications Power spectral density functions in engineering
Learning Resources		1. Ahanasios Papoulis, S. Uniikrishna Pillai, Probability,Random Variables and Stochastic Processes 4'th Edition,Mcgraw Hill, 2002.				
		2. Henry Stark, Probability and Random Processes with Applications to Signal Processing,Third Edition, Pearson				
		3. Veerarajan T., Probability, Statistics and Random Processes with Queueing Theory and Queueing Networks, 4th Edition, McGraw-Hill Education, New Delhi,2015				
		4. Sheldon Ross , Afirst course in Probability, Sixth Edition, 2011				
		5. S.C. Gupta, V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, 11th Edition, 2015.				

	Level of Thinking	Continuous Assessment				Final Examination (50%)
		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					

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

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1	*Mr.V.Maheshwaran*	*CTS, Chennai*	*maheshwaranv@yahoo.com*				
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(b) Internal Experts							
4	*Dr.A.Govindarajan*	*SRMIST*	govindarajan.a@ktr.srmuniv.ac.in	5	Dr. Srinivasan	SRMIST	

Course Code	18MAB302T	**Course Name**	DISCRTE MATHEMATICS FOR ENGINEERS	**Course Category**	*BS*	*Basic Sciences*	L	T	P	C
							3	1	0	4

Pre-requisite Courses	*18MAB102T*	**Co-requisite Courses**	*Nil*	**Progressive Courses**	*Nil*
Course Offering Department	*Mathematics*	**Data Book / Codes/Standards**	*nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Apply set theory, functions and relations in storage, communication and manipulation of data*
CLR-2 :	*Apply number theory concepts in computer engineering such as public key crypto system.*
CLR-3 :	*Apply mathematical reasoning in computer science such as design of computer circuit, verification of programs.*
CLR-4 :	*Learning about groups, rings and fields. Solving problems on coding theory.*
CLR-5 :	*Using graph models in computer network and shortest path problems Apply graph coloring in problems involving scheduling and assignments.*
CLR-6 :	*Apply mathematical reasoning, combinatorial analysis, algebraic structures and graph theory in solving mathematical problems as applied to the respective branches of Engineering.*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	**Learning**			**Program Learning Outcomes (PLO)**														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Problem solving in sets, relations and functions.*	3	85	80	M	H	L						M	L		H			
CLO-2 :	*Solving problems in basic counting principles, inclusion exclusion and number theory.*	3	85	80	M	H		M	M				M			H			
CLO-3 :	*Solving problems of mathematical logic, inference theory and mathematical induction.*	3	85	80	M	H							M			H			
CLO-4 :	*Gaining knowledge in groups, rings and fields. Solving problems in coding theory.*	3	85	80	M	H		M					M			H			
CLO-5 :	*Gaining knowledge in graphs and properties. Learning about trees, minimum spanning trees and graph coloring.*	3	85	80	M	H	L						M	L		H			
CLO-6 :	*Learning mathematical reasoning, combinatorial analysis, algebraic structures and graph theory.*	3	85	80	M	H							M			H			

		Learning Unit / Module 1	**Learning Unit / Module 2**	**Learning Unit / Module 3**	**Learning Unit / Module 4**	**Learning Unit / Module 5**
Duration (hour)		**12**	**12**	**12**	**12**	**12**
S-1	**SLO-1**	Sets and examples. Operations on sets.	Permutation and Combination	Propositions and Logical operators	Binary operation on a set- Groups and axioms of groups.	Basic concepts - Basic Definitions- degree and Hand shaking theorem.
	SLO-2	Laws of Set theory- Proving set	Simple problems using addition and	Truth values and truth tables.	Properties of groups.	Some Special Graphs – complete,

		identities using laws of set theory.	product rules.			regular and bipartite graphs.
S-2	SLO-1	Partition of a set – examples.	Principle of inclusion and exclusion	Propositions generated by a set-Symbolic writing using conditional and biconditional connectives.	Permutation group, equivalence classes with addition modulo m and multiplication modulo m.	Isomorphism of graphs – necessary conditions.
	SLO-2	Cartesian product of sets.	Problems using inclusion and exclusion principle.	Writing converse inverse and contra positive of a given conditional.	Cyclic groups and properties.	Isomorphism- simple examples.
S-3	SLO-1	Relations – Properties.	Pigeon-hole principle and generalized pigeon-hole principle.	Tautology, contradiction and contingency-examples.	Subgroups and necessary and sufficiency of a subset to be a subgroup.	***Paths, cycles and circuits.***
	SLO-2	Equivalence relation and partial order relation	Problems on pigeon-hole principle.	Proving tautology and contradiction using truth table method.	**Group homomorphism and properties.**	***Connectivity in undirected graphs – connected graphs and odd degree vertices.***
S-4	SLO-1	**Problem solving using tutorial sheet 1**	**Problem solving using tutorial sheet 4**	**Problem solving using tutorial sheet 7**	**Problem solving using tutorial sheet 10**	**Problem solving using tutorial sheet 13**
	SLO-2	**Problem solving using tutorial sheet 1**	**Problem solving using tutorial sheet 4**	**Problem solving using tutorial sheet 7**	**Problem solving using tutorial sheet 10**	**Problem solving using tutorial sheet 13**
S-5	SLO-1	Poset - Graphs of relations Digraphs	Divisibility and prime numbers.	Equivalences – truth table method to prove equivalences.	Rings- definition and examples..Zero devisors.	Eulerian and Hamiltonian graphs.
	SLO-2	Hasse diagram – problems.	Fundamental theorem of arithmetic – problems.	Implications- truth table method to prove implications.	Integral domain- definition , examples and properties.	Necessary and sufficient condition for a graph to be Eulerian- examples.
S-6	SLO-1	*Closures of relations- examples*	Finding prime factorization of a given number.	Laws of logic and some equivalences.	Fields – definition, examples and properties.	Matrix representation of graphs-adjacent and incidence matrices and examples.
	SLO-2	Transitive closure and warshall's algorithm	Some more problems using fundamental theorem of arithmetic.	Proving equivalences and implications using laws of logic.	Coding Theory – Encoders and decoders- Hamming codes.	Isomorphism using adjacency.
S-7	SLO-1	Functions – definitions, domain and range of a function - examples	Division algorithm- greatest common divisor and properties-problems.	Rules of inference – Rule P, Rule T and Rule CP	Hamming distance. Error detected by an encoding function.	***Digraphs – in degree and out degree – Hand shaking theorem.***
	SLO-2	Types of functions- one- one and onto- bijection- examples.	**Euclid's algorithm for finding GCD(a,b)-examples..**	Direct proofs	examples.	***Verification of hand shaking theorem in digraphs.***
S-8	SLO-1	**Problem solving using tutorial sheet 2**	**Problem solving using tutorial sheet 5**	**Problem solving using tutorial sheet 8**	**Problem solving using tutorial sheet 11**	**Problem solving using tutorial sheet 14**
	SLO-2	**Problem solving using tutorial sheet 2**	**Problem solving using tutorial sheet 5**	**Problem solving using tutorial sheet 8**	**Problem solving using tutorial sheet 11**	**Problem solving using tutorial sheet 14**
S-9	SLO-1	Composition of functions – examples.	**Problems using Euclid's algorithm.**	***Problems using direct method.***	**Error correction using matrices.**	**Graph colouring – chromatic number-examples.**
	SLO-2	Associatiivity of composition of functions – Identity and inverse of functions.	**Least common Multiple(LCM)- relation between LCM and GCD.**	***Problems using CP rule.***	**Problems on error correction using matrices.**	**Four colour theorem(statement only) and problems.**
S-10	SLO-1	Necessary and sufficiency of existence of inverse of a function.	**Problems on LCM.**	Inconsistency and indirect method of proof.	Group codes-error correction in group codes-parity check matrix.	Trees – definitions and examples. Properties.
	SLO-2	Uniqueness of identity	**Finding LCM and GCD using prime factorization.**	Inconsistent premises and proof by contradiction (indirect method).	Problems on error correction in group codes.	Properties continued.
S-11	SLO-1	Inverse of composition	**Finding GCD and LCM using Euclid's algorithm.**	Principle of mathematical induction.	Procedure for decoding group codes.	Spanning trees – examples.
	SLO-2	Checking if a given function is bijection and if so, finding inverse, domain and range- problems.	**More problems on GCD and LCM.**	Problems based on Mathematical Induction	Problems on decoding group codes.	Kruskal's algorithm for minimum spanning trees.
S-12	SLO-1	**Problem solving using tutorial sheet 3**	**Problem solving using tutorial sheet 6**	**Problem solving using tutorial sheet 9**	**Problem solving using tutorial sheet 12**	**Problem solving using tutorial sheet 15**
	SLO-2	**Applications of sets, relations and functions in Engineering.**	**Applications of sets, relations and functions in Engineering.**	**Applications of sets, relations and functions in Engineering.**	**Applications of sets, relations and functions in Engineering.**	**Applications of sets, relations and functions in Engineering.**

Learning Resources	1.	Kenneth H.Rosen, Discrete Mathematics and its Application, Seventh edition, Tata McGraw-Hill Publishing company PVT .Ltd., New Delhi, 2012.
	2.	Tremblay J. P. and Manohar R., Discrete Mathematical Structures with applications to Computer Science, Tata Mc Graw Hill Publishing Co., 35th edition,2008.
	3.	Narsing Deo, Graph Theory with applications to Engineering and Computer science, Prentice-Hall of India pvt. Ltd., New Delhi, 2004.
	4.	C.L. Liu, Elements of Discrete Mathematics, 4th Edition, McGraw Higher ED, 2012.
	5.	T.Veerarajan, Discrete Mathematics with Graph Theory and Combinatorics, Tata McGraw Hill, 2015.

	Level of Thinking	Continuous Assessment				Final Examination (50%)
		CLA – 1 (10%)	CLA – 2 (15%)	CLA – 3 (15%)	CLA –4 (10%) #	
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Course Code	**18ECS301J**	**Course Name**	**APPLIED PROGRAMMING**	**Course Category**	***S***	***Engineering Sciences***	**L**	**T**	**P**	**C**
							2	**0**	**2**	**3**

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	**Learning**		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Learn a powerful high level language that implements a deliberately clear syntax			
CLR-2 :	Study a highly coherent programming model			
CLR-3 :	*To gain knowledge on* features of portability, productivity and extensive support libraries			
CLR-4 :	Analyze the seamless integration with components coded in any other programming language			
CLR-5 :	To enhance the scientific computing skills			
CLR-6 :	To develop efficient software models.			

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*			
CLO-1 :	Appreciate the basic and advanced features of core language built ins	*2*	*80*	*70*
CLO-2 :	Handle and control system/OS level features	*3*	*85*	*75*
CLO-3 :	Analyze software models for client-server communication	*4*	*75*	*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	PSO - 2	PSO – 3
L	*H*	-	*H*	*L*	-	-	-	*L*	*L*	-	*H*	*H*	-	-
M	*H*	*L*	*M*	*L*	-	-	-	*M*	*L*	-	*H*	*M*	-	-
M	*H*	*M*	*H*	*L*	-	-	-	*M*	*L*	-	*H*	-	*H*	-

CLO-4 :	Communicate using sockets, write client and server side scripts	*3*	*85*	*80*	*M*	*H*	*M*	*H*	*L*	-	-	-	*M*	*L*	-	*H*	-	*H*	-
CLO-5 :	Design applications using database.	*5*	*85*	*75*	*H*	*H*	*M*	*H*	*L*	-	-	-	*M*	*L*	-	*H*	-	-	*H*
CLO-6 :	Implement basic applications with database connectivity	*5*	*80*	*70*	*L*	*H*	-	*H*	*L*	-	-	-	*L*	*L*	-	*H*	-	-	*H*

Module		**Introduction, Types and Operations**	**Classes and OOPS**	**Exceptions and Tools**	**Script Execution tools**	**Graphical User Interfaces**
Duration (hour)		**12 hrs**	**12 hrs**	**12 hrs**	**12 hrs**	**12 hrs**
S-1	SLO-1	Introduction to Python,	Iterations and Comprehensions	OS modules	Introduction to Socket Programming	Introduction to tkinter
	SLO-2	Python Interpreter and its working, Syntax and Semantics				Top Level Windows
S-2	SLO-1	Data Types, Assignments and Expressions	Handling text files, Modules, Class coding basics	Sys modules, Directory Traversal tools	Handling Multiple Clients, Client side scripting, urlib	Dialogs, Message and Entry, Event Handling, Menus
	SLO-2					
S 3-4	SLO-1	**Lab-1-**Solving linear equations- Least squares method	Lab4 - Simulating in time- Differentiator	Lab-8-Simulating a device- Bistable multivibrator	Lab – 11-Using the system module to solve for step and impulse response of op-amp circuits	Lab14-Low pass filtering of signals using digital filters
	SLO-2					
S-5	SLO-1	Control Flow Statements ,Sequences-	Operator Overloading	Parallel System tools: threading	Server Side Scripting	Listboxes and Scrollbars, Text
	SLO-2					
S-6	SLO-1	Lists, Dictionaries,	Designing with Classes	Parallel System tools: threading	CGI Scripts with User Interaction	SQL Database interfaces with sqlite3 : Basic operations
	SLO-2					
S-7,8	SLO-1	**Lab-2-**Solving linear equations- Least squares method	Lab – 5 -Simulating in time- Integrator	Lab – 9-Simulating a device- Monostable multivibrator	Lab-12-Using the DFT to obtain steady state response of linear (and op-amp) circuits	Lab 15-Low pass filtering of signals using digital filters
	SLO-2					
S-9	SLO-1	Tuples and files	Exception Objects and Designing with Exceptions	Parallel System tools : queue	Server Side Scripting : Passing Parameters	SQL Database interfaces with sqlite3 table load scripts
	SLO-2					
S-10	SLO-1	Functions , Lambda expressions	Strings and Regular Expressions	Parallel System tools : Program Exits	Server Side Scripting : Passing Parameters	SQL Database interfaces with sqlite3 table load scripts
	SLO-2					
S-11,12	SLO-1	**Lab-3 -** Solving linear equations- Least squares method	Lab – 6-Simulating in time – Square wave generator	Lab-10-Simulating a device – Astable multivibrator	Lab-13-Simulating noise in circuits	Lab – 16-Effect on SNR
	SLO-2					
	SLO-2					
Learning Resources		1.Mark Lutz ,"Learning Python", O Reily, 4thEdition, 2009, ISBN: 978-0-596-15806-42. 2.Mark Lutz ,"Programming Python ", O Reily, 4thEdition, 2010, ISBN 97805961581183.		3. Tim Hall and J-P Stacey ,"Python 3 for Absolute Beginners" , 2009, ISBN:97814302163224. 4. Magnus Lie Hetland , "Beginning Python: From Novice to Professional", 2ndEdition, 2009, ISBN:9781590599822		

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice

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

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

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

B. Tech in Electronics and Computer Engineering

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	18ECC211J	Course Name	SOLID STATE SEMICONDUCTOR 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
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Understand the basics of semiconductors and PN junction diode operation, characteristics and models			
CLR-2 :	Study and identify the various special diodes.			
CLR-3 :	Interpret the operation, characteristics and biasing arrangements of BJT.			
CLR-4 :	Interpret the operation, characteristics and biasing arrangements of MOSFET.			
CLR-5 :	Construct the diode and transistor circuits for various applications.			
CLR-6 :	Know the fabrication steps of monolithic IC.			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	Describe the operation and characteristics of PN junction diode and evaluate the parameters of a PN junction diode.	1	80	70	L	H	-	H	L	-	-	-	L	L	-	H	H	M	-
CLO-2 :	Identify the various special diodes and describe their features.	1	85	75	M	H	L	M	L	-	-	-	M	L	-	H	H	M	-
CLO-3 :	Characterize the different configurations of BJT and its biasing arrangement	2	75	70	M	H	M	H	L	-	-	-	M	L	-	H	H	M	-
CLO-4 :	Recognize the MOSFET operation, characteristics and its biasing methods	1	85	80	M	H	M	H	L	-	-	-	M	L	-	H	H	M	-
CLO-5 :	Implement and analyze the various diode and transistor circuits	3	85	75	H	H	M	H	L	-	-	-	M	L	-	H	H	M	H
CLO-6 :	Explain the monolithic IC fabrication of active and passive components	2	80	70	L	H	-	H	L	-	-	-	L	L	-	H	H	M	-

Module		*Semiconductor Basics*	*Special diodes*	*Bipolar Junction Transistors*	*MOS Field Effect Transistors*	*Diode and Transistor circuits*
Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Intrinsic and Extrinsic semiconductors*	*Zener diode*	*Device structure*	*Device structure of D and E-MOSFET*	*Rectifiers-Half Wave*
	SLO-2	*Semiconductor conductivity, Drift and diffusion current*	*Backward diode*	*Physical operation of BJT*	*Physical operation of D and E MOSFET*	*Center tapped Full wave and Bridge rectifier*
S-2	SLO-1	***PN Junction Theory:** PN junction formation, energy band structure*	*Varactor diode*	*BJT configurations*	*Current voltage characteristics- Drain characteristics*	*Zener diode voltage regulator*
	SLO-2	*PN junction with open circuited terminals (Equilibrium condition)*	*Step Recovery diode*	*Common Emitter – Current-voltage characteristics*	*Transfer characteristics*	*Diode clipping circuits*
S-3	SLO-1	*Forward biased PN Junction*	*Point contact diode*	*Common Base – Current-voltage characteristics*	*Derivation of Drain current*	*Diode Clamping circuits*
	SLO-2	*Reverse biased PN junction, V-I characteristics*	*PIN diode*	*Common Collector – Current-voltage characteristics*	*Derivation of Transconductance*	*Envelope and Peak to peak detectors*
S 4-5	SLO-1	*Lab 1: PN Junction diode characteristics*	*Lab 4 : Diode clipping and Clamping circuits*	*Lab 7 :BJT Characteristics – Common Emitter, Common base and Common Collector*	*Lab 10: MOSFET Characteristics*	*Lab 13: **PSPICE Simulation:** MOSFET Common Source and Common Drain VI characteristics*
	SLO-2					
S-6	SLO-1	***PN Junction diode**: Ideal diode and V-I characteristics ,*	*Tunnel diode*	***BJT Biasing and Thermal stabilization**: DC load line*	*Body Effect*	*Voltage multipliers*
	SLO-2	*Current components in P-N diode*	*Schottky barrier diode*	*Operating point*	*Temperature Effects on V-I characteristics*	*Diode Digital Logic circuits*

S-7	SLO-1	*Temperature effects on PN junction diode characteristics*	*Gunn diode*	*Bias stability*	*Configurations of MOSFET-Common source*	*BJT as an Amplifier*
	SLO-2	*Calculation of Depletion width*	*Impatt diode*	*Base bias*	*Common Gate and Common Drain*	*BJT as a Switch*
S-8	SLO-1	*Potential barrier*	*Opto Electronic devices: Photo emissivity and Photo Electric Theory*	*Collector Feedback bias*	*Biasing in MOS amplifier circuits: Biasing by fixing Vgs*	*MOSFET as an amplifier*
	SLO-2	*Diode Resistance*	*Photo conductivity*	*Emitter feedback bias*	*Biasing in MOS amplifier circuits: Biasing by fixing Vgs*	*MOSFET as a switch*
S 9-10	SLO-1	*Lab 2: Zener diode characteristics*	*Lab 5: Zener diode voltage regulator*	*Lab 8: BJT Biasing circuits- voltage divider bias and Feedback bias*	*Lab 11: MOSFET Biasing Circuits for common source and Common drain*	*Lab 14 :* ***PSPICE Simulation:*** *Diode Rectifiers, Clipping , Clamping and voltage multipliers*
	SLO-2					
S-11	SLO-1	*Transition and Diffusion Capacitance*	*LED*	*Voltage divider bias*	*Biasing using drain to gate feedback resistor*	***Integrated Circuits:*** *Basic Monolithic Integrated Circuits*
	SLO-2	*DC load line analysis*	*Laser diode*	*Voltage divider bias*	*Biasing using drain to gate feedback resistor*	*Steps of Fabrication*
S-12	SLO-1	***Modeling of a diode:*** *Ideal diode model*	*PIN Photodiodes*	*Bias compensation*	*CMOS FET*	*Integrated resistors and capacitors*
	SLO-2	*Piecewise linear model*	*Avalanche Photodiodes*	***BJT Models:*** *h-parameters*	*Introduction to FinFET and TFET*	*Monolithic diodes*
S-13	SLO-1	*Small signal model*	*Solar Cells & Photo Transistors*	*Hybrid π model*	***Small signal operation and Models:*** *DC bias point*	*Integrated transistors*
	SLO-2	*Problem solving on depletion width, diode capacitance and resistance, diode currents, DC load line*	*Opto couplers & Photo Multiplier tube*	*Eber's Moll Model*	*Small signal Equivalent circuit of MOSFET*	*Integrated MOSFET*
S 14-15	SLO-1	*Lab 3: Diode Rectifier circuits: Half wave, Center tapped Full wave and Bridge rectifiers*	*Lab 6: Diode Envelope detectors and voltage multipliers*	*Lab 9: BJT as an amplifier and switch*	*Lab 12:* ***PSPICE Simulation:*** *BJT common emitter and common Collector VI Characterisitcs*	*Lab 15 :* ***PSPICE Simulation:*** *CMOS Inverter*
	SLO-2					

Learning Resources	1. *Adel.s. Sedra, Kenneth.c.Smith, "Microelectronic Circuits, Theory and Applications", Oxford University Press, 6th Edition,2009* 2. *Jacod Millman, Christos.C.Halkias, Satyabrata Jit, " Electronic Devices and Circuits", Mc Graw Hill Private Limited, fourth Edition, 2015.*	3. *David .A.Bell, "Electronic Devices and Circuits" Oxford University Press, 5th Edition,2008* 4. *Anil.K.Maini, Varsha Agarwal, "Electronic Devices and Circuits", John Wiley and Sons, First edition,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	*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

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Course Code	18ECC212J	Course Name	FUNDAMENTALS OF COMPUTER SYSTEM DESIGN	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18EES101J	Co-requisite Courses	Nil	Progressive Courses	18ECC311J
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

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

		Learning		
		1	2	3
CLR-1 :	Understand binary codes, digital arithmetic operations and able to simplify Boolean logic expressions	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-2 :	Able to design simple combinational logics using basic gates and MSI circuits, familiarize with basic sequential logic components			
CLR-3 :	Understand of the basic structure and operation of a digital computer.			
CLR-4 :	To learn about CPU, Stack and Register Organisation			
CLR-5 :	Know how data transfer and pipelining concept is implemented			

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 :	Review and articulate Logic gates	3	80	70
CLO-2 :	Apply the basic knowledge of logic gates to design combinational circuits	3	85	75
CLO-3 :	Classify different type of flip-flops, and construct the counters using the same	3	75	70
CLO-4 :	To learn about CPU, Stack and Register Organisation	3	85	80
CLO-5 :	Know how data transfer and pipelining concept is implemented	3	85	75

Program Learning Outcomes (PLO)

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

Module		Binary Codes, Digital Arithmetic and Simplification of Boolean Functions	Combinational Circuits	Sequential Circuits	Basic Computer Organization And Design and Programming The Basic Computer	Central Processing Unit and pipeline processing
Duration (hour)		15	15	15	15	15
S-1	SLO-1	Binary Codes	Basic about combinational circuit, Difference between combinational and sequential circuit	Flip-flop and Latch: SR latch	Basic Computer Organization And Design: Instruction codes, Computer registers	Central Processing Unit : Introduction, General Register Organization, Stack Organization
	SLO-2	Digital Arithmetic and Simplification of Boolean Functions	Design of half adder	JK flip-flop, T flip-flop, D flip-flop	Instruction codes, Computer registers	Introduction, General Register Organization, Stack Organization
S-2	SLO-1	Arithmetic number representation	Design of full adder	Master-slave RS flip-flop	Computer instructions	Instruction format
	SLO-2	Binary arithmetic	Design of substractor	Master-slave JK flip-flop	Computer instructions	Instruction format
S-3	SLO-1	Introduction about BCD, Excess 3, Gray code	Code converter	Registers & Counters	Timing and Control, Instruction cycle	Addressing Modes
	SLO-2	BCD arithmetic simplification	Code converter	Shift registers (SISO, SIPO, PISO, PIPO)	Timing and Control, Instruction cycle	Addressing Modes
S 4-5	SLO-1	Lab 1: To study and perform about logic gates.	Lab 4 : To study and perform about Half substractor and full substractor	Lab 7 : To study and perform about Decoder, Demultiplexer, and Multiplexer.	Lab 10: To study and perform about J-K and T flip flop.	Lab 13: Design and implementation of Synchronous Counters
	SLO-2					
S-6	SLO-1	Digital logic gates	N bit parallel adder and substractor	Universal shift register	Memory-Reference Instructions	Data transfer and manipulation
	SLO-2	Basic theorems and properties of Boolean algebra	Look ahead carry generator	Counters: Asynchronous/Ripple counters	Input-output and interrupt	Data transfer and manipulation

S-7	*SLO-1*	*Basic theorems and properties of Boolean algebra*	*Decoder*	*Synchronous counters, Modulus-n Counter*	*Design of Basic computer*	*Program Control, Reduced Instruction Set Computer (RISC)*
	SLO-2	Minimization of Boolean Functions: Algebraic simplification	Encoder	Ring counter, Johnson counter	Design of Basic computer	Program Control, Reduced Instruction Set Computer (RISC)
S-8	SLO-1	Problems on Algebraic simplification	multiplexer	Up-Down counter	Design of Accumulator Unit	Pipeline Processing: Parallel Processing
	SLO-2	NAND and NOR implementation	demultiplexer	Mealy and Moore model	Design of Accumulator Unit	Parallel Processing
S 9-10	SLO-1	Lab 2: To study and perform about NAND and NOR as a universal gates.	Lab 5: To design 3-bit odd/even parity generator and checker.	Lab 8: To realize Boolean functions using multiplexer.	Lab 11: To study universal shift register.	Lab 14 : Model Practical Examination
	SLO-2					
S-11	SLO-1	Karnaugh map simplification	Implementation of combinational circuit using decoder, encoder, multiplexer, demultiplexer.	Synchronous (Clocked) sequential circuits	Programming The Basic Computer : Introduction, Machine Language	Pipelining
	SLO-2	Problems on Karnaugh map simplification	Implementation of combinational circuit using decoder, encoder, multiplexer, demultiplexer.	Synchronous (Clocked) sequential circuits	Assembly Language, the Assembler	Pipelining
S-12	SLO-1	Problems on Karnaugh map simplification	Magnitude comparator	Synchronous (Clocked) sequential circuits	Program loops	Arithmetic Pipeline
	SLO-2	Quine McCluskey or tabulation method	Magnitude comparator	Analyze and design synchronous sequential circuits	Programming Arithmetic and logic operations.	Arithmetic Pipeline
S-13	SLO-1	Problems on Quine McCluskey or Tabulation method	Parity generator (even parity)	State reduction	Subroutines.	Instruction Pipeline
	SLO-2	Problems on Tabulation method	Odd parity generator	State assignment	I-O Programming	Instruction Pipeline, RISC pipeline
S 14-15	SLO-1	Lab 3: To study and perform about Half Adder and full Adder.	Lab 6: To design and implement circuit that converts binary code to gray code and gray to binary code.	Lab 9: To study and perform about R-S and D flip flop.	Lab 12: Design and implementation of Asynchronous Counters	Lab 15 : University Practical Exam
	SLO-2					

Learning Resources	1. Morris Mano M, Michael D. Ciletti, Digital Design with an Introduction to the Verilog HDL, 5th ed., Pearson Education, 2014 2. M. Morris Mano Computer System Architecture 3rd edition, Pearson Education ,2012	. 3. Andrew S. Tanebaum , Structured Computer Organization., 6h edition, Pearson Education, 2013. 4. Hayes, J.P., "Computer Architecture and Organization", 5th Edition, Tata Mc-Graw Hill, 2005.

