23. B. Tech in Electronics and Communication Engineering

23. (a) Mission of the Department

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

23. (b) Program Educational Objectives (PEO)

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

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

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

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

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

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

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

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

Program Specific Outcomes (PSO)

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

PSO – 1	Design, prototype and test modern electronics and telecommunication engineering systems as per the specifications for the professional achievement in an industry and organization
PSO – 2	Apply project management techniques to electrical/ electronic/ telecommunications systems
PSO – 3	Analyze and research appropriate technologies for implementation of the electronics and telecommunication engineering systems

23. (e) Program Structure (B.Tech in Electronics and Communication 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
18PDH103J	Social Engineering	1	0	2	2
18PDH201L	Employability Skills & Practices	0	0	2	1
18CSC308L	Competetive Profesional Skills	0	0	2	1
	Total Learning Credits				**13**

2. Basic Science Courses (B)

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

3. Engineering Science Courses (S)

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

4. Professional Core Courses (C)

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

5. Professional Elective Courses (E)

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

6. Open Elective Courses (O)

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

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

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

8. Mandatory Courses (M)

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

List of Professional Elective Courses (E)
Any 6 Courses

Course Code	Course Title	Hours/ Week L	T	P	C
	Sub-Stream: Electronic System Engineering				
18ECE201J	Python and Scientific Python	2	0	2	3
18ECE202T	Micro- and Nano-Fabrication Technologies	3	0	0	3
18ECE203T	Semiconductor Device Modeling	3	0	0	3
18ECE204J	*ARM based Embedded System Design*	2	0	2	3
18ECE205J	FPGA based Embedded System Design	2	0	2	3
18ECE206J	Advanced Digital System Design	2	0	2	3
18ECE207J	Real Time Operating Systems	2	0	2	3
18ECE301J	CMOS Analog IC Design	2	0	2	3
18ECE302T	MEMS Technologies	3	0	0	3
18ECE303T	Nanoelectronic Devices and Circuits	3	0	0	3
18ECE304T	Microwave Integrated Circuits	3	0	0	3
18ECE305J	ARM-SoC	2	0	2	3
18ECE306J	ARM based Digital Signal Processing	2	0	2	3
18ECE307J	Applied Machine Learning	2	0	2	3
	Sub-Stream: Communication System Engg.				
18ECE220T	Advanced Mobile Communication Systems	3	0	0	3
18ECE221T	Radar And Navigational Aids	3	0	0	3
18ECE222T	Adhoc and Sensor Networks	3	0	0	3
18ECE223T	Satellite Communication and Broadcasting	3	0	0	3
18ECE224T	Cryptography and Network Security	3	0	0	3
18ECE225T	Information Theory and Coding	3	0	0	3
18ECE226T	Optical Components, Systems and Networks	3	0	0	3
18ECE320T	Software Defined Networks	3	0	0	3
18ECE321T	RF and Microwave Semiconductor Devices	3	0	0	3
18ECE322T	Opto Electronics	3	0	0	3
18ECE323T	Advanced Optical Communication	3	0	0	3
	Sub-Stream: Signal Processing				
18ECE240T	Wavelets and Signal Processing	3	0	0	3
18ECE241J	Signal Processing for Auditory System	2	0	2	3
18ECE242J	Pattern Recognition and Neural Networks	2	0	2	3
18ECE243J	Digital Image and Video Processing	2	0	2	3
18ECE244J	DSP System Design	2	0	2	3
18ECE245T	Adaptive Signal Processing	3	0	0	3
18ECE340T	Machine Perception with Cognition	3	0	0	3
18ECE341T	Multimedia Compression Techniques	3	0	0	3
18ECE342T	Acoustical Signal Processing	3	0	0	3
18ECE343T	Automatic Speech Recognition	3	0	0	3
18MBE414T	Essentials of Organizational Behavior	3	0	0	3
18MBE415T	Business Essentials	3	0	0	3

List of Open Elective Courses (O)
Any 4 Courses

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

23. (g) Implementation Plan (B. Tech in Electronics and Communication 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
18ECS201T	Control Systems	3	0	0	3
18ECC102J	Electronic Devices	3	0	2	4
18ECC103J	Digital Electronic Principles	3	0	2	4
18ECC104T	Signals and Systems	3	1	0	4
18ECC105T	Electromagnetics and Transmission Lines	3	0	0	3
18PDH103J	Social Engineering	1	0	2	2
18PDM201L	Competencies in Social Skills	0	0	2	0
18CYM101T	Environmental Science	1	0	0	0
Total Learning Credits					24

Semester - IV

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

Semester - V

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

Semester - VI

Code	Course Title	Hours/ Week L	T	P	C
18ECC206J	VLSI Design	3	0	2	4
18ECC302J	Microwave and Optical Communications	3	0	2	4
18ECC303J	Computer Communication Networks	3	0	2	4
18ECC350T	Comprehension	0	1	0	1
	Professional Elective-3	3	0	0	3
	Professional Elective-4	3	0	0	3
	Open Elective-3	3	0	0	3
18ECP104L/ 18ECP105L/ 18ECP106L	Massive Open Online Course-II / Industrial Training-II / Seminar-II	0	0	2	1
18PDH201L	Employability Skills and Practices	0	0	2	1
18LEM109T	Indian Traditional Knowledge	1	0	0	0
18CSC308L	Competetive Professional Skills	0	0	2	1
Total Learning Credits					25

Semester - VII

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

Semester - VIII

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

B. Tech in Electronics and Communication Engineering

2018 Regulations

Humanities &Social Sciences including
Management course (H)

Department of Electronics and Communication Engineering

SRM Institute of Science and Technology

SRM Nagar, Kattankulathur – 603203, Chengalpattu District, Tamilnadu

Course Code	18LEH101J	Course Name	English	Course Category	*H*	*HS*	L	T	P	C
							2	0	2	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*English and Foreign Languages*	Data Book / Codes/Standards	*NA*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1	*To find the different types of communication in personal and professional contexts* *To make the learners relate the speech sounds in English*	
CLR-2	*To extend the proficiency of learners in vocabulary and grammar for accuracy in the use of language.* *To demonstrate the significance of listening skills.*	
CLR-3	*To develop the learners' writing skills using appropriate mechanisms of writing techniques* *To build their confidence in speaking skills in various contexts.*	
CLR-4	*To enable the learners analyze essays and speeches.* *To enable the learners to use the expression of comparison and contradiction.*	
CLR-5	*To develop critical thinking and evaluation techniques in academic project report writing* *To assist the learners explain their innovative ideas through effective presentations*	
CLR-6	*To strengthen the learners' communicative skills in formulating ideas and problem solving skills*	

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Bloom's Level (1-6)	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
CO-1	*Define and relate various types, modes, channels and barriers of communication and put this awareness into effective use.* *List down different speech sounds.*	2	1	3	1	3	3	3	1	3	3	3	-	3	-	-	-
CO-2	*Rephrase and rectify the common errors in the use of grammar and vocabulary.* *Infer a speech/film/documentary after listening.*	3	1	3	1	3	3	3	1	3	3	3	-	3	-	-	-
CO-3	*Choose a topic sentence, choose key terms and organize their writings.* *Make use the speech techniques for building interpersonal relationships*	5	1	3	1	3	3	2	1	3	3	3	-	3	-	-	-
CO-4	*Analyze, examine and infer a piece of writing.* *Build better relationship by following the etiquettes of work place.*	5	1	3	1	3	3	3	1	3	3	3	-	3	-	-	-
C0-5 :	*Decide, plan, estimate, and prioritize to write a comprehensible academic project.*	6	1	3	1	3	3	3	1	3	3	3	-	3	-	-	-
CO-6 :	*Solve any issue through their discussions.*	4	1	1	1	3	3	3	1	3	3	3	-	3	-	-	-

		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
Duration (hour)		12 Communication	12 Vocabulary and Grammar	12 Discourse Techniques	12 Workplace Communication	12 Project Writing
S-1	SLO-1	Definition–process of communication	Introducing the English words with Foreign roots and **Word formation – inflectional and derivational prefixes and suffixes**	Sentence structure– Phrases and Clauses	Reading Comprehension –Guidelines – types of questions (referential, critical and interpretative)	Topics for project writing
	SLO-2	**Filling in-class worksheets**	Quiz - Identifying the borrowed roots and their meanings-**Worksheet exercise**	**Exercise – worksheet – Identifying phrases and clauses – compound and complex sentences**	**Practice Exercise**	**Discussion**
S-2	SLO-1	Verbal and non-verbal communication	Synonyms and Antonyms and Standard abbreviations	Developing ideas into paragraphs –cohesion markers	Précis-writing - Guidelines	**Collection of Data – importance of avoiding plagiarism-authenticity and credibility of data**
	SLO-2	**Individual and group activities - Role play**	**Context based activity / Learner compiling standard abbreviations from his/her core subject**	**Identifying topic sentence in the given paragraph; writing a paragraph based on a topic sentence**	**Practice Exercise**	**Collection of data for verification**
S-3	SLO-1	***LAB – Individual speech sounds***	***LAB – Listening to long conversations***	***LAB –Listening to short stories - Science fiction***	***LAB – Videos on workplace scenario***	***LAB –Importance of availing credible resources with examples***
	SLO-2	***Courseware on speech sounds (Listening and reproducing)***	*Identifying the various communication contexts and answering questions – use of making a list of words in relation to the context*	***To identify the main idea of the given story and narrate a story on the given topic – Written***	*Open Discussion on Workplace Etiquette (speaking in a language known to everyone, physical space, politeness in words and actions, being objective)*	***Collecting and compiling resource materials***
S-4	SLO-1	***LAB – often mispronounced sounds***	***LAB – Listening to long conversations – daily life***	***LAB – Speaking - practice activity – brain storming – mind mapping***	***LAB – Videos on workplace communication***	***LAB – Guidelines for preparing a PPT; presentation techniques***
	SLO-2	***Audio visual material (Listening to minimal pairs and reproducing)***	*Identifying the various communication contexts and answering questions -* collocation	***JAM***	*Role play based on the given workplace contexts*	*Preparing PPT on the topic of learners' choice*
S-5	SLO-1	**Other Types of Communication – general and technical-formal and informal- external and internal**	Homonyms and Homophones	Inputs on writing precisely – redundancies – wordiness-repetition-clichés	Summarising	**Guidelines for writing an outline- objectives-background-methodology-discussion**
	SLO-2	**Write upon a selected type of communication**	**Fun activities – worksheets- cross words**	**Error analysis and editing**	**Group activity (oral/written) on the given passages**	**Drafting an outline**
S-6	SLO-1	LSRW	Articles – Tenses	Defining – describing technical terms	**Essay Writing – general introduction**	Discussion using sample project
	SLO-2	**Group activity (Newspaper) – Discussion and Feedback**	**Exercise through worksheets- individual activity -peer correction- open discussion**	**Writing definitions-product and process description**	**Brainstorming on relevant technical and non-technical topics**	**Writing the first draft on the selected topic**

S-7	**SLO-1**	***LAB – Material on mispronounced words***	***LAB – Watching documentaries & short films related to science and technology***	***LAB- Describing a scene or event -videos***	***LAB – Technical communication – Interpreting Data***	Giving inputs on documentation based on IEEE
	SLO-2	***Individual oral activity and rectification of the probable mistakes.***	***Picking out the terminology related to science and technology***	***String narration – describing an event or a scene***	*Group activity - interpretation of data - oral presentation*	Preparing references
S-8	**SLO-1**	***LAB – sentence types***	***LAB – Introduction to English es –British and American -Videos***	***LAB – Channels of communication - videos***	***LAB –External communication- Advertising***	**Checklist for project format (PPT)**
	SLO-2	***Practice on sentence stress and intonation***	***Discussion on difference between British and American words***	***Observing and identifying the channels of communication –Role play***	***ADZAP (promoting a product) - Oral***	**Self verification and submission of final draft**
S-9	**SLO-1**	Communication barriers	Noun-pronoun agreement and subject-verb agreement	Inputs on Classifying/categorising and sequencing ideas with relevant diagrams	Essay Writing - Guidelines for writing introduction, elaboration and conclusion with examples	***LAB – Formal Presentation***
	SLO-2	**Individual activity- sharing of personal experiences**	**Identifying and learning through error analysis - worksheets**	**Writing a passage on the given hints, tree diagram, classification table and flow chart**	**Individual activity (Written) on the given topic**	***LAB – Formal Presentation***
S-10	SLO-1	Organizational communication - Channels of communication	Misplaced modifiers - prepositions- prepositional verbs and phrasal verbs	Importance of punctuation – miscommunication –ambiguity caused due to errors in punctuation	Organisational Report Writing - Progress report- Guidelines	***LAB – Formal Presentation***
	SLO-2	Group activity (worksheet) with visuals or written material.	**Identifying and learning through practice – placing same modifier in different places in a sentence**	Fun activities - worksheets for appropriate punctuation - written	Writing a progress report	***LAB – Formal Presentation***
S-11	SLO-1	***LAB – short biographical account on famous personalities -video***	***LAB – Watching video based on daily life***	***LAB – Barriers of communication Language barriers - videos***	***LAB- - Sample case studies for work ethics - videos***	***LAB – Formal Presentation***
	SLO-2	***Oral paraphrasing of the content shown***	*Observing and recording the features of spoken English*	***Identifying the language barriers of communication –Written***	***Debate on the videos shown***	***LAB – Formal Presentation***
S-12	SLO-1	***LAB – Listening to short conversations***	***LAB – Watching interviews of famous personalities***	***LAB – Barriers of communication-personal and organizational - video***	***LAB –Learning interview techniques through models***	***LAB – Formal Presentation***
	SLO-2	*Answering the questions on the above content*	*Quiz on the video shown*	*Role play on the videos shown*	***Mock interview***	***LAB – Formal Presentation***
Learning Resources		1. **Text / Audio / Video** 2. **Text / Audio / Video**				

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 (50%)	Practice (50%	Theory (50%)	Practice (50%	Theory (50%)	Practice (50%	Theory (50%)	Practice (50%	Theory (50%)	Practice (50%
Level 1	Remember	25%	25%	10%	10%	5%	5%	5%	5%	5%	5%
Level 2	Understand	25%	25%	15%	15%	5%	5%	5%	5%	5%	5%
Level 3	Apply	-	-	25%	25%	5%	5%	5%	5%	5%	5%
Level 4	Analyze	-	-	-	-	5%	5%	15%	15%	5%	5%
Level 5	Evaluate	-	-	-	-	15%	15%	20%	20%	15%	15%
Level 6	Create	-	-	-	-	15%	15%	-	-	15%	15%
	Total	100 %		100 %		100 %		100 %		100 %	

 # CLA – 3 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Suggested Readings:

1. Swan, Michael. *Practical English Usage*. OUP, 1995.
2. Kumar Sanjay and Pushpa Lata. *Communication Skills*. OUP, 2011.
3. CIEFL, Hyderabad. *Exercises in Spoken English*. Parts I-III. OUP.
4. Anbazhagan K., B. Cauveri and M. P. Devika. *English for Engineers*. Cengage, 2016.