Learning Assessment

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

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

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

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

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

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

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)															
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1	PSO – 2	PSO – 3
CLO-1 :	Acquire knowledge of various classifications of Signals and Systems	1	85	70	H	-	-	-		-	-	-	-	-	-	-	-	-	-
CLO-2 :	Analyze Periodic and Aperiodic Continuous time Signals using Fourier series and Fourier Transform	2	85	70	H	M	-	-	M	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Analyze and characterize the Continuous time system through Laplace transform and Convolution integral.	2	85	70	H	M	-	-	M	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Analyze and characterize the Discrete time signals and system through DTFT, Convolution sum	2	85	70	H	M	-	-	M	-	-	-	-	-	-	-	-	-	-
CLO-5 :	Analyze and characterize the Discrete time system using Z transform	2	85	70	H	M	-	-	M	-	-	-	-	-	-	-	-	-	-
CLO-6 :	Present the mathematical techniques used for continuous-time signal and discrete-time signal and system analysis	3	85	70	H	M	-	-	-	-	-	-	-	-	-	L	L	-	-

Duration (hour)		Classification of Signals and Systems	Analysis of Continuous Time Signals	Analysis of LTI CT System	Analysis of DT Signals and Systems	Analysis of LTI DT System using Z-Transform
		12	12	12	12	12
S-1	SLO-1	Introduction to signals and systems	Introduction to Fourier series	System modeling	Representation of sequences	Z transform – introduction
	SLO-2	Requirements of signal and system analysis in communication	Representation of Continuous time Periodic signals	Description of differential equations	Discrete frequency spectrum and range	Region of convergence of finite duration sequences
S-2	SLO-1	Continuous time signals (CT signals)	Fourier series: Trigonometric representation	Solution of Differential equation	Discrete Time Fourier Transform (DTFT) – Existence	Properties of ROC
	SLO-2	Discrete time signals (DT signals)	Fourier series: Trigonometric representation	Differential equation: Zero initial conditions	DTFT of standard signals	Properties of ROC
S-3	SLO-1	Representation of signals: Step, Ramp, Pulse, Impulse	Fourier series: Cosine representation	Differential equation: Zero state response	Properties of DTFT	Properties of Z transform
	SLO-2	Representation of signals: Sinusoidal, Exponential	Fourier series: Cosine representation	Differential equation: Zero Input response	Properties of DTFT	Properties of Z transform
S-4	SLO-1	Basic operation on the signals	Symmetry conditions	Total Response	Inverse DTFT	Unilateral z transforms
	SLO-2	Problems on signal operations	Properties of Continuous time Fourier series	Step response	Practice on IDTFT	Properties of z transform
S-5	SLO-1	Classification of CT and DT signals: Periodic & Aperiodic signals.	Practice problems on Fourier series	Impulse response	Impulse response of a system with DTFT	Bilateral Z transforms
	SLO-2	Classification of CT and DT signals: Deterministic & Random signals.	Practice problems on Fourier series	Frequency response	Frequency response of a system with DTFT	Properties of z transform
S-6	SLO-1	Energy signal	Gibb's Phenomenon	Convolution integral	Practice problems	Relation between DTFT and Z transform

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

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

Learning Assessment

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

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

Course Designers

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

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

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

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

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	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
		Program Learning Outcomes (PLO)			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
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*	*80*	*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*	*80*	*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*	*80*	*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*	*80*	*70*	*L*	*M*	*H*	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	*Present the basic circuit building blocks that are used in the design of IC amplifiers, namely current mirrors and sources*	*2,3*	*80*	*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*	-	-	*L*	*M*	-	-	*M*	*H*	*L*	-

Module		**BJT Amplifiers**	**FET Amplifiers**	**Feedback amplifies & Oscillators**	**Oscillators & Power Amplifiers**	**IC Biasing & Amplifiers with Active Load**
Duration (hour)		**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	*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*
	SLO-2					
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 SLO-2	*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*
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 SLO-2	*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*

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

Learning Assessment

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

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

Course Designers

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

Course Code	18CSC201J	Course Name	DATA STRUCTURES AND ALGORITHMS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	18CSC202J
Course Offering Department	Computer Science and Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Utilize the different data types; Utilize searching and sorting algorithms for data search			
CLR-2 :	Utilize linked list in developing applications			
CLR-3 :	Utilize stack and queues in processing data for real-time applications			
CLR-4 :	Utilize tree data storage structure for real-time applications			
CLR-5 :	Utilize algorithms to find shortest data search in graphs for real-time application development			
CLR-6 :	Utilize the different types of data structures and its operations for real-time programming applications			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	Identify linear and non-linear data structures. Create algorithms for searching and sorting	1	80	70	L	H	-	H	L	-	-	-	L	L	-	H	-	-	-
CLO-2 :	Create the different types of linked lists and evaluate its operations	3	85	75	M	H	L	M	L	-	-	-	M	L	-	H	-	-	-
CLO-3 :	Construct stack and queue data structures and evaluate its operations	2	75	70	M	H	M	H	L	-	-	-	M	L	-	H	-	-	-
CLO-4 :	Create tree data structures and evaluate its types and operations	3	85	80	M	H	M	H	L	-	-	-	M	L	-	H	-	-	-
CLO-5 :	Create graph data structure, evaluate its operations, implement algorithms to identify shortest path	3	85	75	H	H	M	H	L	-	-	-	M	L	-	H	-	-	-
CLO-6 :	Construct the different data structures and evaluate their types and operations	2	80	70	L	H	-	H	L	-	-	-	L	L	-	H	-	-	-

Module		1	2	3	4	5
Duration (hour)		15	15	15	15	15
S-1	SLO-1	Introduction-Basic Terminology	Array	Stack ADT	General Trees	Graph Terminology
	SLO-2	Data Structures	Operations on Arrays – Insertion and Deletion	Stack Array Implementation	Tree Terminologies	Graph Traversal
S-2	SLO-1	Data Structure Operations	Applications on Arrays	Stack Linked List Implementation	Tree Representation	Topological sorting
	SLO-2	ADT	Multidimensional Arrays- Sparse Matrix	Applications of Stack- Infix to Postfix Conversion	Tree Traversal	Minimum spanning tree – Prims Algorithm
S-3	SLO-1	Algorithms – Searching techniques	Linked List Implementation - Insertion	Applications of Stack- Postfix Evaluation	Binary Tree Representation	Minimum Spanning Tree - Kruskal's Algorithm
	SLO-2	Complexity – Time , Space Trade off	Linked List- Deletion and Search	Applications of Stack- Balancing symbols	Expression Trees	Network flow problem
S 4-5	SLO-1	Lab 1: Implementation of Searching - Linear and Binary Search Techniques	Lab 4 :Implementation of Array – Insertion, Deletion.	Lab 7 :Implementation of stack using array and Linked List	Lab 10: Implementation of Tree using array	Lab 13: Implementation of Graph using Array
	SLO-2					
S-6	SLO-1	Algorithms - Sorting	Applications of Linked List	Applications of Stack- Nested Function Calls	Binary Tree Traversal	Shortest Path Algorithm- Introduction
	SLO-2	Complexity – Time , Space Trade off	Polynomial Arithmetic	Recursion concept using stack	Threaded Binary Tree	Shortest Path Algorithm: Dijkstra's Algorithm
S-7	SLO-1	Mathematical notations	Cursor Based Implementation – Methodology	Applications of Recursion:Tower of Hanoi	Binary Search Tree :Construction, Searching	Hashing: Hash functions - Introduction
	SLO-2	Asymptotic notations-Big O, Omega	Cursor Based Implementation	Queue ADT	Binary Search Tree : Insertion and Deletion	Hashing: Hash functions

S-8	SLO-1	*Asymptotic notations - Theta*	*Circular Linked List*	*Queue Implementation using array*	*AVLTrees: Rotations*	*Hashing : Collision avoidance*
	SLO-2	*Mathematical functions*	*Circular Linked List - Implementation*	*Queue Implementation using Linked List*	*AVL Tree: Insertions*	*Hashing : Separate chaining*
S 9-10	SLO-1	*Lab 2: Implementation of sorting Techniques – Insertion sort and Bubble Sort Techniques*	*Lab 5: Implementation of Linked List - Cursor Based Implementation*	*Lab 8: Implementation of Queue using Array and linked list*	*Lab 11: Implementation of BST using linked list*	*Lab 14 :Implementation of Shortest path Algorithm*
	SLO-2					
S-11	SLO-1	*Data Structures and its Types*	*Applications of Circular List -Joseph Problem*	*Circular Queue*	*B-Trees Constructions*	*Open Addressing*
	SLO-2	*Linear and Non-Linear Data Structures*	*Doubly Linked List*	*Implementation of Circular Queue*	*B-Trees Search*	*Linear Probing*
S-12	SLO-1	*1D, 2D Array Initialization using Pointers*	*Doubly Linked List Insertion*	*Applications of Queue*	*B-Trees Deletions*	*Quadratic probing*
	SLO-2	*1D, 2D Array Accessing usingPointers*	*Doubly Linked List Insertion variations*	*Double ended queue*	*Splay Trees*	*Double Hashing*
S-13	SLO-1	*Declaring Structure and accessing*	*Doubly Linked List Deletion*	*Priority Queue*	*Red Black Trees*	*Rehashing*
	SLO-2	*Declaring Arrays of Structures and accessing*	*Doubly Linked List Search*	*Priority Queue - Applications*	*Red Black Trees Insertion*	*Extensible Hashing*
S 14-15	SLO-1	*Lab 3: Implement Structures using Pointers*	*Lab 6: Implementation of Doubly linked List*	*Lab 9: Applications of Stack, Queue*	*Lab 12:Implementation of B-Trees*	*Lab 15 :Implementation of Minimal Spanning Tree*
	SLO-2					

Learning Resources	1. *Seymour Lipschutz, Data Structures with C, McGraw Hill, 2014* 2. *R.F.Gilberg, B.A.Forouzan, Data Structures, 2nd ed., Thomson India, 2005* 3. *A.V.Aho, J.E Hopcroft , J.D.Ullman, Data structures and Algorithms, Pearson Education, 2003* 4. *Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2nd ed., Pearson Education, 2015*	5. *Reema Thareja, Data Structures Using C, 1st ed., Oxford Higher Education, 2011* 6. *Thomas H Cormen, Charles E Leiserson, Ronald L Revest, Clifford Stein, Introduction to Algorithms 3rd ed., The MIT Press Cambridge, 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	*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. Dr. Nagaveer, CEO, Campus Corporate Connect,nagaveer@campuscorporateconnect.com	*1. Dr. Srinivasa Rao Bakshi, IITM, Chennai, sbakshi@iitm.ac.in*	*1. Mr. K. Venkatesh, SRMIST*
2. Dr. Sricharan Srinivasan, Wipro Technologies, sricharanms@gmail.com	*2. Dr. Ramesh Babu, N , nrbabu@iitm.ac.in*	*2. Dr.Subalalitha C.N, SRMIST*
	3. Dr.Noor Mahammad, IIITDM, Kancheepuram,noor@iiitdm.ac.in	*3. Ms. Ferni Ukrit, SRMIST*

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

Pre-requisite Courses	*18ECC102J or 18ECC211J*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	Electronics and Communication Engineering	**Data Book / Codes/Standards**	*Nil*		

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

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

Module		**1**	**2**	**3**	**4**	**5**
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 SLO-2	*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*
S-6	SLO-1	*AC performance characteristics of op-amp*	*V-to-I Converters*	*IC 555 Timer: Circuit schematic*	*Design of Band Reject Filters*	*Inverted R-2R Ladder DAC*
	SLO-2	*Solving Problems*	*I-to-V converters*	*Operation and its applications*	*Solving problems*	*Monolithic DAC*
S-7	SLO-1	*Frequency response*	*Differentiators*	*IC 555 Timer: Monostable operation*	*State Variable Filters – All Pass Filters,*	*Analog to Digital conversion: ADC specifications*
	SLO-2	*Frequency response*	*Integrators*	*Applications & Solving problems*	*Solving problems*	*Solving problems*

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

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

Learning Assessment

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

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

Course Designers

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

Course Code	18CSC202J	Course Name	OBJECT ORIENTED DESIGN AND PROGRAMMING	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18CSS101J	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Science and Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Utilize class and build domain model for real-time programs			
CLR-2 :	Utilize method overloading and operator overloading for real-time application development programs			
CLR-3 :	Utilize inline, friend and virtual functions and create application development programs			
CLR-4 :	Utilize exceptional handling and collections for real-time object oriented programming applications			
CLR-5 :	Construct UML component diagram and deployment diagram for design of applications			
CLR-6 :	Create programs using object oriented approach and design methodologies for real-time application development			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	Identify the class and build domain model	3	80	70	H	H	M	-	-	-	-	-	H	H	-	-	M	H	H
CLO-2 :	Construct programs using method overloading and operator overloading	3	85	75	H	H	H	H	H	-	M	-	H	H	-	-	M	H	H
CLO-3 :	Create programs using inline, friend and virtual functions, construct programs using standard templates	3	75	70	H	H	M	H	H	-	M	-	H	H	-	-	M	H	H
CLO-4 :	Construct programs using exceptional handling and collections	3	85	80	H	H	H	-	-	-	-	-	H	M	-	-	M	H	H
CLO-5 :	Create UML component diagram and deployment diagram	3	85	75	H	M	M	M	M	M	M	-	H	H	-	M	M	H	H
CLO-6 :	Create programs using object oriented approach and design methodologies	3	80	70	H	H	M	-	-	-	-	-	H	H	-	-	M	H	H

Module		1	2	3	4	5
Duration (hour)		15	15	15	15	15
S-1	SLO-1	Comparison of Procedural and Object Oriented Programming	Types of constructor (Default, Parameter)	Feature Inheritance: Single and Multiple	Generic - Templates : Introduction	STL: Containers: Sequence and Associative Container
	SLO-2	OOPS and its features	Static constructor and copy constructor	Inheritance: Multilevel	Function templates	
S-2	SLO-1	I/O Operations, Data Types, Variables, static	Feature Polymorphism: Constructor overloading	Inheritance: Hierarchical	Example programs Function templates	Sequence Container: Vector, List
	SLO-2	Constants, Pointers, Type Conversions	Method Overloading	Inheritance: Hybrid	Class Templates	Sequence Container: Deque, Array
S-3	SLO-1	Features: Class and Objects	Example for method overloading	Inheritance: Example Programs	Class Templates	STL : Stack
	SLO-2	UML Diagrams Introduction	Method Overloading: Different parameter with different return values		Example programs for Class and Function templates	
S 4-5	SLO-1 / SLO-2	Lab 1: I/O operations	Lab 4: Constructor and Method overloading	Lab 7: Inheritance and its types	Lab 10: Templates	Lab 13: STL Containers
S-6	SLO-1	Feature :Class and Objects	Operator Overloading and types	Advanced Functions: Inline, Friend	Exceptional Handling: try and catch	Associative Containers: Map, Multimap
	SLO-2	Examples of Class and Objects	Overloading Assignment Operator	Advanced Functions: Virtual, Overriding	Exceptional Handling: Multilevel exceptional	
S-7	SLO-1	UML Class Diagram and its components	Overloading Unary Operators	Advanced Function: Pure Virtual function	Exceptional Handling: throw and throws	Iterator and Specialized iterator
	SLO-2	Class Diagram relations and Multiplicity	Example for Unary Operator overloading	Example for Virtual and pure virtual function	Exceptional Handling: finally	Functions of iterator
S-8	SLO-1	Feature Abstraction and Encapsulation	Overloading Binary Operators	Abstract class and Interface	Exceptional Handling: User defined exceptional	Algorithms: find(), count(), sort()

	SLO-2	*Application of Abstraction and Encapsulation*	*Example for Binary Operator overloading*	*Example Program*	*Example Programs using C++*	*Algorithms: search(), merge()*
S 9-10	SLO-1	*Lab 2: Classes and Objects, Class Diagram*	*Lab 5: Polymorphism : Operators Overloading*	*Lab 8: Virtual Function and Abstract class*	*Lab 11: Exceptional Handling*	*Lab 15: STL Associative containers and algorithms*
	SLO-2					
S-11	SLO-1	*Access specifiers – public, private*	*UML Interaction Diagrams*	*UML State Chart Diagram*	*Dynamic Modeling: Package Diagram*	*Function Object : for_each(), transform()*
	SLO-2	*Access specifiers - protected, friend, inline*	*Sequence Diagram*	*UML State Chart Diagram*	*UML Component Diagram*	*Example for Algorithms*
S-12	SLO-1	*UML use case Diagram, use case, Scenario*	*Collaboration Diagram*	*Example State Chart Diagram*	*UML Component Diagram*	*Streams and Files: Introduction*
	SLO-2	*Use case Diagram objects and relations*	*Example Diagram*	*UML Activity Diagram*	*UML Deployment Diagram*	*Classes and Errors*
S-13	SLO-1	*Method, Constructor and Destructor*	*Feature: Inheritance*	*UML Activity Diagram*	*UML Deployment Diagram*	*Disk File Handling Reading Data and Writing Data*
	SLO-2	*Example program for constructor*	*Inheritance and its types*	*Example Activity Diagram*	*Example Package, Deployment, Package*	
S 14-15	SLO-1	*Lab 3: Methods and Constructor, Usecase*	*Lab 6: UML Interaction Diagram*	*Lab 9: State Chart and Activity Diagram*	*Lab12 : UML Component, Deployment, Package diagram*	*Lab15: Streams and File Handling*
	SLO-2					

Learning Resources	1. *Grady Booch, Robert A. Maksimchuk, Michael W. Engle, Object-Oriented Analysis and Design with Applications, 3rd ed., Addison-Wesley, May 2007* 2. *Reema Thareja, Object Oriented Programming with C++, 1st ed., Oxford University Press, 2015* 3. *Sourav Sahay, Object Oriented Programming with C++, 2nd ed., Oxford University Press, 2017*	4. *Robert Lafore, Object-Oriented Programming in C++, 4th ed., SAMS Publishing, 2008* 5. *Ali Bahrami, Object Oriented Systems Development", McGraw Hill, 2004* 6. *Craig Larmen, Applying UML and Patterns, 3rd ed., Prentice Hall, 2004*

Learning Assessment

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

For the laboratory component the students are advised to take an application and apply the concepts

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Girish Raghavan, Senior DMTS Member, Wipro Ltd.	*1. Dr. Srinivasa Rao Bakshi, IITM Chennai, sbakshi@iitm.ac.in*	*1. Ms. C.G.Anupama, SRMIST*
Ms. Thamilchelvi, Solutions Architect, Wipro Ltd	*2. Dr. Ramesh Babu, N, IITM Chennai, nrbabu@iitm.ac.in*	*2. Mr. C.Arun, SRMIST*
		3. Mr. Geogen George, SRMIST
		4. Mr. Muthukumaran, SRMIST

Course Code	18CSC203J	Course Name	COMPUTER ORGANIZATION AND ARCHITECTURE	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

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

course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize the functional units of a computer
CLR-2 :	Analyze the functions of arithmetic Units like adders, multipliers etc.
CLR-3 :	Understand the concepts of Pipelining and basic processing units
CLR-4 :	Study about parallel processing and performance considerations.
CLR-5 :	Have a detailed study on Input-Output organization and Memory Systems.
CLR-6 :	Simulate simple fundamental units like half adder, full adder etc

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	Identify the computer hardware and how software interacts with computer hardware	2	80	70	H	H	-	-	-	-	-	-	M	L	-	M	-	-	-
CLO-2 :	Apply Boolean algebra as related to designing computer logic, through simple combinational and sequential logic circuits	3	85	75	H	H	H	-	H	-	-	-	M	L	-	M	-	-	-
CLO-3 :	Analyze the detailed operation of Basic Processing units and the performance of Pipelining	2	75	70	H	H	H	H	-	-	-	-	M	L	-	M	-	-	-
CLO-4 :	Analyze concepts of parallelism and multi-core processors.	3	85	80	H	-	-	H	-	-	-	-	M	L	-	M	-	-	-
CLO-5 :	Identify the memory technologies, input-output systems and evaluate the performance of memory system	3	85	75	H	-	H	H	-	-	-	-	M	L	-	M	-	-	-
CLO-6 :	Identify the computer hardware, software and its interactions	3	85	75	H	H	H	H	H	-	-	-	M	L	-	M	-	-	-

Module		1	2	3	4	5
Duration (hour)		15	15	15	15	15
S-1	SLO-1	Functional Units of a computer	Addition and subtraction of Signed numbers	Fundamental concepts of basic processing unit	Parallelism	Memory systems -Basic Concepts
	SLO-2	Operational concepts	Problem solving	Performing ALU operation	Need, types of Parallelism	Memory hierarchy
S-2	SLO-1	Bus structures	Design of fast adders	Execution of complete instruction, Branch instruction	applications of Parallelism	Memory technologies
	SLO-2	Memory locations and addresses	Ripple carry adder and Carry look ahead adder	Multiple bus organization	Parallelism in Software	RAM, Semiconductor RAM
S-3	SLO-1	Memory operations	Multiplication of positive numbers	Hardwired control	Instruction level parallelism	ROM,Types
	SLO-2	Memory operations	Problem Solving	Generation of control signals	Data level parallelism	Speed,size cost
S 4-5	SLO-1	Lab 1: To recognize various components of PC-Input Output systems Processing and Memory units	Lab4:Study of TASM Addition and Subtraction of 8-bit number	Lab-7: Design of Half Adder Design of Full Adder	Lab-10: Study of Array Multiplier Design of Array Multiplier	Lab-13: Study of Carry Save Multiplication Program to carry out Carry Save Multiplication
	SLO-2					
S-6	SLO-1	Instructions, Instruction sequencing	Signed operand multiplication	Micro-programmed control-	Challenges in parallel processing	Cache memory
	SLO-2	Addressing modes	Problem solving	Microinstruction	Architectures of Parallel Systems - Flynn's classification	Mapping Functions
S-7	SLO-1	Problem solving	Fast multiplication- Bit pair recoding of Multipliers	Micro-program Sequencing	SISD,SIMD	Replacement Algorithms

	SLO-2	*Introduction to Microprocessor*	*Problem Solving*	*Micro instruction with Next address field*	*MIMD, MISD*	*Problem Solving*
S-8	SLO-1	*Introduction to Assembly language*	*Carry Save Addition of summands*	*Basic concepts of pipelining*	*Hardware multithreading*	*Virtual Memory*
	SLO-2	*Writing of assembly language programming*	*Problem Solving*	*Pipeline Performance*	*Coarse Grain parallelism, Fine Grain parallelism*	*Performance considerations of various memories*
S 9-10	SLO-1	*Lab-2:To understand how different components of PC are connected to work properly*	*Lab 5: Addition of 16-bit number Subtraction of 16-bit number*	*Lab-8: Study of Ripple Carry Adder Design of Ripple Carry Adder*	*Lab-11: Study of Booth Algorithm*	*Lab-14: Understanding Processing unit Design of primitive processing unit*
	SLO-2	*Assembling of System Components*				
S-11	SLO-1	*ARM Processor: The thumb instruction set*	*Integer division – Restoring Division*	*Pipeline Hazards-Data hazards*	*Uni-processor and Multiprocessors*	*Input Output Organization*
	SLO-2	*Processor and CPU cores*	*Solving Problems*	*Methods to overcome Data hazards*	*Multi-core processors*	*Need for Input output devices*
S-12	SLO-1	*Instruction Encoding format*	*Non Restoring Division*	*Instruction Hazards*	*Multi-core processors*	*Memory mapped IO*
	SLO-2	*Memory load and Store instruction in ARM*	*Solving Problems*	*Hazards on conditional and Unconditional Branching*	*Memory in Multiprocessor Systems*	*Program controlled IO*
S-13	SLO-1	*Basics of IO operations.*	*Floating point numbers and operations*	*Control hazards*	*Cache Coherency in Multiprocessor Systems*	*Interrupts-Hardware, Enabling and Disabling Interrupts*
	SLO-2	*Basics of IO operations.*	*Solving Problems*	*Influence of hazards on instruction sets*	*MESI protocol for Multiprocessor Systems*	*Handling multiple Devices*
S 14-15	SLO-1	*Lab -3To understand how different components of PC are connected to work properly*	*Lab-6: Multiplication of 8-bit number Factorial of a given number*	*Lab-9: Study of Carry Look-ahead Adder Design of Carry Look-ahead Adder*	*Lab-12: Program to carry out Booth Algorithm*	*Lab-15: Understanding Pipeline concepts Design of basic pipeline.*
	SLO-2	*Disassembling of System Components*				

Learning Resources	1. *Carl Hamacher, ZvonkoVranesic, SafwatZaky, Computer Organization, 5th ed., McGraw-Hill, 2015* 2. *Kai Hwang, Faye A. Briggs, Computer Architecture and Parallel Processing", 3rd ed., McGraw Hill, 2016* 3. *Ghosh T. K., Computer Organization and Architecture, 3rd ed., Tata McGraw-Hill, 2011* 4. *P. Hayes, Computer Architecture and Organization, 3rd ed., McGraw Hill, 2015.*	5. *William Stallings, Computer Organization and Architecture – Designing for Performance, 10th ed., Pearson Education, 2015* 6. *David A. Patterson and John L. Hennessy Computer Organization and Design - A Hardware software interface, 5th ed., Morgan Kaufmann,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	*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. *T. V. Sankar, HCL Technologies Ltd, Chennai, sankar_t@hcl.com*	*1. Prof. A.P. Shanthi, ANNA University Chennai, a.p.shanthi@cs.annauniv.edu*	*1.Dr. V. Ganapathy, SRMIST*
		2. Dr. C. Malathy, SRMIST
		3. Mrs M.S.Abirami, SRMIST

Course Code	18ECC311J	Course Name	MICROCONTROLLERS AND INTERFACING	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18ECC212J	Co-requisite Courses	Nil	Progressive Courses	18ECC411J
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

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

		Learning
		1
CLR-1 :	Studying 8086 microprocessor architecture and interfacing signals, forms a strong basic for designing processor based systems.	
CLR-2 :	Learn 8051 microcontroller architecture and programming	
CLR-3 :	8051 chips are used in a wide variety of control systems, telecom applications, robotics as well as in the automotive industry. Interfacing 8051 with peripherals is necessary for building the above applications.	
CLR-4 :	PIC microcontrollers (Programmable Interface Controllers), are electronic circuits that can be programmed to carry out a vast range of tasks.	
CLR-5 :	PIC microcontrollers are used in different new applications such as smart phones, audio accessories and advanced medical devices.	

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

		Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking(Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	Understand 8086 microprocessor and do simple programs.	2	80	70	M														
CLO-2 :	Design and develop 8051 programs in assembly and C	3	80	70	L	H	H	M	M										
CLO-3 :	Paraphrasing 8051 interfacing and design small systems.	2	80	70															
CLO-4 :	Understand PIC Microcontroller and its Peripherals	3	80	60		H	H												
CLO-5 :	Design hardware circuit and program software for specific applications using PIC microcontroller	3	80	60		H	H	M	M										

Module		8051 Microcontroller	8051 peripherals	External peripheral interfacing	PIC microcontroller	PIC peripheral Interfacing
Duration (hour)		15	15	15	15	15
S-1	SLO-1	Basics of Microprocessor	Comparisons between Microprocessors and microcontroller	LCD interfacing	PIC Architecture	Timers
	SLO-2	Basics of Microprocessor	8051 architecture, Pin functions	LCD interfacing	Registers organization	Interrupts
S-2	SLO-1	*8086 registers and its functions*	Memory organization	Keyboard interfacing	Memory organization	I/O ports
	SLO-2	*8086 registers and its functions*	Special Function Registers	Keyboard interfacing	**Addressing modes**	I2C bus
S-3	SLO-1	Instruction set of 8086 and simple programs	Instruction set-classification	Interfacing with external ROM	Instruction set: classification	LCD Interfacing
	SLO-2	Instruction set of 8086 and simple programs	Instruction set-addressing modes	Interfacing with external RAM	logical operation	LCD Interfacing
S 4-5	SLO-1	*Lab 1: Program(s) to demonstrate data transfer operation, logical operation*	Lab 4 : Program(s) – Basic Assembly language programming	*Lab 7 :Interfacing LED / 7-segment / LCD displays/ keyboard*	*Lab 10: Program(s) to demonstrate logical operation*	*Lab 13: Interfacing LCD displays*
	SLO-2					
S-6	SLO-1	*Microprocessor bus, and signals*	C Programming	ADC interfacing	Arithmetic operation	CCP modules
	SLO-2	*Microprocessor bus, and signals*	C Programming	ADC interfacing	Arithmetic operation	Flash and EPROMS
S-7	SLO-1	8086 Hardware architecture	I/O programming	DAC interfacing	branching	ADC Interfacing
	SLO-2	8086 Hardware architecture	I/O programming	DAC interfacing	branching	ADC Interfacing

S-8	SLO-1	Min mode system configuration	Timer programming	Sensor interfacing	time delay loop	DAC Interfacing
	SLO-2	Min mode system configuration	Timer programming	sensor interfacing	time delay loop	DAC Interfacing
S 9-10	SLO-1	*Lab 2: Program(s) to demonstrate arithmetic operation, shift operation*	Lab 5: Program(s) Timer and counter	*Lab 8: Interfacing ADC / DAC*	*Lab 11:Program(s) to demonstrate arithmetic operation*	*Lab 14 : Interfacing ADC / DAC*
	SLO-2					
S-11	SLO-1	*Max mode system configuration*	Programming the 8051 to transfer data serially	Stepper motor interfacing	CALL	PIC timer programming
	SLO-2	*Max mode system configuration*	Programming the 8051 to receive data serially	Stepper motor interfacing	CALL	serial port programming
S-12	SLO-1	Advanced instructions,	8051 interrupts	DC motor interfacing	Programming in assembly	serial port programming
	SLO-2	Interrupt processing	Programming timer interrupts	DC motor interfacing	Programming in assembly	interrupt programming
S-13	SLO-1	HALT and WAIT for test states	Programming external hardware interrupts	DS12887 RTC interfacing	Programming in Embedded C	CCP programming
	SLO-2	DMA	Programming serial communication interrupts	DS12887 RTC interfacing	Programming in Embedded C	CCP programming
S 14-15	SLO-1	*Lab 3: Program(s) to demonstrate decision making and looping operation*	Lab 6: Program(s) – Serial communication using interrupt	*Lab 9: Interfacing DC motor / stepper motor / servo motor*	*Lab 12:Program(s) to demonstrate CALL function*	*Lab 15 Program(s)Timer / Serial / Interrupt / CCP*
	SLO-2					

Learning Resources

1. *Krishna Kant, "Microprocessor and Microcontrollers, Architecture, Programming and System Design 8085, 8086, 8051, 8096", PHI, 2011.*
2. *Muhammad Ali Mazidi and Janice GillispieMazidi, "The 8051 - Microcontroller and Embedded systems", 7th Edition, Pearson Education, 2011.*
3. *Kenneth.J.Ayala, "8051 Microcontroller Architecture, Programming and Applications", 3rd edition, Thomson, 2007*
4. *Subrataghoshal " 8051 Microcontroller Internals Instructions ,Programming And Interfacing",2nd edition Pearson 2010*
5. *Muhammad Ali Mazidi-Rolin-D-Muckinlay, Danny Caussey. "PIC MICROCONTROLLER AND EMBEDDED SYSTEM USING ASSEMBLY AND C FOR PIC 18"*
6. *John B Beatman. "DESIGN WITH PIC MICROCONTROLLERS" prentice Hall*

Learning Assessment

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

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

Course Designers

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

Course Code	18CSC303J	Course Name	DATABASE MANAGEMENT SYSTEMS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

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

course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Understand the fundamentals of Database Management Systems, Architecture and Languages
CLR-2 :	Conceive the database design process through ER Model and Relational Model
CLR-3 :	Design Logical Database Schema and mapping it to implementation level schema through Database Language Features
CLR-4 :	Familiarize queries using Structure Query Language (SQL) and PL/SQL
CLR-5 :	Familiarize the Improvement of the database design using normalization criteria and optimize queries
CLR-6 :	Understand the practical problems of concurrency control and gain knowledge about failures and recovery

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	Learning 2 Expected Proficiency (%)	Learning 3 Expected Attainment (%)
CLO-1 :	Acquire the knowledge on DBMS Architecture and Languages	3	80	70
CLO-2 :	Apply the fundamentals of data models to model an application's data requirements using conceptual modeling tools like ER diagrams	3	85	75
CLO-3 :	Apply the method to convert the ER model to a database schemas based on the conceptual relational model	3	75	70
CLO-4 :	Apply the knowledge to create, store and retrieve data using Structure Query Language (SQL) and PL/SQL	3	85	80
CLO-5 :	Apply the knowledge to improve database design using various normalization criteria and optimize queries	3	85	75
CLO-6 :	Appreciate the fundamental concepts of transaction processing- concurrency control techniques and recovery procedures	3	85	75

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

Module		1	2	3	4	5
Duration (hour)		15	15	15	15	15
S-1	SLO-1	What is Database Management System	Database Design	Basics of SQL-DDL,DML,DCL,TCL	Relational Algebra – Fundamental Operators and syntax, relational algebra queries, Tuple relational calculus	Transaction concepts, properties of transactions,
	SLO-2	Advantage of DBMS over File Processing System	Design process	Structure Creation, alternation		
S-2	SLO-1	Introduction and applications of DBMS	Entity Relation Model	Defining Constraints-Primary Key, Foreign Key, Unique, not null, check, IN operator		serializability of transactions,
	SLO-2	Purpose of database system				testing for serializability, System recovery,
S-3	SLO-1	Views of data	ER diagram	Functions-aggregation functions	Pitfalls in Relational database, Decomposing bad schema	Concurrency Control
	SLO-2			Built-in Functions-numeric, date, string functions, string functions, Set operations,	Functional Dependency – definition, trivial and non-trivial FD	
S 4-5	SLO-1	Lab 1: SQL Data Definition Language Commands on sample exercise	Lab4 : Inbuilt functions in SQL on sample exercise.	Lab 7 : Join Queries on sample exercise.	Lab10: PL/SQL Procedures on sample exercise.	Lab 13: PL/SQL Exception Handling
	SLO-2	* The abstract of the project to construct database must be framed		* Frame and execute the appropriate DDL,DML,DCL,TCL for the project	* Frame and execute the appropriate Join Queries for the project	* Frame and execute the appropriate PL/SQL Procedures and Functions for the project
S-6	SLO-1	Database system Architecture	Keys , Attributes and Constraints	Sub Queries, correlated sub queries	closure of FD set , closure of attributes	Two- Phase Commit protocol, Recovery and Atomicity
	SLO-2				irreducible set of FD	
S-7	SLO-1	Data Independence	Mapping Cardinality	Nested Queries, Views and its Types	Normalization – 1Nf, 2NF, 3NF,	Log-based recovery
	SLO-2					
S-8	SLO-1	The evolution of Data Models	Extended ER - Generalization,	Transaction Control Commands	Decomposition using FD- dependency	concurrent executions of transactions and
	SLO-2		Specialization and Aggregation	Commit, Rollback, Savepoint	preservation,	related problems
	SLO-1	Lab 2: SQL Data Manipulation Language	Lab 5: Construct a ER Model for the	Lab 8: Set Operators & Views.	Lab 11: PL/SQL Functions	Lab 14: PL/SQL Trigger

S 9-10	SLO-2	*Commands * Identification of project Modules and functionality*	*application to be constructed to a Database*	** Frame and execute the appropriate In-Built functions for the project*	** Frame and execute the appropriate Set Operators & Views for the project*	** Frame and execute the appropriate PL/SQL Cursors and Exceptional Handling for the project*
	SLO-1		*ER Diagram Issues*	*PL/SQL Concepts- Cursors*	*BCNF*	*Locking mechanism, solution to concurrency related problems*
S-11	SLO-2	*Degrees of Data Abstraction*	*Weak Entity*			
	SLO-1			*Stored Procedure, Functions Triggers and Exceptional Handling*	*Multi- valued dependency,*	*Deadlock*
S-12	SLO-2	*Database Users and DBA*	*Relational Model*		*4NF*	
	SLO-1			*Query Processing*	*Join dependency and 5NF*	*two-phase locking protocol, Isolation, Intent locking*
S-13	SLO-2	*Database Languages*	*Conversion of ER to Relational Table*			
	SLO-1	*Lab 3: SQL Data Control Language Commands and Transaction control commands to the sample exercises*	*Lab 6: Nested Queries on sample exercise*	*Lab9: PL/SQL Conditional and Iterative Statements*	*Lab 12: PL/SQL Cursors*	*Lab 15 : * Frame and execute the appropriate PL/SQL Cursors and Exceptional Handling for the project * Demo of the project*
S 14-15	SLO-2	** Identify the issues that can arise in a business perspective for the application*	** Construction of Relational Table from the ER Diagram*	** Frame and execute the appropriate Nested Queries for the project*	** Frame and execute the appropriate PL/SQL Conditional and Iterative Statements for the project*	

Learning Resources	1. *Abraham Silberschatz, Henry F. Korth, S. Sudharshan, Database System Concepts*ll*, Sixth Edition, Tata McGraw Hill,2011.* 2. *Ramez Elmasri, Shamkant B. Navathe, Fundamentals of Database Systems*ll*, Sixth Edition, Pearson Education,2011.* 3. *CJ Date,A Kannan,S Swamynathan, An Introduction to Database Systems, Eight Edition, Pearson Education,2006.* 4. *Rajesh Narang, Database Management Systems, 2nd ed., PHI Learning Private Limited,2011.*	4. *Martin Gruber, Understanding SQL, Sybex,1990* 5. *SharadMaheshwari,IntroductiontoSQLandPL/SQL,2ded.,LaxmiPublications,2016.* 6. *RaghuramaKrishnan,JohannesGehrke,DatabaseManagementSystems,3rdEdition,McGrawHill Education,2003.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember / 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, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.Mariappan Vaithilingam, Engineering Leader *Amazon, dr.v.m@ieee.org*		*1. Ms. Sasi Rekha Sankar SRMIST*
2. Mr. Badinath, SDET, Amzon, sbadhrinath@gmail.com		*2. Mr.Elizer, SRMIST*

Course Code	18ECC312T	Course Name	HARDWARE INTERFACING AND NETWORKING	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Prerequisite 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 :	CAN is widely used wired quasi real time network; it is essential to know about the standard, electrical requirements and signaling
CLR-2 :	CANopen is an industry standard application protocol used with CAN as underlying layer. It is used in many industrial controllers
CLR-3 :	LIN bus, MODBUS, ProfiBus are widely used automotive networks; they also appear along with CAN.
CLR-4 :	Flexray protocol is a latest sophisticated protocol standard for use in automotive control networks.
CLR-5 :	Automotive Ethernet is an emerging networking in automotive applications. As an upcoming field it is essential to know about it and acquire basic skills.
CLR-6 :	Understand the practical problems of concurrency control and gain knowledge about failures and recovery

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning: Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLO-1 :	Know and understand the CAN electrical, mechanical standards and signaling methods.	3	80	70
CLO-2 :	Know and understand the CANopen protocol and will be able to analyze a typical application.	3	85	75
CLO-3 :	Know and understand the LINbus, MODBUS, and Profibus protocols and the software interfacing	3	75	70
CLO-4 :	Know and understand the Flexray protocol, its application using software interfaces in "C", study corresponding support hardware chips	3	85	80
CLO-5 :	Know and understand the Automotive Ethernet, its specific EMI, EMC requirements as applied to automotive environment, study corresponding support hardware chips.	3	85	75

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

Module		CAN bus Introduction Module 1	CAN and CANopen Module 2	Profibus, LINbus, MODBUS Module 3	Flexray Protocol Module 4	Automotive Ethernet Module 5
Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction to CAN	CANopen overview	Profibus, network topologies	Introduction to Flexray	Intro to Automotive networking
	SLO-2	Electrical properties	CANopen overview	Profibus, network topologies	Bus architectures	Intro to Automotive networking
S-2	SLO-1	CAN signaling and data rates	Communication requirements for embedded networking	Network configuration	Protocol operation control context	Electrical requirements
	SLO-2	CAN signaling and data rates	Communication requirements for embedded networking	Network configuration	Operational overview	Electrical requirements
S-3	SLO-1	CAN data frame format	The object dictionary concept	Active components	Protocol operation control process	Network layer protocols. TCP/IP, UDP
	SLO-2	CAN data frame format	The object dictionary concept	Active components	Protocol operation control process	Network layer protocols. TCP/IP, UDP
S-4	SLO-1	Collision and arbitration	Communication entries	Passive components: connectors, cables, etc.	Behavior during normal operation	Ports and sockets
	SLO-2	Design examples	SDO and PDO	Testing of profibus	Coding and decoding	Ports and sockets
S-5	SLO-1	Error handling	SDO and PDO	LIN bus basics	Coding and decoding	Ports and sockets
	SLO-2	Error state diagram	PDO linking	LIN bus basics	Flexray Payload	Ports and sockets
S-6	SLO-1	CAN controller block diagram and working	Identifying objects COB-ID	LINbus protocol; master slave configuration	Wakeup and startup	Audio, video bridging
	SLO-2	CAN controller block diagram and working	EDS and DCF	LINbus protocol; master slave configuration	Wakeup and startup	Audio, video bridging
S-7	SLO-1	Software for CAN controller interfacing	PDO communication	Basics of MODBUS	Clock synchronization	Audio/Video transport protocol - IEEE1722
	SLO-2	Software for CAN controller interfacing	PDO communication	Basics of MODBUS	Clock synchronization	Audio/Video transport protocol
S-8	SLO-1	CAN development tools	SDO communication	MODBUS protocol	Controller host interface	Measurement, calibration, diagnostics

	SLO-2	*CAN development tools*	*SDO communication*	*MODBUS protocol*	*Controller host interface*	*Measurement, calibration, diagnostics*
S-9	*SLO-1*	*Demonstration of a typical CAN connection*	*Network management and safety critical features*	*MODBUS application*	*System parameters*	*Case studies*
	SLO-2	*Demonstration of a typical CAN connection*	*Network management and safety critical features*	*MODBUS application*	*System parameters*	*Case studies*

Learning Resources	1. *Olaf Pfeiffer, Andrew Ayre and Christian Keydel, "Embedded networking with CAN and CANopen", Copper hill Technologies Corporation, 2008.* 2. *Reference: www.can-cia.org"* 3. *SGS-Thompson, "Lin Application note AN1278", SGS - Thompson Ltd,. 2002.* 4. *Modbus-IDA, "MODBUS application protocol specification", Modbus-IDA, 2006.* 5. *Siemens, "Profibus network manual", Siemens manual, 2009.* 6. *Xiu Ji, "Profibus in practice: System Architecture and Design", CRC press, 2015.*	7. *Domnique parot, "Flexray and its applications: Real time multiplexed network", Wiley online library, 2012.* 8. *Charles M. Kozierok, Colt Correa, Robert B. Boatright, Jeffery Quesnelle, "Automotive Ethernet: A definitive guide", Intrepid Control Systems, 2014.* 9. *FlexRay Consortium, "FelxRay Communication system: Protocol specifications", FexRay Consortium, 2010.*

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

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

Course Designers		
Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*1. Dr. Meenakshi, Professor of ECE, CEG, Anna University,*	*1. Prof. V. Natarajan SRMIST*
2.Dr.Mariappan Vaithilingam, Engineering Leader Amazon, dr.v.m@ieee.org	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECC313J	Course Name	EMBEDDED HARDWARE AND OPERATING SYSTEMS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18ECC311J	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/ Standards	Data catalog of MSP420 or any other M-CORTEX uP		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Embedded system functions have become complex.
CLR-2 :	Embedded systems has high end processors of many varieties
CLR-3 :	To implement complex requirements with simple coding is becoming difficult. Hence operating systems are needed.
CLR-4 :	To study and design processor based embedded systems along with OS implementation. (Specifically RTOS)

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning: Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLO-1 :	Read and understand many microprocessor instruction sets and their use.	3	80	70
CLO-2 :	To implement and write code in assembly and C for embedded applications.	3	85	75
CLO-3 :	Understand the concepts and requirements of RTOS, in general basic OS principles.	3	75	70
CLO-4 :	The implementation and use of RTOS for embedded programs	3	85	80
CLO-5 :	Gain knowledge in related sample use cases.	3	85	75

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

Module		Microprocessor and Microcontroller Module 1	I/O Programming Module 2	Thread Management Module 3	Time Management Module 4	Case Studies Module 5
Duration (hour)		15	15	15	15	15
S-1	SLO-1	Cortex-M processor architecture	Parallel I/O programming	Introduction to RTOS	Spin-lock semaphore	Real time systems: Data acquisition system
	SLO-2	Cortex-M processor architecture	Sample programs	Introduction to RTOS	Cooperative scheduler	Approach
S-2	SLO-1	Cortex-M processor architecture	Interrupt processing basics	Concurrent programming	Blocked state	Performance metrics
	SLO-2	Cortex-M processor architecture	System tick; periodic interrupts	Thread fundamentals	Implementation	Examples
S-3	SLO-1	ARM Cortex assembly language - part1	Conditional execution	Shared resources and Critical sections	Thread rendezvous	Multilevel feedback queue
	SLO-2	Programming exercises	Conditional execution	Consumer producer problem	Example	priority scheduler
S-4	SLO-1	Practice: ARM Cortex assembly language with simulator	Practice: Interrupts and timers in C and assembly	Practice: Simple thread programming in RTOS	Practice: Two semaphore implementation	Practice: Priority based scheduling; threads and communications
	SLO-2	Practice: ARM Cortex assembly language with simulator	Practice: Interrupts and timers in C and assembly	Practice: Simple thread programming in RTOS	Practice: One semaphore implementation	Practice: Priority based scheduling; threads and communications
S-5	SLO-1	Practice: ARM Cortex assembly language with simulator	Practice: Interrupts and timers in C and assembly	Practice: Simple thread programming in RTOS	Practice: Semaphore implementation experiment in RTOS	Practice: Priority based scheduling; threads and communications
	SLO-2	Practice: ARM Cortex assembly language with simulator	Practice: Interrupts and timers in C and assembly	Practice: Simple thread programming in RTOS	Practice: Semaphore implementation experiment in RTOS	Practice: Priority based scheduling; threads and communications
S-6	SLO-1	ARM Cortex assembly language - part2	UART programming	Switching threads	FIFO & Little's theorem	DMA / high speed interface
	SLO-2	Programming exercises	UART programming	Profiling the OS	FIFO & Little's theorem	DMA / high speed interface
S-7	SLO-1	ARM Cortex microcontroller interface standards	Digital signal time measurement	Semaphores and implementation	Three semaphore implementation	Solid state disk

	SLO-2	*IDE software tools*	*Use of timers and compare, capture registers.*	*Operations on semaphores*	*Three semaphore implementation*	*Flash device driver*
S-8	*SLO-1*	*Embedded debugging tools in Keil IDE*	*SSI interface*	*Resource sharing*	*Kahn process networks*	*SD card interface*
	SLO-2	*Embedded debugging example with simulation*	*SSI interface*	*Conditional variable*	*Kahn process networks*	*SD card interface*
S-9	SLO-1	Practice: C & assembly programming using Keil IDE and kit - I	Practice: Debugging hardware with target board	Practice: Multi threaded application in RTOS	Practice: Multi threaded application with communication.	Practice: Semaphore implementation experiment in RTOS
	SLO-2	Practice: C & assembly programming using Keil IDE and kit - I	Practice: Debugging hardware with target board	Practice: Multi threaded application in RTOS	Practice: Multi threaded application with communication.	Practice: Semaphore implementation experiment in RTOS
S-10	*SLO-1*	Practice: C & assembly programming using Keil IDE and kit - I	Practice: Debugging hardware with target board	Practice: Multi threaded application in RTOS	Practice: Multi threaded application with communication.	Practice: Semaphore implementation experiment in RTOS
	SLO-2	Practice: C & assembly programming using Keil IDE and kit - I	Practice: Debugging hardware with target board	Practice: Multi threaded application in RTOS	Practice: Multi threaded application with communication.	Practice: Semaphore implementation experiment in RTOS
S-11	*SLO-1*	*Memory management -1*	*SSI programming with interrupt*	*Thread communications*	*Thread sleeping*	*Communication systems with Ethernet*
	SLO-2	*Memory management -2*	*Analog I/O; A/D converter interfacing*	*Thread communications*	*Thread sleeping*	*Communication systems with ethernet*
S-12	*SLO-1*	*Embedded debugging tools in Keil IDE*	*Programming example*	*Process management*	*Deadlocks, monitors*	*Application layer protocols for embedded systems*
	SLO-2	*Embedded debugging example with simulation*	*Programming example*	*Process management*	*Deadlocks, monitors*	*Application layer protocols for embedded systems*
S-13	*SLO-1*	*Review class*	*OS considerations of I/O devices*	*Dynamic linking and loading*	*Fixed scheduling*	*CoAP, MQTT*
	SLO-2	*Review class*	*OS considerations of I/O devices*	*Dynamic linking and loading*	*Fixed scheduling*	*CoAP, MQTT*
S-14	*SLO-1*	Practice: C & assembly programming using Keil IDE and kit – II	Practice: A/D interfacing	Practice: Program profiling	Practice: Priority based scheduling; threads and communications	Practice: Any application program using RTOS
	SLO-2	Practice: C & assembly programming using Keil IDE and kit – II	Practice: A/D interfacing	Practice: Program profiling	Practice: Priority based scheduling; threads and communications	Practice: Any application program using RTOS
S-15	*SLO-1*	Practice: C & assembly programming using Keil IDE and kit – II	Practice: A/D interfacing	Practice: Program profiling	Practice: Priority based scheduling; threads and communications	Practice: Any application program using RTOS
	SLO-2	Practice: C & assembly programming using Keil IDE and kit – II	Practice: A/D interfacing	Practice: Program profiling	Practice: Priority based scheduling; threads and communications	Practice: Any application program using RTOS

Learning Resources	1. *Jonathan Valvano, "Real time operating systems for ARM Cortex-M Microcontrollers, Embedded systems - Volume 3", Jonathan Valvano, 2017.* 2. *Andrew Sloss et all, "ARM system developers guide", Elsevier, 2004.* 3. *Quing Li, "Real time techniques for embedded systems", CMP Books, 2003.*	4. *K.C. Wang, "Embedded and Real time operating systems", Springer, 2017.* 5. *www.arm.com, for ARM cortex M references*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50%								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, 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. Prof. V. Natarajan, Professor, ECE Dept, SRMIST*
2.Dr.Mariappan Vaithilingam, Engineering Leader Amazon, dr.v.m@ieee.org	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECC411J	Course Name	FPGA based Embedded Systems	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*18ECC203J or 18ECC212J*	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 :	Many high volume embedded systems need to be function specific
CLR-2 :	These systems have to be cost effective, with short development time.
CLR-3 :	FPGAs/PSoCs are cost effective solution for specific embedded modules and low-power designs.
CLR-4 :	Platform FPGAs will find future applications.
CLR-5 :	Designing systems with Platform FPGAs is a necessary skill.