Suggested online resources:

1. www.mmm.english.com
2. www.usingenglish.com
3. www.onlinewriting.com/purdue
4. https://www.ieee.org/index.html

Course Designers		
Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
Dr. Usha Kodandaraman, ABK AOTS, Chennai . drushak@gmail.com	Dr. S. P.Dhanavel, Professor of English, IIT, Chennai dhanavelsp@iitm@ac.in	**1.** Dr .K.Anbazhagan, Head, Dept. of EFL, SRMIST, hod.efl@ktr.srmuniv.ac.in 2.Dr. B. Cauveri, Asst. Prof. SG, Dept of EFL, SRMIST, cauveri.b@ktrsrmuniv.ac.in
Mr. Durga Prasad Bokka, TCS Chennai durgaprasad@tcs.com	**Ms. Subashree, Asst. Prof., VIT, Chennai** subashree@vit.ac.in	1.Dr. M. M.Umamaheswari, Asst. Prof. SG, SRMIST, umamaheswari.m@vdp.srmuniv.ac.in 2.Dr.Sukanya Saha, Asst. Prof., SRMIST sukanyasaha@ktr.srmuniv.ac.in 3.Ms .S. Ramya, Asst. Prof., SRMIST, ramya.s@ktr.srmuniv.ac.in

Course Learning Syllabus

Course Code	18LEH102J	Course Name	Chinese Language I	Course Category			L	T	P	C
							2	0	2	3

Pre-requisite Courses	*NIL*	Co-requisite Courses	*NIL*	Progressive Courses	
Course Offering Department	*English and Foreign Languages*	Data Book / Codes/Standards		*Clark's Table, IS : 456-2000*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	Recall Chinese Pinyin , tones, scripts and greetings.
CLR-2 :	Construct simple affirmative, negative, interrogative sentences with Chinese grammar. Apply numbers translate time and date in Chinese
CLR-3 :	Apply basic grammar asking about nationality, direction, location.
CLR-4 :	Translate sentences with more vocabulary knowledge.
CLR-5 :	Apply construction and few frequently used words framing sentences; acquire knowledge about Chinese festival and city.
CLR-6 :	Develop basic knowledge of the language, gain the four language skills, learning, speaking, reading and writing Chinese scripts.

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Learning		Program Outcomes (PO)														
		Blooms Level(1-6)		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
CO-1 :	Recall Chinese Romanization , Outline of China and the Chinese speaking countries, basic characters, Greetings	2		-	-	1	-		3	3		1	3	-	3	-	-	-
CO-2 :	Basic conversations with simple sentences, counting numbers, Greet each other, express time and date in Chinese.	3		-	-	1	-		3	3		2	3	-	3	-	-	-
CO-3 :	Utilize WH words make interrogative sentence, translate sentences into Chinese.	3		-	-	1	-		3	3		3	3	-	3	-	-	-
CO-4 :	Make use of various Chinese grammar and vocabulary and introduce own self.	3		-	2		-		3	3		3	3	-	3	-	-	-
CO-5 :	Develop knowledge about Chinese festivals and culture, acquire conversational skills	3		-	-	1	-		3	3		3	3	-	3	-	-	-
CO-6 :	Develop Chinese language skills that help in career orientation, acquire writing ability and communicate with Chinese speaker.	3		-	2	1	-		3	3		3	3	-	3	-	-	-

		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	General discussion about china,Chinesespeaking country,chineselanguage& culture.	Numbers in Chinese.	Introduction of few basic W/H words and framing basic interrogative sentences	Making of Affirmative negative question in Chinese	Introduction & application of few frequentlyused construction in Chinese.
	SLO-2	Introduction of initials and finals in Mandarin	Counting numbers and numeric system	Nationality	conversation how to makesuggestion, how to accept of dealing suggestion and to makecomments.	Introduction & application of few frequentlyused construction in Chinese.
S-2	SLO-1	Tables of combination of initials and finals in Putonghua(Mandarin)	Chinesemonetary system，CountingChinesecurrency.	Direction in Chinese.	Introduction of sentence with nominal predicate, Subjectverb construction as itspredicate.	FamousChinese festivals
	SLO-2	Basic greetings and phrases used in daily life (in pinyin)	*Converse to greetothers and express yourneed*	Making question wih 几,多少	Fruit relatedvocabulary, application.	Major Chinesecities

S-3	**SLO-1**	Tables of combination of initials and finals in Putonghua(Mandarin)	Asking your need	Introducingone'snationality	. Asking question withma ,whwords, affermative -negative	Application and usage of construction
	SLO-2	Tables of combination of initials and finals in Putonghua(Mandarin)	Nominal measureword	Asking aboutnationality	*Lianxi*	*lianxi*
S-4	**SLO-1**	*Prononciation of Pinyin chart*	Telling phone number in chinese	Askingprice	Asking question withma ,whwords, affermative -negative	Application and usage of construction
	SLO-2	*Prononciation of Pinyin chart*	Convertingnumbers	*Lianxi*	*Lianxi*	*lianxi*
S-5	**SLO-1**	Introduction of FourTones in Chineselanguage.	Time & time relatedgreetings,	Politelyand formallyaskingnames ,Expressingapology.	MakingChinese sentences with verbal & Adjectival predicate.	Grammarrelated to 但是，可是，以前，以后，后来。
	SLO-2	Four Tones and relatedpronunciation.	Days&Seasons.	Introduction & Application of verbal Measure Word.	Introduction of 地	Introduction & Application of the basic optative verbslike 会，能，可以.
S-6	**SLO-1**	Tonesandhi（一，不）in ChineseTonediscrimination in Chinese	The basic sentence patterns in Chinese, S-V-O sentences withdetailedexamples.Framing simple sentences.	*Make sentences with 在,and few corelated location wordslike 这儿，那儿 withexample*	Few basic verbs and adjectives.	conversation how todescribelikes ,dislikes,interest and hobbies
	SLO-2	Introduction of Chinese characters. The eight basic strokes of characters- Chinese characters with proper stoke orders.	Introduce 是 and 不是	Important locations used in daily life.	Opposite words.	Conduct conversation how todescribelikes, dislikes.,interest and hobbies
S-7	**SLO-1**	Pronounceword in propertone	Vocabulary	Asking about places..	Usage of verbs	Usage of grammar
	SLO-2	PersonalPronouns and relations,Pluralforms of pronouns	Asking date and time	*lianxi*	*练习*	*lianxi*
S-8	**SLO-1**	Writing characters with proper stroke order	Usage of time words in a sentence	Asking about directions.	*Usage of adjectives with different adverbs*	*Asking about interest and hobbies*
	SLO-2	Writing characters with proper stroke order	Introducingeachother	*lianxi*	*练习*	*lianxi*
S-9	**SLO-1**	Sentence structure with the adjective 很 and Framing sentences, negative of 很。	Weekdays in Chinese, Month, Year&Writing Date.	Profession relatedvocabulary, application withexamples.	Colour and vocabulary, application withexamples.	conversation how to bergain and purchaseproducts.
	SLO-2	Introduction of adverb 也， Interrogative particle 呢， application & Usages.	Introduction of verb 有 and it'snegativeform.Nominalmeasureword.	Basicconversation about personsouccupation	conversation how to describeyourfamilymembers and talk about university and department	conversation how to bergain and purchaseproducts.
S-10	**SLO-1**	Possesive/ Structural Particle 的, application of 的 withpronouns.WritingChinesecharacters	Framing of basic interrogative sentences with modal particle 吗。	Introduction of interrogative phrase 多大， Tellingone'sage in Chinese.	Sports &Gamesrealatedvocabulary, special usages,	Use of conjugation 还是，或者 with example.
	SLO-2	basic conversation related to greetings	Framing of basic interrogative sentences with modal particle 吗。	Introduction of pasttenseand aspect particle 了。	application withexamples.	
S-11	**SLO-1**	Writing greetings in characters with proper stoke order	Asking simple question	Askingage	*Askingaboulikes and dislikes*	Asking about purchasing products
	SLO-2	*练习*	*Asking date*	*lianxi*	*Askingaboulikes and dislikes*	Asking about purchasing products
S-12	**SLO-1**	Basic Expression	birthday in Chinese	*Asking about occupation*	*Asking about familymembers*	Usage of conjugation
	SLO-2	*练习*	Grammar – has, have	*lianxi*	*Asking about familymembers*	Usage of conjugation
Learning Resources		3. Text / Audio / Video 4. Text / Audio / Video				

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	25%	25%	20%	20%	20%	20%	20%	20%	20%	20%
Level 2	Understand	25%	25%	20%	20%	20%	20%	20%	20%	20%	20%
Level 3	Apply	-	-	10%	10%	10%	10%	10%	10%	10%	10%
Level 4	Analyze	-	-	-	-	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

 # CA – 3 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		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. USHA KOTHANDARAMAN, Faculty of Japanese, ABK AOTS DOSOKAI, Chennai, Tamilnadu.	**Ms.Subhashri Vijaykumar , Assistant Professor VIT Chennai,**	**1.Ms. Poulomi Ghosal Assistant Professor SRM IST.**
2. Mr. PAUL DAS. Senior Manager, NEC, Chennai	**2. Dr. P.DHANAVEL Professor, IIT, Chennai.**	**2. Ms. Ling Yun Tsai, Visiting Faculty SRM IST**

Course Learning Syllabus

Course Code	18LEH103J	Course Name	French Language I	Course Category	H	H S	L	T	P	C
							2	0	2	3

Pre-requisite Courses	*NIL*	**Co-requisite Courses**	*NIL*	**Progressive Courses**	*NIL*
Course Offering Department	*English and Foreign Languages*	**Data Book / Codes/Standards**		*NA*	

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

		Learning
CLR-1:	List of greetings, Expressions for daily conversation, basic French grammar.	
CLR-2:	Illustrate lexicon related to adjectives, 1er Groupe verbs, family.	
CLR-3:	Utilize the prepositions, 2e groupe verbs, Possessifs adjectives.	
CLR-4:	Combine time, reflexive verbs in a sentence.	
CLR-5:	Make use of adverbs related to alimentation.	
CLR-6:	Adapt the four-language skills learning, speaking, reading and writing.	

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Blooms Level (1 -6)	Program Outcomes (PO)														
			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
CO-1:	Identify French greetings, expressions, self-Introduction.	3	-	-	2	-	2	3	1	2	3	3	-	3	-	-	-
CO-2:	Construct paragraph to describe a person.	3	-	-	3	-	3	2	1	2	3	3	-	3	-	-	-
CO-3:	Analyse a map and find directions.	4	-	-	1	-	2	1	1	3	1	1	-	3	-	-	-
CO-4:	Develop simple routine tasks using reflexive verbs.	6	-	-	3	-	3	3	1	2	3	3	-	3	-	-	-
CO-5:	Decide adverbs of quantity related to food.	5	-	-	3	-	3	3	1	2	2	3	-	3	-	-	-
CO-6:	Develop the language skills coupled with technical skills to communicate effectively.	6	-	-	3	-	3	3	1	2	3	3	-	3	-	-	-

		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**	L'alphabet, Les accents	Les nombres 70 à 100	Les articles contractes (au...)	Les adjectifs démonstratifs	La forme négative (2) (ne…plus, ne…. Jamais
	SLO-2	Les salutations	Les nombres 101 a 1000	Les articles contractes (du..)	La famille	La forme négative (2) (ne…que. Ne… rien)
S-2	**SLO-1**	Les pronoms sujets, Les verbes: être, avoir, s'appeler, habiter	Le genre des noms	Les verbes : Vouloir, pouvoir, devoir	Les 2 groupes verbes	Les verbes acheter, manger, Commencer, payer
	SLO-2	Les articles indéfinis	le nombre des noms	Les verbes irréguliers	Les verbes : sortir, partir	L'argent
S-3	**SLO-1**	L'expression	Comprendre une petite annonce	Faire une enquête	Proposer a qqn pour une sortie	Demander le prix
	SLO-2	Les salutations	Rédiger une annonce simple	Ecrire une liste	Proposer a qqn de faire qqc	Faire les courses
S-4	**SLO-1**	Se communiquer en classe	Chercher un logement	Les gouts des autres	Apprécier qqc	Les services et les commerces
	SLO-2	Epeler, s'appeler	Décrire un logement	Les temps libres et les loisirs	Ne pas apprécier qqc	Payer ses achats
S-5	**SLO-1**	Les numéros 0 a 69	Le 1 e groupe verbe, les professions	Les adjectifs interrogatifs	Le 3e groupe verbes	L'impératif affirmatif
	SLO-2	Les jours, les mois, les émotions	Les verbes venir et aller	Les mots interrogatifs	Les vêtements	L'impératif négatif
S-6	**SLO-1**	Les pays, les couleurs	Le genre des adjectifs	Les verbes pronominaux(1)	Les adverbes de fréquence	Les articles partitifs
	SLO-2	Des portraits de pays francophones	les nombre des adjectifs	Les verbes pronominaux(1)	Les adverbes de temps	Les exp. De quantités
S-7	**SLO-1**	Présentez- vous	Les vocabulaires des objets	Parler de ses loisirs	Décrire une tenue	Accepter une invitation
	SLO-2	Présenter qqn	Décrire son voisin	Exprimer ses gouts	Décrire les accessoires	refuser une invitation
S-8	**SLO-1**	S'informer sur qqn	Décrire votre profession	Exprimer une préférence	Parler qqc	Donner son appréciation
	SLO-2	Demander des informations personnelles	La langue, activité recap.	Exprimer une envie, Activité quotidienne	justifier	S'exprimer a table

S-9	**SLO-1**	Les prépositions de lieu (1)	Les adjectifs possessifs (sing)	Le verbe aller	Le passe compose : avoir	Le pronom « en » de quantité
	SLO-2	Les verbes : parler, habiter	Les adjectifs possessifs (pl)	Le futur proche	Le passe compose : etre	Il faut
S-10	SLO-1	Les articles définis	Les prépositions de lieu(2)	L'heure	L\imparfait (1)	Les festivals du mot
	SLO-2	Les pronoms Personnelles	Les orientations	Les Temps	L'imparfait (2)	Les festivals en France
S-11	SLO-1	Demander poliment	Les pièces, l'équipement	Demander l'heure	Parler d'un film	Donner des instructions (il Faut)
	SLO-2	Répondre poliment	S'infirmer un logement	Dire l'heure	Féliciter un souhait	Cuisine d'une parisienne d'adoption
S-12	SLO-1	Les vocabulaires d'informatique	Ecrire un portrait	Raconter sa vie sur un blog	Adresser un souhait	Commander au restaurant
	SLO-2	S'inscrire sur un site	La description physique	Justifier	Ecrire une carte postale	Ecrire une recette
Learning Resources		1. SAISONS 1 – Didier - 2017 2. BIENVENUE – Course Book in French – Department of EFL, SRMIST- 2017				

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	20%	10%	10%	5%	5%	5%	5%	5%	5%
Level 2	Understand	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%
Level 3	Apply	20%	20%	15%	15%	10%	10%	10%	10%	10%	10%
Level 4	Analyze	-	-	15%	15%	10%	10%	10%	10%	10%	10%
Level 5	Evaluate	-	-	-	-	10%	10%	10%	10%	10%	10%
Level 6	Create	-	-	-	-	10%	10%	10%	10%	10%	10%
	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.,
SLO – Session Learning Outcome
SLO – Session Learning Outcome

Course Designers		
Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
Mr.D.Hemachandran Renault Nissan Senior Language Specialist	Ms.Judy Niranjala, Assistant Professor SIET college for Women, Chennai	Dr.K.Anbazhagan Prof &Head, Dept of EFL SRMIST
Mr. Durga Prasad Bokka, TCS	DR.S.P. Dhanavel Professor Dept of English IIT - Chennai	Ms. K.Sankari, Assistant Professor Dept of EFL SRMIST
		Mr. J. Sabastian Satish , Assistant Professor Dept of EFL SRMIST

 # CA – 3 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		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1. Dr.K.ANBAZHAGAN, **Professor and Head, Department of EFL.** **SRM University.**	**1.Ms. PoulomiGhosal** **VisistingLecturer** **SRM University.**
	2 Dr. P.DHANAVEL **Professor, IIT, Chennai.**	**2. Mr. SoumyaBrataHalder,** **VisistingLecturer** **SRM University**

Syllabus of the course

Course Code	18LEH104J	Course Name	GERMAN LANGUAGE I	Course Category	H	H S	L	T	P	C
							2	0	2	3

Pre-requisite Courses	NIL	Co-requisite Courses	NA	Progressive Courses	NA
Course Offering Department	ENGLISH AND FOREIGN LANGUAGES	Data Book / Codes/Standards	NA		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	To show the students the Basics of the language like Grammar, Self-introduction and greetings.
CLR-2 :	To build how to introduce oneself and ask and give information about others and express simple terms like hobbies, Telephone numbers.
CLR-3 :	To plan and give directions, an overview of German cities, buildings and everyday life like Cuisine.
CLR-4 :	To analyze the ability among the students to read, understand and initiate the conversation.
CLR-5 :	To prioritize the students to achieve basic conversational skills.
CLR-6 :	They can compose and use familiar everyday expressions and very simple sentences in German.