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	*Learning*		
		1	*2*	*3*
		Level of Thinking (Bloom)	*Expected Proficiency (%)*	*Expected Attainment (%)*
CLO-1 :	*Micro controller subsystem understanding*	*2*	*80*	*50*
CLO-2 :	*Understanding and designing with PSoCs*	*3*	*99*	*70*
CLO-3 :	*Understanding of Platform FPGAs*	*2*	*80*	*70*
CLO-4 :	*Understanding of FPGA architecture design*	*3*	*90*	*70*
CLO-5 :	*Designing with Platform FPGAs (examples)*	*2*	*90*	*85*

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

Module		Microcontrollers and embedded systems	PSoC3/5	Platform FPGAs	System Design – I	System Design – II
Duration (hour)		15	15	15	15	15
S-1	SLO-1	Embedded systems performance criteria - Interrupts	PSoC3/5 architecture overview	Design challenges, life cycle	Design quality: correctness, reliability, resilience.	Spatial design: Principles of parallelism
	SLO-2	Embedded systems performance criteria - Interrupts	PSoC3/5 architecture overview	Metrics: measures of success	Modules and interfaces	Granularity, degree of parallelism
S-2	SLO-1	Embedded systems performance criteria - DMA	PSoC3 architecture details and 8051 instructions	PLD basics	Abstraction and state,	Spatial organizations
	SLO-2	Latency and problems	PSoC3 architecture details and 8051 instructions	FPGA configurations	Cohesion and coupling and control flow graph	Spatial organizations
S-3	SLO-1	Embedded system subsystems: A/D conversion	PSoC C language	VHDL and Verilog intro	Origin of Platform FPGA Designs	Identifying parallelism
	SLO-2	Digital ports & its current capacity	Interrupt priority and nesting	VHDL and Verilog intro	Platform FPGA components	Ordering, dependence, uniform dependence vectors
S-4	*SLO-1*	*Practice : Keil IDE – 8051 Simulation experiment*	*Practice: PSoC 8051 simulation program in C*	*Practice: VHDL and Verilog practice session*	*Practice: Creating IP core*	*Practice: Useful VHDL topics for spatial design*
	SLO-2	*Practice : Keil IDE – 8051 Simulation experiment*	*Practice: PSoC 8051 simulation program in C*	*Practice: VHDL and Verilog practice session*	*Practice: Creating IP core*	*Practice: Useful VHDL topics for spatial design*
S-5	*SLO-1*	*Practice : Keil IDE – 8051 Simulation experiment*	*Practice: PSoC 8051 simulation program in C*	*Practice: VHDL and Verilog practice session*	*Practice: Creating IP core*	*Practice: Useful VHDL topics for spatial design*
	SLO-2	*Practice : Keil IDE – 8051 Simulation experiment*	*Practice: PSoC 8051 simulation program in C*	*Practice: VHDL and Verilog practice session*	*Practice: Creating IP core*	*Practice: Useful VHDL topics for spatial design*
S-6	SLO-1	Introduction to other digital interfaces	The concept of memory and its connectivity to CPU	Xilinx Virtex 5 IDE	Adding to platform FPGA systems	Parallelism within FGPA hardware cores within FPGA designs
	SLO-2	Introduction to other digital interfaces	External memory access	Xilinx Virtex 5 IDE	Assembling custom compute cores	Parallelism within FGPA hardware cores within FPGA designs
S-7	SLO-1	Sensors and sensing principles. Optical, capacitive sensors	Memory access priority, Direct Memory Access	Slices and CLBs	Software design: root file system, cross-developmental tools	Managing bandwidth: Balancing
	SLO-2	Magnetic, RF sensors	Different DMA modes	Various slices in Virtex 5	Monitors and bootloaders	Managing bandwidth: Balancing
S-8	SLO-1	Other sensors	Clocking system: Internal master oscillator	Bit stream	Monitors and bootloaders	Khan process network
	SLO-2	Interfacing techniques	IMO, and sleep/wake up modes	Programming FPGA	Connecting the hardware to the base system.	Khan process network
S-9	*SLO-1*	*Practice: Embedded sensors and sensing*	*Practice: PSoC 8051 simulation program in C*	*Practice: Sample programming FPGA – I*	*Practice :Hardware Integration*	*Practice: On-chip memory access, FIFOs*
	SLO-2	*Practice: Embedded sensors and sensing*	*Practice: PSoC 8051 simulation program in C*	*Practice: Sample programming FPGA - I*	*Practice :Hardware Integration*	*Practice: On-chip memory access, FIFOs*
S-10	*SLO-1*	*Practice: Embedded sensors and sensing*	*Practice: PSoC 8051 simulation program in C*	*Practice: Sample programming FPGA – I*	*Practice :Hardware Integration*	*Practice: On-chip memory access, FIFOs*
	SLO-2	*Practice: Embedded sensors and sensing*	*Practice: PSoC 8051 simulation program in C*	*Practice: Sample programming FPGA – I*	*Practice :Hardware Integration*	*Practice: On-chip memory access, FIFOs*
S-11	SLO-1	Processing: Mathematical views.	Clock distribution	Spectrometer example using Xilinx IDE	Overview of partitioning platform	Platform FPGA bandwidth techniques
	SLO-2	Processing: Mathematical views.	Internal low speed clock	Spectrometer example using Xilinx IDE	Analytical solution to partitioning	Platform FPGA bandwidth techniques
S-12	SLO-1	Micro controller subsystems	Types of reset	Sample IP core design for digital logic	Resource considerations	On-chip, off-chip memory
	SLO-2	Micro controller subsystems	Interrupts and interrupt lines	Sample IP core design for digital logic	Analytical approach	Memory access techniques
S-13	SLO-1	Programmable logic and mixed signal design fundamentals	Clock distribution	Sample IP core design for digital logic	Transfer of state	Off chip memory access: I/O, DMA.

	SLO-2	Programmable logic and mixed signal design fundamentals	Power management: Internal regulators	Sample IP core design for digital logic	Practical issues: profiling issues	Bus and bus controller
S-14	*SLO-1*	*Practice: Programmable logic design*	*Practice: PSoC 8051 simulation program in C*	*Practice: Sample programming FPGA – II*	*Practice: Building base systems*	*Practice: Block RAM, local link interface*
	SLO-2	*Practice: Programmable logic design*	*Practice: PSoC 8051 simulation program in C*	*Practice: Sample programming FPGA – II*	*Practice: Building base systems*	*Practice: Block RAM, local link interface*
S-15	*SLO-1*	*Practice: Programmable logic design*	*Practice: PSoC 8051 simulation program in C*	*Practice: Sample programming FPGA – II*	*Practice: Building base systems*	*Practice: Block RAM, local link interface*
	SLO-2	*Practice: Programmable logic design*	*Practice: PSoC 8051 simulation program in C*	*Practice: Sample programming FPGA – II*	*Practice: Building base systems*	*Practice: Block RAM, local link interface*

Learning Resources	1. Robert Ashby, "Designers guide to the Cypress PSoC", Cypress Semiconductors, 2005. 2. Edward H. Currie and David Van Ess, " PSoC3/5 Reference Book", Cypress Semiconductor, 2010.	3. Sass and Schmidt, "Embedded system design with Platform FPGAs", Morgan Kaufmann, 2010. *www.arm.com for processor architecture*

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, Conf. Paper etc.,

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
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2.Dr.Mariappan Vaithilingam, Engineering Leader Amazon, dr.v.m@ieee.org	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

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

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

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

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Practice and gain confidence and competence to solve problems in Analog and Digital Electronics (Discrete & IC)*	*3*	*85*	*80*	*H*	*H*	*H*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*M*	*L*	*M*
CLO-2 :	*Practice and gain confidence and competence to solve problems in Data structures and Object Oriented Programming*	*3*	*85*	*80*	*H*	*H*	*M*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*M*	*M*	*M*
CLO-3 :	*Practice and gain confidence and competence to solve problems in Computer architecture and Data base Management*	*3*	*85*	*80*	*H*	*H*	*M*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*M*	*L*	*M*
CLO-4 :	*Practice and gain confidence and competence to solve problems in Microprocessor, Microcontrollers and Interfacing*	*3*	*85*	*80*	*H*	*H*	*M*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*M*	*M*	*M*
CLO-5 :	*Practice and gain confidence and competence to solve problems in FPGA Design based embedded systems*	*3*	*85*	*80*	*H*	*H*	*H*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*M*	*L*	*M*
CLO-6 :	*Practice and gain confidence and competence to solve problems in Operating Systems and Embedded Hardware*	*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*** *Semiconductor Devices*	***Tutorial on Signals and Systems***	***Tutorial on Data Structures***	***Tutorial on Microcontrollers & Interfacing***	***Tutorial on FPGA based embedded system design***
	SLO-2	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Problem Solving*
S-2	SLO-1	***Tutorial on Digital Electronics***	***Tutorial on Computer Systems***	***Tutorial on Object Oriented Programming***	***Tutorial on Computer Architecture***	*Model Test*
	SLO-2	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Model Test*
S-3	SLO-1	***Tutorial on Integrated Circuits***	***Tutorial on Computer System Design***	***Tutorial on Database Management***	***Tutorial on Operating Systems***	*Final Test*
	SLO-2	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Final Test*

Learning Resources	
1. *Rahul Nigam, "Basic Electronics Interview Questions and Answers" Amazon Asia-Pacific Holdings Private Limited,ebook,2019*	**3.** *Arshad Iqbal, "Computer Fundamentals MCQs", ebook,Amazon Asia-Pacific Holdings Private Limited,2019*
2. *Hwei Hsu , "Schaum's Outline of Signals and Systems, 3rd Edition (Schaum's Outlines)", 2013*	**4.** *Samantha Abraham, "MCQs in Computer Organization and Architecture", Amazon Asia-Pacific Holdings Private Limited, 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	-	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.anit@gmail.com	*1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*Dr. M.S.Vasanthi, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.r@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

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B. Tech in Electronics and Computer Engineering

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	18ECE211T	Course Name	ELECTROMAGNETICS AND ANTENNA THEORY	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

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

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

		Learning
CLR-1 :	Create the insights of Electric and magnetic fields on materials	
CLR-2 :	Analyze the effects of combination of both electric and magnetic field - Electromagnetic Induction	
CLR-3 :	Understand the basic parameters of antennas	
CLR-4 :	Study the working principles of antennas	
CLR-5 :	Introduce modern antenna concepts and measurement techniques	

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

		1 Level of Thinking (Bloom)	2 Expected Proficiency (%)	3 Expected Attainment (%)
CLO-1 :	Understand the different types of laws associated with Electric and Magnetic Field	1	75	60
CLO-2 :	Explore the concept of EM fields and its components	1	75	60
CLO-3 :	Acquire knowledge about the various antenna parameters and fundamentals	2	75	60
CLO-4 :	Understand the basic working of antennas	2	75	60
CLO-5 :	Analyze the various methods involved in the measurement of antenna parameters	3	75	60

Program Learning Outcomes (PLO)

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

Module		Electric Field and Magnetic Field	Electromagnetic Induction	Antenna Fundamentals	Broadband And Narrowband Antennas	Modern Antennas And Antenna Measurements
Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction - Orthogonal co-ordinate systems – Divergence theorem, Stoke's theorem	Faraday's law of electromagnetic induction	Introduction to antennas	Traveling wave antennas	Case study - Modern antennas - Wearable and Reconfigurable antennas
	SLO-2			Basic Antenna parameters		
S-2	SLO-1	Coulomb's law - Electric field intensity	Inductance of solenoids	Antenna field zones	Square Loop antenna	Introduction to measurement techniques - Impedance measurement
	SLO-2	Electric fields due to point charge	Toroids			
S-3	SLO-1	Electric fields due to point charge	Transmission lines and cables	Antenna Reciprocity Theorems	Reflector antenna and its feeding mechanisms	Gain measurement
	SLO-2	line charge				
S-4	SLO-1	surface charge and volume charge distributions – Electric flux density	Mutual inductance	Friis transmission equation	Folded dipole antenna	Radiation pattern measurement
	SLO-2				Helical antenna	
S-5	SLO-1	Gauss's law and its applications	Inductors in series and parallel circuits	Radiation: Retarded potential Far Field due to an alternating current element	Horn antenna	Beam width measurement
	SLO-2					
S-6	SLO-1	Magnetic field introduction, Vector	Energy stored in magnetic fields and		Yagi -Uda antenna	Antenna efficiency measurement

	SLO-2	magnetic potential – Force on a current element	energy density	Radiation: Retarded potential Far Field due to an alternating current element		
S-7	**SLO-1**	Biot- savart's law and applications – Magnetic flux density and magnetic field intensity	Force and torque on closed circuits	Power Radiated by a current element	Design and operation of Log periodic antenna	Directivity measurement
	SLO-2		Boundary conditions at the surface of dielectric			
S-8	**SLO-1**	Force between current carrying conductors – Torque on closed conductors	Boundary conditions at the surface of conductor	Far field due to sinusoidal current distribution for half wave dipole	Design and operation of Micro strip antenna	Phase measurement
	SLO-2					
S-9	SLO-1	Ampere's law and modified Ampere's law	Boundary conditions at the surface of magnetic	Far field due to sinusoidal current distribution for Quarter wave monopole	Microstrip antenna design problem	Typical sources of errors in antenna measurement
	SLO-2					

Learning Resources	1.David K. Cheng, "Field and Wave Electromagnetics", Second Edition, Pearson Education, Asia, 2008. 2. Edward C.Jordan and Keith G.Balaman, "Electromagnetic waves and radiating systems", Second Edition, PHI Learning, 2007. 3. C. A. Balanis, "Advanced Engineering Electromagnetics," John Wiley & Sons, 2009. 4. J. D. Kraus, "Electromagnetics", McGraw Hill, 2007. 5. C. A. Balanis, "Antenna Theory: Analysis and Design," John Wiley & Sons, 2009.	6. R. J. Marhefka, A. S. Khan and J. D. Kraus, "Antennas and Wave Propagation", Tata McGraw - Hill Education 2010. 7. R. E. Collin, "Antenna and radio wave propagation," McGraw Hills, 1985. 8. K.A.Gangadhar, "Field Theory", Khanna Publishers, 2006. 9. William H. Hayt, "Engineeering Electromagnetics", McGraw Hill, Fifth Edition, 2008. 10. M. Sachidananda and A. R. Harish "Antennas and Wave Propagation" Oxford University Press, USA 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	Theory	Theory	Theory	Theory
Level 1	Remember	*40%*	*15%*	*15%*	*15%*	*15%*
	Understand					
Level 2	Apply	*40%*	*20%*	*20%*	*20%*	*20%*
	Analyze					
Level 3	Evaluate	*20%*	*15%*	*15%*	*15%*	*15%*
	Create					
	Total	100 %	100 %	100 %	100 %	100 %

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

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

Course Code	18ECE212T	Course Name	CONTROL SYSTEMS : THEORY AND APPLICATIONS	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Learn about mathematical modeling of mechanical and electrical systems			
CLR-2 :	Impart knowledge about the transient and steady state error and analysis			
CLR-3 :	Know about different frequency domain analytical techniques and compensator designs			
CLR-4 :	Identify and analyze stability of a system using diverse technique			
CLR-5 :	Acquire the knowledge of feedback controllers for processes			
CLR-6 :	Impart knowledge on modern control methods			

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

Module		Modeling and Transfer function	Time domain analysis	Frequency domain analysis and compensator design	Stability analysis	Applications
Duration (hour)		9	9	9	9	9
S-1	SLO-1	Basic elements in control system	Standard test signals types	Frequency domain specifications	Stability analysis, techniques, condition for stability	Controllers-Significance and Need
	SLO-2	Open and closed loop control system	Type number, order of a system	Types of frequency plots and advantages	Concept of stability from pole zero location	SISO and MIMO control systems
S-2	SLO-1	Transfer function of a system	Transfer function of First order system for Step and ramp signal	Bode plot approach	Significance of Routh Hurwitz Technique	Types of controllers-ON-OFF,P,I,D
	SLO-2	Need for first principles models and types: white box, black box and grey box.		Rules for sketching bode plot	Computation of Routh array	Composite Controller-PI,PD and PID
S-3	SLO-1	Differential equations and Transfer function of mechanical translational systems	General transfer function of second order system	Bode plot of typical systems	Routh array of stable systems	Set point tracking control
	SLO-2		Identification of damping factor and classification based on it	Bode plot of typical systems	Routh array of stable systems	Load disturbance rejection control
S-4	SLO-1	Differential equations and Transfer function of mechanical rotational systems	Step response of critically damped second order system	Polar plot and significance	Routh array of Unstable systems	Position control of object using AC servomotor
	SLO-2		Step response of undamped second order system	Sketching of polar plot on polar graphs	Routh array of Unstable systems	Transfer function of AC servomotor

S-5	SLO-1	*Electrical analogous of Mechanical translational system*	*Step response of under damped second order system*	*Polar plot of typical systems*	*Nyquist stability criterion*	*Liquid level control in a tank*
	SLO-2	*F-V and F-I electrical analogous circuits*	*Numerical solution*	*Polar plot of typical systems*	*Analysis using Nyquist plot*	*Transfer function derivation*
S-6	SLO-1	*Block diagram reduction rules*	*Time domain specifications and their significance*	*Design of Compensators*	*Analysis using Nyquist plot*	*Multivariable Control*
	SLO-2		*Numerical solution*	*S plane representation of Lag Compensator*	*Analysis using Nyquist plot*	
S-7	SLO-1	*Determination of transfer function using block diagram reduction for single input and single output*	*Steady state error and constants*	*S plane representation of Lead Compensator*	*Relative stability*	*Feedback and feed forward control analysis*
	SLO-2		*Static and dynamic Error coefficients*	*Frequency response*	*Root locus technique*	
S-8	SLO-1	*Signal flow graphs and evaluation of transfer function*	*Static error constants and evaluation of steady state error*	*Lag compensator design using Bode plot*	*Rules for sketching root locus*	*Model based control-IMC*
	SLO-2					
S-9	SLO-1	*Block diagram to signal flow conversion*	*Dynamic error constants and evaluation of steady state error*	*Lead compensator design using Bode plot*	*Root locus plot of typical systems*	*Adaptive control systems*
	SLO-2				*Root locus plot of typical systems*	

Learning Resources	*1.*Nagrath.J and Gopal.M,, "Control System Engineering", 5th Edition, New Age, 2007 2. Benjamin C Kuo, "Automatic Control System", 9th edition, John Wiley & Sons, 2010	3. Gopal.M, "Control System Principles and Design", 2nd Edition, TMH, 2002 4. Seborg, Edgar, Mellichamp and Doyle, "Process Dynamics and Control", 3rd edition, John Wiley & Sons, 2010

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

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

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

Course Code	18ECE311J	Course Name	Applied Digital Signal processing	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Understand the operations involved in digital conversion of analog signals.*
CLR-2 :	*Design digital FIR filter using windowing technique and frequency sampling methods.*
CLR-3 :	*Design IIR filters using both direct method and method involving conversion of analog filter to digital filter.*
CLR-4 :	*Understand the need for Multirate DSP and Poly Phase Decomposition*
CLR-5 :	*Study the architecture of TMS320C54x*
CLR-6 :	*Study the architecture of TMS320C6748*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	**Learning**		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLO-1 :	*Acquire knowledge of sampling and quantization and understand the errors that arise due to quantization.*	*3*	*80*	*70*
CLO-2 :	*Understand the concept of DFT and its efficient computation by using FFT algorithm.*	*3*	*85*	*75*
CLO-3 :	*Design FIR and IIR filters using several methods*	*3*	*75*	*70*
CLO-4 :	*Understand the basics of multirate DSP and its applications.*	*3*	*85*	*80*
CLO-5 :	*Implement DSP algorithms using TMS320C54x*	*3*	*85*	*75*
CLO-6 :	*Implement DSP algorithms using TMS320C6748*	*3*	*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	PSO - 2	PSO – 3
CLO-1 :	*H*	*H*	*L*	*M*	*L*	-	-	-	*L*	*L*	-	*M*	*H*	-	-
CLO-2 :	*M*	*H*	*L*	*M*	*L*	-	-	-	*M*	*L*	-	*H*	*M*	-	-
CLO-3 :	*M*	*H*	*M*	*H*	*L*	-	-	-	*M*	*L*	-	*H*	-	*H*	-
CLO-4 :	*M*	*H*	*M*	*H*	*L*	-	-	-	*M*	*L*	-	*H*	-	*H*	-
CLO-5 :	*H*	*H*	*M*	*H*	*L*	-	-	-	*M*	*L*	-	*H*	-	-	*H*
CLO-6 :	*L*	*H*	*H*	*H*	*L*	-	-	-	*L*	*L*	-	*H*	-	-	*H*

Module		**DSP and Digital Filter Realization**	**FFT and FIR Filters**	**IIR Filters and Multirate signal processing**	**Polyphase Decomposition and TMS320C54x**	**TMS320C6748Architecture and Programming**
Duration (hour)		**12**	**12**	**12**	**12**	**12**
S-1	SLO-1	*Basic Elements of DSP*	*Need for FFT and computation complexity between DFT and FFT*	*Comparison of FIR and IIR filters and Design of digital IIR filters*	*Polyphase structure of decimator*	*Introduction to TMS320C6748*
	SLO-2	*Advantages and applications of DSP*	*NPoint DFT Decimation-in-Time FFT Radix-2 FFT Algorithm*	*Analog IIR filter design*	*Polyphase decimation using z transform*	*Advanced Features of C6748*
S-2	SLO-1	*Sampling of analog signals Sampling theorem*	*N Point DFT Decimation-in-Frequency FFT*	*Properties of chebyshev filters and Butterworth filters*	*Polyphase structure of interpolator*	*Dual Core Architecture, RISC*
	SLO-2	*Aliasing and Quantization of continuous amplitude signals*	*Inverse FFT algorithms*	*Analog IIR filter design*	*Polyphase interpolation using z transform*	*Block Diagram and Explanation*
S 3-4	SLO-1	*Lab: Generation of Continuous and discrete time fundamental signals*	*Lab: Spectrum analysis using DFT and Computation of IDFT*	*Lab :Design of analog Butterworth IIR filter*	*Lab: Design of anti-aliasing filter*	*Lab: Simple programs using TMS320C54x*
	SLO-2					
S-5	SLO-1	*Quantization noise*	*FIR Filters - Introduction*	*Design of digital filters using Impulse invariance method*	*DSP Systems - Introduction*	*Instruction Set of C6748 processor*
	SLO-2	*Errors due to truncation and Rounding off*	*Design of Linear Phase FIR filters General consideration*	*Practice problems*	*Harvard Architecture and Von- Neuman Architecture*	*Instruction Set of C6748 processor*
S-6	SLO-1	*Realization of digital filters- Direct form I realization*	*Design of FIR filters Fourier series method*	*Design of digital filters Bilinear transformation*	*Texas Instruments TMS320 Family*	*Addressing Modes of C6748 processor*
	SLO-2	*Canonical structure Realization*	*Design of FIR filters Fourier series method-Problems*	*Practice problems*	*TMS320C54x DSP Functional Block Diagram and Explanation*	*Sample Programs using Assembly language*
S 7-8	SLO-1	*Lab: Study of sampling theorem and Aliasing Effects*	*Lab: Efficient computation of DFT using FFT DIT and DIF algorithms*	*Lab: Design of digital Butterworth filter using bilinear transformation*	*Lab: Design of anti-imaging filter*	*Lab: Random wave generation using processor*
	SLO-2					

S-9	SLO-1	*Cascade form of realization*	*Practice problems*	*Multirate signal processing*	*MAC Unit, Pipeling and Parallel Processing*	*Sample Programs using C language*
	SLO-2	*Parallel form of realization*	*Need for filter design using window Comparison of various windowing techniques*	*Decimation of Signals*	*Instruction Set of TMS320C54x*	*Procedure to work with non real time using simulator mode in v6/7:*
S-10	SLO-1	*Computation of DFT*	*Filter Design using windowing technique*	*Interpolationof Signals*	*Instruction Set of TMS320C54x*	*General procedure for working with the real time projects using c6748l cdk*
	SLO-2	*Properties of DFT Periodicity, linearity and symmetry properties*	*Practice problems*	*Sampling rate conversion by a rational factor I/D*	*Addressing Modes of TMS320C54x*	*General Procedure for working with Assembly Projects Using C6748LCDK*
S 11-12	SLO-1	*Lab: Linear and Circular convolution of DT Signals*	*Lab: Design of digital FIR Low, High, Band Pass filters using different windows*	*Lab: Effect of interpolation and decimation on signals*	*Lab: Introduction to code composer studio and Procedure to work on ccs using target*	*Lab:Sample Programs using processor*
	SLO-2					

Learning Resources	1. John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing, Principles, Algorithms and Applications", Pearson Education, 4th edition, 2007 2. Alan V. Oppenheim, Ronald W. Schafer, John R. Buck, "Discrete Time Signal Processing", Pearson Education, 8th edition, 2011	3. SanjitMitra, "Digital Signal Processing –A Computer Based Approach", McGraw Hill, India, 4th Edition,2013. 4. Ronald D.Crochier,LawrenceR.Rabiner, Multirate Digital Signal Processing,1st edition,1983 Prentice Hall series 5. *TMS320C6748 - Lab Manual - Texas Instruments*

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. Dr. Nagaveer, CEO, Campus Corporate Connect,nagaveer@campuscorporateconnect.com	*1. Dr. Srinivasa Rao Bakshi, IITM, Chennai, sbakshi@iitm.ac.in*	*1. Dr.S.Dhanalakshmi, Associate Professor/ECE Dept*
2. Dr. Sricharan Srinivasan, Wipro Technologies, sricharanms@gmail.com	*2. Dr. Ramesh Babu, N , nrbabu@iitm.ac.in*	
	3. Dr.Noor Mahammad, IIITDM, Kancheepuram,noor@iiitdm.ac.in	

Course Code	18ECE312T	Course Name	WIRELESS AND OPTICAL SENSORS	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

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

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

CLR-1 :	*Identify the applications of electrical effects on sensors*
CLR-2 :	*Identify the applications of magnetic effects on sensors*
CLR-3 :	*Identify the applications of optical effects on sensors*
CLR-4 :	*Create insights to the concepts nano and optical sensors*
CLR-5 :	*Analyse the working principle of self generating and optical fiber sensors*
CLR-6 :	*Utilize the concepts in physics for the understanding of nano and optical sensors*

Learning

Program Learning Outcomes (PLO)

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	1 Level of Thinking (Bloom)	2 Expected Proficiency (%)	3 Expected Attainment (%)	1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO – 3
CLO-1 :	*Identify the principle of electric field on sensors*	*2*	*80*	*70*	*H*	*H*	-	-	-	-	-	-	-	-	-	-	*H*	-	-
CLO-2 :	*Analyse photoelectric and magnetic effects*	*2*	*85*	*75*	*H*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	*Apply nanotechnology to basic sensor applications*	*2*	*75*	*70*	*H*	*H*	-	*H*	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	*Apply physical effects in self generating sensors*	*2*	*85*	*80*	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-	*M*	-
CLO-5 :	*Identify the basic concepts used in optical fiber sensors*	*2*	*85*	*75*	*H*	-	*H*	-	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	*Apply the concepts of optical fiber sensing to specific engineering field*	*2*	*80*	*70*	-	*H*	-	*H*	-	-	*H*	-	-	-	-	-	-	-	*M*

Module		***Sensor Characteristics and Physical Effects***	***Nano Sensors***	***Self Generating Sensors***	***Optical Fiber Sensors***	***Applications of Fiber Optic Sensors***
Duration (hour)		***9***	***9***	***9***	***9***	***9***
S-1	*SLO-1*	*Introduction to sensors*	*Density of State: 3D, 2D, 1D and 0D materials*	*Thermoelectric Sensors*	*Introduction to Optical Fiber*	*Displacement Sensor*
	SLO-2	*Nanotechnology enabled sensors*	*General Idea on Density of state*			
S-2	*SLO-1*	*Static characteristics of sensors*	*One Dimensional Gas Sensors*	*Thermoelectric Effects*	*Types of Optical fibers: Snell's Law and Total Internal Reflection*	*Working principle of Displacement Sensor*
	SLO-2	***Discussion on each*** *characteristics*				
S-3	*SLO-1*	*Dynamic characteristics of sensors*	*Gas sensing with nanostructured thin films*	*Thermocouples*	*Step-Index Single-Mode Optical Fiber*	*Applications of Displacement Sensor*
	SLO-2	***Discussion on each*** *characteristics*				
S-4	*SLO-1*	*Physical Effects: Photoelectric effect*	*Phonons in sensing applications*	*Piezoelectric Sensors*	*Pulse Dispersion*	*Strain Sensors*
	SLO-2	*Physical Effects: Photodielectric effect*		*Piezoelectric effect*		
S-5	*SLO-1*	*Photoluminescence effects, Electroluminescence effects*	*One Dimensional Piezoelectric Sensors*	*Piezoelectric materials Piezoelectric applications*	*Graded Index Fiber*	*Working principle of Strain Sensors*
	SLO-2					
S-6	*SLO-1*	*Chemiluminescence effects, Doppler*	*Mechanical Sensors: Nanoparticle*	*Pyroelectric Sensors: Pyroelectric effect*	*Polarization Preserving Single-Mode Fiber*	*Applications of Strain Sensors*

	SLO-2	*Effects,*	*oscillators*			
S-7	*SLO-1*	*Barkhausen Effect, Hall Effect*	*One-Dimensional Mechanical Sensors, Piezoresistors*	*Pyroelectric materials and applications*	*Fiber Optic Sensor Fundamentals*	*Temperature Sensors Working principle and applications*
	SLO-2					
S-8	*SLO-1*	*Seebeck Effect, Thermoresistive Effects*	*Optical Sensors: Chemiluminescence based Sensors*	*Photovoltaic Sensors: Photovoltaic effect*	*Sensor Categories*	*Working principle of Temperature Sensors*
	SLO-2					
S-9	*SLO-1*	*Peizoresistive Effects, Peizoelectric Effects*	*Plasmonic Sensors*	*Photovoltaic materials and applications*	*Distributed Fiber Optic Systems*	*Applications of Temperature Sensors*
	SLO-2					

Learning Resources	*Kourosh Kalantar –Zadeh, Benjamin Fry, "Nanotechnology- Enabled Sensors", Springer, USA, 2008* *Ramon Pallas-Areny, John G. Webster, "Sensors and signal conditioning" John Wiley & Sons, USA,2001*	*Eric Udd, William B. Spillman Jr.,"Fiber Optic Sensors," Second Edition, John Wiley & Sons, New Jersey, 2011* *David Krohn, Trevor MacDougall, Alexis Mendez,"Fiber Optic Sensors: Fundamentals and Applications," Fourth Edition, SPIE Press, Washington, USA, 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	Theory	Theory	Theory	Theory
Level 1	Remember	*40%*	*40%*	*40%*	*40%*	*30%*
	Understand					
Level 2	Apply	*40%*	*40%*	*40%*	*40%*	*40%*
	Analyze					
Level 3	Evaluate	*20%*	*20%*	*20%*	*20%*	*30%*
	Create					
	Total	100 %	100 %	100 %	100 %	100 %

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*Dr. G. P. Mishra, National Institute of Technology Raipur*	*Dr. Soumyaranjan Routray, Dept. of ECE, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	
	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	

Course Code	18ECE313T	Course Name	DIGITAL COMMUNICATION SYSTEMS	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Learn the types of pulse modulation techniques and data formatting methods			
CLR-2 :	Understand the waveform coding methods			
CLR-3 :	To know about the various baseband modulation and demodulation techniques			
CLR-4 :	To learn about the band pass modulation methods			
CLR-5 :	Analyse source coding and Channel coding methods			

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 :	Understand how sampling, quantisation and pulse modulation takes place and the necessity of data formatting methods	1	80	70
CLO-2 :	Learn the role of Nyquist criteria and pulse shaping along with the need for equalization in digital modulation.	1	85	75
CLO-3 :	Analyse the various shift keying techniques for bandpass modulation	3	75	70
CLO-4 :	Measure the channel capacity by applying information theory concepts	2	85	80
CLO-5 :	Implement Source and channel coding	3	85	75

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	Management	PSO – 3: Analyze & Research
CLO-1 :	H	-	-	-	H	-	-	-	-	-	-	-	-	H	-
CLO-2 :	H	H		H	H	-	-	-	-	-	-	-	-	-	H
CLO-3 :	H		H	H	-	-	-	-	-	-	-	-	H	-	-
CLO-4 :	H	H	H	H	H	-	-	-	-	-	-	-	-	-	H
CLO-5 :	H	-		H	-	-	-	-	-	-	-	-	-	-	-

Module		Sampling and Quantization	Waveform coding	Baseband Digital Demodulation and Detection	Band pass Digital Modulation and Detection	Information Theory and coding
Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction to Digital Communication	Waveform coding concepts	Introduction to Baseband Demodulation and Detection process	Introduction Band pass signal reception	A logarithmic measure of information
	SLO-2	Advantages and Disadvantages of Digital Communication	Noise consideration in PCM system-Bandwidth of PCM	Autocorrelation and Cross correlation of signals	Comparison of baseband and band pass reception process	Lossless coding & lossy data compression
S-2	SLO-1	Pulse modulation systems, Overview of PAM,PWM,PPM	Prediction filtering	Sources of noise in Digital Communication	Coherent Binary Phase Shift keying: Generation	Uncertainty Principle,
	SLO-2	Sampling –Aliasing	Prediction filtering	Optimum Receivers-Matched filter	Coherent Binary Phase Shift keying: Detection	Measures of Information
S-3	SLO-1	Signal Reconstruction	Differential PCM	Optimum Receivers-Matched filter	Quadrature PSK: Generation	Entropy,
	SLO-2	Signal Reconstruction	Differential PCM	Optimum Receivers -Correlation Receiver	Quadrature PSK: Detection	Source Coding theorem,
S-4	SLO-1	Quantization- Uniform	Differential PCM- limitations	Optimum Receivers -Correlation Receiver	Binary Frequency Shift Keying: Generation	Huffman Coding
	SLO-2	Quantization- Non-uniform	Differential PCM- limitations	Inter Symbol Interference	Binary Frequency Shift Keying: Detection	Huffman Coding
S-5	SLO-1	Quantization noise	Delta Modulation- Generation	Nyquist Criterion for distortion less transmission	QAM: Generation	Problems on Entropy, source coding
	SLO-2	Quantization noise	Delta Modulation- Detection	Eye Pattern	QAM: Detection	Problems on Huffman coding
S-6	SLO-1	Logarithmic Companding of speech signal	Noise in Delta modulation	Pulse shaping to reduce ISI,	Signal space diagram for BPSK, BFSK, QPSK, QAM	Discrete Memoryless Channel: Binary Symmetric Channel
	SLO-2	Logarithmic Companding of speech signal	Noise in Delta modulation	Introduction to Correlative coding	Signal space diagram for BPSK, BFSK, QPSK, QAM	Discrete Memoryless Channel: Binary Symmetric Channel

S-7	SLO-1	Companding Techniques	Problem on waveform coding	Duobinary Signaling	Error Probability for BPSK, BFSK, QPSK, QAM	Channel Capacity, Channel Coding Theorem, Shannon Capacity Limit
	SLO-2	Companding Techniques	Problem on waveform coding	Duobinary Signaling	Comparison of bandpass modulation schemes	Problems on Channel Capacity and Channel coding
S-8	SLO-1	PCM-Time Division Multiplexing	ADPCM & ADM principles	Maximum likelihood detector	Introduction to non-coherent modulation	Problems on Channel Capacity and Channel coding
	SLO-2	PCM -Time Division Multiplexing	ADPCM & ADM principles	Error probability	DPSK-Generation & Detection	Introduction to Error coding
S-9	SLO-1	Data formatting methods	Comparison of PCM, DPCM, ADPCM & DM	Equalization concepts	Introduction to Multicarrier modulation	Convolutional codes
	SLO-2	Data formatting methods	Comparison of PCM, DPCM, ADPCM & DM	Equalization concepts	Introduction to OFDM	Problem on Convolutional codes

Learning Resources	Simon Haykin, "Communication Systems", John Wiley & Sons, 4th Edition, 2014 Bernard Sklar, "Digital Communication, Fundamentals and Application", Pearson Education Asia, 2nd Edition, reprint 2013	3. John G. Proakis,MasoudSalehi, "Digital Communication", McGraw Hill Inc, 5th Edition, 2015. 4. Shu Lin, Daniel Costello, "Error control coding – Fundamentals and Applications", Prentice Hall, Upper Saddle River, NJ, 2nd Edition, 2004.

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

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

Course Designers		
Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*1. Dr. M.S.Vasanthi, Associate Professor/TCE Dept*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	2. Dr.T.Deepa, Associate Professor/TCE, deepat@srmist.edu.in

course Code	18ECE314T	Course Name	WIRELESS COMMUNICATION NETWORKS	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	**Learning**		
CLR-1 :	*Understand the classifications of Wireless Communication networks and Introduction to mobile communications*	*1*	*2*	*3*
CLR-2 :	*Understand the Mobile Radio Wave Propagation - Large Scale Fading*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-3 :	*Analyze how to apply Mobile Radio Wave Propagation - Small Scale Fading*			
CLR-4 :	*Study the concepts in wireless communications to improve the link performance of wireless networks*			
CLR-5 :	*Acquire the knowledge of Wireless communication networks and Standards*			

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*			
CLO-1 :	Acquire the knowledge of Wireless communication networks and basic cellular concepts	*1*	*75*	*60*
CLO-2 :	Understand` the essential Radio wave propagation and mobile channel models	*1*	*75*	*60*
CLO-3 :	Familiarize about Various performance analysis of mobile communication system.	*2*	*75*	*60*
CLO-4 :	Attain the knowledge of Diversity and equalisation concepts	*3*	*75*	*60*
CLO-5 :	Be familiar with the Various network Standards and architectures of wireless communication networks	*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	PSO - 2	PSO – 3
H	-	-	-	-	-	-	-	-	-	-	*M*	-	-	-
H	*H*	*H*	*H*	-	-	-	-	-	-	-	*M*	-	-	-
H	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-	-
H	*H*	-	-	-	-	-	-	-	-	-	-	-	-	-
H	-	-	-	-	-	-	-	-	-	-	*M*	-	-	-

Module		**Introduction to Wireless communications and networks**	**Large Scale Fading**	**Small scale Fading**	**Improvement in link performance**	**Wireless Networks and standards**
Duration (hour)		**9**	**9**	**9**	**9**	**9**
S-1	SLO-1	Introduction to wireless communication and mobile radio communication	Introduction to Radio wave Propagation	Introduction Small scale multipath propagation	Improvement in link performance/ communication networks - introduction to diversity, equalization and capacity	Evolution of various wireless standards
	SLO-2	Classification of wireless communications/networks - simplex, half duplex, dull duplex	Large scale and small scale fading	Impulse response model of multipath channel		
S-2	SLO-1	Paging and Cordless systems	Friis transmission equation- Free space propagation model - pathloss model	Impulse response model of multipath channel	Space diversity	GSM system architecture and its interfaces, GSM frame structure
	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	CDMA Transmitter network architecture
	SLO-2	Timing diagram - mobile to mobile		Small scale multipath measurements - Swept frequency measurement	Equal gain diversity	
S-4	SLO-1	Frequency reuse, sectored and omni-directional antennas	Simplified pathloss model	Parameters of mobile multipath channels - Time dispersion and Coherent bandwidth	Rake Receiver	CDMA Receiver network architecture
	SLO-2		Emperical model – Okumara			
S-5	SLO-1	Channel assignment strategies	Emperical model –Okumara model problem	Parameters of mobile multipath channels - Doppler spread and Coherent time	MIMO/Diversity, Massive MIMO (elementary level)	OFDM Block diagram
	SLO-2	Handoff and its types	Emperical model - Walfish and bertoni			

			model			
S-6	SLO-1	Interference and system capacity	Piecewise linear model - log normal model	Types of fading: Flat and Frequency selective fading	Equalizer and its mode	Importance of Cyclic Prefix
	SLO-2					
S-7	SLO-1	Cell splitting and Sectoring	Shadowing	Types of fading: Fast and Slow fading	Adaptive equalizer block diagram	Introduction to 4G and 5G communications(Frequency allocations and data rates)
	SLO-2		Combined pathloss and shadowing			
S-8	SLO-1	Microcell zone concepts	Outage Probabilty	Ricean distribution	Types of Equalizers - elementary level only	Case study –4G LTE Architecture
	SLO-2	*Umbrella cells*				
S-9	SLO-1	Introduction to telecommunication networking: Trunking and Grade of Service	Cell Coverage Area	Rayleigh distribution	Shannons capacity equation and throughput	Case study –5G Architecture
	SLO-2					

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

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

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

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

Course Code	18ECE315T	Course Name	ASIC DESIGN	Course Category	E	Professional elective course	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 Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Understand all the principles required to design an ASIC with high impact on performance, cost and power	1	2	3
CLR-2 :	Provide verilog HDL constructs and modelling techniques for Digital Logic Design			
CLR-3 :	Learn the back-end design of Partitioning, Floor planning and Placement			
CLR-4 :	Describe the Routing algorithms and Timing Analysis			
CLR-5 :	Gain knowledge on design rules for physical layout			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:			
CLO-1 :	Develop digital designusing CMOS logic	1	80	70
CLO-2 :	Expose to hierarchical modelling concepts and the necessary knowledge to write small models and run simulations.	1	85	75
CLO-3 :	Estimate the Chip area using an efficient algorithms	3	75	70
CLO-4 :	Analyse the critical path delay and speed	2	85	80
CLO-5 :	Design sub-systems and Implement the physical layout	3	85	75

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	PSO – 3: Analyze & Research
M		H	L											
M		H	M	H										
L		M	H											
M	M		H											
M	M	H	M											

Module		CMOS Transistor Theory	Front End Design with Verilog HDL	Back End Design- Partitioning, Floor planning & Placement	Routing and Timing Analysis	Physical Layout Design
Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction to VLSI	Emergence of HDL	Introduction to Partitioning	Introduction to Routing	Introduction to Layout
	SLO-2	ASIC Design flow	Hierarchical Modeling Concepts	Goals and Objectives	Goals and Objectives	Layout Design rules, DRC
S-2	SLO-1	Static CMOS Inverter	Modules and Ports	KL Algorithm	Types of Routing	Layout for CMOS Logic Circuits
	SLO-2	Static CMOS Inverter	Data Types	KL Algorithm	Global Routing	CMOS Inverter Layout
S-3	SLO-1	DC Characteristics	Different Abstract Levels	KL Algorithm: Problems	Maze Routing	CMOS NAND Layout
	SLO-2	DC Characteristics	Gate-Level Modeling	KL Algorithm: Problems	Maze Routing: Problems	CMOS NOR Layout
S-4	SLO-1	Second order effects: Channel Length Modulation	Gate-Level Modeling: Programs	Introduction to Floor Planning	Detailed Routing	Layout for any Boolean Expressions using CMOS Logic
	SLO-2	Body Effect, Sub threshold Current	Dataflow Modeling	Goals and Objectives	Detailed Routing : Problems	Layout for any Boolean Expressions using CMOS Logic
S-5	SLO-1	Velocity Saturation	Dataflow Modeling: Programs	Channel routing using slicing tree	Left Edge Algorithm	Subsystem Design: Carry Save adder
	SLO-2	CMOS Latch up	Behavioral Modeling	Channel routing using slicing tree	Left Edge Algorithm: Problems	Carry Save adder
S-6	SLO-1	Power Dissipation and it types	Behavioral Modeling: Programs	Channel routing using slicing tree: Problems	Special Routing	Carry Look ahead adder
	SLO-2	Static & Dynamic Power Dissipation	Structural Modeling	Channel routing using slicing tree: Problems	Special Routing: Problems	Carry Look ahead adder
S-7	SLO-1	CMOS Logic	Task	I/O Planning & Power planning	Timing Analysis	Carry Skip adder
	SLO-2	CMOS Inverter	Task: Programs	Clock planning	Time borrowing	Carry Skip adder
S-8	SLO-1	Basic Logic Gates	Functions	Introduction to Placement	Introduction to Static Timing Analysis	Wallace Tree Multiplier
	SLO-2	CMOS MUX	Functions: Programs	Goals & Objectives	Static Timing Analysis	Wallace Tree Multiplier
S-9	SLO-1	Types of ASICs	Switch level Modeling	Min cut & placement Algorithms	Static Timing Analysis: Problems	Braun Array Multiplier
	SLO-2	Semi Custom and Full Custom ASIC	Switch level Modeling: Programs	Min cut & placement Algorithms: Problems	Static Timing Analysis: Problems	Braun Array Multiplier

Learning Resources	1. Weste, N. H., & Harris, D. (2015). CMOS VLSI design: a circuits and systems perspective. Pearson Education India. 2. Palnitkar, Samir. Verilog HDL: a guide to digital design and synthesis. Pearson Education India, 2003. 3. Smith, M. J. S. (2008). Application-specific integrated circuits. Addison-Wesley Professional.

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%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Understand										
Level 2	Apply	*30%*	*30%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*0%*	*0%*	*10%*	*10%*	*10%*	*10%*	*10%*	*10%*	*10%*	*10%*
	Create										
	Total	100 %		100 %		100 %		100 %		-	

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Mr. R. Ramesh. Altran, Chennai,* ***a.rameshrajen@gmail.com***	1. *Dr. S. Balaji, Loyola ICAM College of Engineering and Technology, Chennai,* ***sbalaji@licet.ac.in***	*Dr. E. Chitra, Assistant Professor/ECE Dept, chitrae@srmist.edu.in*
2. *Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com*	2. *Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*Mrs. M. Valarmathi, , Assistant Professor/ECE Dept, valarmam@srmist.edu.in*
3. *Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com*	3. *Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECE316T	Course Name	EMBEDDED LINUX	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil - Suggested to do MOOC on Linux fundamentals	Progressive Courses	
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 Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Acquire skill to use and know Linux operating system			
CLR-2 :	Acquire skill to write programs in C and Scripting languages; interface with Git repository			
CLR-3 :	Get knowledge on embedded Linux; software development process for embedded Linux.			
CLR-4 :	Know the methods of software design for Embedded Linux			
CLR-5 :	Acquire skill of writing embedded applications, in Linux platform			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLO-1 :	Understand the Linux OS and work with the command line.	1	80	70
CLO-2 :	Write C programs and Interfacing with Git repository	1	85	75
CLO-3 :	Understand the GNU development tool chain and some basic C programming and shell programming.	1	75	70
CLO-4 :	Build flash based embedded Linux system to work with typical micro controller board	2	85	80
CLO-5 :	Develop, test, debug and profile embedded application programs	3	85	75

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	PSO – 3: Analyze & Research
	L														L
	L	H	H												L

Module		Linux Essentials Module 1	Linux Programming Fundamentals Module 2	Elements of Embedded Linux Module 3	System Architectures and design choices Module 4	Writing Embedded Applications Module 5
Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction to Linux	Revision on "C" w.r.t GNU C compiler	Introduction to embedded Linux; cross platform tools	Embedded system storage; choosing the parameters	Process and threads
	SLO-2	Introduction to Linux	Revision on "C" w.r.t GNU C compiler	Introduction to embedded Linux; cross platform tools	Embedded system storage; choosing the parameters	Process and threads
S-2	SLO-1	Linux file system architecture	GNU Tool chain: introduction & installation	Sample programs for cross platform use	Flash memory and system memory operation	POSIX thread commands; syntax and use
	SLO-2	Linux file system architecture	GNU Tool chain: introduction & installation	Sample programs for cross platform use	Access time considerations	POSIX thread commands; syntax and use
S-3	SLO-1	Linux commands : User level	Editing source code in C with "gedit" or IDE	Booting process and boot loader	Introduction to device drivers; identifying and using them	Memory allocation and management; leak detection
	SLO-2	Linux commands : User level	Editing source code in C with "gedit" or IDE	Booting process and boot loader	Introduction to device drivers; identifying and using them	Memory allocation and management; leak detection
S-4	SLO-1	Linux commands: System level (Superuser specific)	Compiling and building executable.	Linux kernel; introduction	Internals and architecture of device drivers	GDB debugging revisited
	SLO-2	Linux commands: System level (Superuser specific)	Introduction to "gdb"	Linux kernel; introduction	Internals and architecture of device drivers	GDB debugging revisited
S-5	SLO-1	"vi" text editor; its commands	Running the program; on terminal; using gdb.	Porting and configuring the kernel	Writing sample device driver; char device	FT- Trace utility and its use in debugging
	SLO-2	"gedit" text editor; its commands	Running the program; on terminal; using gdb.	Porting and configuring the kernel	Writing sample device driver; char device	FT- Trace utility and its use in debugging
S-6	SLO-1	Introduction to "bash"; the Borne shell.	Introduction to Git repository	Simple typical kernel programming	Writing sample device driver; block device	Use of graphics plotting tools;
	SLO-2	Shell programming	Cloning files from Git Hub	Simple typical kernel programming	Writing sample device driver; block device	Use of graphics plotting tools;
S-7	SLO-1	Shell programming	Git essentials	Building root file system	Debugging the device driver	Installing and using FT trace utilities
	SLO-2	Shell programming	Git essentials	Building root file system	Debugging the device driver	Installing and using FT trace utilities

S-8	*SLO-1*	*Important system commands & its use*	*Advanced Git features*	*Selecting a build system; build process*	*Making the "init"*	*Debug/test data collection and profiling*
	SLO-2	*Important system commands & its use*	*Advanced Git features*	*Selecting a build system; build process*	*Making the "init"*	*Debug/test data collection and profiling*
S-9	*SLO-1*	*Demo: Linux shell programming.*	*Demo: Programming using Git hub*	*Demo: Simple kernel programs*	*Demo: Kernel programming; device driver programming*	*Real time Linux*
	SLO-2	*Demo: Linux shell programming.*	*Demo: Programming using Git hub*	*Demo: Simple kernel programs*	*Demo: Kernel programming; device driver programming*	*Real time Linux*

Learning Resources	1. *Karim Yaghmore, Jon Masters, Gilad Ben Yosef, Phillepe Gerome, "Building Embedded Linux Systems, Oreilly Publications, Safari Books, 2nd Reprint, 2008.* 2. *Chris Simonds, "Mastering Embedded Linux Programming", Packt Publishing, Open source, 2015.* 3. *https://www2.packtpub.com/books/subscription/packtlib.* 4. *Richard Stones, Neil Mathew, "Begining Linux Programming", Wiley Publications, 4th edition, 2008.* 5. *Willam Rothwell, "Jump start your Linux programming skills", Addison Wesley, 2017.*

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

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

Course Designers		
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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	18ECE231J	Course Name	IOT SYSTEM DESIGN	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	It is advised the student to take a MOOC course on Linux Fundamentals	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/ Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Understand IoT hardware and software and utilize them			
CLR-2 :	Understand and use sensors for IOT applications; to gain knowledge on the standards used,			
CLR-3 :	To gain programming skill to Implement IOT applications			
CLR-4 :	To understand the modifications and use of IP in IOT communications			
CLR-5 :	To study and understand the security issues of IOT and data analytics methods for IOT.			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:			
CLO-1 :	Develop software for IOT nodes interfacing sensors.	2	80	70
CLO-2 :	Develop software for IOT node communications for transferring sensed data.	3	85	75
CLO-3 :	Develop software for typical IOT applications	2	75	70
CLO-4 :	To understand the protocols used in the IOT and its application areas.	3	85	80
CLO-5 :	To understand the use of Data Analytics for IoT.	2	85	75

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	Management	PSO – 3: Analyze & Research
CLO-1 :	M				M										
CLO-2 :	M	M	H		M										
CLO-3 :					M										
CLO-4 :		M	L	M	L										M
CLO-5 :		M	L	M	L										

Module		IoT Technology	IoT Technology	IOT Design Applications	Protocols for IoT	Data Analytics and Security
Duration (hour)		12	12	12	12	12
S-1	SLO-1	Sensors , Actuators And Smart Objects	IEEE802.11 WiFi communication	Non-IP smart object technologies	Need For Optimization And Nodes, Networks	Introduction To Data Analytics For IoT: IoT Data Analytics Overview & Challenges
	SLO-2	Sensors , Actuators And Smart Objects	IEEE802.11 WiFi communication	Non-IP smart object technologies	Optimizing IP For IoT	Machine Learning Networks: Overview – Supervised & Unsupervised Learning – Neural Networks
S-2	SLO-1	Smart sensor object hardware and software	Light weight IP stack	Smart Grid	IoT Layers: : Physical And Controllers – Connectivity Edge Computing And Upper Layers	Machine Learning Networks & Getting Intelligence From Bigdata – Predictive Analysis
	SLO-2	Smart sensor object hardware and software	Light weight IP stack	Smart Grid	IoT Layers: : Physical And Controllers – Connectivity Edge Computing And Upper Layers	Big Data Analytics Tools And Technology :Massively Parallel Processing Databases – Nosql Databases.
S-3	SLO-1	Practice: Sensor measuring experiment using IOT node	Practice: Communication through WiFi	Practice: IOT Design Application	Practice : IOT Gateway router	Practice: IOT Cloud data analysis
	SLO-2	Practice: Sensor measuring experiment using IOT node	Practice: Communication through WiFi	Practice: IOT Design Application	Practice : IOT Gateway router	Practice: IOT Cloud data analysis
S-4	SLO-1	Practice: Sensor measuring experiment using IOT node	Practice: Communication through WiFi	Practice: IOT Design Application	Practice : IOT Gateway router	Practice: IOT Cloud data analysis
	SLO-2	Practice: Sensor measuring experiment using IOT node	Practice: Communication through WiFi	Practice: IOT Design Application	Practice : IOT Gateway router	Practice: IOT Cloud data analysis
S-5	SLO-1	Energy management of nodes	IPv6 for smart object networks	Smart cities and Urban networks	**Comparing IoT** Architectures: One M2M IoT Standardized Architecture & IoTWF	Big Data Analytics Tools And Technology : Hadoop And Ecosystem - Apache Kafka
	SLO-2	Energy management of nodes	IPv6 for smart object networks	Smart cities and Urban networks	**Comparing IoT** Architectures: One M2M IoT Standardized Architecture & IoTWF	Big Data Analytics Tools And Technology: Lambda Architecture
S-6	SLO-1	Communication standard IEEE802.15.4	IPv6 for smart object networks	Smart cities and Urban networks	Core IoT Functional Stack: Sensors And Actuators Layer - Communication Network Layer - Access Network Layer – Gateways And Backhaul	An Architecture For The Connected Factory

	SLO-2	*Communication standard IEEE802.15.4*	*IPv6 for smart object networks*	*Smart cities and Urban networks*	*Network Transport - Sublayer - IoT Network Management Sublayer - Applications And Analytics Layer*	*Industrial Automation Control Protocols*
S-7	SLO-1	*Practice: Sensor measuring experiment using IOT node*	*Practice: Communication through WiFi*	*Practice: IOT Design Application*	*Practice : IOT Gateway router*	*Practice: IOT Cloud data analysis*
	SLO-2	*Practice: Sensor measuring experiment using IOT node*	*Practice: Communication through WiFi*	*Practice: IOT Design Application*	*Practice : IOT Gateway router*	*Practice: IOT Cloud data analysis*
S-8	SLO-1	*Practice: Sensor measuring experiment using IOT node*	*Practice: Communication through WiFi*	*Practice: IOT Design Application*	*Practice : IOT Gateway router*	*Practice: IOT Cloud data analysis*
	SLO-2	*Practice: Sensor measuring experiment using IOT node*	*Practice: Communication through WiFi*	*Practice: IOT Design Application*	*Practice : IOT Gateway router*	*Practice: IOT Cloud data analysis*
S-9	*SLO-1*	*IoT Access Technologies IEEE 802.15.4g And 802.15.4e*	*RPL routing in smart objects*	*Home automation*	*Data Versus Network Analytics- Smart Services*	*Connected Factory Security*
	SLO-2	*IoT Access Technologies IEEE 802.15.4g And 802.15.4e*	*RPL routing in smart objects*	*Home automation*	*IoT Data Management & Compute Stack*	*Connected Factory Security*
S-10	*SLO-1*	*IoT Access Technologies: LoRaWAN*	*RPL routing in smart objects*	*Building automation*	*IoT Application Transport Methods And Protocols*	*IoT Architecture Of Smart City And Its Security*
	SLO-2	*IoT Access Technologies: LoRaWAN*	*RPL routing in smart objects*	*Building automation*	*IoT Application Transport Methods And Protocols: SCADA*	*IoT Architecture Of Smart City And Its Security*
S-11	*SLO-1*	*Practice: Sensor data transfer over communication link,*	*Practice: Communication through Bluetooth*	*Practice: IOT Design Application*	*Practice : Cloud connectivity*	*Practice: Full sample IOT case study*
	SLO-2	*Practice: Sensor data transfer over communication link*	*Practice: Communication through Bluetooth*	*Practice: IOT Design Application*	*Practice : Cloud connectivity*	*Practice: Full sample IOT case study*
S12	*SLO-1*	*Practice: Sensor data transfer over communication link*	*Practice: Communication through Bluetooth*	*Practice: IOT Design Application*	*Practice : Cloud connectivity*	*Practice: Full sample IOT case study*
	SLO-2	*Practice: Sensor data transfer over communication link*	*Practice: Communication through Bluetooth*	*Practice: IOT Design Application*	*Practice : Cloud connectivity*	*Practice: Full sample IOT case study*

Learning Resources	*Hanes David, Salgueiro Gonzalo, Grossetete Patrick, "IoT fundamentals: Networking technologies, protocols and use cases for the Internet of Things", Cisco, Pearson India, 2015.* *Jean-Philippe Vasseur, Adam Dunkels, "Interconnecting Smart Objects with IP, The next Internet", Morgan Kofmann, 2010.* *Arsheep Bahga, Vijay Madlseti, "Internet of Things: A hands-on approach", Elsevier, 2009.* *Adrin McEwan, Hakim Cassimally, "Designing for Internet of Things", John Wiley, 2014.* *"Mbed based IOT", www.arm.com*

Learning Assessment

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

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

Course Designers

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

Course Code	18ECE206J	Course Name	ADVANCED DIGITAL SYSTEM DESIGN	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Understand advanced Boolean theorems for logic simplification and implementation
CLR-2 :	Understand the formal procedures for the analysis and design of synchronous and asynchronous sequential circuits
CLR-3 :	Understand concept of Programmable Devices (PROM, PLA, PAL, CPLD and FPGA) and implement combinational and sequential logic circuits using them.
CLR-4 :	Adopt systematic approach with the use of ASM chart ASMD chart, RTL representation for the design of digital circuits and systems
CLR-5 :	Use VHDL as a design-entry language for FPGA in electronic design automation of digital circuits
CLR-6 :	Develop the ability to simulate circuits for more advanced design projects.