Course Outcomes (CO):	At the end of this course, learners will be able:	Learning Bloom's level (BL)	Program Outcomes (PO) 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
CO-1 :	To relate and know the culture and geography. Greet each other and introduce themselves.	1	-	-	1	1	2	3	1	3	3	3	-	3	-	-	-
CO-2 :	To construct dialogues between strangers to ask for simple information's like telephone numbers, seasons etc ..,	3	-	-	2	1	2	3	1	3	3	3	-	3	-	-	-
CO-3 :	To discuss with someone about the directions by using Imperatives and different types of definite & indefinite articles.	6	-	-	2	2	3	2	2	3	3	3	-	3	-	-	-
CO-4 :	To list the dialogue during shopping by using different verbs of Accusative articles.	4	-	-	2	2	3	3	2	3	3	3	-	3	-	-	-
CO-5 :	To decide how to order food, different varieties of food in Germany and also hold conversation in the Restaurant.	5	-	-	2	2	3	3	1	3	3	3	-	3	-	-	-
CO-6 :	To formulate a framework for communication. So that the students will learn basic grammatical structures. There will be variety of classroom activities that cover all four skills as reading, speaking, writing and listening. The pace of the class should suit all the learners abilities, enabling students to familiarize themselves with the German Language.	6	-	-	3	3	3	3	3	3	3	3	-	3	-	-	-

		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		15	15	15	15	15
S-1	**SLO -1**	Alphabets, Grüßen und Verabschieden.	UmbestimmtArtikel im Nominativ.	T, N, D verbenkonjugati onen und Satzschreiben.	Die Uhezeiten verstehen und nennen.	Etwasgemeinsamplanen, über Geburtstag sprechen.
	SLO -2	Über Länder und Sprachensprechenim Deutschland, WichtigeStädteim Deutschland.	Zahlenbis 1000 und Wortschatz.	Ordinal Zahlen und Tagezeiten	Zeitangabenmachen.	Schreiben Sie: Einladung für ihre Geburtstag.
S-2	**SLO -1**	Zahelenbis 20,Sich und andere Vorstellen.	Plätze und Gebäudebe nennen, Fragenzuortenstellen.	Überessensprechen und VerschiedeneGerichte in Deutschland durch PPT.	Umregelmäßige verbenkonjugati onen und BeispieleSatz.	Possessive Artikel im Akkuativ.
	SLO -2	Telefonnummerund E-mail Adressenennen.	Negation undübersetzung.	Buchstabieren und Wortschtz.	"ieren" verben conjugation und Beispielesatz.	BeispieleSätze.

S-3	**SLO -1**	Alphabet Aussprache undhört die grüßen.	Hörübung: Die Telefonnummer.	Hörübung: Aussprache dieUmlauteä, ö, üund beispieleSätze.	Hörübung: DemDialog zuhörenund die Zeit schreiben.	E-mail schreiben: Einladung ihrer Geburtstagsferie r.
	SLO -2	Verabschiedenen Wörten.	Buchstabieren und Wortschtz.	Hören und buchstabieren.	Übungen.	Übungen.
S-4	**SLO -1**	Länder undSprachen Der Film: Über den Guten Tag und die Telefonnummer.	Der Film: Über die Sehenwürdigkeiten in Detschland.	Dialog: Über das Essen und seine preisepraktizieren.	Mit den Reguläßige und Umregelmäßigenverbeneigene Sätze schreiben	Das Gesprächhören und verstehen.
	SLO -2	Übungen.	Sprechen überden wichtige Städte im Deutschland.	Übungen.	"ieren" verben konjugationen.	Wortschatz undbuchstabieren.
S-5	**SLO -1**	Über Länder und Sprachensprechen.	Himmelsrichtungen und Verkehrsmittel nennen.	Einen EinkaufPlanen und sprechen	Über die Familiesprechenund sichverabreden.	Das Briefeschreibenerklären, eineEinldung verstehen und schreiben.
	SLO -2	Hören und buchstabieren.	NachdemWegfragen und einem Wegbeschreiben	Gespräche beimEinkauf führen.	Sich für eineverspätung entschuldigen.	Personal pronomen und beispieleSätze.
S-6	**SLO -1**	Aussagesatz und personal pronomen in Nominativ und beispieleSätze.	Texte mit internationalenwörtern verstehen.	GesprächebeimEssen führen.	EinenTermintelefonisch vereinbaren.	ImRestaurentbestellen und bezahlen, übereinEreignis sprechen,
	SLO -2	ÜberArbeit, Berufe und Arbeitszeitensp rechen.	Artikel lernen.	W-fragen texteverstehen.	Schreiben Sie dieUhrzeiten.	BestimmtInformationen in Textenfinden.
S-7	**SLO -1**	Übersich und anderesprechen .	Hörübung: Schreiben Sie die Zahlen.	Kurzer Dialogüber das Einkaufen.	Üben: Wie manden Termin festlegt.	Schreiben einesBriefes über jede gegebenesituation.
	SLO -2	Fragen undantworten.	Events imHamburg.	Übungen: Verben konjugationen.	Hören und buchstabieren.	Übungen: Trennbare Verben konjugationen.
S-8	**SLO -1**	Sich und anderevorstellen.	Fragen Sie die Wegbeschreibun g in dem sie dieBildersehen.	Kurzer Dialog über das Essen.	Hörübung: Die Zeit durch hören des Dialogsschreiben.	Hörübung und Schreiben: Freizeitaktivitäten.
	SLO -2	W-Fragen.	Lesen undverstehen.	Hören: wie manbestellt.	Übungen.	Satzmithilfsverben.
S-9	**SLO -1**	**Zahlen ab 20 nennen, über Jahrezeiten imDeutschland.**	**Imperativ mit Sie, Lesen und verstehen.**	**Wortschatz undBuchstabieren.**	**UmbestimmtArtikel im Akkusativ.**	**Untrennbare verben konjugationen. Beispiele Sätze.**
	SLO -2	**Wochentageund Monate.**	**Lange und KurzeVokale.**	**Schreiben Sie dieSätze.**	**Zeitangabenmit am, um, von…. bis.**	**BeispieleSätze.**
S-10	**SLO-1**	**Bestimmt Artikelin Nominativ.**	**Regelmäßige verben Konjugationen.**	**PositionenimSatz, Bestimmt Artikel imAkkusativ.**	**Erklärt die Grammatik Präpositionen imAkkusativ.**	**Präteritum von Hilfsverben und konjugationen.**
	SLO-2	**Verwendungen vonHilfsverben.**	**Satzschreiben.**	**AkkusativVerbenkonjugationen.**	**BeispieleSätze im Präpositionen .**	**Modal verben konjugationen und beispiele Sätze.**
S-11	**SLO-1**	**Ja oder NeinFragen durchPPT.**	**Der Imperetivsätzeund auch die Regelmäßigeverben**	**Essen im D-A-CH,Beruferund ums Essen.**	**Hören und sprechen: die Tagesablauf.**	**Übung für Modalverben wie, Aussagesatz, Satzfrage.**
	SLO-2	**Typische Hobby's.**	**Lernen Sie die Sätzedurch PPT.**	**Hören Sie dendialog.**	**Schreiben: DieTagesabluf.**	**W-Frage und Trennabreverben.**

S-12	**SLO-1**	**Der Film: Überden Termin.**	**Der Film: Die Autofahrt und dasVerkehrsmittel.**	**Der Film: Frühstückbei den Bergs.**	**Pünktlichkeit in D- A-CH und Der Film:Nie hast du Zeit undTermine.**	**Der Film: Hast du Zeit? Im Restaurantund Überraschung.**
	SLO-2	**Über deineFamilie.**	**Claudia Berg in derArbeit.**	**Einkaufen planen.**	**Der Termin und dieVerabredung.**	**Schreiben Sie die Sätze mit Hilfsverben.**
Learning Resources		**1. Netzwerk – Klett – Langeiseheidt , Munchen- 2015** **2. Grundkurs Deutsch – Dept.of EFL – SRMIST**				

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	50%	50%	10%	10%	-	-	-	-	-	-
Level 2	Understand	-	-	20%	20%	-	-	-	-	-	-
Level 3	Apply	-	-	20%	20%	20%	20%	10%	10%	10%	10%
Level 4	Analyze	-	-	-	-	10%	10%	20%	20%	20%	20%
Level 5	Evaluate	-	-	-	-	10%	10%	20%	20%	20%	20%
Level 6	Create	-	-	-	-	10%	10%			10%	10%
	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.,
SLO – Session Learning Outcome

Course Designers		
Dr. Usha Kodandaraman, ABKAOTS, Chennai . drushak@gmail.com	**Ms.Subhashri Vijaykumar ,Assistant Professor**	**Dr.K.AnbazhaganProf &Head, Dept of EFL**
Mr.Vivek Raghunathan Language Expert, Health care Vivek.raghunathan@waikatodhb.health.nz	**DR.S.P. DhanavelProfessor Dept of EnglishIIT - Chennai**	
		Dr.P.Tamilarasan, Assistant ProfessorDept of EFL

Course Code	18LEH105J	Course Name	JAPANESE LANGUAGE I	Course Category	H	HS	L	T	P	C
							2	0	2	3

Pre-requisite Courses	NIL	Co-requisite Courses	NIL	Progressive Courses	NIL
Course Offering Department	English and Foreign Languages	Data Book / Codes/Standards	NA		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning
CLR-1 :	Explain basics concept and facts of Japanese language.	
CLR-2 :	Compare demonstrative pronouns to ask information.	
CLR-3 :	Select different verbs ,demonstrative pronouns for place	
CLR-4 :	Outline Japanese etiquette by using vocabularies related to daily activities and time.	
CLR-5 :	Explain diverse food habits of Japanese.	
CLR-6 :	Summarize Japanese culture	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Blooms Level(1-6)	Program Outcomes (PO)														
			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
CO-1 :	Recall Japanese alphabet pronunciation	2	2	1	1	1	2	3	2	3	3	2	1	3	2	2	2
CO-2 :	Relate the class activity through conversation	2	2	1	1	1	2	3	3	3	3	2	1	3	2	2	2
CO-3 :	Find directions	3	2	1	1	1	2	3	2	3	3	2	1	3	2	2	2
CO-4 :	Summarize everyday conversations.	2	2	1	1	1	2	3	2	3	3	2	1	3	2	2	2
CO-5 :	Compare the food habits of Japanese and others	2	2	1	1	1	2	3	2	3	3	2	1	3	2	2	2
CO-6 :	Construct sentence and communicate effectively with any native speakers	2	2	1	1	1	2	3	2	3	3	2	1	3	2	2	2

		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
1	SLO-1	Introduction to Japan	Lesson2– reading.	Hiragana Lesson 5 (vowels and related words)	Lesson 5– reading.	Lesson 7– reading
	SLO-2	Japaneselanguage and culture	Lesson 2 Are wa nan desuka.	Hiragana Lesson 6 (vowels and related words)	Lesson 5 Keeki o yattsukudasai.	Lesson 7 ChokoreetoKoujou o shisatsushimashita.
2	SLO-1	Greetings, Days of the week	Grammar- Demonstrative Pronouns (kono, sono, ano,dono)	Lesson 4 reading	Grammar (Counters)	**Grammar tense**
	SLO-2	Numbers and Months of the year.	grammar (ni, ga, arimasu. Imasu. dare, donata)	Lesson 4 ToukyoTawaawadocchidesuka	grammar (Counters)	**Grammar tense**
3	*SLO-1*	*Japan General Information (PPT)*	*Lesson 2 (PPT),*	*Hiragana Lesson 5 (PPT)*	***Lesson 5 (PPT)***	***Lesson 7 (PPT)***
	SLO-2	*Contd., Japan General Information (PPT)*	*Lesson-2 (Audio)*	*Hiragana Lesson 6 (PPT)*	***Lesson 5 (Audio)***	***Lesson 7 (Audio)***
4	*SLO-1*	*Greetings and Days of the week (PPT)*	*Lesson 2 Renshuu 1, 2 & 3 (PPT)*	*Lesson 4 (PPT)*	*Lesson 5 Renshuu 1, 2 & 3 (PPT)*	*Lesson 7 Renshuu 1, & 2 (PPT)*
	SLO-2	*Number and Months of the year (PPT)*	*Lesson 2 – renshuu-4, 5, 6 & 7 (PPT)*	*Lesson 4 audio*	*Lesson 5 Renshuu 4, 5, 6 & 7 (PPT)*	*.Lesson 7 Renshuu 3 & 4 (PPT)*
5	SLO-1	Lesson1– reading.	Hiragana Lesson 3 (vowels and related words)	Grammar(kochirasochira, achira and Dochira)	Hiragana Lesson 9Double consonants	Hiragana Lesson 11Compound components
	SLO-2	Lesson 1 Self-introduction	Hiragana Lesson 4 (vowels and related words)	Grammar (kocchi, socchi, docchi.	Hiragana Lesson 10Long vowels	Hiragana Lesson 12particles in Hiragana
6	SLO-1	Grammar (wa,ka,mo,no)	Japanese Festivals	***Japanese Culture***	***Japanese Sports and Martial arts***	***Japanese House and living style***
	SLO-2	grammar (no,desu/jaarimasen)	Contd., Japanese Festivals	***Contd Japanese culture***	***Contd., Japanese Sports and Martial arts***	***Japanese House and living style***

7	**SLO-1**	*Lesson 1 (PPT)*	Hiragana Lesson 3 PPT	*Lesson4Renshuu 1, 2 &3 PPT*	Hiragana Lesson 9 PPT)	Hiragana Lesson 11 PPT)
	SLO-2	*Lesson-1 (Audio)*	Hiragana Lesson 4 PPT	*Lesson4Renshuu4, 5 & 6 PPT*	Hiragana Lesson 10 PPT)	Hiragana Lesson 12 PPT)
8	***SLO-1***	*Lesson 1 renshuu-1,2,3 (PPT)*	***Festivals of Japan PPT***	***Japanese Culture PPT***	***Japanese sports and martial arts. PPT***	***Japanese House and living style (PPT)***
	SLO-2	*Lesson 1 renshuu-4 & 5 (PPT)*	***Festivals of Japan PPT***	***Japanese Culture PPT***	***Japanese sports and martial arts. PPT***	***Japanese House and living style (PPT)***
9	***SLO-1***	***Introduction to Japanese Script- Hiragana, Katakana, and Kanji.***	*Lesson3– reading.*	Hiragana Lesson 7 (vowels and related words)	*Lesson 6– reading.*	*Introduction to Kanji*
	SLO-2	Hiragana Lesson 1(a, i,u,e,o) vowels and related words	*Lesson 3 Sore o kudasai*	Hiragana Lesson 8 (vowels and related words)	*Lesson 6 Ginza e ikimasu.*	*Kanji 1-10*
10	SLO-1	Hiragana Lesson 2 (ka, ki,ku,ke,ko) related words	grammar (time expressions)	Lesson-5 counters- General Counter& Nin	grammar (e particle, Ni particle)	*Kanji 11-20*
	SLO-2	Hiragana Lesson 2 (ga, gi,gu,ge,go) related words	grammar (hours and minutes)	Lesson-5 counters- Nin, Dai	grammarverbs (masu, masen, ga)	*Kanji 21-30*
11	SLO-1	***Introduction to Japanese Script****(PPT)*	Lesson 3 *(PPT)*	Hiragana Lesson 6 *(PPT)*	Lesson 6 *(PPT)*	*Introduction to Kanji (PPT)*
	SLO-2	Hiragana Lesson 1 *(PPT)*	Lesson 3 audio	Hiragana Lesson 6 *(PPT)*	Lesson 6 audio	*Kanji 1-10 (PPT)*
12	SLO-1	Hiragana Lesson 2 *(PPT)*	*Lesson3Renshuu 1, 2 (PPT)*	Lesson-5 counters- General Counter and Nin*(PPT)*	*Lesson6Renshuu 1, 2& 3(PPT)*	*Kanji 11-20 (PPT)*
	SLO-2	Hiragana Lesson 2 *(PPT)*	*Lesson3Renshuu3,4 & 5 (PPT)*	Lesson-5 counters- Dai, Kai*(PPT)*	*Lesson6Renshuu4, 5 & 6(PPT)*	*Kanji 21-25 (PPT)*
Learning Resources		5. **Minna no Nihongo – 3A Corporation, Tokyo, Japan – 2002.** 6. **A Basic Course in Japanese – Department of EFL,SRMIST- 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	25%	25%	10%	10%	25%	25%	25%	25%	10%	10%
Level 2	Understand	25%	25%	20%	20%	25%	25%	25%	25%	20%	20%
Level 3	Apply			20%	20%					20%	20%
Level 4	Analyze										
Level 5	Evaluate	-		-		-		-		-	
Level 6	Create	-		-		-		-		-	
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1 Dr. USHA KOTHANDARAMAN, Faculty of Japanese, ABK AOTS DOSOKAI, Chennai, Tamilnadu.	**1. Dr.K.ANBAZHAGAN, Professor and Head, Department of EFL. SRM University.**	**1. Ms.R.PADMAJAA, Assistant Professor (Sr.G) SRM University.**
2.NIRMAL EPHRAIM, Functional consultant, Korconmptenz, GreamsRoad, Chennai.	**2 Dr. P.DHANAVEL Professor, IIT, Chennai.**	**1. Mr. B.VIJAYA KUMAR, Assistant Professor (Sr.G) SRM University**

Course Learning Syllabus *(// includes Learning Outcomes, Learning Plan & Assessment Plan)*

Course Code	18LEH106J	Course Name	KOREAN LANGUAGE	Course Category	BS	Basic Sciences	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18LEH106J	Co-requisite Courses	NII	Progressive Courses	Nil
Course Offering Department	English and Foreign Languages	Data Book / Codes/Standards		Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning
CLR-1:	Learn about Korea and its culture: to be able to read and write the Korean script, and to introduce oneself and other people in the language.	
CLR-2:	Be able to manage daily life living in Korea - talking about daily activities, asking for and giving directions, describing the location of things, learning numbers and to shop for things (asking for items and the number of said items).	
CLR-3:	Be able to shop by asking for the availability of things, and learning about the currency system; To be able to talk about past activities (past tense) and the weather.	
CLR-4:	Tell time, to socialize: make appointments, phone calls	
CLR-5:	Communicate about studying Korean and about future career or academic plans.	
CLR-6	This course is designed to develop the basic knowledge of the country and the language by training the candidate in reading, writing, listening and speaking. The conversational level of various basic topics covered in the course eliminates the fundamental hardships of language barriers faced in Korea.	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Blooms Level (1-6)	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
CO-1:	Spell, pronounce, and demonstrate the Korean script, and to define oneself and other people in the language. Get to know about Korea, its culture, and its language.	1			1		3	3	1	2	2	3		3
CO-2:	Illustrate daily life in Korea - ask for and give directions, describe locations, count, shop, and talk about daily activities.	2			1		3	2	1	2	3	3		3
CO-3:	Spell about past activities (past tense), the weather and use the Korean currency.	1			1		2	3	1	2	2	2		3
CO-4:	Interpret time, to socialize make appointments, phone call etiquettes	2			1		3	3	1	2	3	3		3
CO-5:	Explain about studying Korean and about future career or academic plans.	2			1		3	2	1	2	3	3		3
CO-6:	Summarize Read, write, and converse effectively in basic Korean, making it easy to even live in the country.	2			1		3	3	1	2	3	3		3

		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	INTRODUCTION to Korea and Korean -	일상 생활 daily life, new vocab	***Listening & keysentence drilling***	***Dialogue 1 &2***	grammar point 1-그래서
	SLO-2	**한글소개, 한국 소개**	(action, places	***Reading&writing***		grammar point1-(으)르거예요
S-2	SLO-1	single vowels (단모음)	grammar point1-아요/	new vocab (counter noun)	listening &key sentences drilling	***Dialogue 1 & dialogue 2***
	SLO-2		어요&grammar point2-에 가다		***Reading&writing***	
S-3	SLO-1	이중모음과 자음 double vowels & basic	***Dialogue 1 & dialogue 2***	grammar point1-ㅂ니다/습니다,-	시간 time new vocab (time	eading
	SLO-2	consonants		ㅂ니까/습니까		
S-4	SLO-1	쌍 자음과 음절 double consonants &	**Listening & reading/ writing**	**Teaching money**	**Teaching dates & weeks**	**Writing for weekend activitsies**
	SLO-2	syllables				
S-5	SLO-1	받침과 음절 1 Batchim & syllables	위치 location new vocab(object	dialogue1& dialogue2	grammar point1-에	한국어 공부(studying Korean) new
	SLO-2		/location)	practice	grammar point2-시-분	vocab(pronouns)
S-6	SLO-1	받침과 음절 2 Batchim & syllables	grammar point1-이 I/가	Listening& key sentences drilling	dialogue 1& dialogue 2 practice	grammar point1- 나/저, 내/제

	SLO-2		grammar point2-에 있다/없다	Reading/writing		grammar point2-'ㄷ' irregular verbs
S-7	**SLO-1**	자모 연습. (practices vowels and consonants	***Dialogue 1 & dialogue 2 practice***	어제 일과 yesterday's daily routine new vocab (action, places)	Listening & key sentences drilling	***dialogue 1 & dialogue 2 practice***
	SLO-2				Reading/writing	
S-8	**SLO-1**	듣기. 교실 표현(listening & class terms)	**Listening& Key sentences drilling**	grammar point1-았/었	약속 appointment new vocab(location& plan	**Listening& Key sentences drilling**
	SLO-2		**Reading/writing**	grammar point2-에서		**Reading/writing**
S-9	**SLO-1**	자기소개 self –introduction , new vocab(nationality, occupation	쇼핑 1shopping1 new vocab (items to shop)	dialogue1& dialogue2 practice	grammar point1- (으)ㄹ까요	계획(plan) –(으)ㄹ 거예요
	SLO-2				grammar point2-아요/어요	
S-10	SLO-1	grammar point1-이에요/예요	Shopping & teaching Numbers	Listening & Key sentences drilling	Dialogue 1 & dialogue 2 practice	grammar point1- pro nouns 이/그/저 +것(things)
	SLO-2	grammar point2-은/는		Reading/writing		grammar point2- 'ㅡ' irregular verbs & dialogue2
S-11	SLO-1	Dialogue 1 & dialogue 2 practice	grammar point1-을/를	날씨 weather new vocab(season& weather	Listening & key sentences drilling	Dialogue 1 & dialogue 2 practice
	SLO-2		grammar point2-(으)세요		Reading/writing	
S-12	SLO-1	**Listening key sentences drilling**	***Dialogue 1& dialogue 2 practice***	grammar point1-그리고	***Phone call new vocab and expressions, key sentences***	**Listening & key sentences drilling**
	SLO-2	**Reading/writing**		grammar point2-안		**Reading/writing**
Learning Resources		1. ACTIVE KOREAN 1- Language Education Institute, Seoul National University- Moonjin Media-2006 2. ACTIVE KOREAN 1 WORKBOOK- Language Educational Institute, Seoul National University – Moonjin Media -2010 3. SEJONG OREAN 1- The National Institute of Korean Language – Hawoo-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	50%	50%	25%	25%	20%	20%	10%	10%	10%	10%
Level 2	Understand			25%	25%	30%	30%	20%	20%	30%	30
Level 3	Apply								40%	10%	10%
Level 4	Analyze										
Level 5	Evaluate	-		-		-		-		-	
Level 6	Create	-		-		-		-		-	
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers							
(a) Experts from Industry							
1	***Dr, USHA KOTHANDARAMAN,Faculty of Japanese, ABK AOTS DOSOKAI, Chennai, Tamilnadu***						

2	***Mr. Paul Das , Senior Manager, NEC ,Chennai***						
(b) Experts from Higher Technical Institutions							
1	***Ms. Subhasri Vijay kumar, Asst. professor***	***VIT chennai***		2	***Dr.P. Dhanavel,Professor***	***IIT***	
(b) Internal Experts							
1	***Jang kyung A Visiting faculty Korean***	***SRMIST***		2	***Ms. Cho Seul Hee Visiting faculty Korean***	***SRMIST***	

B. Tech in Electronics and Communication Engineering

2018 Regulations

Basic Science Courses (B)

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

Course Code	18PYB101J	Course Name	PHYSICS: ELECTROMAGNETIC THEORY, QUANTUM MECHANICS, WAVES AND OPTICS	Course Category	B	Basic Sciences	L	T	P	C
							3	1	2	5

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

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

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

		Blooms Level
CLR-1 :	Identify the applications of electric field on materials	
CLR-2 :	Identify the applications of magnetic field on materials	
CLR-3 :	Identify the significance of quantum theory	
CLR-4 :	Create insights to the concepts of optical effects	
CLR-5 :	Analyze the working principle of lasers and optical fibers	
CLR-6 :	Utilize the concepts in physics for the understanding of engineering and technology	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Blooms Level	Program Outcomes (PO)										
			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
CO-1 :	Express the significance of electrostatic fields	4	3	3	-	-	-	-	-	-	-	-	-	-
CO-2 :	Analyze electromagnetic induction	4	3	3	-	-	-	-	-	-	-	-	-	-
CO-3 :	Apply quantum mechanics to basic physical problems	4	3	-	-	3	-	-	-	-	-	-	-	-
CO-4 :	Apply ray propagation and optical effects	4	3	3	-	-	-	-	-	-	-	-	-	-
CO-5 :	Understand the types of lasers, structure and propagation properties of optical fiber and analyse its applications	4	3	-	3	-	-	-	-	-	-	-	-	-
CO-6 :	Apply the concepts of electromagnetic theory and optics in real time applications	4	3	3	-	3	-	-	-	-	-	-	-	-

Duration (hour)		18	18	18	18	18
S-1	SLO-1	*Del, divergence, curl and gradient operations in vector calculus*	*Magnetization, permeability and susceptibility*	*Introduction to Quantum mechanic s*	*Introduction to interference*	*Absorption and emission processes-two level*
	SLO-2	*Gauss-divergence and Stoke's theorem*	*Classification of magnetic materials*	*Explanation of wave nature of particles*	*Introduction to diffraction*	*Einstein's theory of matter radiation A and B coefficients*
S-2	SLO-1	*Electric field and electrostatic potential for a charge distribution*	*Ferromagnetism*	*Black body radiation, Concept of Photon*	*Fresnel diffraction*	*Characteristics of laser beams*
	SLO-2	*Gauss' law and its applications*	*Concepts of ferromagnetic domains*	*Photoelectric effect, Compton effect*	*Fraunhofer diffraction*	*Amplification of light by population inversion*
S-3	SLO-1	*Laplace's equations for electrostatic potential*	*Hard and soft magnetic materials*	*de Broglie hypothesis for matter waves*	*Fraunhofer diffraction at single slit*	*Threshold population inversion*
	SLO-2	*Poisson's equations for electrostatic potential*	*Energy product*	*Physical significance of wavefunction*	*Fraunhofer diffraction at double slit*	*Essential components of laser system and pumping mechanisms*
S-4	SLO-1	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*
	SLO-2	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*
S 5-6	SLO-1	*Basics of experimentation*	*Calibrate Ammeter using Potentiometer*	*Determine Planck's Constant*	*Determine wavelength of monochromatic light Newton's ring*	*Determine laser parameters – divergence and wavelength for a given laser source*
	SLO-2					
S-7	SLO-1	*Concepts of electric current*	*Ferrimagnetic materials*	*Time independent Schrödinger's wave equation*	*Fraunhofer diffraction at multiple slit*	*Nd: YAG laser*

	SLO-2	*Continuity equation*	*Ferrites-regular spinel and inverse spinel*	*Time independent Schrödinger's wave equation*	*Diffraction grating*	*Semiconductor laser*
S-8	**SLO-1**	*Laws of magnetism* *Faraday's law*	*Magnetic bubbles*	*Time dependent Schrödinger's wave equation*	*Characteristics of diffraction grating*	*CO2 laser: Vibrational modes*
	SLO-2	*Ampere's law*	*Magnetic thin films*	*Time dependent Schrödinger's wave equation*	*Applications of diffraction grating*	*CO2 laser: energy level*
S-9	**SLO-1**	*Maxwell's equations*	*Spintronics*	*Particle in a 1 D box*	*Polarization by reflection*	*Optical fiber-physical structure*
	SLO-2	*Maxwell's equations*	*GMR*	*Normalization*	*Polarization by double refraction*	*Total internal reflection*
S-10	**SLO-1**	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*
	SLO-2	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*
S 11-12	**SLO-1** **SLO-2**	*Determine Coulomb's potential and Coulomb's field of metal spheres*	*Calibrate Voltmeter using Potentiometer*	*Repeat/Revision of experiments*	*Determine particle size using laser*	*Study of attenuation and propagation characteristic-optical fiber*
S-13	**SLO-1**	*Polarizations, permeability and dielectric constant*	*TMR*	*Born interpretation of wave function*	*Scattering of light*	*Numerical aperture*
	SLO-2	*Polar and non-polar dielectrics*	*CMR*	*Verification of matter waves*	*Circular polarization*	*Acceptance angle*
S-14	**SLO-1**	*Types of polarization*	*Garnets*	*Concept of harmonic oscillator*	*Elliptical polarization*	*Losses associated with optical fibers*
	SLO-2	*Frequency and temperature dependence*	*Magnetoplumbites*	*Quantum harmonic oscillator*	*Optical activity*	*Classification of optical fibers*
S-15	**SLO-1**	*Internal field in a field*	*Multiferroic materials*	*Hydrogen atom problem*	*Fresnel's relation*	*Optical fiber communications system*
	SLO-2	*Clausius-Mossotti equation*	*Applications of multiferroic materials*	*Hydrogen atom problem*	*Brewster's angle*	*Optical sensors*
S-16	**SLO-1**	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*
	SLO-2	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*
S 17-18	**SLO-1** **SLO-2**	*Determine dielectric constant of the sample (Expt-2)*	*Determine magnetic susceptibility-Quincke's method*	*Study of I-V characteristics of a light dependent resistor (LDR)*	*Determine Wavelength- diffraction grating*	*Mini project*

Learning Resources	*1 1.David Jeffery Griffiths, Introduction to Electrodynamics, Revised edition, Pearson, 2013* *2 2.Ajay Ghatak, Optics, Tata McGraw Hill Education, 5th edition, 2012*	*3 David Halliday, Fundamentals of Physics, 7th edition, John Wiley & Sons Australia, Ltd, 2004* *4 . Eisberg and Resnick, Quantum Physics: Of Atoms, Molecules, Solids, Nuclei and Particles, 2nd Edition, 1985*	

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	10%	10%	7%	7%	7%	7%	10%	10%	10%	10%
Level 2	Understand	10%	10%	8%	8%	8%	8%	10%	10%	10%	10%
Level 3	Apply	20%	20%	15%	15%	15%	15%	20%	20%	15%	10%
Level 4	Analyze	10%	10%	20%	20%	20%	20%	10%	10%	15%	20%
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. Vinay Kumar Gupta, National Physical Laboratory,guptavinay@nplindia.org	*Prof .C.Vijayan, IITM, Chennai, cvijayan@iitm.ac.in*	*Dr.C.Preferencial Kala, SRMIST*
	Prof.S.Balakumar, Univ of Madras, balakumar@unom.ac.in	*Dr.M.Krishnamohan, SRMIST*