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	**Learning**		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLO-1 :	Apply advanced theorems to simplify the design aspects of various practical circuits	3	80	75
CLO-2 :	Analyze and design synchronous sequential circuits	3	80	70
CLO-3 :	Identify methods to analyze and design Asynchronous sequential circuits	3	75	70
CLO-4 :	Implement various digital circuits using Programmable Logic Devices	3	80	75
CLO-5 :	Design and implement digital circuits using VHDL.	3	80	70
CLO-6 :	Perform experiments in the laboratory with hardware and as well with software (VHDL) to simulate and verify the design	3	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
CLO-1 :		M														
CLO-2 :			M	M												
CLO-3 :			M	M												
CLO-4 :			M	M												
CLO-5 :			H	H	H	H			L	H	M					L
CLO-6 :													H	H		L

Duration (hour)		12	12	12	12	12
S-1	SLO-1	Shannon's Expansion theorem	state reduction	Analyze asynchronous sequential circuit	Dynamic hazards	Xilinx 3000 series FPGA
	SLO-2	Shannon's Expansion theorem application	state reduction	flow table reduction	Essential hazards	Xilinx 3000 series FPGA
S-2	SLO-1	Shannon's Expansion theorem and its application	state assignment	races-state assignment	Programming logic device families	Xilinx 4000 series FPGA
	SLO-2	Consensus theorem	state assignment	Variables Signals, Constants, Sequential statements VHDL processes	Designing synchronous sequential circuit using PROM	Xilinx 4000 series FPGA
S 3-4	SLO-1 / SLO-2	Lab 1: Implement six-variable function using four-variable function generators	Lab 4: Implement hazard-free circuits	Lab 7: VHDL Programming Practice	Lab 10: Construct multiplexers, de-multiplexers in VHDL	Lab13: Implement BCD adder, comparator in VHDL
S-5	SLO-1	Reed-Muller Expansion technique	Design of synchronous sequential circuits	races-state assignment	Designing synchronous sequential circuit using PROM	Design of sequential circuits (using VHDL)
	SLO-2	Reed-Muller Expansion technique	Design of synchronous sequential circuits	Transition table and problems in transition table	Designing synchronous sequential circuit using PROM	Design of sequential circuits (using VHDL)
S-6	SLO-1	Multiplexer logic as function generators	Introduction to VHDL, Entity and Architecture description	Transition table and problems in transition table	Programmable Array Logic (PAL)	Design of sequential circuits (using VHDL)
	SLO-2	Implementation of Multiple output logic functions	VHDL Data types and Operators	Design of asynchronous sequential circuit	Programmable Array Logic (PAL)	Design of sequential circuits (using VHDL)
S 7-8	SLO-1 / SLO-2	Lab 2: Implement Reed-Muller expressions using logic gates.	Lab 5: Demo of VHDL programmes, Simple programmes	Lab 8: Combinational Circuit Design using Structural, behavioral, data flow modeling	Lab 11: Construct code converters, 4-bit binary adders in VHDL	Lab 14: Mini Project Work

S-9	SLO-1	*Mealy and Moore machines*	*ASM chart and realization using ASM*	*Design of asynchronous sequential circuit*	*Programmable Logic Array (PLA)*	*Additional circuit designs using VHDL*
	SLO-2	*Clocked synchronous sequential circuit design procedure*	*ASM chart and realization using ASM*	*Design of asynchronous sequential circuit*	*Programmable Logic Array (PLA)*	*Additional circuit designs using VHDL*
S-10	SLO-1	*State diagrams*	*Concurrent, Sequential Assignment Statements, Types of Modeling in VHDL*	*Static hazards*	*FPGA-Xilinx FPGA*	*Additional system designs using VHDL*
	SLO-2	*State table*	*Behavioral, dataflow and structural modeling*	*Static hazards*	*FPGA-Xilinx FPGA*	*Additional system designs using VHDL*
S 11-12	SLO-1 SLO-2	*Lab 3: Implementation of Sequence detector circuit.*	*Lab 6: VHDL Programming Practice*	*Lab 9: Implement Combinational Circuits using Structural, behavioral and data flow modeling- Arithmetic circuits, decoders, encoders.*	*Lab 12:* BCD adder, comparator, Design of Sequential circuits (using VHDL)	*Lab 15: End-Semester Practical Examinations*

Learning Resources	1. *Charles H. Roth, Jr. University of Texas at Austin. Larry L. Kinney, Fundamentals of Logic Design, 7th ed., Cengage Learning, 2012* 2. *Richard S. Sandige, Michal L. Sandige, Fundamentals of digital and computer design with VHDL, Mc Graw Hil, 2014*	3. *Jayaram Bhasker, A VHDL Primer, 3rd ed., Prentice Hall, 2011* 4. *Charles. H. Roth, Jr, Digital Systems Design using VHDL, CENGAGE Learning, 2010* 5. *Morris Mano M, Michael D. Ciletti, Digital Design with an Introduction to the Verilog HDL, 5th ed., Pearson, 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	*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

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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.*

Course Code	18ECE224T	Course Name	CRYPTOGRAPHY AND NETWORK SECURITY	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Utilize classical and modern encryption methods			
CLR-2 :	Utilize the different key generation standards			
CLR-3 :	Utilize the various techniques in authentication of information			
CLR-4 :	Analyze the aspects in network security			
CLR-5 :	Identify the effect of various malwares and counter measures			
CLR-6 :	*Understand various conventional and modern cryptography techniques with its added security features*			

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLO-1 :	Identify the methods of classical and modern Encryption	3	80	75
CLO-2 :	Identify the concepts of Number theory, Key generation and distribution standards	3	80	70
CLO-3 :	Analyze Message authentication and Digital Signature algorithm.	3	75	70
CLO-4 :	Obtain information about various forms of network security	3	80	75
CLO-5 :	Analyze the effects of intrusion, viruses, firewalls and various levels of system security	3	80	70
CLO-6 :	*Obtain the knowledge about various encryption techniques, standards and security aspects*	*3*	*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
CLO-1 :	-	-	M	L	-	-	-	-	-	-	-	H	-	-	H
CLO-2 :	L	H	M	-	-	-	-	-	-	-	-	-	-	H	-
CLO-3 :	-	M	L	-	-	-	-	-	-	-	-	H	-	-	M
CLO-4 :	H	M	L	-	-	-	-	-	-	-	-	-	-	-	M
CLO-5 :	L	-	-	-	-	-	-	-	-	-	-	M	-	M	-
CLO-6 :	*M*	-	-	*L*	-	-	-	-	-	-	-	-	-	-	*M*

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Security Services Mechanisms*	*Number Theory*	*Basics of Message authentication codes*	*IP Security*	*Intruders*
	SLO-2	*Attacks*	*Basics of Modulo operations, additive and multiplicative inverse*	*Basics of Message authentication codes*	*Overview of techniques*	*Intrusion*
S-2	SLO-1	*Network Security Model*	*Euclidean algorithm*	*Requirements of MAC*	*Architecture*	*Intrusion Detection*
	SLO-2	*Block cipher, stream cipher, symmetric and Assymetric*	*Extended Euclidean algorithm*	*MAC logic*	*Authentication Header*	*Techniques*
S-3	SLO-1	*Conventional Encryption techniques*	*Fermet's theorem*	*MD5 Logic, MD5 Compression Function,*	*Authentication Protocols*	*Password Management*
	SLO-2	*Substitution and transposition techniques*	*Euler's theorem*	*MD4, Strength of MD5*	*Mututal authentication, one way authentication*	*Techniques*
S-4	SLO-1	*Steganography*	*Key cryptography*	*Requirements for a Hash Function, simple Hash Function,*	*Encapsulating Security Payload*	*Viruses*
	SLO-2	*Basics of LSB, Histogram,DE techniques*	*Key cryptography*	*Birthday Attacks, Block Chaining Techniques*	*Encapsulating Security Payload*	*Worms*
S-5	SLO-1	*DES*	*RSA*	*Securities*	*Security Associations*	*Advanced Security*
	SLO-2	*Algorithm and examples*	*Algorithms and examples*	*HASH - MAC*	*Techniques overview*	*OS Security*
S-6	SLO-1	*SDES*	*Key distribution*	*Birthday Attack*	*Kerbros V4, V5 certificate*	*WLAN Security*

	SLO-2	*Block cipher modes operation*	*Algorithms*	*SHA*	*Authentication Procedure*	*Ad hoc Network Security*
S-7	SLO-1	*Overview of IDEA*	*Key Management*	*Digital Signature standard*	*PGP*	*GSM Security*
	SLO-2	*Overview of Blowfish*	*Algorithms*	*Overview of blocks*	*Email Security*	*E-commerce Security*
S-8	SLO-1	*Overview of RC5*	*Diffie Hellman key exchange*	*Digital Signature Algorithms*	*Web security requirements*	*Cloud Computing Security*
	SLO-2	*Overview of CAST-128*	*Diffie Hellman key exchange*	*Examples*	*SSL -TLS - SET*	*Introduction to Firewall*
S-9	SLO-1	*Characteristics of advanced symmetric Block ciphers*	*Elliptic curve cryptography*	*Basics of proof*	*Port Scanning*	*Firewall-Types, configurations*
	SLO-2	*Characteristics of advanced symmetric Block ciphers*	*Elliptic curve cryptography*	*Proof of DSS Message Authentication Codes.*	*Port Knocking*	*Trusted System*

Learning Resources	1. *William Stallings, Cryptography & Network Security,6th ed., Pearson, 2014* 2. *Bruce Schneier, Applied Cryptography, 2nd ed., 2015* 3. *Eric Maiwald,Fundamentals of Network Security, Tata McGraw Hill, 2011*	4. *BehrouzA.Forouzan, Debdeep Mukhopadhyay, Cryptography and Network Security, 2nd ed., Tata McGraw Hill, 2010* 5. *Bernard Menezes, Network Security and Cryptography, Cengage Learning, 2010*

Learning Assessment

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

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

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu	1. Dr. P. Malarvezhi, 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	18ECE243J	Course Name	DIGITAL IMAGE AND VIDEO PROCESSING	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

Pre-requisite Courses	18ECC204J	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 :	Introduce the fundamentals of image processing and transforms
CLR-2 :	Understand the concepts of image enhancement and restoration
CLR-3 :	Acquire knowledge on image compression and segmentation methods
CLR-4 :	Gain knowledge on basics of video processing
CLR-5 :	Know about motion estimation methods in video processing
CLR-6 :	Utilize the concepts of image and video processing for practical applications

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Understand the basics of digital image processing fundamentals and transforms	1,2	95	70	L	-	-	-	-	-	-	-	-	-	-	H	M	-	-
CLO-2 :	Design 2D filters and apply it for image enhancement and restoration	2	90	70	M	H	-	H	H	-	-	-	-	-	-	H	M	-	H
CLO-3 :	Apply image compression and segmentation methods on digital images	2	90	65	M	H	-	H	H	-	-	-	-	-	-	H	-	-	H
CLO-4 :	Analyze the video formation techniques	1	95	70	H	H	-	H	H	-	-	-	-	-	-	H	-	-	H
CLO-5 :	Learn about the techniques for applying motion estimation in video coding	1,2	90	65	M	H	-	H	H	-	-	-	-	-	-	H	-	-	H
CLO-6 :	Apply the concepts of digital image, video processing and their applications	1,2	90	70	-	-	-	-	-	-	-	-	-	-	-	-	M	-	H

Duration (hour)		Digital Image Fundamentals and Image Transforms	Image Enhancement and Restoration	Image Compression and Segmentation	Basic Steps of Video Processing	2D Motion Estimation
		12	12	12	12	12
S-1	SLO-1	Origin of digital image processing	Some basic intensity transformation functions – image negatives, log transformations	Fundamentals of image compression-coding redundancy, spatial and temporal redundancy	Analog video signals, standard	2D motion estimation – Optical flow – 2D motion vs. apparent motion
	SLO-2	Fundamental steps in digital image processing	Piecewise linear transformation functions	Irrelevant information, measuring image information	Digital video signal, standard, Digital video processing	Correspondence and optical flow
S-2	SLO-1	Components of an image processing system	Histogram equalization, Matching	Image compression model, Lossless compression, Huffman coding	Time varying image formation models – 3D motion models	Occlusion problem
	SLO-2	Structure of human eye, Image formation	Local Histogram Processing	Arithmetic Coding, Run length coding	Rigid motion in Cartesian, Homogenous coordinates	Aperture problem, 2D motion field models
S- 3-4	SLO-1	Lab 1: To learn MATLAB software and its basic commands for image processing	Lab 4: Histogram Modifications	Lab 7: Run length coding	Lab 10: Wavelet coding	Lab 13: Convert video into frames and process them
	SLO-2					
S-5	SLO-1	Brightness adaptation and discrimination	Using histogram statistics for image enhancement	Lossy compression - Transform coding	Deformable motion	Block motion models- translational block motion
	SLO-2	Basic concepts in sampling and Quantization , Representing digital images	Smoothing linear filters	Wavelet coding	Geometric image formation	Generalized/ Deformable block motion
S-6	SLO-1	Neighbors of a pixel, Adjacency, Connectivity, Regions and Boundaries	Order statistics nonlinear filters	Image segmentation – detection of isolated points, line detection	Perspective projection	Block matching criteria, Matching procedures
	SLO-2	Distance Measures, A simple image	Sharpening spatial filters	Edge models, Basic edge detection	Photometric image formation	Hierarchical motion estimation

		formation model				
S- 7-8	SLO-1 SLO-2	*Lab 2: Fourier analysis of image*	*Lab 5: Image smoothing and sharpening*	*Lab 8: Basic edge detection operations*	*Lab 11: JPEG Compression*	*Lab 14:Filtering video signals*
S-9	SLO-1	*Fourier transform of sampled functions*	*Combined spatial enhancement methods*	*Region based segmentation – region growing*	*Photometric effects of 3D motion*	*Gradient based optimization*
	SLO-2	*Sampling theorem, Aliasing, Obtaining the DFT from the Continuous Transform of a Sampled Function*	*Homomorphic filtering, A model of image degradation/ restoration process*	*Region splitting and merging*	*Observation noise, Sampling structures of analog, digital video*	*Steepest Descent method*
S-10	SLO-1	*Properties of 2D DFT – Relationship between spatial and frequency interval, Translation and Rotation, Periodicity, symmetric properties*	*A model of image degradation/ restoration process, Noise models*	*Spatial, frequency domain techniques*	*2D fourier transform relations, Intra frame filtering- LMMSE filtering*	*Newton Raphson method, Transform coding , 3D waveform coding*
	SLO-2	*DWT, DCT*	*Singular value decomposition*	*Texture based segmentation*	*Median and weighted median filtering, Motion detection based filtering*	*Local vs. Global minima, Predictive coding*
S-11 - 12	SLO-1 SLO-2	*Lab 3: Image filtering*	*Lab 6: Singular value decomposition*	*Lab 9: Repeat/Revision of experiments*	*Lab 12: Region based image segmentation*	*Lab 15: Mini project*

Learning Resources	*1. Rafael C Gonzalez, Richard E Woods, "Digital Image Processing"- 3rd Edition, Pearson Education 2008.* *2. Yao wang, JoemOstarmann and Ya – quin Zhang, "Video processing and communication ",1st edition , PHI* *3. M. Tekalp ,"Digital video Processing", Prentice Hall International*	*4. A.K. Jain, "Fundamentals of Digital Image Processing". Pearson education* *5. William K Pratt, "Digital Image Processing", John Willey (2001).*

Learning Assessment

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

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

Course Designers

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

Course Code	18ECE322T	Course Name	OPTOELECTRONICS	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18ECC102J	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 :	Identify the working and nature of optical wave
CLR-2 :	Identify the working and nature of optical semiconductors
CLR-3 :	Analyze the working principles of different photonic sources
CLR-4 :	Analyze the working principles of different photonic detectors
CLR-5 :	Create knowledge about various optoelectronic applications
CLR-6 :	Familiarize the concepts of optoelectronic integrated circuits

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	Learning 2 Expected Proficiency (%)	Learning 3 Expected Attainment (%)
CLO-1 :	Review the basics of optics, optical semiconductors	2	85	80
CLO-2 :	Understand the working principle of different photonic sources	4	85	75
CLO-3 :	Familiarize the principle and operation of various detectors	4	85	75
CLO-4 :	Acquire knowledge of various optoelectronic modulators and switches	4	80	70
CLO-5 :	Explore the concepts of optoelectronic integrated circuits and components	4	80	70
CLO-6 :	Design and analyze the working of different components in optical system and use it for various applications.	4	80	70

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

Module		WAVE NATURE OF LIGHT AND SEMICONDUCTOR OPTICS	SEMICONDUCTOR PHOTON SOURCES AND DISPLAY DEVICES	SEMICONDUCTOR PHOTON DETECTORS	OPTOELECTRONIC MODULATORS, INTERCONNECTS AND SWITCHES	OPTOELECTRONIC INTEGRATED CIRCUITS (OEIC) AND APPLICATIONS
Duration (hour)		9	9	9	9	9
S-1	SLO-1	Light Waves In A Homogeneous Medium- Plane electromagnetic wave, Maxwell's wave equation	LED Principles- Homojunction LED, Heterostructure LED	Principle of Photo Detection	Electro-Optic Modulator: Principles, Electro optic effect	Introduction
	SLO-2	Refractive Index And Dispersion- Sellmeier equation and diamond, Cauchy equation and diamond	Quantum Well High Intensity LEDs	The PIN Photodiode	Single waveguide electro optic modulators	Need For Integration
S-2	SLO-1	Polarization Of Light	LED Materials and Structures	Avalanche Photodiode- Principles, Structures	Dual channel waveguide electro optic modulator	Slab and stripe waveguides
	SLO-2	Snell's law and Total internal reflection	LED Efficiencies and Luminous Flux	Responsivit, Efficiency	Electro optic modulator employing reflection or Diffraction	Basic IO structural elements
S-3	SLO-1	Reflection And Refraction	Manufacturing Process and Applications	Heterojunction Photodiodes	Integrated Optical Modulators: Phase and polarization modulation	IO devices: Optical disk read head
	SLO-2	Solving problems	Solving Problems	Schottky Junction Photodetectors	Mach Zehnder modulator, Coupled waveguide modulator	OIC temperature sensor
S-4	SLO-1	Superposition And Interference Of Waves	LASER: Threshold Condition	Solving problems	Acousto-Optic Modulator: Principles, Acousto optic effect, Raman nath and Bragg type modulators	IO high voltage sensor
	SLO-2	Diffraction Principles- Fraunhofer diffraction, Diffraction Grating	Emission and Absorption of Radiation	Solving problems	Performance characteristics, Acousto optic frequency shifters	IO chemical sensor
S-5	SLO-1	Overview Of Semiconductors	Population Inversion	Metal-Semiconductor, Metal Photodiode	Solving problems	IO wavelength meters and spectrum analyzers
	SLO-2	Interaction of Photons With Charge Carriers	Principle of the Laser Diode	Phototransistors	Solving problems	RF Spectrum Analyzer

S-6	SLO-1	*Hole Pair Formation And Recombination*	*Heterostructure Laser Diodes*	*Array Detectors*	*Faraday Rotation*	*Monolithic Wavelength-Multiplexed Optical Source*
	SLO-2	*Absorption In Semiconductors*	*Device Fabrication*	*Photoconductive detectors*	*Optical Isolators*	*Analog-To-Digital Converter*
S-7	SLO-1	*Effect Of Electric Field On Absorption*	*Solving problems*	*Noise In Photodetectors*	*Nonlinear Optics*	*Integrated-Optic Doppler Velocimeter*
	SLO-2	*Absorption In Quantum Wells*	*Display Device: Photo Luminescence*	*Noise In Photodetectors*	*Second Harmonic Generation*	*Guided Wave Devices*
S-8	SLO-1	*Radiation In Semiconductors*	*Cathode Luminescence, Electro Luminescence*	*Solving problems*	*Optical Interconnects*	*Guided Wave Devices*
	SLO-2	*Solving Problems*	*Injection Luminescence*	*Solving problems*	*Optical gates*	*OEIC: Transmitter*
S-9	SLO-1	*Heterojunctions*	*Plasma Displays*	*Charge Coupled Devices (CCD)*	*Photonic Switches*	*OEIC: Receiver*
	SLO-2	*Heterojunctions*	*LCD, Numeric Displays*	*Charge Coupled Devices (CCD)*	*Solving problems*	*OEIC phased array antenna driver*

Learning Resources	Kasap, "Optoelectronics & Photonics: Principles & Practices", 2nd edition, Pearson Education, 2013. Pallab Bhattacharya "Semiconductor Optoelectronic Devices", 2nd Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2009. B. E. A. Saleh and m.c. Teich, "Fundamentals Of Photonics," 2nd edition, John Wiley & Sons, Inc. 2007.	Robert G. Hunsperger, "Integrated Optics- Theory And Technology", Springer, 2009 J. Wilson and J F B Hawkes "Optoelectronics- An Introduction", 3rd edition, Pearson Education Taiwan Ltd, 2010. A Ghatak and K Thyagarajan, "Introduction to Fiber Optics", Cambridge University Press 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	*40%*	-	*40%*	-	*35%*	-	*35%*	-	*40%*	-
	Understand										
Level 2	Apply	*40%*	-	*40%*	-	*35%*	-	*35%*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20%*	-	*20%*	-	*30%*	-	*30%*	-	*20%*	-
	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. Ms. Ramya A, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

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

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

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

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLO-1 :	*Understand the concepts of machine learning*	*2*	*80*	*85*
CLO-2 :	*Learn and understand machine tools and libraries of machine learning*	*2*	*75*	*80*
CLO-3 :	*Learn and understand the linear learning models and classification in machine learning*	*2*	*85*	*80*
CLO-4 :	*Understand the clustering techniques and their utilization in machine learning*	*2*	*80*	*75*
CLO-5 :	*Study the tree based machine learning techniques and to appreciate their capability*	*2*	*75*	*85*

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

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

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

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

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

Course Designers		
Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
		Dr.G.Vadivu *Dr. UshaKiruthika* *Mr.S.Joseph James*

Course Code	18CSE449T	Course Name	DATA ANALYSIS AND VISUALIZATION	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

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

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

CLR-1 :	*Obtain knowledge in handling data*
CLR-2 :	*Learn the various statistical techniques in data handling*
CLR-3 :	*Know the various regression and classification techniques*
CLR-4 :	*Identify various data sources and dealing with messy date*
CLR-5 :	*Create insights to art of visualization*
CLR-6 :	*Knowing the impact of visual effects*

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

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

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

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

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

Learning Assessment

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

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

Course Designers

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

Course Code	18CSE378T	Course Name	PRINCIPLES OF CLOUD COMPUTING	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Understand the fundamental ideas behind Cloud Computing, the evolution of the paradigm, its applicability; benefits, as well as current and future challenges
CLR-2 :	Learn cloud enabling technologies and get exposure to advanced clouds
CLR-3 :	Explore cloud storage technologies and relevant distributed file systems, NoSQL databases and object storage;
CLR-4 :	Understand the cloud security threats and protective mechanism for cloud computing
CLR-5 :	Participate in team-based peer reviews to analyze the security development life cycle and mitigate risks and vulnerabilities

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLO-1 :	Explain terms used in secured software development and life cycle process	2	80	70
CLO-2 :	Apply fundamental concepts in cloud infrastructures to understand the cloud system, network and virtualization and outline their role in enabling the cloud computing system model.	3	85	75
CLO-3 :	Illustrate the fundamental concepts of cloud storage and demonstrate their use in storage systems such as Amazon S3 and HDFS	1	75	70
CLO-4 :	Evaluate the security issues related to cloud computing and handle the security threats and construct different cloud delivery design models.	3	85	80
CLO-5 :	Analyze various cloud programming models and apply them to solve problems on the cloud.	3	85	75

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

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction to Cloud Computing	Cloud enabling technologies- Broadband networks and Internet architecture	Introduction to Cloud Data Storage, The evaluation of storage technology	Fundamental Cloud Security	Cloud Application Development and Architectural Styles
	SLO-2	Evolution of cloud computing			Basic Terms and Concepts	
S-2	SLO-1	Network-Centric Computing	Data Center Technology	Storage Models	Threat Agents, Cloud Security Threats	MapReduce Programming Model
	SLO-2	Network-Centric Content				
S-3	SLO-1	Origin of Cloud Computing, Basic Concepts and Terminology	Web Technology	File Systems and databases	Cloud Security Mechanisms	Case Study: the GrepTheWeb Application
	SLO-2		Multitenant Technology			
S-4	SLO-1	Goals and Benefits	Service Technology Virtualization Technology	Distributed File Systems Google File System	Encryption Hashing	Hadoop: Yarn and Tez
	SLO-2	Risks and Challenges, Roles and Boundaries, Cloud Characteristics				
S-5	SLO-1	Cloud Service Models	Virtual Machines	HDFS	Digital Signature, Public Key Infrastructure	SQL on Hadoop: Pig, Hive, and Impala
	SLO-2	Cloud Deployment Models		NoSQL Databases		
S-6	SLO-1	Cloud Service Providers and the Cloud Ecosystem	Full Virtualization and Para-virtualization	Cloud Databases (HBase, MongoDB, Cassandra, DynamoDB)	Identity and Access Management, Single Sign-On: Kerberos authentication	Current Cloud Applications and New Opportunities
	SLO-2					

S-7	SLO-1 SLO-2	Amazon Web Services(AWS), Google Clouds, Microsoft Azure Cloud	Hardware Support for Virtualization	Cloud Object Storage (Amazon S3, OpenStack Swift, Ceph)	One-time password, Basic cloud data security mechanisms	Design approaches with Case Study
S-8	SLO-1 SLO-2	SLA Management in Cloud Computing: A Service Providers Perspective	Kernel-Based Virtual Machine, Hypervisors	Data Storage for Online Transaction Processing Systems	Virtual Machine Security, Security of Virtualization, A Trusted Hypervisor	Design methodology for IaaS Service Model
S-9	SLO-1 SLO-2	Case Study on Open Source & Commercial Clouds: Eucalyptus, OpenStack, Aneka	Containers; Docker Containers, Kubernetes	Disk Locality versus Data Locality in Computer Clouds	Mobile Devices and Cloud Security	Google API, AWS EC2 Instances.