Course Code	18CYB101J	Course Name	CHEMISTRY	Course Category	B	Basic Sciences	L	T	P	C
							3	1	2	5

Pre-requisiteCourses	Nil	Co-requisiteCourses	Nil	ProgressiveCourses	Nil

Course Offering Department	Chemistry	Data Book / Codes/Standards	Periodic Table

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

		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Utilize the atomic and molecular manipulation towards the design of new materials and interpret water quality parameters			
CLR-2 :	Employ various spectroscopic techniques in identifying the structure and correlate it with their properties and measure the acidic strength of aqueous solution			
CLR-3 :	Exploit the periodic properties of elements for bulk property manipulation towards technological advancement and measure of conductance, redox potentials and average molecular weight of the polymer			
CLR-4 :	Address concepts related to electrochemistry, such as corrosion, using thermodynamic principles and estimate rate constant of reaction			
CLR-5 :	Employ various organic reactions towards the design of fine chemical and drug molecules for industries			

1	2	3	4	5	6	7	8	9	10	11	12
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

Course Learning Outcomes (CO):	At the end of this course, learners will be able to:												
CO-1 :	Analyze atomic, molecular orbitals of organic, inorganic molecules to identify structure, bonding, molecular energy levels, evaluate water quality parameters	4	70	65	3	-	2	3	-	-	-	-	-	-	-	-
CO-2 :	Utilize the principles of spectroscopic technique in analysing the structure and properties of molecules, determine acidic strength of aqueous solution	3	80	70	3	-	-	3	3	-	-	-	-	-	-	-
CO-3 :	Rationalize bulk properties using thermodynamic considerations and periodic properties of elements, demonstrate conductance, redox potentials and average molecular weight of the polymer	2	75	60	3	3	-	3	-	-	-	-	-	-	-	-
CO-4 :	Utilize the concepts of thermodynamics in understanding thermodynamically driven chemical reactions, interpret the rate constant of reaction	3	70	70	3	3	-	3	-	-	-	-	-	-	-	-
CO-5 :	Perceive the importance of stereochemistry in synthesizing organic molecules applied in pharmaceutical industries	3	80	70	-	3	3	2	-	-	-	-	-	-	-	-

Duration (hour)		18	18	18	18	18
S-1	SLO-1	Schrodinger equation- introduction	Crystal field theory-Explanation	surface characterization techniques – XPS - Introduction	Hard soft acids and bases	Optical activity, absolute configurations
	SLO-2	Schrodinger equation-Derivation	Crystal field theory-Explanation	surface characterization techniques – XPS - Explanation	Hard soft acids and bases	conformational analysis
S-2	SLO-1	Particle in a box solutions	Energy level diagrams for transition metal ions	Diffraction and scattering of solids	Thermodynamic functions: energy	Isomerism in transitional metal compounds-Introduction
	SLO-2	Applications for conjugated molecules	Energy level diagrams for transition metal ions	Explanation	Entropy and free energy	Isomerism in transitional metal compounds-Types
S-3	SLO-1	Forms of the hydrogen atom wave functions	Magnetic properties of transition compounds	Ionic, dipolar interactions	Estimation of entropy	Introduction to reactions involving substitution
	SLO-2	plots of these functions to explore their spatial variations	Magnetic properties of transition compounds	Van der Waals interactions	Estimation of free energies.	Addition reaction

S-4	SLO-1	*Tutorial Session*	*Tutorial Session*	*Tutorial Session*	*Tutorial Session*	*Tutorial Session*
	SLO-2	*Tutorial Session*	*Tutorial Session*	*Tutorial Session*	*Tutorial Session*	*Tutorial Session*
S5-6	SLO-1	*Lab Introduction*	*Estimate of amount of chloride content in a water sample.*	*Determine strength of a mixture of aceticand hydrochloric acid by conductometry.*	*Determine adsorption of oxalic/acetic acidfrom aqueous soln. by activated charcoal*	*Experiment - Repeat - 2*
	SLO-2					
S-7	SLO-1	*Molecular orbitals of diatomic molecules-Homonuclear*	*Principles of spectroscopy-Introduction*	*Equations of state of real gases*	*Free energy and emf. Cell potentials*	*Elimination reaction*
	SLO-2	*Heteronuclear diatomic molecules*	*Principles of spectroscopy-Explanation*	*critical phenomena*	*The Nernst equation and applications*	*Oxidation reaction*
S-8	SLO-1	*Equations for atomic orbitals*	*Selection rules-Introduction*	*Effective nuclear charge, penetration of orbitals*	*Acid base, oxidation reduction*	*Reduction reaction*
	SLO-2	*Equations for molecular orbitals*	*selection rules-Explanation*	*variations of s, p, d and f orbital energies of atoms in the periodic table*	*Solubility equilibria*	*Examples*
S-9	SLO-1	*Energy level diagrams of diatomic-introduction*	*Electronic spectroscopy -Introduction*	*Electronic configurations, atomic and ionicsizes*	*Water chemistry*	*Cyclization*
	SLO-2	*Energy level diagrams of diatomic-explanation*	*Electronic spectroscopy-Explanation*	*Electronic configurations, atomic and ionic sizes*	*Water chemistry*	*Ring opening reactions*
S-10	SLO-1	*Tutorial Session*	*Tutorial Session*	*Tutorial Session*	*Tutorial Session*	*Tutorial Session*
	SLO-2	*Tutorial Session*	*Tutorial Session*	*Tutorial Session*	*Tutorial Session*	*Tutorial Session*
S 11-12	SLO-1	*Determine amount of sodium carbonate, sodium hydroxide in a mixture by titration*	*Determine strength of an acid using pHmeter*	*Determine ferrous ion using potassiumdichromate by potentiometric titration*	*Determine rate constant of Acid hydrolysisof an ester*	*Experiment - Repeat - 3*
	SLO-2					
S-13	SLO-1	*π-molecular orbitals of butadiene*	*Rotational spectroscopy of diatomic molecules*	*ionization energies, electron affinity and electronegativity*	*Corrosion*	*Synthesis of a commonly used drug molecule-Introduction*
	SLO-2	*π-molecular orbitals of benzene*	*Rotational spectroscopy of diatomic molecules*	*ionization energies, electron affinity and electronegativity*	*Corrosion*	*Synthesis of a commonly used drug molecule-Examples*
S-14	SLO-1	*Aromaticity-Introduction*	*Vibrational spectroscopy of diatomic molecules.*	*Polarizability, oxidation states*	*Representations of 3 dimensionalstructures*	*Synthesis of a commonly used drug molecule-Introduction*
	SLO-2	*Aromaticity-explanation*	*Applications of vibrational and rotational spectroscopy of diatomic molecule*	*Polarizability, oxidation states*	*structural isomers and stereoisomers*	*Synthesis of a commonly used drug molecule-Examples*
S-15	SLO-1	*Crystal field theory-Introduction*	*Nuclear magnetic resonance - Introduction*	*Coordination numbers and geometries*	*Configurations and symmetry and chirality*	*Question & Answer*
	SLO-2	*Crystal field theory-Introduction*	*Nuclear magnetic resonance - Explanation*	*Coordination numbers and geometries*	*enantiomers, diastereomers*	*Question & Answer*
S-16	SLO-1	*Tutorial Session*	*Tutorial Session*	*Tutorial Session*	*Tutorial Session*	*Tutorial Session*
	SLO-2	*Tutorial Session*	*Tutorial Session*	*Tutorial Session*	*Tutorial Session*	*Tutorial Session*
S 17-18	SLO-1	*Determine hardness (Ca^{2+}) of water usingEDTA – complexometry method*	*Determine strength of an acid by conductometry*	*Determine molecular weight of a polymerby viscosity average method*	*Experiment - Repeat - 1*	*Demonstration Practical Session*
	SLO-2					

Learning Resources	1. *B. H. Mahan, R. J. Meyers, University Chemistry, 4th ed., Pearson publishers, 2009.* 2. *M. J. Sienko, R. A. Plane, Chemistry: Principles and Applications, 3rd ed., McGraw-Hill publishers, 1980* 3. *C. N. Banwell, Fundamentals of Molecular Spectroscopy, 5th ed., McGraw-Hill publishers, 2013*	4. *B. L. Tembe, Kamaluddin, M. S. Krishnan, Engineering Chemistry (NPTEL Web-book) http://nptel.ac.in/downloads/122101001/* 5. *Peter W. Atkins, Julio de Paula, James Keeler, Physical Chemistry, 11th ed., Oxford publishers, 2018* 6. *K. P. C. Vollhardt, N. E. Schore, Organic Chemistry: Structure and Function 7thed., Freeman, 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	15	15	15	15	15	15	10	10	10	10

Level 2	Understand	15	15	20	20	20	20	10	10	15	15
Level 3	Apply	10	10	15	15	15	15	15	15	15	15
Level 4	Analyze	10	10	-	-	-	-	15	15	10	10
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Ravikiran Allada, Head R&D, Analytical, Novugen Pharma, Malaysia, ravianalytical@gmail.com	*1. Prof. G. Sekar, IIT Madras, gsekar@iitm.ac.in*	*1. Prof. M. Arthanareeswari, SRMIST*
2. Dr. Sudarshan Mahapatra, Dr. Reddy' s Laboratories, smahapatra@drreddys.com	*2. Prof. Kanishka Biswas, JNCASR Bengaluru, kanishka@jncasr.ac.in*	*2. Dr. K. K. R. Datta, SRMIST*

Course Code	18MAB101T	Course Name	CALCULUS AND LINEAR ALGEBRA	Course Category	B	Basic Sciences	L	T	P	C
							3	1	0	4

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
		Blooms level (1-6)
CLR-1 :	Apply the concept of Matrices in Science and Engineering	
CLR-2 :	Utilize Taylor series, Maxima minima, composite function and Jacobian in solving various Engineering problems	
CLR-3 :	Apply the concept of Differential Equations in problems of Science and Engineering	
CLR-4 :	Utilize the concepts of radius of curvature, evolute, envelope in problems of Science and Engineering	
CLR-5 :	Apply Sequences and Series concepts in Science and Engineering	
CLR-6 :	Utilize appropriate mathematical techniques for the different solutions required in Science and Engineering applications	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*				Program Outcomes (PO)											
					1	2	3	4	5	6	7	8	9	10	11	12
					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
CLO-1 :	Apply the concepts of Matrices to find Eigenvalues and Eigen Vectors problem-solving in Science and Engineering				3	3	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Apply Maxima and Minima, Jacobian, and Taylor series to solve problems in Science and Engineering				3	3	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Solve the different types of Differential Equations in Science and Engineering applications				3	3	-	-	-	-	-	-	-	-	-	-
CLO-4- :	Identify Radius, Centre, envelope, and Circle of curvature and apply them in Science and Engineering				3	3	-	-	-	-	-	-	-	-	-	-
CLO-5 :	Identify convergence and divergence of series using different tests in Engineering applications				3	3	-	-	-	-	-	-	-	-	-	-
CLO-6 :	*To participate in any level of conversation and discussion presented in English with both proficiency in the language and positive caliber in the content of speech*	2	75	70	H	H	-	H	M	H	M	H	H	H	H	H

Duration (hour)		12	12	12	12	12
S-1	SLO-1	Characteristic equation	Functions of two variables – Partial derivatives	Linear equations of second order with constant coefficients when PI=0 or exp	Radius of Curvature – Cartesian coordinates	Series of Positive terms – Test of Convergence-
	SLO-2	Eigen values of a real matrix	Total differential	Linear equations of second order with constant coefficients when PI=sinx or cosx	Radius of Curvature – Cartesiancoordinates	Comparison test – Integral test-
S-2	SLO-1	Eigen vectors of a real matrix	Total differential	Linear equations of second order with constant coefficients when PI=polynomial	Radius of Curvature – Polar coordinates	Comparison test – Integral test-
	SLO-2	Eigen vectors of a real matrix	Taylor's expansion with two variables up to second order terms	Linear eqn. of second order with constant coefficients when PI=exp. with sinx / Cosx	Radius of Curvature – Polar coordinates	Comparison test – Integral test-.
S-3	SLO-1	Properties of Eigen values	Taylor's expansion with two variables up to third order terms	Linear eqn. of second order with constant coefficients when PI= exp.l with polynomial	Circle of curvature	D'Alemberts Ratio test,
	SLO-2	Cayley – Hamilton theorem	Maxima and Minima	Linear eqn. of 2nd order with const. coeff. when PI=polynomial with sinax or cosax	Circle of curvature	D'Alemberts Ratio test,
S-4	SLO-1	Problem solving using tutorial sheet 1	Problem solving using tutorial sheet 4	Problem solving using tutorial sheet 6	Problem solving using tutorial sheet 11	Problem solving using tutorial sheet 14
	SLO-2	Problem solving using tutorial sheet 1	Problem solving using tutorial sheet 4	Problem solving using tutorial sheet 6	Applications of Radius of curvature in engineering	Problem solving using tutorial sheet 14
S-5	SLO-1	Finding A inverse using Cayley – Hamilton theorem	Maxima and Minima	Linear equations of second order variable coefficients	Centre of curvature	Raabe's root test.
	SLO-2	Finging higher powers of A using Cayley – Hamilton theorem	Maxima and Minima	Linear equations of second order variable coefficients	Centre of curvature	Raabe's root test.
	SLO-1	orthogonal reduction of a symmetric matrix to diagonal form	Maxima and Minima	Homogeneous equation of Euler type	Centre of curvature	Covergent of Exponential Series

S-6	SLO-2	orthogonal reduction of a symmetric matrix to diagonal form	Constrained Maxima and Minima by Lagrangian Multiplier method	Homogeneous equation of Legendre's Type	Evolute of a parabola	Cauchy's Root test
S-7	SLO-1	orthogonal reduction of a symmetric matrix to diagonal form	Constrained Maxima and Minima by Lagrangian Multiplier method	Homogeneous equation of Legendre's Type	Evolute of an ellipse	Log test
	SLO-2	orthogonal reduction of a symmetric matrix to diagonal form	Constrained Maxima and Minima by Lagrangian Multiplier method	Equations reducible to homogeneous form	Envelope of standard curves	Log test
S-8	SLO-1	Problem solving using tutorial sheet 2	Problem solving using tutorial sheet 5	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 2	Problem solving using tutorial sheet 5	Problem solving using tutorial sheet 9	Applications of Curvature in engineering	Problem solving using tutorial sheet 15
S-9	SLO-1	Reduction of Quadratic form to canonical	Jacobians of two Variables	Equations reducible to homogeneous form	Beta Gamma Functions	Alternating Series: Leibnitz test
	SLO-2	Quadratic form to canonical form by orthogonal transformations	Jacobians of Three variables	Variation of parameters	Beta Gamma Functions and Their Properties	Alternating Series: Leibnitz test
S-10	SLO-1	Quadratic form to canonical form byorthogonal transformations	Jacobians problems	Variation of parameters	Sequences – Definition and Examples	Series of positive and Negative terms.
	SLO-2	Orthogonal matrices	Jacobians Problems	Simultaneous first order equations with constant co-efficient.	Series – Types of Convergence	Series of positive and Negative terms.
S-11	SLO-1	Reduction of quadratic form to canonical form	Properties of Jacobians and Problems	Simultaneous first order equations with constant co-efficient	Series of Positive terms – Test of Convergence-	Absolute Convergence
	SLO-2	Reduction of quadratic form to canonical form	Properties of Jacobians and problems	Simultaneous first order equations withconstant co-efficient.	Comparison test – Integral test-	Conditional Convergence
S-12	SLO-1	Problem solving using tutorial sheet 3	Application of Taylor's series Maxima Minima Jacobians in Engineering	Problem solving using tutorial sheet 10	Problem solving using tutorial sheet 13	Problem solving using tutorial sheet 13
	SLO-2	Applications of Matrices in Engineering	Application of Taylor's series Maxima Minima Jacobians in Engineering	Applications of Differential Equation in engineering	Problem solving using tutorial sheet 13	Applications Convergence of series in engineering

Learning Resources	1. B. H. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons,2006. 2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010. 3. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi,2008	4. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010 5. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson,Reprint, 2002 6. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008

Learning Assessment						
Bloom's Level of Thinking		Continuous Learning Assessment (50% Weightage)				Final Examination (50% Weightage)
		CLA –1 (10%)	CLA – 2 (15%)	CLA – 3 (15%)	CLA –4 (10%) #	
Level 1	Remember	20%	20%	20%	20%	20%
Level 2	Understand	20%	20%	20%	20%	20%
Level 3	Apply	30%	30%	30%	30%	30%
Level 4	Analyze	30%	30%	30%	30%	30%
Level 5	Evaluate					
Level 6	Create					
Total		100%	100%	100%	100%	100%

 # CA – 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		
2. Dr. Sricharan Srinivasan, Wipro Technologies, sricharanms@gmail.com	*2. Dr. Nanjundan, Bangalore University, nanzundan@gmail.com*	*2. Dr. Srinivasan, SRMIST*

Course Learning Syllabus (// includes Learning Outcomes & Learning Plan & Assessment Plan)

Course Code	18MAB102T	Course Name	ADVANCED CALCULUS AND COMPLEX ANALYSIS	Course Category	B	Basic Sciences	L	T	P	C
							3	1	0	4

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning
CLR-1 :	Determine the Double and triple Integrals and its applications in Science and Engineering.	
CLR-2 :	Gain Knowledge in interpretation of Vector differentiation and Vector integration which relates Line Integral, Green's, Stoke' s and Gauss Divergence theorem.	Level of Thinking (Bloom)
CLR-3 :	Identify the techniques of Laplace Transforms and Inverse Laplace transforms and extend them in the problems of Science and Engineering.	
CLR-4 :	Construct analytic functions, discuss Conformal mapping and Bilinear Transformation in Engineering problems	
CLR-5 :	Evaluate Complex integrals and Power series using various theorems	
CLR-6 :	Analyze the transform techniques and Integral techniques in Science and Engineering.	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning
CO-1 :	Apply multiple integrals in solving problems in Science and Engineering.	4
CO-2 :	Analyze vector differentiation and vector integration and related Theorems	4
CO-3 :	Apply Laplace Transforms techniques in solving Engineering problems	4
CO-4 :	Extend their knowledge in Fundamentals of analytic functions	4
CO-5 :	Utilize Complex integrals and Power series in solving Engineering problems	4
CO-6 :	Apply the transform techniques and Integral techniques in Science and Engineering problems	4

Program Outcomes (PO)												
1	2	3	4	5	6	7	8	9	10	11	12
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
3	3	-	-	-	-	-	-	-	-	-	-
3	3	-	-	-	-	-	-	-	-	-	-
3	3	-	-	-	-	-	-	-	-	-	-
3	3	-	-	-	-	-	-	-	-	-	-
3	3	-	-	-	-	-	-	-	-	-	-
3	3	-	-	-	-	-	-	-	-	-	-

		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	Evaluation of double integration Cartesian and plane polar coordinates	Review of vectors in 2,3 dimensions ,	Laplace Transformsof standard functions	Definition of Analytic Function – Cauchy Riemann equations	Cauchy's integral formulae - Problems
	SLO-2	Evaluation of double integration of plane polar coordinates	Gradient, divergence,	Transformsproperties	Cauchy Riemannequations	Cauchy's integral formulae- Problems
S-2	SLO-1	Evaluation of double integration of plane polar coordinates	curl – Solenoidal	Transforms of Derivatives and Integrals	Properties of analytic function functions	Cauchy's integral formulae- Problems
	SLO-2	Evaluation of double integration of plane polar coordinates	Irrotational fields	Transform of derivatives and integrals	Determination of analytic function using – Milne- Thomson's method	Taylor's expansionswith simple problems

S-3	SLO-1	Evaluation of double integral by changing of order of integration	Vector identities (without proof) – Directional derivatives	Initial value theorems (without proof) and verification for some problems	Determination of analytic function using – Milne- Thomson's method	Taylor's expansionswith simple problems
	SLO-2	Evaluation of double integral by changing of order of integration	Line integrals	Final value theorems (without proof) and verification for some problems	Determination of analytic function using – Milne- Thomson's method	Laurent's expansions with simple problems
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 tutrial sheet 7	Problem solving using tutorial sheet 10	Problem solving using tutorial sheet 13
S-5	SLO-1	Evaluation of double integral by changing of order of integration	Line integrals	Inverse Laplace transforms using partial fractions	Conformal mappings:magnification	Laurent's expansions with simple problems
	SLO-2	Area as a double integral (Cartesian)	Surface integrals	Inverse Laplace transforms using Partial fractions	Conformal mappings rotation	Singularities
S-6	SLO-1	Area as a double integral (Cartesian)	Surface integrals	Inverse Laplace transforms section shfting theorem	Conformal mappings:inversion	Types of Poles andResidues
	SLO-2	Area as a doubleintegral (polar)	Volume Integrals	LT using Convolution theorem -problems only	Conformal mappings:inversion	Types of Poles andResidues
S-7		Area as a double integral (polar)	Green's theorem (without proof)	LT using Convolution theorem -problems only	Conformal mappings: reflection	Cauchy's residue theorem (without proof)
	SLO-2	Triple integration in Cartesian coordinates	Green's theorem (without proof)	LT using Convolution theorem -problems only	Conformal mappings: reflection	Contour integration: Unit circle
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	Conversion from Cartesian to polar in double integrals	Gauss divergence theorem (without proof), verification	LT of periodic functions - problems only	bilinear transformation	Contour integration: Unit circle
	SLO-2	Conversion from Cartesian to polar in double integrals	Gauss divergence theorem (without proof applications to parallelepiped	LT of periodic functions - problems only	bilinear transformation	Contour integration: Unit circle
S-10	SLO-1	Triple integration in Cartesian coordinates	Gauss divergence theorem (without proof applications to parallelepiped	Applications of Laplace transforms for solving linear ordinary differential equations up to second order with constant coefficient only	bilinear transformation	Contour integration: semicircular contour
	SLO-2	Triple integration in Cartesian coordinates	Stoke's theorems (without proof) – Verification	Applications of Laplace transforms for solving linear ordinary differential equations up to second order with constant coefficient only	bilinear transformation	Contour integration: semicircular contour

S-11	SLO-1	Triple integration in Cartesian coordinates	Stoke's theorems (without proof) – Applications to cubes	Solution of Integral equation involving convolution type	Cauchy's integral theorem (without proof)	Contour integration: semicircular contour
	SLO-2	Area of triple Integral	Stoke's theorems (without proof) – Applications to parallelepiped only	Solution of Integral equation involving convolution type	Cauchy's integral theorem applications	Contour integration: semicircular contour
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	Application of Multiple integral in engineering	Application of Line and Volume Integrals in engineering	Application of Laplace Transform in engineering	Application of Bilinear Transformation and Cauchy Integral in engineering	Application Contour integration in engineering

	REFERENCE BOOKS/OTHER READING MATERIAL
	Text Book
1	Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons,2006.
2	B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.
3	Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi,2008
4	Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010
5	G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson,Reprint,2002
6	N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications,Reprint, 2008

	Learning Assessment										
	Bloom's Level of Thinking	**Continuous Learning Assessment (50% weightage)**								**Final Examination (50% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (15%)**		**CLA – 3 (15%)**		**CLA – 4 (10%)#**			
		Theory	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**
Level 1	Remember	20%		20%		20%		20%		20%	
Level 2	Understand	20%		20%		20%		20%		20%	
Level 3	Apply	30%		30%		30%		30%		30%	
Level 4	Analyze	30%		30%		30%		30%		30%	
Level 5	Evaluate	-		-		-		-		-	
Level 6	Create	-		-		-		-		-	
	Total	100 %		100 %		100 %		100 %		100 %	

 # CA – 3 can be fr
om 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.Maheshvaran	TCS, Chennai	maheshvaranv@yahoo.com				
(b) Expert from Higher Technical Institutions							
1	Dr.K.C.Sivakumar	IIT, Madras	kcskumar@iitm.ac.in				
(c) Internal Experts							
1	Dr.A.Govindarajan	SRMIST, KTR	Hod.maths.ktr@srmist.edu.in	2	Dr.N.Parvathi	SRMIST, KTR	parvathn@srmist.edu.in

Course Learning Syllabus *(// includes Learning Outcomes, Learning Plan & Assessment Plan)*

Course Code	18MAB201T	Course Name	TRANSFORMS AND BOUNDARY VALUE PROBLEMS	Course Category	B	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:	Learning
CLR-1 :	Analyze different types of partial differential equations, interpret the solutions that relate PDE to the respective branches of engineering	
CLR-2 :	Relate Fourier series expansion to examine Sine and Cosine Series.	
CLR-3 :	Apply PDE and Solve one dimensional wave and heat equations.	
CLR-4 :	Examine the various types of integral transforms.	
CLR-5 :	Analyze z transform for solving discrete-time Signal problems.	
CLR-6 :	Distinguish the importance of PDE, Fourier series, one dimensional wave and heat equations, Fourier and Z – transform	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Iooms Level (1-6)
CO-1 :	Construct and solve partial differential equations using various techniques	4
CO-2 :	Explain the Fourier series expansion of a function in terms of sine and cosine series.	4
CO-3 :	Identify Partial differential equations and utilize Fourier series techniques to solve one dimensional wave and heat equations.	4
CO-4 :	Apply Fourier transforms techniques in signal analysis.	4
CO-5 :	Solve discrete-time signal problems using z transforms.	4
CO-6 :	Utilize PDE, Fourier series, one dimensional wave and heat equations, Fourier and Z transforms to solve engineering problems.	4

Program Outcomes (PO)	1	2	3	4	5	6	7	8	9	10	11	12
	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
CO-1 :	3	3	-	-	-	-	-	-	-	-	-	-
CO-2 :	3	3	-	-	-	-	-	-	-	-	-	-
CO-3 :	3	3	-	-	-	-	-	-	-	-	-	-
CO-4 :	3	3	-	-	-	-	-	-	-	-	-	-
CO-5 :	3	3	-	-	-	-	-	-	-	-	-	-
CO-6 :	3	3	-	-	-	-	-	-	-	-	-	-

		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 the 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 arbitrary functions	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

	SLO-2	Formation of partial 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 transform	Z-transform of $a^n, \frac{1}{n}, \frac{1}{n+1}$
S-3	SLO-1	Formation of partial differential equation by eliminating arbitrary functions of the form $\phi(u,v)=0$	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 $\frac{1}{n^2}, \frac{1}{(n+1)^2}$
	SLO-2	Solution of first-order nonlinear partial differential equations-standard type I F (p, q) =o	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 applications	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	Final 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 problem		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	PI Type 3: polynomials	Harmonic Analysis for finding harmonic in $(0,2l)$	One dimensional heat equation -Steady state conditions with zero velocity more problems		Parseval's Identity for Fourier sine & cosine transforms applications	Inverse Z-transform - residue theorem method-problems
	SLO-2	PI Type 4: Exponential shifting - $e^{ax+by}f(x,y)$	Harmonic Analysis for finding harmonic in periodic interval $(0,T)$	One dimensional heat 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, New Delhi, Reprint,3rd edition,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%		20%		20%		20%	
Level 2	Understand	20%		20%		20%		20%		20%	
Level 3	Apply	30%		30%		30%		30%		30%	
Level 4	Analyze	30%		30%		30%		30%		30%	
Level 5	Evaluate	-		-		-		-		-	
Level 6	Create	-		-		-		-		-	
	Total	100 %		100 %		100 %		100 %		100 %	

 # CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,
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	Dr.K.Ganapathy subramanian	SRMIST	ganapathy.k@ ktr.srmuniv.ac.in

Course Code	18MAB203T	Course Name	PROBABILITY AND STOCHASTIC PROCESSES	Course Category	B	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		Statistical tables	

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning	Program Outcomes (PO)											
			1	2	3	4	5	6	7	8	9	10	11	12
CLR-1:	Describe the applications on discrete and continuous random variables.	Bloom's Level (1-6)	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
CLR-2:	Assess the applications of two-dimensional random variables.													
CLR-3:	Infer the various modes of convergence of random variables and their limit theorems.													
CLR-4:	Relate the specialized knowledge in random processes in signals and systems.													
CLR-5:	Determine the applications of spectral density functions and linear time invariant systems													
CLR-6:	Interpret random variables and stochastic processes in the applications of practical engineering problems.													
Course Outcomes (CO):	At the end of this course, learners will be able to:													
CO-1:	Evaluate the characteristics of discrete and continuous random variables.	4	3	3	-	-	-	-	-	-	-	-	-	-
CO-2:	Explain the model and analyze systems using two dimensional random variables.	4	3	3	-	-	-	-	-	-	-	-	-	-
CO-3:	Classify limit theorems and use various inequalities.	4	3	3	-	-	-	-	-	-	-	-	-	-
CO-4:	Analyze the characteristics of random processes.	4	3	3	-	-	-	-	-	-	-	-	-	-
CO-5:	Examine problems on spectral density functions and linear time invariant systems.	4	3	3	-	-	-	-	-	-	-	-	-	-
CO-6:	Utilize the concepts on random variables and stochastic processes in signals and systems.	4	3	3	-	-	-	-	-	-	-	-	-	-

		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	10	14
S-1	SLO-1	One dimensional random variable: Discrete Case-Probability function, Cumulative Distribution Function	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 without proof	Classification of random processes	Proof of properties
S-2	SLO-1	Cumulative distribution function-properties	Conditional probability distribution of (X, Y)	Chebyshev's inequality - Applications	Distribution of the process	Problems on power spectral density function
	SLO-2	Problems on one dimensional random variable	Problems on discrete random variables	Chebyshev's inequality – Applications using Binomial distribution	Averages of the process	Problems on power spectral density function
S-3	SLO-1	Expectation, variance	Continuous random variables-Joint PDF	Chebyshev's inequality– Applications using Exponential distribution	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 without proof	Problems on WSS process	Linear systems with random inputs
	SLO-2	Characteristic function	Problems on continuous two-dimensional random variables	Central limit theorem - Applications	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- Applications using Poisson random variables	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- Applications using Exponential random variables	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 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 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 of power spectral density functions in engineering
Learning Resources		1. A. 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, A first course in Probability, Sixth Edition, 2011				
		5. S.C. Gupta, V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, 11th Edition, 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%)	
Level 1	Remember	20%	20%	20%	20%	20%
Level 2	Understand	20%	20%	20%	20%	20%
Level 3	Apply	30%	30%	30%	30%	30%
Level 4	Analyze	30%	30%	30%	30%	30%
Level 5	Evaluate					
Level 6	Create					
	Total	100%	100%	100%	100%	100%

CA – 3 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
(c) Internal Experts						
4	Dr. A. Govindarajan	SRMIST	govindarajan.a@ktr.srmuniv.ac.in	5. Dr. V. Srinivasan	SRMIST	

To emerge as a World - Class University in creating and disseminating knowledge, and providing students a unique learning experience in Science, Technology, Medicine, Management and other areas of scholarship that will best serve the world and betterment of mankind.
MOVE UP through international alliances and collaborative initiatives to achieve global excellence.
ACCOMPLISH A PROCESS to advance knowledge in a rigorous academic and research environment.
ATTRACT AND BUILD PEOPLE in a rewarding and inspiring environment by fostering freedom, empowerment, creativity and innovation.