Learning Resources	1.Dan C. Marinescu," Cloud Computing Theory and Practice", Second Edition Copyright © **2018** Elsevier Inc. All.https://www.sciencedirect.com/book/9780128128107/cloud-computing 2.Rajkumar Buyya, James Broberg, AndrzejGoscinski, Cloud Computing Principles and Paradigms, Wiley Publications, 2017. 3. Thomas Erl, ZaighamMahmood, and RichardoPuttini, "Cloud Computing: Concepts, Technology & Architecture", Prentice Hall/PearsonPTR, Fourth Printing, 2014, ISBN: 978013338752.	4.K. Chandrasekaran, "Essentials of Cloud Computing", Chapman and Hall/CRC Press, 2014, ISBN 9781482205435 5.Arshdeep Bahga, Vijay Madisetti, "Cloud Computing: A Hands-On Approach", University Press, 2016, ISBN-13: 978-0996025508.

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**
SuriyadeepanRamamoorthy Research Engineer at Saama Technology Puducherry, Puducherry, India Information Technology and Services	Dr.E. Ilavarasan Professor,CSE Pondicherry Engineering college.	1.Mrs Krishnaveni,SRMIST,KTR-SWE
		2.Dr.S.Ramamooorthy,SRMIST,KTR-CSE
		3.Mr.K. Venkatesh,SRMIST,KTR-IT
		4.Mr. S.VidhyaSagar,SRMIST,Vadapalani campus

Course Code	18CSE390T	Course Name	COMPUTER VISION	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Recognize and describe both the theoretical and practical aspects of computing with images. Connect issues from Computer Vision to Human Vision
CLR-2 :	Describe the foundation of image formation and image analysis. Understand the basics of 2D and 3D Computer Vision.
CLR-3 :	Become familiar with the major technical approaches involved in computer vision. Describe various methods used for registration, alignment, and matching in images.
CLR-4 :	Get an exposure to advanced concepts leading to object and scene categorization from images.
CLR-5 :	Build computer vision applications.

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLO-1 :	Provide an introduction to computer vision including fundamentals of image formation	3	80	70
CLO-2 :	Provide a clear view of image formation	3	85	75
CLO-3 :	Provide a clear view of image processing	3	75	70
CLO-4 :	Provide knowledge about Computational photography	3	85	80
CLO-5 :	Provide knowledge about Image rendering	3	85	75

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

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction to Computer Vision	Points and patches-An Introduction	Active contours	Triangulation	Motion models
	SLO-2	Image formation	Feature detectors	Snakes	Two-frame structure from motion	Planar perspective motion
S-2	SLO-1	Geometric primitives	Feature descriptors	Dynamic snakes and CONDENSATION	Projective reconstruction	Rotational panoramas
	SLO-2	2D,3D Transformations			Self-calibration	
S-3	SLO-1	3D to 2D Projection	Feature matching	Scissors	Perspective and projective factorization	Gap closing
	SLO-2	Lighting,Reflectance and shading		Level Sets	Bundle adjustment	
S-4	SLO-1	Sampling and aliasing	Feature tracking	Split and merge	Exploiting sparsity	Cylindrical and spherical coordinates
	SLO-2	Image processing Point operators				
S-5	SLO-1	Pixel transforms	Edge detection	Mean shift and mode finding	Constrained structure and motion	Bundle adjustment
	SLO-2	Color transforms				
S-6	SLO-1	Histogram equalization	Edge linking	Normalized cuts	Hierarchical motion estimation	Parallax removal
	SLO-2					

S-7	SLO-1	*Linear filtering*	*Successive approximation*	*Graph cuts and energy-based methods*	*Fourier-based alignment*	*Recognizing panoramas*
	SLO-2	*Non Linear filtering*	*Hough transforms*			
S-8	SLO-1	*Fourier transforms*	*Hough transforms*	*2D and 3D feature-based alignment*	*Incremental refinement*	*Compositing*
S-9	SLO-1	*Two-dimensional Fourier transforms* ,	*Vanishing points*	*Pose estimation*	*Case Study*	*Case Study*

Learning Resources	*RichardSzeliski,"ComputerVision:AlgorithmsandApplications",Springer,2010.* *Forsyth/Ponce,"ComputerVision:AModernApproach",PearsonEducationIndia;2edition(2015)* *S.Nagabhushana,"ComputerVisionandImageProcessing",NewAgeInternationalPvtLtd;First edition(2005)*	*4. Rafael C. GonzaLez'"Digital Image Processing",Pearson Education; Fourth edition (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%)#	
Level 1	Remember	40%	30%	30 %	30%	*30%*
	Understand					
Level 2	Apply	*40%*	40%	40 %	40%	*40%*
	Analyze					
Level 3	Evaluate	*10%*	*30%*	*30%*	*30%*	*30%*
	Create					
	Total	100 %	100 %	100 %	100 %	-

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	Dr. A.P.Shanthi , CEG Campus Anna University	*1.Dr.V.Ganapathy,SRMIST*
		2.T.Senthil Kumar,SRMIST

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

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Understand the concepts of Data Mining*
CLR-2 :	*Familiarize with Association rule mining*

Learning		
1	2	3
rnki	of	Att ain

Program Learning Outcomes (PLO)														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
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CLR-3 :	*Familiarize with various Classification algortihms*
CLR-4 :	*Understand the concepts of Cluster Analysis*
CLR-5 :	*Familiarize with Outlier analysis techniques*
CLR-6 :	*Familiarize with applications of Data mining in different domains*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*			
CLO-1 :	*Gain knowledge about the concepts of Data Mining*	*2*	*80*	*85*
CLO-2 :	*Understand and Apply Association rule mining techniques*	*2*	*75*	*80*
CLO-3 :	*Understand and Apply various Classification algortihms*	*2*	*85*	*80*
CLO-4 :	*Gain knowledge on the concepts of Cluster Analysis*	*2*	*80*	*75*
CLO-5 :	*Gain knowledge on Outlier analysis techniques*	*2*	*75*	*85*
CLO-6 :	*Understand the importance of applying Data mining concepts in different domains*	*2*	*80*	*85*

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Why Data mining? What is Data mining ?*	*Mining frequent patterns: Basic concepts*	*Classification: Basic concepts*	*Cluster Analysis: Introduction*	*Outliers: Introduction*
	SLO-2	*Kinds of data meant for mining*	*Market Basket Analysis*	*General approach to Classification*	*Requirements and overview of different categories*	*Challenges of outlier detection*
S-2	SLO-1	*Kinds of patterns that can be mined*	*Frequent itemsets, Closed itemsets*	*Decision tree induction*	*Partitioning method: Introduction*	*Outlier detection methods: Introduction*
	SLO-2	*Applications suitable for data mining*	*Association rules-Introduction*	*Algorithm for Decision tree induction*	*k-means*	*Supervized and Semi-supervized methods*
S-3	SLO-1	*Issues in Data mining*	*Apriori algorithm-theoritical approach*	*Numerical example for Decision tree induction*	*k-medoids*	*Unsupervized methods*
	SLO-2	*Data objects and Attribute types*	*Apply Apriori algorithm on dataset-1*	*Attribute selection measure*	*Hierarchical method: Introduction*	
S-4	SLO-1	*Statistical descriptions of data*	*Apply Apriori algorithm on dataset-2*	*Tree pruning*	*Agglomerative vs. Divisive method*	*Statistical and Proximity based methods*
	SLO-2		*Generating Association rules from frequent itemsets*	*Scalability and Decision tree induction*	*Distance measures in algorithmic methods*	
S-5	SLO-1	*Need for data preprocessing and data quality*	*Improving efficiency of Apriori*	*Bayes' Theorem*	*BIRCH technique*	*Statistical approaches*
	SLO-2			*Naïve Bayesian Classification*		
S-6	SLO-1	*Data cleaning*	*Pattern growth approach*	*IF-THEN rules for classification*	*DBSCAN technique*	*Statistical data mining*
	SLO-2	*Data integration*		*Rule extraction from a decision tree*		
S-7	SLO-1	*Data reduction*	*Mining frequest itemsets using Vertical data format*	*Metrics for evaluating classifier performance*	*STING technique*	*Data mining and recommender systems*
	SLO-2		*Strong rules vs. weak rules*	*Cross validation*		
S-8	SLO-1	*Data transformation*	*Association analysis to Correlation analysis*	*Bootstrap*	*CLIQUE technique*	*Data mining for financial data analysis*
	SLO-2			*Ensemble methods-Introduction*		
S-9	SLO-1	*Data cube and its usage*	*Comparison of pattern evaluation measures*	*Bagging and Boosting*	*Evaluation of clustering techniques*	*Data mining for Intrusion detection*
	SLO-2			*Random Forests: Introduction*		
Learning Resources		*Jiawei Han and Micheline Kamber, " Data Mining: Concepts and Techniques", 3rd Edition, Morgan Kauffman Publishers, 2011.*				

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

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

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

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

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLO-1 :	Apply basic mathematical concepts in Deep Learning	2	80	85
CLO-2 :	Work with powerful framework for supervised learning	3	75	80
CLO-3 :	Deal with Convolution Neural Networks	2	85	80
CLO-4 :	Analyze various types efficient data encoders	2	80	75
CLO-5 :	Apply various network models in deep learning	3	75	85

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

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

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

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

Learning Assessment

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

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1.	*1.*	*1. Dr.E.Poovammal, Prof/CSE Dept*
2.	*2.*	*2. Dr.G.Vadivu*
		3. Mr.Joseph James

Course Code	18ECE331J	Course Name	MULTI-CORE ARCHITECTURE AND PROGRAMMING	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

Pre-requisite Courses	18CSC203J	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	*Electronics and Computer Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Learn about Multicore processors and Parallelization*
CLR-2 :	*Impart knowledge about Parallel architectures and Thread Programming*
CLR-3 :	*To comprehend caches and memory hierarchy concepts*
CLR-4 :	*To impart knowledge on Parallel programming models*
CLR-5 :	*Acquire the knowledge of thread programming*
CLR-6 :	*To emphasize hands-on knowledge on using OpenMP tools*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	**Learning**			**Program Learning Outcomes (PLO)**														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	*Identify the Multicore processorsunderstand pipelining, and data and instruction parallelism*	*1,2*	*80*	*80*	*H*				*H*				*H*			*M*			*H*
CLO-2 :	*Understand the concepts of multithreading and thread-level parallelism (TLP).*	*1,2*	*85*	*80*	*H*				*H*				*H*			*M*			*H*
CLO-3 :	*Understand multiprocessor cache mapping techniques, cache coherence and memory consistency models*	*2,3*	*90*	*85*	*H*				*L*				*H*			*M*			*H*
CLO-4 :	*Comprehend the multicore parallel programming models and constructs*	*2,3*	*90*	*85*	*H*		*M*		*H*				*H*			*M*		*M*	*H*
CLO-5 :	*Interpret the thread programming and synchronization mechanisms.*	*1,2,3*	*80*	*80*	*H*		*M*		*M*				*H*			*M*		*M*	*H*
CLO-6 :	*Perform experiments to evaluate a parallel program's performance using OpenMP*	*1,2,3*	*85*	*85*	*H*		*L*		*M*				*H*			*M*		*L*	*H*

Module		**Introduction to Multicore Processors and Parallelization**	**Parallel Architectures and Thread Programming**	**Caches and Memory Hierarchy**	**Parallel Programming Models**	**Thread Programming Overview**
Duration (hour)		**12**	**12**	**12**	**12**	**12**
S-1	**SLO-1**	*The motivation of multicore processors*	*Overview of parallelism, Basic concepts in parallel programming*	*Caches and memory hierarchy and Cache memory characteristics*	*Multicore parallel processing models, Parallelization of programs*	*Creating Threads, Setting thread priority and Compiling multithreaded code*
	SLO-2		*Microprocessor design phases and trends, Categorizations of multicore architectures*	*Cache mapping techniques: Direct mapped caches*	*Levels of parallelism: Instruction level parallelism and Data level parallelism*	*Process termination, Sharing data between threads*
S-2	**SLO-1**	*Supporting multiple threads on a single chip*	*Memory Organization of Parallel Computers and distributed memory organization*	*Fully associative caches*	*Loop parallelism and Functional parallelism*	*Reentrant codes and Protecting Access Using Mutex Locks, Mutex Attributes*
	SLO-2			*Set associative caches*	*Implicit and explicit parallelism*	
S-3 & S-4	**LAB**	*Lab: i) Introduction to OpenMP: To Print helloworld using OpenMP ii) To count Prime numbers using OpenMP*	*Lab: Program Control: Nested loop constructs*	*Lab: Combined and Orphaned parallel loop reduction*	*Lab: Tasking: The task and taskwait Constructs*	*Lab: Multitasking OpenMP*
S-5	**SLO-1**	*Pipelined processor cores, Characteristics of multi-processor systems*	*Shared memory organization and Reducing memory access times*	*Block replacement methods*	*Parallel programming patterns: Creation of threads*	*Using Spin Locks, Semaphores, Mutex and Deadlocks*
	SLO-2			*Write policies: Write-Through, Write-Back Policy*	*Use of Fork-Join, Parbegin and Parend constructs*	*Sharing semaphores between processes*
S-6	**SLO-1**	*Processes, Threads*	*Multithreading, caches, Thread level parallelism*	*Number of caches, Two-level cache hierarchy*	*SPMD and SIMD models*	*Static and Dynamic library creation*

	SLO-2			*Cache coherency: Snooping protocol*		*Makefile creation*
S-7 & S-8	**LAB**	*Lab: To add all elements in an array in parallel.*	*Lab: To perform dense matrix multiplication Using OpenMP*	*Lab: To get and Print Environment Information*	*Lab: Tasking: Task priority*	*Lab: Creation of driver file using kernel programming – stepper motor communication / GPS Module*
S-9	**SLO-1**	*Parallelization patterns: Data parallelism*	*Simultaneous multithreading, and Multicore processors*	*Write-back invalidation protocol*	*Master-slave and client-server models*	*Linux Kernel module level programming & Device drivers*
	SLO-2			*Directory based cache coherence protocol*	*Pipelining, Task pools*	
S-10	**SLO-1**	*parallelization by processes and Application Dependencies*	*Architecture of multicore processors*	*Memory Consistency: Sequential consistency model*	*Performance evaluation of computer systems: Evaluation of CPU performance and Performance of processors with a memory hierarchy*	*Speed of rotations, Pulses and*
	SLO-2			*Relaxed consistency model*		*Checking of processor ADC/DAC calculations*
S-11 & S-12	**LAB**	*Lab: Program Control: Conditional compilation*	*Lab: To parallelize a simple loop using the parallel loop construct*	*Lab: Random number generation*	*Lab: Tasking: Tasking dependencies*	*Lab: Memory write /read, digital/analog input and output switch checking*

Learning Resources	*1.*Darryl Gove, "Multicore Application Programming: for Windows, Linux, and Oracle Solari", Pearson Education Inc., 2011. *2.* Thomas Rauber, Gudula Runger, "Parallel Programming For Multicore and Cluster Systems", Springer Publications, 2010.	3. Abderazek Ben Abdallah, "Advanced Multicore Systems-On-Chip, Architecture, On-Chip Network, Design", Springer Publications, 2017. 4. Shameem Akhter, Jason Roberts, "Multi-Core Programming: Increasing performance through software multi-threading", BPB Publications, 2010.

Learning Assessment

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

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr.Antony Sam Sunil, VVDN Technologies, Chennai	*1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*Mr.K.Ramesh, Assistant Professor, ECE Dept, SRM IST, Chennai*
Mr.Shashikar Vangala, AMS Semiconductors Ltd, Hyderabad	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	
Mr.N.Sakthi, HCL Japan, Technical Delivery Manager		

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

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

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

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

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

		Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*Obtain knowledge about artificial intelligence*	*1*	*85*	*80*	*H*	-	-	-	-	-	-	-	-	-	-	-	*L*	*L*	*L*
CLO-2 :	*Apply the searching strategies*	*2*	*85*	*80*	*H*	*H*	-	-	-	-	-	-	-	-	-	-	*M*	*L*	*M-*
CLO-3 :	*Formulate inference rules for given problem*	*3*	*80*	*75*	*H*	*H*	*H*	-	-	-	-	-	-	-	-	-	*M*	*L*	*M*
CLO-4 :	*Create appropriate solution plan using AI for real time problems*	*3*	*80*	*75*	*H*	*H*	-	-	-	-	-	-	-	-	-	-	*M*	*M*	*M*
CLO-5 :	*Handle uncertainty using mathematical axioms*	*3*	*75*	*70*	*H*	-	*H*	-	-	-	-	-	-	-	-	-	*H*	*M*	*H*
CLO-6 :	*Apply the concepts of image processing and robotics in the perspective of Artificial intelligence*	*2*	*80*	*75*	*H*	*H*	*H*	*H*	-	-	-	-	-	-	-	-	*H*	*M*	*H*

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

S-5	SLO-1	*Problem solving by searching: Problem solving agents*	*First order logic: syntax and semantics, assertions and queries*	*Planning using graphs*	*Exact inferences in Bayesian networks*	*Vision for manipulation*
	SLO-2	*Problem solving by uninformed searching*	*First order logic: knowledge engineering*	*Planning using propositional logic*	*Approximate inferences in Bayesian networks*	*Vision for navigation*
S-6	SLO-1	*Problem solving by informed searching*	*Inferences in first order logic, forward chaining*	*Hierarchical task network planning*	*Filtering and prediction in temporal methods*	*Robotics : introduction*
	SLO-2	*Memory bounded heuristic searching*	*Solving problems*	*Modifying the planner*	*Smoothing and likelihood in temporal methods*	*Hardware and perception*
S-7	SLO-1	*Heuristic function*	*Backward chaining, resolution*	*Conditional planning in fully observable environments*	*Hidden Markov model*	*Movement plan: configuration space, cell decomposition method*
	SLO-2	*Local search algorithms and optimizations :Hil climbing, Simulated annealing*	*Solving problems*	*Conditional planning in partially observable environments*	*Simplified matrix algorithms*	*Movement plan: skeletonization method*
S-8	SLO-1	*Local search algorithms and optimizations: Local beam search, Genetic algorithms*	*Knowledge representation: Ontological engineering*	*Monitoring and re planning*	*Kalman filters*	*Planning uncertain movements*
	SLO-2	*Searching in continuous space*	*Categories and objects*	*Continuous planning*	*One dimensional example*	*Controls in uncertain movements*
S-9	SLO-1	*Online search agents and unknown environments: problems and agents*	*Actions, situations and events*	*Multi agent planning*	*Dynamic Bayesian network*	*Software architectures for robotics*
	SLO-2	*Online search agents and unknown environments: local search and learning*	*Mental events and objects*	*Coordination in multi agent planning*	*Approximate and exact inferences in dynamic Bayesian network*	*Programming languages for robotics*

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

Learning Assessment

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

course Code	18ECE333T	Course Name	PRINCIPLES OF CYBER PHYSICAL SYSTEMS	Course Category	E	*Elective Course*	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Communcation 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 :	*Practical knowledge on cyber physical machines*
CLR-2 :	*Understanding of process, model and compositions of cyber physical systems*
CLR-3 :	*Identify the significance of networking and design components of cyber physical systems*
CLR-4 :	*Create insights to the temporal logic and asynchronous model*
CLR-5 :	*Analyze the working principle of continuous model and predictive model*
CLR-6 :	*Utilize the concepts in cyber physical systems for the understanding of engineering and technology*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	*1* Level of Thinking (Bloom)	*2* Expected Proficiency (%)	*3* Expected Attainment (%)	1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO – 3
CLO-1 :	*Use cyber physical system for engineering applications*	*2*	*80*	*70*	*H*	*H*	-	-	*M*	-	-	-	-	*H*	-	*M*	*H*	-	-
CLO-2 :	*Design specific parts of the engineering schemes with cyber physical model*	*4*	*85*	*75*	*H*	*H*	-	-	-	*H*	-	-	-	-	-	-	-	-	-
CLO-3 :	*Solve simple engineering problems with cyber physical solutions*	*3*	*75*	*70*	*H*	-	-	*H*	-	-	-	*H*	-	-	-	-	-	*H*	-
CLO-4 :	*Apply the CPS model to replace older existing technology models*	*3*	*85*	*80*	*H*	*H*	-	-	-	-	-	-	-	*H*	-	*H*	-	-	*H*
CLO-5 :	*Use Cyber physical systems for further new application and developments*	*2*	*85*	*75*	*H*	-	*H*	-	-	-	*H*	-	-	-	-	-	-	-	-
CLO-6 :	*Apply the concepts of cyber physical systems in real time applications*	*3*	*80*	*70*	-	-	-	-	-	*H*	*H*	*H*	*H*	-	-	-	*H*	-	-

Duration (hour)		**Introduction to Cyber Physical System (CPS) & State Machines**	**Composition, Models & Process on CPS**	**Components, Networks & Designs on CPS**	**Asynchronous & Temporal Logic on Model CPS**	**Continuous, Linear & Periodic Model on CPS**
S-1	SLO-1	*The Design Process of Cyber Physical Systems*	*Supervisory Control Systems*	*Synchronous Model*	*Asynchronous Model*	*Continuous-TimeModels*
	SLO-2	*Motivating Examples and Applications*	*Composition of State Machines*	*Reactive Components*	*States, input, internal actions and executions.*	*Continuously Evolving Inputs and Outputs*
S-2	SLO-1	*Newtonian Mechanics*	*Synchronous Composition*	*Variables, Valuations and Expressions*	*Extended state machines, operations on process,*	*Models with Disturbance*
	SLO-2	*Actor Models*	*Asynchronous Composition*	*Inputs, Outputs and Sates, Update and Exceuction*	*Asynchronous Design Primitives, Blocking and Non-Blocking Synchronization*	*Composing Components, Stability*
S-3	SLO-1	*Feedback Control*	*Scheduling Semantics*	*Properties of Components*	*Deadlocks and Shared Memory*	*Linear Systems, Linearity*
	SLO-2	*Proportional Control, Tracking Error*	*Shared Variable*	*Finite State and Combination Components*	*Asynchronous Coordination Protocols*	*Solutions of Linear Differential Equations*
S-4	SLO-1	*Discrete Dynamics*	*General and Cascade Composition*	*Event Triggered, Non Deterministic Component*	*Reliable Transmission*	*Designing Controllers, Open-Loop vs. Feedback Controller*
	SLO-2	*The Notion of State*	*Hierarchical State Machine*	*Composing Components, Parallel Composition*	*Wait Free Consensus*	*Scheduling Concepts, Scheduler Architecture*
S-5	SLO-1	*Finite Sate Machines*	*Structure of Models*	*Synchronous Designs*	*Temporal Logic*	*Periodic JobModel, Schedulability*
	SLO-2	*Transition, Reaction and Update of Finite State Machines*	*Synchronous Reactive Models*			
S-7	SLO-1	*Extended State Machines*	*Feedback , well formed and ill formed models*	*Cruise Control System*	*Linear Temporal Logic*	*Alternative JobModels, EDF Scheduling*
	SLO-2	*Examples of Extended State Machines*	*Data Flow Model for Computation*	*Synchronous Networks*	*LTL Specifications*	*EDF for Periodic JobModel*

S-8	SLO-1	*Behaviour and Traces in State Machines*	*Synchronous Data Flow*	*Safety Specifications*	*Model Checking*	*Optimality of EDF*
	SLO-2	*Hybrid Systems*	*Dynamic and Structured Data Flow*	*Invariants of Transition Systems*	*B¨uchi Automata, Nested Depth First Search*	*Utilization-Based Schedulability Test*
S-9	SLO-1	*Classes of Hybrid Systems*	*Process Networks*	*Role of requirements of system design*	*Nested Depth-First Search*	*Fixed-Priority Scheduling*
	SLO-2	*Classes of Hybrid Systems,*	*Timed Models of Computation*	*Verifying invariants, proving invariants*	*Symbolic Repeatability Checking*	*Deadline-Monotonic and Rate-Monotonic Policies*
S-9	SLO-1	*Hybrid Systems*	*Time Triggered Models*	*Automated Invariant Verification*	*Proving Liveness, Eventuality Properties*	*Optimality of Deadline-Monotonic Policy*
	SLO-2	*Hybrid Systems*	*Events Systems*	*Enumerative Search*	*Conditional Response Properties*	*Schedulability Test for Rate-Monotonic Policy*

Learning Resources	*1. Principles of Cyber Physical Systems, MIT Press, 2018* 2. Lee and Seshia, *Introduction to Embedded Systems , — A Cyber-Physical Systems Approach, Second Edition — MIT Press — 2017*	*3. Andrea Bondavalli · Sara Bouchenak, Cyber-Physical Systems of Systems, Springer, 2019*

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

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

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

Course Code	18ECE334T	Course Name	HARDWARE SOFTWARE CODESIGN	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Understand the fundamental ideas behind hardware software co-design, the evolution of the paradigm, its applicability; benefits, as well as current and future challenges
CLR-2 :	Learn hardware-software co- design modeling technologies and get exposure to advanced Co-design
CLR-3 :	Explore Micro Programmed architecture technologies and relevant interfaces.
CLR-4 :	Understand the system design methodology Object oriented technique for Co-design
CLR-5 :	Understand State based models- Programming skills in System C based modeling.