Course Code	18MAB302T	Course Name	DISCRETE MATHEMATICS FOR ENGINEERS	Course Category	B	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:	Learning
CLR-1 :	Enhance the mathematical skills by applying the principles of sets and functions in storage, communication and processing the data	
CLR-2 :	Culminate in extensive use and application of counting strategies in enumeration of data	Blooms level (1 - 6)
CLR-3 :	Apply the rules of inference theory to design electronic circuits and to verify computer programs	
CLR-4 :	Apply the knowledge of algebraic structures and coding theory to solve problems on detection and correction of errors occurring in binary communication channels	
CLR-5 :	Acquire knowledge to solve problems in communication networks using graph models	
CLR-6 :	Apply the concepts of discrete structures to solve problems in Electrical, Communication and Computer Science Engineering	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning
CO-1 :	Apply the concepts of set theory and its operations in data structures and mathematical modelling languages	4
CO-2 :	Solve problems using counting techniques and understanding the basics of number theory	4
CO-3 :	Comprehend and validate the logical arguments using concepts of inference theory	4
CO-4 :	Inculcate the curiosity for applying the concepts of algebraic structures to coding theory	4
CO-5 :	Apply graph theory techniques to solve wide variety of real world problems	4
CO-6 :	Acquire knowledge in mathematical reasoning, combinatorial analysis and discrete structures	4

Program Outcomes (PO)												
1	2	3	4	5	6	7	8	9	10	11	12	
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	
3	3	-	-	-	-	-	-	-	-	-	-	
3	3	-	-	-	-	-	-	-	-	-	-	
3	3	-	-	-	-	-	-	-	-	-	-	
3	3	-	-	-	-	-	-	-	-	-	-	
3	3	-	-	-	-	-	-	-	-	-	-	
3	3	-	-	-	-	-	-	-	-	-	-	

		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 identities using laws of set theory.	Simple problems using addition and product rules.	Truth values and truth tables.	Properties of groups.	Some Special Graphs – complete, 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 divisorand 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 McGraw Hill Publishing Co., 35th edition,2008.
	3.	NarsingDeo, 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.

	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%	
Level 2	Understand	20%		20%		20%		20%		20%	
Level 3	Apply	30%		30%		30%		30%		30%	
Level 4	Analyze	30%		30%		30%		30%		30%	
Level 5	Evaluate	-		-		-		-		-	
Level 6	Create	-		-		-		-		-	
	Total	100 %		100 %		100 %		100 %		100 %	

 # CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,
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	**Dr.Sundarammal Kesavan**	**SRMIST**	**sundarammal.k@ktr.srmuniv.ac.in**

To emerge as a World - Class University in creating and disseminating knowledge, and providing students a unique learning experience in Science, Technology, Medicine, Management and other areas of scholarship that will best serve the world and betterment of mankind.
MOVE UP through international alliances and collaborative initiatives to achieve global excellence.

B. Tech in Electronics and Communication Engineering

2018 Regulations

Engineering Science Courses (s)

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

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

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

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

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

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

S-5	**SLO-1**	*Conversions of Mechanical system to Electrical system*	*Step response of over damped second order system*	*Computation of Routh array*	*Bode plot of typical systems*	*Design Specification, controller configurations-PID controller*
	SLO-2	*f-V and f-I electrical analogies*	*Step response of undamped second order system*	*Routh array of stable systems*		
S-6	**SLO-1**	*Block diagram reduction rules and methodology*	*Time domain specifications and their significance*	*Routh array of Unstable systems*	*Polar plot and significance*	*Design of speed control system for DC motor*
	SLO-2		*Numerical solution*	*Routh array of Unstable systems*	*Nyquist stability criterion*	
S-7	**SLO-1**	*Evaluation of transfer function using block diagram reduction*	*Transient and steady state error analysis*	*Root locus technique*	*Sketching of polar plot on polar graphs*	*Design of control system for Twin Rotor Multi input Multi output System(TRMS) with one degree of freedom*
	SLO-2		*Static and dynamic Error coefficients*	*Rules for sketching root locus*		
S-8	SLO-1	*Signal flow graphs and evaluation of transfer function*	*Static error constants and evaluation of steady state error*	*Root locus plot of typical systems*	*Polar plot of typical systems*	*Case study 1*
	SLO-2					
S-9	SLO-1	*Block diagram to signal flow conversion*	*Dynamic error constants and evaluation of steady state error*	*Root locus plot of typical systems*	*Polar plot of typical systems*	*Case study 2*
	SLO-2					

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

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

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Mr. Anuj Kumar, Bombardi*er Transportation, Ahmedabad, *kumaranuj.anii@gmail.com*	1. *Dr. Meenakshi, Professo*r of ECE, CEG, Anna University, *meena68@annauniv.edu*	*Dr. T. Deepa, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*Mrs. R. Bakhya Lakshmi, SRMIST*

B. Tech in Electronics and Communication Engineering

2018 Regulations

Special Course

Department of Electronics and Communication Engineering

SRM Institute of Science and Technology

SRM Nagar, Kattankulathur – 603203, Chengalpattu District, Tamilnadu

Course Code	18CSC308L	Course Name	COMPETITIVE PROFESSIONAL SKILLS (for non computing braches)	Course Category	C	Professional Core	L	T	P	C
							0	0	2	1

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			Program Outcomes (PO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	Understand importance of mathematics and problem solving approaches for programming.	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLR-2 :	Understand importance of optimized solutions for problems solving and its relevance to industry.																		
CLR-3 :	Implement mathematical and logical understanding approaches to implement test driven development practices.																		
CLR-4 :	Start participating in global coding competitions relevant to the syllabus.																		

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:																		
CO-1 :	Able to understand test and development aspects of programming by solving problems at Industry standards.	2	85	80	1	3	3	3	3	-	-	2	2	1	-	3	-	-	-
CO-2 :	Able to interpret any given problem using required domain skills, mathematics.	3	85	80	1	3	3	3	3	-	-	2	2	1	-	3	-	-	-
CO-3 :	Able to learn and apply methods to optimize solutions for any given problem.	3	85	80	1	3	3	3	3	-	-	2	2	1	-	3	-	-	-
CO-4 :	Able to solve problems using C & Python languages on elementary data structures with test driven development.	3	85	80	1	3	3	3	3	-	-	2	2	1	-	3	-	-	-

Duration (hour)		6	6	6	6	6
S-1	SLO-1	*Introduction to Competitive coding, various coding platforms, working on data, Coding Essentials, Program Execution Steps, Tokens of a coding language*	*Introduction to Linear data, Subscript of an array, Representing the array data, Insert values into an array, Print the values of an array, print the values of an array in reverse, find an element in an array, Find the Max element in an array, Find the min element in an array, Print the sum of the elements of an array, Print the sum of positive elements of an array.*	*Introduction to Recursion, Recursive nature, Recursion evaluation methods, Head and Tail recursion,*	*Classical Coding problems on Linked Lists. Formation of a Circular linked list, Operations, Formation of a Double Linked List, Operations,*	*Introduction to tuple, accessing tuples, tuple operations,*
	SLO-2	*, Data Representation, Input Format, Output Format, Escape Sequence Characters.*	*Introduction to 2D Array, 2D Array Subscript, RMO & CMO Representation, Matrix Problems.*	*Iteration Vs Recursion*	*Coding problems on Circular Linked list & Double linked lists.*	*introduction to dictionaries, accessing values in dictionaries, properties and functions.*
S-2	SLO-1	*Lab 1:Programs include coding for basic math expression evaluations.*	*Lab 4:Basic list data problems, classical problems on arrays. matrix data, Matrix rotations*	*Lab 7:Coding programs using recursions, finding factorial/Fibonacci series etc*	*Lab 10:Coding problems on Circular/Double linked lists*	*Lab 13:Coding problems implementing tuples using python*
	SLO-2					
S-3	SLO-1	*Expression Evaluation, Arithmetic Operations, Assignment Operations, Relational Operations, Logical Operations, Bitwise Operations,*	*Introduction to Pointers, Pointer Variable, Pointer Arithmetic, Pointer to an array, Pointer to a String, Memory Layout, Runtime memory allocation, Stack memory Vs Heap memory, Array Vs Pointer Array, Array Vs Pointer,.*	*Introduction to user defined data, structures, array within structure, array of structures, nested structures,*	*Programming using Python Introduction to Python, Basic syntax, variables and data types, operators, Input and Output,*	*Introduction to modules, importing modules, math module, random module,*
	SLO-2	*Ternary Operations, Increment Operations, Decrement Operations, Special Operators usage, Example Problems*	*Introduction to String Data, User defined string handling methods, String handling functions*	*structure padding, bit-fields, union, enumeration*	*conditional statements and loops*	*packages, composition*

S-4	SLO-1 SLO-2	*Lab 2:Implement codes expression evaluations and to understand operator's precedence and associativity.*	*Lab 5:Pointer indirection, Problem solving involving pointer references. Problem solving involving strings*	*Lab 8: Essential coding problems on display patterns*	*Lab 11: Problem solving on display patterns and series using python*	*Lab 14:Problem solving implementing math and random modules and packages using python*
S-5	SLO-1	*Control Structures, Branching, If statement, If-Else statement, Else-If Ladder, Nested If, Loops, While Statement, Nested while statement, do while statement, for statement, nested for statement,*	*Introduction to Modular Programming, Function Terminology, Inter Function communication, call-by-value and call-by-reference, passing an array, returning a pointer,*	*Structure member reference, structure member pointer reference, formation of links, example codes,*	*String Manipulation and lists Accessing strings, string operations, string slices, functions and methods,*	*Introduction to exceptions, exception handling, except clause,*
	SLO-2	*Switch-case statement, Branching Un-Conditional, goto statement, break statement, continue statement, return statement.*	*Dangling pointing & Memory leak, Global Vs. Local data space, Storage classes*	*Introduction to Linked lists, creating a linked list, Insertion, deletion, search traversal operations on linked lists.*	*Introduction to lists, accessing list, Working on Lists*	*try? finally clause, user defined exceptions*
S-6	SLO-1 SLO-2	*Lab 3:Programs include coding for Control structure evaluations and pattern display problems*	*Lab 6:Coding programs using functions*	*Lab 9: Essential Coding problems on linked lists*	*Lab 12:Problem solving on strings, matrix using python*	*Lab 15:Implementation of exception handling using python*

Learning Resources	*Guide to Competitive Programming: Learning and Improving Algorithms Through Contests, Antti Laaksonen - Springer; 1st ed. 2017* *Problem solving with C++ -9e- Walter Savitch – Pearson, 2018*	*Programming in Python 3, A complete introduction to Python language - 2e - Mark Summerfield – Addison-Wiley,2009*

Learning Assessment

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

CLA – 4 will be weekly Assignments

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Experts from Campus Corporate Connect		

B. Tech in Electronics and Communication 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	18ECC102J	Course Name	ELECTRONIC DEVICES	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18EES101J	Co-requisite Courses	Nil	Progressive Courses	18ECC201J, 18ECC202J, 18ECE203T, 18ECE303T, 18ECE321T, 18ECE322T

Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil

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

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning	Program Outcomes (PO)											(PSO)		
			1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design,	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	1 Professional Achievement	2 Project Management Techniques	3 Analyze & Research
CO-1 :	Explain the operation, characteristics, parameters and specifications of PN junction diode	2	3	-	-	-	-	-	-	-	-	-	-	2	-	-	-
CO-2 :	Executing relevant applications of PN junction diodes	3	-	3		-	-	-	-	-	-	-	-	2	-	-	-
CO-3 :	Extend the knowledge to functionality, characteristics and application of special semiconductor diodes	2	3	-	-	-	-	-	-	-	-	-	-	2	-	-	-
CO-4 :	Articulate the construction, operation, characteristics and parameters of Bipolar Junction transistor	3	3	-	-	-	-	-	-	-	-	-	-	2	-		-
CO-5	Demonstrating construction, operation, characteristics and parameters Field Effect Transistor as well as their application in amplification and switching.	3	3	-	-	-	-	-	-	-	-	-	-	2	-		-
CO-5 :	Create a circuit for specific design problem, construct a circuit and make functional measurements a and evaluate its characteristics performance using modern engineering tools such as PSPICE.	6	-	-	-	-	3	-	-	-	3	2	-	-	1	1	-

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

S 4-5	SLO-2	*Lab 1: PN Junction Diode Characteristics*				
S-6	SLO-1	*Calculate depletion width*	*Filters: Inductor & Capacitor Filters*	*Tunnel Diode*	*Current-Voltage characteristics of CC BJT configuration*	*Derive transconductance*
	SLO-2	*Calculate barrier potential*	*Problem solving*	*Tunnel Diode*	*Current-Voltage characteristics of CC BJT configuration*	*Problem solving*
S-7	SLO-1	*Derive diode current equation*	*Filters: LC & CLC Filters*	*Gunn Diode*	*BJT as an amplifier*	*CMOS FET*
	SLO-2	*Derive diode current equation*	*Problem solving*	*Gunn Diode*	*BJT as a switch*	*MOSFET as an amplifier*
S-8	SLO-1	*Effect of Capacitance in PN junction: Transition Capacitance*	*Diode Clippers*	*IMPATT Diode*	*BJT circuit models – h-parameter*	*MOSFET as a switch*
	SLO-2	*Diffusion Capacitance*	*Problem solving*	*IMPATT Diode*	*BJT circuit models – hybrid-π parameter*	*Problem solving*
S 9-10	SLO-1 SLO-2	*Lab 2: Zener diode characteristics*	*Lab 5: BJT Characteristics*	*Lab 8: MOSFET Characteristics*	*Lab 11: Photoconductive Cell, LED, and Solar Cell Characteristics*	*Lab-14: Model Examination*
S-11	SLO-1	*Energy band structure of PN Junction Diode*	*Diode Clampers*	*PIN Diode*	*BJT biasing circuits and stability analysis: Base bias and emitter bias*	*Biasing Circuits for MOSFET: Gate Bias*
	SLO-2	*Ideal diode and its current-voltage characteristics*	*Problem solving*	*PIN Photodiode*	*Problem solving*	*Problem Solving*
S-12	SLO-1	*Terminal characteristics & parameters*	*Voltage Multipliers*	*Avalanche photodiode*	*Voltage-divider bias*	*Self-bias*
	SLO-2	*Diode modeling*	*Zener diode: Characteristics, breakdown mechanisms*	*Laser diode*	*Problem solving*	*Problem Solving*
S-13	SLO-1	*DC load line and analysis*	*Zener resistances and temperature effects Zener diode as voltage regulator*	*Problem solving*	*Collector-feedback bias*	*Voltage-divider bias*
	SLO-2	*Problem solving*	*Problem solving*	*Problem solving*	*Problem solving*	*Problem Solving*
S 14-15	SLO-1 SLO-2	*Lab 3: Diode rectifier circuits*	*Lab 6: BJT Biasing Circuits*	*Lab 9: MOSFET Biasing Circuits*	*Lab 12: Simulation experiments using PSPICE*	*Lab 15: End-Semester Practical Examination*

Learning Resources

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	25%	10%	15%	10%	15%	10%	15%	5%	10%	10%
Level 2	Understand	25%	20%	25%	20%	20%	20%	20%	10%	30%	20%
Level 3	Apply		10%	10%	10%	15%	10%	15%	15%	10%	10%
Level 4	Analyze		10%		10%		10%		10%		10%
Level 5	Evaluate								5%		
Level 6	Create								5%		
	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 Code	18ECC103J	Course Name	DIGITAL ELECTRONIC PRINCIPLES	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Understand binary codes, digital arithmetic operations and able to simplify Boolean logic expressions			
CLR-2 :	Describe how basic TTL and CMOS gates operate at the component level			
CLR-3 :	Able to design simple combinational logics using basic gates and MSI circuits			
CLR-4 :	Familiarize with basic sequential logic components: flip-flops, registers, counters and their usage, and able to design and analyze sequential logic circuits and Finite State Machines.			
CLR-5 :	Know how to implement logic circuits using PLDs.			
CLR-6 :	Use modern engineering tools such as PSPICE / Logisim to carry out design experiments and gain experience with instruments and methods used by technicians and electronic engineers			