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLO-1 :	To acquire the knowledge about system specification and modeling.	2	80	70
CLO-2 :	To learn the formulation of partitioning the hardware and software.	2	85	75
CLO-3 :	To analyze about the hardware and software integration	4	75	70
CLO-4 :	To study the hardware design languages and its components.	3	85	80
CLO-5 :	To formulate the design specification and module creation.	3	85	75

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

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Nature of hardware & software. Introduction to energy Efficient techniques.	Partitioning source description into different implementation domains.	Prototyping and Emulation Techniques.	System Design Methodology.	Introduction- State-Based Models
	SLO-2				System Design Methodology	
S-2	SLO-1	Quest for energy efficiency.	Dataflow modeling and transformation.	Target Architectures – Micro Programmed Architecture introduction	Processor and Communication Modeling	-Process-based Models-
	SLO-2	Energy efficient techniques.				
S-3	SLO-1	Driving factors for hardware-software co-design space.	Data flow implementation in Hardware and Software,	Micro Programmed Architectures, General-Purpose Embedded Cores	Transaction level Models-Software Synthesis.	System C- Design Methodology,
	SLO-2		System-level executable specifications.			
S-4	SLO-1	Goals and Benefits.	Control-flow and data flow.	System-on-Chip- Introduction, Methodology	Communication Synthesis.	System C -Modules and Hierarchy,
	SLO-2	System specification and modeling.				
S-5	SLO-1	Embedded Systems-Functional decomposition.	Basic block representation of software.	Hardware-Software Interfaces	Hardware Synthesis- hardware optimization.	System C -Processes, Ports and signals,
	SLO-2	Hardware Software trade-offs.		Hardware- Software Interfaces		
S-6	SLO-1	Comparison of Co-Design Approaches.	Finite state machines with data path, cycle based simulation of hardware and software	Principles of Hardware/Software Communication- hardware Perspectives	Motivation for object oriented techniques.	System C – Introduction to Data types
	SLO-2					
S-7	SLO-1	Model of Computation.	Hardware-software co-synthesis _ Introduction	Principles of Hardware/Software Communication – software perspectives	object oriented design strategies.	Simulation using System C.
	SLO-2					
S-8	SLO-1	Requirements for Embedded system	Hardware-software co-synthesis –	Microprocessor Interfaces	modeling hardware components as	CASE STUDY: Processor/Coprocessor

	SLO-2	requirements.	techniques and Methodology		classes.	design using System C – Main Processor Design
S-9	SLO-1	Case Study on significant energy efficient techniques.	Distributed SystemCo-Synthesis.	Hardware Interfaces	designing specialized components, data decomposition	CASE STUDY: Processor/Coprocessor design using System C- Coprocessro Design.
	SLO-2					

Learning Resources	1. Patrick Schaumont "A Practical Introduction to Hardware/Software Co-design", Patrick Schaumont, Springer, 2012. 2. Ralf Niemann, "Hardware/Software Co-Design for Data Flow Dominated Embedded Systems", Kluwer, 1998. 3. Alxel Jantsch, "Modeling Embedded Systems and SOC's. Concurrency and Time in Models of Computation", MK, 2004.	4. Vahid and Frank, "Embedded System Design: A Unified Hardware/Software Introduction", Wiley, 2002. 5. Wolf and Wayne, "Computers as Components: Principles of Embedded Computing System Design", MK, 2001. 6. Grotker T, Liao S, Martin G and Swan S, "System design with System C", Kluwer Academic Publishers, 2002.

Learning Assessment

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

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

Course Designers

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

Course Code	18ECE335T	Course Name	INTRODUCTION TO VIRTUAL COMPUTING	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Understanding Distributed computing System, Virtual Machines and Virtualization
CLR-2 :	Understanding Scalable Computing , Parallel and Distributed Programming Models
CLR-3 :	Analyze and understand Implementation Levels of Virtualization ,Virtual Clusters and Resource Management
CLR-4 :	Create insights to Cloud Platform Architecture over Virtualized Data Centers
CLR-5 :	understand the Service-Oriented Architectures for Distributed Computing
CLR-6 :	understand Cloud Programming and Software Environments and the Application

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	understand the System Models for Distributed and Cloud Computing	2	80	70	H	-	-	-	H	-	-	-	-	-	-	-	-	H	-
CLO-2 :	Analyze Virtual Clusters and Resource Management	4	85	75	H	H		H	H	-	-	-	-	-	-	-	-	-	H
CLO-3 :	UnderstandA Generic Cloud Architecture Design challenge	2	75	70	H		H	H	-	-	-	-	-	-	-	-	H	-	-
CLO-4 :	Apply programming knowledge on Public Clouds and Service	3	85	80	H	H	H	H	H	-	-	-	-	-	-	-	-	-	H
CLO-5 :	Understand theService-Oriented Architecture. ,Cloud Security and Trust Management	2	85	75	H	-		H	-	-	-	-	-	-	-	-	-	H	-
CLO-6 :	Understand Programming of cloud	2	80	70	H	-	H	-	H	-	-	-	-	-	-	-	H	-	-

Duration (hour)		Distributed System Models and Enabling Technologies	Virtual Machines and Virtualization of Clusters and Data Centers	Cloud Platform Architecture over Virtualized Data Centers	Service-Oriented Architectures for Distributed Computing.	Cloud Programming and Software Environments
		9	9	9	9	9
S-1	SLO-1	Scalable Computing over the Internet	Implementation Levels of Virtualization-Levels of Virtualization Implementation, MM Design Requirements and Providers,	Cloud Computing and Service Models-Public, Private, and Hybrid Clouds,	Services and Service-Oriented Architecture. . ,REST and Systems of Systems, ,	Features of Cloud and Grid Platforms, Cloud Capabilities and Platform Features, Traditional Features Common to Grids and Clouds
	SLO-2	Scalable Computing Trends and New Paradigms	Virtualization Support at the OS Level, Middleware Support	Cloud Ecosystem and Enabling Technologies,	Services and Web Services	Data Features and Databases, Programming and Runtime Support
S-2	SLO-1	Technologies for Network-Based Systems-Multicore CPUs and Multithreading Technology, GPU Computing to Exascale and Beyond, Memory, Storage, and Wide-Area Networking	Virtualization Structures/Tools and Mechanisms. - Hypervisor and Xen Architecture ,Binary Translation with Full Virtualization,	Infrastructure-as-a-Service (IaaS)	Enterprise Multitier Architecture , Grid Services and OGSA,	Parallel and Distributed Programming Paradigms-, Parallel Computing and Programming Paradigms,
	SLO-2	Virtual Machines and Virtualization Middleware ,Data Center Virtualization for Cloud Computing	Para-Virtualization with Compiler Support	Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS)	Other Service-Oriented Architectures and Systems	MapReduce, Twister, and Iterative MapReduce ,
S-3	SLO-1	System Models for Distributed and Cloud Computing.-Clusters of Cooperative Computers, Grid Computing Infrastructures,	Virtualization of CPU, Memory, and I/O Devices-Hardware Support for Virtualization,	Data-Center Design and Interconnection Networks-. ,Warehouse-Scale Data-Center Design,	Message-Oriented Middleware. ,Enterprise Bus,Publish-Subscribe Model and Notification,	Hadoop Library from Apache
	SLO-2	Peer-to-Peer Network Families, Cloud Computing over the Internet..	CPU Virtualization	Data-Center Interconnection Networks,	Queuing and Messaging Systems, Cloud or Grid Middleware Application	,Dryad and DryadLINQ from Microsoft,

S-4	SLO-1	*Software Environments for Distributed Systems and Clouds- Service-Oriented Architecture (SOA)., Trends toward Distributed Operating Systems*	*Memory Virtualization*	*Modular Data Center in Shipping Containers, ,Interconnection of Modular Data Centers,*	*Portals and Science Gateways. ,Science Gateway Exemplars, HUBzero Platform for Scientific Collaboration,*	*Sawzall and Pig Latin High-Level Languages,*
	SLO-2	*Parallel and Distributed Programming Models*	*I/O Virtualization, Virtualization in Multi-Core Processors*	*Data-Center Management Issue*	*Open Gateway Computing Environments (OGCE)*	*Mapping Applications to Parallel and Distributed Systems*
S-5	SLO-1	*Performance, Security, and Energy Efficiency- Performance Metrics and Scalability Analysis, Fault Tolerance and System Availability*	*Virtual Clusters and Resource Management.- Physical versus Virtual Clusters*	*Architectural Design of Compute and Storage CloudS*	*Discovery, Registries, Metadata, and Databases. , ,*	*Programming Support of Google App Engine, Programming the Google App Engine, Google File System (GFS, BigTable,*
	SLO-2	*Network Threats and Data Integrity Energy Efficiency in Distributed Computing*	*Live VM Migration Steps and Performance Effects, Migration of Memory*	*A Generic Cloud Architecture Design,*	*UDDI and Service Registries*	*Google's NOSQL System, Chubby, Google's Distributed Lock Service*
S-6	SLO-1	*Computer Clusters for Scalable Parallel Computing-Clustering for Massive Parallelism. , Cluster Development Trends,*	*Files, and Network Resources Dynamic Deployment of Virtual Clusters*	*Layered Cloud Architectural Development, Virtualization Support and Disaster Recovery,*	*Databases and Publish-Subscribe , Metadata Catalogs, Semantic Web and Grid,*	*Programming on Amazon AWS and Microsoft Azure. ,Programming on Amazon EC2,Amazon Simple Storage Service (S3),*
	SLO-2	*Design Objectives of Computer Clusters, Fundamental Cluster Design Issues, Analysis of the Top 500 Supercomputer*	*Virtualization for Data-Center Automation*	*Architectural Design Challenges*	*Job Execution Environments and Monitoring*	*Amazon Elastic Block Store (EBS) and SimpleDB, Microsoft Azure Programming Support*
S-7	SLO-1	*Computer Clusters and MPP Architectures. ,Cluster Organization and Resource Sharing, Node Architectures and MPP Packaging,*	*Server Consolidation in Data Centers,*	*Public Clouds and Service Offerings-oogle App Engine (GAE,Amazon Web Services (AWS,)*	*Workflow in Service-Oriented Architectures. ,Basic Workflow Concepts,*	*Emerging Cloud Software Environnements. , Open Source Eucalyptus and Nimbus*
	SLO-2	*Cluster System Interconnects, Hardware, Software, and Middleware Support, GPU Clusters for Massive Parallelism*	*Virtual Storage Management,*	*Microsoft Windows Azu*	*Workflow Standards,*	*OpenNebula, Sector/Sphere, and OpenStack, Manjrasoft Aneka Cloud and Appliance*
S-8	SLO-1	*Design Principles of Computer Clusters - Single-System Image Features, High Availability through Redundancy,*	*Cloud OS for Virtualized Data Centers*	*Inter-cloud Resource Management. - Extended Cloud Computing Services,*	*Workflow Architecture and Specification, Workflow Execution Engine ,*	*Application and case study of cloud computing-Massively Multiplayer Online Game Hosting on Cloud Resources*
	SLO-2	*Fault-Tolerant Cluster Configurations, Checkpointing and Recovery Techniques*	*Trust Management in Virtualized Data Centers*	*Resource Provisioning and Platform Deployment,*	*Scripting Workflow System Swift*	*Building Content Delivery Networks Using Clouds*
S-9	SLO-1	*Cluster Job and Resource Management. ,Cluster Job Scheduling Methods, cluster Job Management Systems,*	*Case Studies of Top Supercomputer Systems.-Tianhe-1A*	*Virtual Machine Creation and Management,*	*Cloud Security and Trust Management*	*Introduction to fog computing and application*
	SLO-2	*Load Sharing Facility (LSF) for Cluster Computing*	*Cray XT5 Jaguar,IBM Roadrunner*	*. Global Exchange of Cloud Resources*	*Cloud Security and Trust Management*	*Introduction to fog computing and application*

Learning Resources	1. *Kai Hwang Geoffrey C. Fox Jack J. Dongarra ,Distributed and Cloud Computing From Parallel Processing to the Internet of Things ,Morgan Kaufmann(an imprint of Elsevier),2012* **2.** *Rajkumar Buyya,James Broberg,Andrzej Goscinsk CLOUD COMPUTING Principles and Paradigms,John Wiley & Sons,2011.*	3. ***3.****Evangelos Markakis, George Mastorakis, Constandinos X. Mavromoustakis, Evangelos Pallis ,Cloud and Fog Computing in 5G Mobile Networks: Emerging Advances and Applications,IET telecommunications series,2017*

Learning Assessment

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

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

Course Designers

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

Course Code	18ECE336T	Course Name	MOBILE COMPUTING	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

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

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

		Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	*understand the concept of mobile computing paradigm, its novel applications and limitations*			
CLR-2 :	*understand the typical mobile networking infrastructure through 5G*			
CLR-3 :	*Identify the significance of Heterogeneous Networks*			
CLR-4 :	*Create insights to the concepts of Security*			
CLR-5 :	*Analyse the Applications in various Mobile Platforms.*			

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

Program Learning Outcomes (PLO)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*Identify the effect of Mobile computing*	*H*	*H*	-	-	-	-	-	-	-	-	-	-	*H*	-	-
CLO-2 :	*Analyse any new technical issue related to this new paradigm and come up with a solution*	*H*	*H*	-	-	-	-	-	-	-	-	-	-	*M*	*M*	-
CLO-3 :	*Apply communication Network Principles in 5G Perspective*	*H*	-	-	*H*	-	-	-	-	-	-	-	-	-	-	*H*
CLO-4 :	*Apply Security and Privacy in Mobile environment*	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-	-	*H*
CLO-5 :	*Identify the applications in various Mobile Platforms*	*H*	-	*H*	-	-	-	-	-	-	-	-	-	*M*	*H*	-
CLO-6 :	*Apply the concepts and develop any existing or new protocol related to mobile environment*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*H*

Module		MOBILE COMMUNICATIONS: AN OVERVIEW	ADVANCES IN COMMUNICATION NETWORKS	MULTICELLULAR HETEROGENEOUS NETWORKS: A 5G PERSPECTIVE	SECURITY IN COMPUTING	MOBILE PLATFORMS AND APPLICATIONS
Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Mobile communication*	*Introduction*	*Introduction*	*Introduction*	*Device Operating Systems*
	SLO-2	*Introduction to Mobile computing*	*Evolution toward 5G Networks*	*OFDMTechniques in HetNets*	*Context-aware computing*	*Special Constrains & Requirements*
S-2	SLO-1	*Mobile Computing Architecture*	*Challenges in 5G Networks*	*OFDMA Techniques in HetNets*	*location-aware systems*	*Commercial Mobile Operating Systems*
	SLO-2	*Mobiledevices*	*Emerging Trends in 5G Networks*	*Dense HetNets*	*Active Badge*	*iOS, Android,*
S-3	SLO-1	*Mobile System Networks*	*Multiple Radio Access Technology(M-RAT)*	*Components ofMulti-Cellular Heterogeneous Networks*	*Context-aware computing using RADAR*	*BlackBerry, WindowsPhone*
	SLO-2	*Data dissemination*	*OFDM and Multiple MIMO Systems*	*Physical significance of wavefunction*	*Context-aware computing GPS technology*	*MCommerce Structure*
S-4	SLO-1	*Mobile management,*	*Device-to –Device Communication Systems*	*Software-Defined Cellular Networks*	*location-aware services*	*Pros & Cons of Operating Systems*
	SLO-2	*security*	*Software-Defined Networks*	*Mobile CloudComputing in Multi-Cellular HetNets*	*issues and challenges in contextawareness*	*Mobile Payment System.*
S-5	SLO-1	*MOBILE DEVICES AND SYSTEMS*	*LTE/LTE-A 4G and Beyond Technology*	*Architecture of Multi-Cellular HetNets*	*Securityin mobile computing environment*	*Security Issues*
	SLO-2	*Mobile phones*	*LTE Release 8/9 Features*	*Multi-Tier Architecture of Cloud RAN for Efficient DataManagement in HetNets*	*privacyin mobile computing environment*	*Applications of Mobile Computing systems*

S-6	SLO-1	*digital Music players*	*LTE –A Enhancements*	*Features of Cloud RAN*	*Security in RFID technology*	*Internet of Things*
	SLO-2	*Handheld Pocket computers*	*MIMO Enhancements*	*Internet of Things in LTE*	*Security and privacy insmartphones*	*smart home,*
S-7	SLO-1	*Handheld devices*	*3D -Beamforming*	*Internet of Things in HetNets*	*Sensortechnology*	*smart offices*
	SLO-2	*Smart systems*	*Full-DimensionMIMO*	*Inband VehicularCommunication in Small Cell HetNets.*	*wireless sensor networks*	*intelligent traffic systems*
S-8	SLO-1	*Limitations of mobile devices*	*Massive MIMO*	*Outband VehicularCommunication in Small Cell HetNets*	*Architecture ofsensor networks*	*Uses of social computing*
	SLO-2	*Automotive systems*	*Millimeter-Wave Communication Technology*	*Energy-Efficient Schemes for HetNets*	*Types of sensor networks*	*social computing Cons*
S-9	SLO-1	*Solving Problems in Mobile System Networks*	*Mm Wave for 5G Cellular*	*Energy Efficiency Improvements Using HetNets*	*Solving problems in Securityin mobile computing environment*	*wearable computing Methods*
	SLO-2	*Solving Problems in Mobile management and Security issues.*	*60Ghz WLAN and WPAN*	*Solving problems in Energy Efficiency Improvements UsingHetNets*	*Solving problems in privacyin mobile computing environment*	*wearable computing Advantages*

Learning Resources	*1. Prasant Kumar Pattnaik, Rajib Mall, "Fundamentals of Mobile Computing", PHI Learning Pvt. Ltd, New Delhi – 2012.* *2. Laurence T. Yang, Handbook On Mobile And Ubiquitous Computing Status And Perspective, 2012, CRC Press*	*3. M. Bala Krishna, Jaime Lloret Mauri, —Advances in Mobile Computing andCommunications: Perspectives and Emerging Trends in 5G Networks‖, CRC 2016* *4. Stefan Poslad, Ubiquitous Computing: Smart Devices, Environments And Interactions tion, 2010, Wiley India Pvt Ltd*

Learning Assessment

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

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

Course Designers

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

Course Code	15ECE337T	Course Name	WEB OF THINGS	Course Category	E	ELECTIVE	L	T	P	C
							3	0	0	3

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

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

CLR-1 :	Obtain knowledge about Web of Things
CLR-2 :	Learn the communication protocols and testbed
CLR-3 :	Identify various patterns and discovering things
CLR-4 :	Create insights about integration of devices from various platforms
CLR-5 :	Identify the security mechanisms and authentication schemes in WoT
CLR-6 :	Know the various health and social impact of WoT

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

		Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	Gain knowledge about WoT	2	85	80	H	-	H	-	H	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Analyse the various protocols and testbed	3	80	75	H	H	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Distinguish and appreciate various patterns	2	80	75	H	H	-	-	H	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Organize the devices working on heterogeneous platform	2	75	70	H	H	-	H	H	-	-	-	-	-	-	-	-	-	-
CLO-5 :	Learn the security and authentication aspects of WoT	2	85	80	H	-	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	Gain insight about social effects of WoT	2	85	80	-	-	-	-	-	H	H	-	-	-	-	-	-	-	-

Module		Introduction to WoT and Tools	Networking in IoT	Integration in WoT	Representation and Storage	Security in WoT
Duration (hour)		9	9	9	9	9
S-1	SLO-1	Defining Internet of Things (IoT) and Web of Things(WoT)	Building network of things: Topologies	Web API's for things: Devices, resources, things	Automatic integration and querying of semantic rich heterogeneous data: introduction	Securing things
	SLO-2	Comparison of IoT and WoT	Classification models	Principles for web API's	Semantic WoT (SWoT)	Open issues and challenges
S-2	SLO-1	Connected objects	Network protocols for things: spatial considerations, Internet protocols and IoT	Publish subscribe model	Semantic web as enabler of SWoT	Web of Topics (WoX) model
	SLO-2	Applications	IoT Personal Area Networks, IoT Wide Area Networks	Webhooks, Comes and websockets	Case study: smart application	Design and implementation
S-3	SLO-1	Features of WoT	Application protocol for things: Zigbee, Bluetooth application stack	Implementing web things	Building entity graphs for WoT	Security from IoT to WoT
	SLO-2	Shortcomings of WoT	Application protocol for things: Apple homekit, Google weave	Connecting devices to the web	Background and methodology	Existing models
S-4	SLO-1	Ontology of WoT	Message Queuing Telemetry Transport (MQTT)	Direct integration pattern	DisCor-T: classification	Security in WoT: Encryption 101, TLS
	SLO-2	Context modelling	Constraint application protocol	REST on devices	DisCor-T: recommendation	Enabling HTTPS and WSS with TLS on Pi

S-5	*SLO-1*	*Embedded devices*	*WoT architecture: Access, Find*	*Gateway integration pattern*	*Interoperability and cross domain applications*	*Authentication and access control with REST and API tokens*
	SLO-2	*Introduction to Raspberry Pi*	*WoT architecture: Share, Compose*	*CoAP*	*Trends and evolution*	*OAuth*
S-6	*SLO-1*	*Node.js on Raspberry Pi*	*Building IoT with Avatars: Avatar based IoT platform*	*Cloud integration pattern*	*Challenges in interoperability*	*Social WoT authentication proxy*
	SLO-2	*Connecting sensors and actuators on Pi*	*Disruption tolerant communication*	*MQTT communication*	*Contributions*	*Implementing a social WoT authentication proxy*
S-7	*SLO-1*	*Modeling RESTful services*	*Context modeling and management*	*Findability problem*	*M3 framework*	*Social impact and vulnerable populations*
	SLO-2	*Mashup tools*	*Social vision of WoT*	*Discovering things*	*Data storage in WoT: framework*	*WoT and health*
S-8	*SLO-1*	*Model driven engineering for WoT*	*Challenges of WoT*	*Describing web things*	*Methods and challenges*	*Potential positive implications for health*
	SLO-2	*Comparing mashup and model driven tools*	*Testbeds of WoT and IoT*	*Implementing web thing model on Pi*	*Data storage in cloud platform*	*Challenges from health perspective*
S-9	*SLO-1*	*Modeling of RESTful services*	*Hardware of a WoT testbed*	*Semantic WoT*	*Tendency for data storage technology*	*Unintended consequences for social health*
	SLO-2	*Modeling WoT system with generic RESTful operations*	*Software of WoT testbed*	*Schema and JSON-LD*	*Future directions*	*Implications*

Learning Resources	1. Quan Z.Sheng, Yongrui Qin, Lina Yao, Boualem Benatallah, Managing the Web of Things, Morgan Kaufmann publishers, 2017 2. Dominique D. Guinard, Vlad M. Trifa, Building the Web of Things, Manning publishers, 2016	3. http://www.w3.org/WoT/. 4. http://webofthings.org. 5. http://www.element14.com/community/.

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***
Mr.Baraneedhara Karthikeyan, Director, Skylim Infotech Pvt Ptd	*Dr. Bhuvaneshwari, Professor, MIT, Anna University, Chennai*	*Dr. Revathy Venkataraman, Prof/CSE Dept, SRMIST*

Course Code	18ECE338T	Course Name	QUANTUM COMPUTING	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	To acquire knowledge on basics of quantum mechanics
CLR-2 :	To acquire knowledge on basics of quantum mechanics postulates and quantum circuits
CLR-3 :	To know the basic concepts of Quantum algorithms,
CLR-4 :	To know the basic concepts of Quantum information theory and quantum error correction
CLR-5 :	To learn quantum cryptography
CLR-6 :	To learn the security analysis of quantum cryptography

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	Learning 2 Expected Proficiency (%)	Learning 3 Expected Attainment (%)
CLO-1 :	Recall basic linear algebra and identify the use of Hilbert space	2	85	80
CLO-2 :	Apply and Analyze quantum computing Postulates , quantum circuits	2,3	85	80
CLO-3 :	Apply Quantum algorithms	2,3	90	85
CLO-4 :	Apply Quantum information theory and quantum error correction	2,3	85	80
CLO-5 :	Analyze Quantum cryptography	2	85	80
CLO-6 :	Apply the concepts of Quantum algorithms and quantum circuits	2,3	85	80

	PLO 1 Engineering Knowledge	PLO 2 Problem Analysis	PLO 3 Design & Development	PLO 4 Analysis, Design, Research	PLO 5 Modern Tool Usage	PLO 6 Society & Culture	PLO 7 Environment & Sustainability	PLO 8 Ethics	PLO 9 Individual & Team Work	PLO 10 Communication	PLO 11 Project Mgt. & Finance	PLO 12 Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	H	H	-	-	-	-	-	-	-	-	-	H	H	-	H
CLO-2 :	H	H	-	H	-	-	-	-	-	-	-	H	H	H	H
CLO-3 :	H	-	-	H	-	-	-	-	-	-	-	H	H	H	H
CLO-4 :	H	H	-	H	-	-	-	-	-	-	-	H	H	H	H
CLO-5 :	H	-	H	-	-	-	-	-	-	-	-	H	-	-	H
CLO-6 :	-	-	-	H	-	-	-	-	-	-	-	-	-	-	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Linear algebra basics, Vector Spaces	Computing -Introduction	Deutsch algorithm-Introduction	Quantum information theory	Classical cryptography
	SLO-2	Tensor products,inner and outer product	Need for Quantum Computing and its advantages	Deutsch algorithm circuit and explanation	Entropy	Classical cryptography scenario
S-2	SLO-1	Matrices,Norms	Postulates of Quantum mechanics	Deutsch Josza algorithm	Shannon entropy	Quantum cryptography-Introduction
	SLO-2	Eigen Values and Adjoints	Postulate I	Compare Deutsch and Deutsch Josza algorithm	Shannon entropy properties	Quantum cryptography-Block diagram
S-3	SLO-1	Hilbert Space-Introduction	Postulate II	Grover's search algorithm-circuit	Von Neumann entropy	Classical RSA algorithm
	SLO-2	N dimensional inner product, Infinite dimensional inner product, inner product space with functions, Schwarz's Inequality)	Postulate III and IV	Grover's search algorithm advantages	Von Neumann entropy properties	RSA working and applications
S-4	SLO-1	Hilbert space examples	Summary of postulates	Quantum Fourier transform	Noisy coding theorem	BB84 Protocol
	SLO-2	Unitary dynamics	Qu-bits and dirac delta notation	Shor's factoring algorithm	Errors and correction for errors	BB84 Protocol-Explanation
S-5	SLO-1	Probabilities and measurements	Bloch Sphere	Fault tolerance	Simple examples of error correction in classical coding	B92 Protocol
	SLO-2	Spectral decomposition	Qu-bit on Bloch sphere	Quantum Cryptography	Classical and quantum information theory comparison	Analysis of B92 protocol
S-6	SLO-1	Quantum entanglement-Introduction	Basic quantum gates	Implementing Quantum computing	Linear codes	Eckart protocol
	SLO-2	Quantum entanglement-Measurement and EPR paradox	Symbols and their matrices	Issues in fidelity	Quantum error correction	Security analysis of Eckart protocol

S-7	SLO-1	Spectral decomposition, Bell's inequalities	Quantum circuits	Problems in quantum computing	Shor's code	Quantum Key distribution
	SLO-2	Density Operators	Quantum circuits- advantages	Scalability in quantum computing	Fault-tolerant computation	QKD- Scenario
S-8	SLO-1	Properties of density operators	No cloning theorem	Constraints on state preparation	Schrodinger's cat	Practical realization of quantum computer
	SLO-2	Reduced density operators	No cloning theorem-Proof	Qubit-Implementation	Stabilizer's code	Quantum computing supremacy
S-9	SLO-1	Correlation, Perfect Correlation	Quantum teleportation	Quantum dots, optical qubits, topological qubits	Error correction for stabilizer code	Issues in realizing quantum computer
	SLO-2	Broadcasting for correlation	Quantum teleportation-Proof	NMR in quantum computing.	Error correction condition for stabilizer code	IBM's 4 Qubit quantum computing machine
Learning Resources		1 .Michael A. Nielsen and Issac L. Chuang, "Quantum Computation and Information, Cambridge (2002). 2. Mikio Nakahara and Tetsuo Ohmi, "Quantum Computing", CRC Press (2008).		3. N. David Mermin, "Quantum Computer Science", Cambridge (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 Understand	40%	–	40%	–	30%	–	40%	–	40%	-
Level 2	Apply Analyze	40%	–	40%	–	40%	–	40%	–	40%	-
Level 3	Evaluate Create	20%	–	20%	–	30%	–	20%	–	20%	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

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

B. Tech in Electronics and Computer Engineering

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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