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 :	Simplify Boolean expressions; carry out arithmetic operations with binary numbers; apply parity method for error detection and correction.	1	90	75	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Explain the operational characteristics / properties of digital ICs; implement gates as well as other types of IC devices using two major IC technologies, TTL and CMOS.	1	80	70	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Identify eight basic types of fixed-function combinational logic functions and demonstrate how the devices / circuits can be used in building complete digital systems such as computers.	2,3	90	75	-	M	H	-	H	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Analyze and design Mealy and Moore models of sequential circuits using several types of flip-flops.	2,3	90	75	-	M	H	-	H	-	-	-	-	-	-	-	-	-	-
CLO-5 :	Implement multiple output combinational logic circuits using PLDs; Explain the operation of a CPLD and FPGA.	2	80	75	-	M	H	-	L	-	-	-	-	-	-	-	-	-	-
CLO-6 :	Solve specific design problem, which after completion will be verified using modern engineering tools such as PSPICE / Logisim	2	90	75	-	M	H	-	H	-	-	-	H	-	-	-	M	-	L

Duration (hour)		Binary Codes, Digital Arithmetic and Simplification of Boolean Functions	Logic Families	Combinational Systems	Sequential Systems	Memory and Programmable Logic
		15	15	15	15	15
S-1	SLO-1	Binary Codes, Digital Arithmetic and Simplification of Boolean Functions	Introduction	Binary arithmetic units	Flip-flop and Latch: SR latch,	RAM Memory decoding
	SLO-2	Error detecting codes	TTL Logic Family	Adder	JK flip-flop, T flip-flop, D flip-flop	ROM
S-2	SLO-1	Error correcting code	Totem-pole TTL	Design of Half adder	Master-slave RS flip-flop	Programmable Logic Devices (PLDs): Basic concepts
	SLO-2	Hamming Code	open-collector and tristate TTL	Design of Full adder	Master-slave JK flip-flop	PROM
S-3	SLO-1	Arithmetic number representation	Schottkey TTL, standard TTL characteristics	Subtractor	Registers & Counters	PROM as PLD
	SLO-2	Binary arithmetic	Metal Oxide Semiconductor logic families	Design subtractor using logic gates	Shift registers (SISO, SIPO, PISO, PIPO)	Programmable Array Logic (PAL)
S 4-5	SLO-1	LAB 1: Study of logic gates	LAB 4: Design and implement encoder and decoder using logic gates	LAB 7: Implement combinational logic functions using standard ICs	LAB 10: Design and implement Synchronous Counters	LAB 13: Construct combinational circuit using Logisim
	SLO-2					
S-6	SLO-1	Hexadecimal arithmetic	N-MOS	n-bit parallel adder & subtractor	Universal shift register	Programmable Array Logic (PAL)
	SLO-2	Hexadecimal arithmetic	P-MOS	look ahead carry generator	Counters: Asynchronous/Ripple counters	Programmable Logic Array (PLA)

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

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

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

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

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*1. Mr. Viswanathan B, SRMIST*
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
CLR-1 :	Know about requirements of signal and system analysis in communication.	Blooms level (1-6)
CLR-2 :	Understand the analysis of Periodic and Aperiodic Continuous time Signals using Fourier series and transforms	Level of Thinking (Bloom)
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 Outcomes (CO):	At the end of this course, learners will be able to:	Learning
CO-1 :	Explain the classifications of Signals and Systems	2
CO-2 :	Apply Fourier series and Fourier Transform techniques to Periodic and Aperiodic Continuous time Signals	3
CO-3 :	Describe the characteristics of Continuous time system through Laplace transform and Convolution integral.	3
CO-4 :	Estimate the characteristics of Discrete time signals and system through DTFT, Convolution sum	4
CO-5 :	Analyze the characteristics of Discrete time system using Z transform	4

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

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	40 %		20 %		20 %		30 %		20 %	
Level 2	Understand	60 %		20 %		20 %		40 %		20 %	
Level 3	Apply			60 %		40 %		30 %		40 %	
Level 4	Analyze					20 %				20 %	
Level 5	Evaluate										
Level 6	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers

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

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

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning
CLR-1 :	Gain knowledge on the basic concepts and insights of Electric field	Blooms Level (1-6)
CLR-2 :	Gain knowledge on the basic concepts and insights of Magnetic field and Emphasize the significance of Maxwell's equations.	
CLR-3 :	Understand the mechanism of Electromagnetic wave propagation in different medium.	
CLR-4 :	Acquire the fundamental knowledge on Transmission Line Theory.	
CLR-5 :	Acquire the knowledge on transmission line parameter calculation and impedance matching concepts.	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning
CO-1 :	Apply the concepts and knowledge to solve problems related to electric field.	3
CO-2 :	Analyze the concepts of Magnetic field and Maxwell's equations in the real world application.	4
CO-3 :	Demonstrate how electromagnetic waves are generated using Maxwell's equations and how waveguides are used to transfer electromagnetic energy.	3
CO-4 :	Discover the fundamentals of transmission line theory.	3
CO-5 :	Solve transmission line parameter and impedance matching through analytical and graphical methods.	3

	Program Outcomes (PO)												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
	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	Professional	Project Management Techniques	Analyze & Research
CO-1 :	2	3	-	-	-	-	-	-	-	-	-	-	-	-	1
CO-2 :	3	2	-	-	-	-	-	-	-	-	-	-	-	-	1
CO-3 :	2	3	-	-	-	-	-	-	-	-	-	1	-	-	3
CO-4 :	2	3	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-5 :	2	3	-	-	-	-	-	-	-	-	-	-	-	-	2

Duration (hour)		Electrostatics	Magnetostatics and Maxwells Equations	Electromagnetic Waves and Waveguides	Transmission Line Theory	Transmission Line Calculator and Impedance Matching
		9	9	9	9	9
S-1	SLO-1	Introduction	Energy density in electrostatic field	Introduction	Transmission line parameters	Introduction
	SLO-2	Rectangular co-ordinate	Problem discussion.	Waves in general	Transmission line parameters	Smith chart Introduction
S-2	SLO-1	Cylindrical & Spherical Co-ordinate	Biot savart law-Magnetic field intensity due to Infinite line charge	Plane wave in lossless dielectric	Transmission line equivalent circuit	Reflection coefficient, Standing wave ratio Input impedance calculation in smith chart
	SLO-2	Review of vector calculus	H- due finite and semi finite line charge	Plane wave in free space	Explanation	Practice problems.
S-3	SLO-1	Coulomb's Law and field intensity	Ampere's circuital law& application: Infinite line current	Plane wave in good conductor	Transmission line equation derivation	Single stub matching Introduction
	SLO-2	Problem based on coulomb's law	Infinite Sheet current	Problems based on plane waves in lossless, free space and good conductor	Problem discussion.	Procedure for single stub matching
S-4	SLO-1	Electric field due to continuous charge distribution-.Concept	Infinitely long coaxial Transmission line	Rectangular waveguide	Transmission line characteristics: lossless line	Problems solving in smith chart
	SLO-2	Derivation of E due Infinite Line charge	Problem based on ACL.	Rectangular waveguide-Problems	Distortionless line.	Problems solving in smith chart
S-5	SLO-1	Electric field due to sheet charge	Magnetic flux density	Transverse Electric (TE) mode	Input impedance derivation	Impedance matching using Quarter wave transformer
	SLO-2	Problem based on sheet charge	Problem based on magnetic field and flux.	Transverse Electric (TE) mode-problems	Problems for input impedance calculation.	Problems.
S-6	SLO-1	Electric field due to volume charge	Maxwell's equation for static field	Transverse Electric (TE) mode	Standing wave ratio	Single stub tuner
	SLO-2	Electric flux density	Faraday's law	Transverse Electric (TE) mode-Problems	Calculation of standing wave ratio.	Problem discussion
	SLO-1	Gauss law application-point charge	Transformer EMF	Wave propagation in guide	Reflection coefficient	Slotted Line (Impedance Measurement)

S-7	SLO-2	*Electric flux due infinite line charge*	*Motional EMF*	*Problem discussion*	*Problem discussion.*	*Problem discussion*
S-8	SLO-1	*Electric flux due sheet charge*	*Displacement current.*	*Power Transmission*	*Shorted line, open circuited line*	*Transmission Lines as circuit Elements*
	SLO-2	*Electric flux due coaxial cable*	*Maxwell's equation in time varying field*	*Calculation of Pavg and Ptotal*	*Matched line*	*Problem discussion*
S-9	SLO-1	*Relation between E&V*	*Time varying potential concepts*	*Power attenuation*	*Power calculations*	*Additional smith chart problem solving.*
	SLO-2	*Electric dipole and flux lines*	*Time varying potential derivation.*	*Calculation of αTE and αTE*	*Problem discussion.*	*Additional smith chart problem solving.*

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20 %*	-	*20 %*	-	*20 %*	-	*20 %*	-	*20 %*	-
Level 2	Understand	20 %	-	20 %	-	20 %	-	20 %	-	20 %	-
Level 3	Apply	*60 %*	-	*40 %*	-	*60 %*	-	*60 %*	-	*50 %*	-
Level 4	Analyze	-	-	20 %	-		-		-	*10 %*	-
Level 5	Evaluate	-	-		-		-		-		-
Level 6	Create	-	-		-		-		-		-
	Total	100%		100%		100 %		100 %		100 %	

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

Course Designers

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

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

Pre-requisite Courses	18ECC102J / 18ECC211J	Co-requisite Courses	18ECC201J	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning (Level of Thinking (Bloom))
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 Outcomes (CO):	*At the end of this course, learners will be able to:*	Learning (Level of Thinking (Bloom))	Program Outcomes (PO) 1	2	3	4	5	6	7	8	9	10	11	12	Program Specific Outcomes (PSO) 1	2	3
			Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design,	Modern Tool Usage	Society & Culture	Environment &	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CO-1 :	Analyze the DC and AC characteristics of operational amplifiers and its effect on output and their compensation techniques	4	3	2	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-2 :	Demonstrate the linear and non-linear applications of an opamp and special application ICs	4	-	2	3	-	-	-	-	-	-	-	-	-	-	-	2
CO-3 :	Illustrate the working of multivibrators using special application IC 555 and general purpose opamp	4	-	2	3	-	-	-	-	-	-	-	-	-	1	-	-
CO-4 :	Describe the working principle of data converters and active filters	6	-	2	3	-	-	-	-	-	-	-	-	-	2	-	-
CO-5 :	Summarize the function of application specific ICs such as Voltage regulators, PLL and its application in communication	6	-	2	3	-	-	-	-	-	-	-	-	-	-	-	3

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Op-amp symbol, terminals, packages	Basic op-amp circuits: Inverting & Non-inverting voltage amplifiers	Waveform Generators: Sine-wave Generators - Design	Filters: Comparison between Passive and Active Networks	Digital to Analog Conversion: DAC Specifications
	SLO-2	Op-amp-Specifications	Voltage follower	Implementation & Solving problems	Active Network Design	Solving problems
S-2	SLO-1	Block diagram Representation of op-amp	Summing, scaling & averaging amplifiers,	Square Wave generators- Design	Filter Approximations	Weighted Resistor DAC
	SLO-2	Ideal op-amp & practical op-amp - Open loop & closed loop configurations	AC amplifiers	Implementation & Solving problems	Design of LPF & Solving problems	Solving problems
S-3	SLO-1	DC performance characteristics of op-amp	Linear Applications: Instrumentation Amplifiers	Triangle wave generators	Design of HPF & Solving problems	R-2R Ladder DAC
	SLO-2	Solving Problems	Instrumentation Amplifiers, Solving Problems	Saw-tooth Wave generators.	Design of BPF& Solving problems	Solving problems
S 4-5	SLO-1	Lab-1:Basic op-amp circuits	Lab 4: Comparators	Lab 7: Waveform generators: using op-amp & 555 Timer	Lab 10: Design of LPF, HPF, BPF and Band Reject Filters	Lab 13: Flash Type ADC
	SLO-2					
S-6	SLO-1	AC performance characteristics of op-amp	V-to-I Converters	IC 555 Timer: Circuit schematic	Design of Band Reject Filters	Inverted R-2R Ladder DAC
	SLO-2	Solving Problems	I-to-V converters	Operation and its applications	Solving problems	Monolithic DAC
S-7	SLO-1	Frequency response	Differentiators	IC 555 Timer: Monostable operation	State Variable Filters – All Pass Filters,	Analog to Digital conversion: ADC specifications
	SLO-2	Frequency response	Integrators	Applications & Solving problems	Solving problems	Solving problems
S-8	SLO-1	Frequency compensation	Non-linear Applications: Precision Rectifiers	IC 555 Timer: Astable operation	Switched Capacitor Filters.	Ramp Type ADC
	SLO-2	Frequency compensation	Wave Shaping Circuits (Clipper and Clampers)	Applications & Solving problems	Solving problems	Solving problems

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

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

Learning Assessment										
Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
	CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Remember	15%	15%	15%	15%	5%	5%	10%	5%	5%	5%
Understand	15%	15%	15%	15%	5%	5%	10%	5%	10%	10%
Apply	10%	10%	10%	10%	10%	10%	10%	10%	15%	15%
Analyze	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Evaluate					10%	10%	5%	10%	5%	5%
Create					10%	10%	5%	10%	5%	5%
Total	100 %		100 %		100 %		100 %		100 %	

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

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

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

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

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

Course Outcomes (CO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)
CO-1 :	Apply a basic concept of digital fundamentals to Microprocessor based personal computer system	3
CO-2 :	Demonstrate programming proficiency using the various addressing modes of the 8086 microprocessor	3
CO-3 :	Develop interfacing techniques using various peripheral chips with microprocessor	4
CO-4 :	Evaluate programming proficiency using the various addressing modes of the 8051 microcontroller	4
CO-5 :	Construct a system to interface various peripheral chips with microcontroller	3
CO-6 :	Implement the practical knowledge through laboratory experiments using microprocessor and microcontroller	6

	Program Outcomes (PO)												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
	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 &
CO-1 :	3	3	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-2 :	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-3 :	3	-	-	3	-	-	-	-	-	-	-	-	-	-	3
CO-4 :	3	-	-	2	-	-	-	-	-	-	-	-	-	2	-
CO-5 :	3	2	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-6 :	-	-	3	-	2	-	-	-	-	-	-	-	-	-	3

		Learning Unit / Module 1: Intel 8086 – Architecture, Signals and Features	Learning Unit / Module 2: Programming with Intel 8086	Learning Unit / Module 3: 8086 Interfacing with Memory and Programmable Devices	Learning Unit / Module 4: Intel 8051 – Architecture and Programming	Learning Unit / Module 5: Interfacing of 8051
Duration (hour)		15	15	15	15	15
S-1	SLO-1	Introduction: History of computers, Block diagram of a microcomputer	Addressing modes of 8086	Semiconductor memory interfacing	Introduction: Differences between microprocessor and microcontroller	8051 parallel ports, and
	SLO-2	Intel 80x86 evolutions		Dynamic RAM interfacing	Intel's family of 8-bit microcontrollers, and feature of 8051 microcontroller	its programming
S-2	SLO-1	Features of 8086 microprocessor	Instruction Set of 8086: Data Transfer Instructions	Programmable Peripheral Interface 8255	Architecture of 8051	8051 timers, and
	SLO-2	Register organization of 8086	Example programs	Interfacing 8255 with 8086 and programming	Architecture of 8051	its programming
S-3	SLO-1	Architecture of 8086	Data Conversion Instructions, Arithmetic Instructions	Interfacing ADC with 8086 and programming	Signal descriptions of 8051	8051 interrupts, and
	SLO-2	Architecture of 8086	Example programs	Interfacing DAC with 8086 and programming	Signal descriptions of 8051	its programming
S	SLO-1					

4-5	SLO-2	Lab-1: (a) Learning to Program with 8086 processor kit; Learning the hardware features of the 8086 processor kit	Lab-4: General Purpose Programming in 8086	Lab-7: Interfacing DAC / ADC with 8086 / 8051	Lab-10: Programming timer / counter in 8086 / 8051	Lab-13: Simulation of 8051 using Keil Software
S-6	SLO-1	Instruction queue and pipelining	Logical instructions and Processor control instructions	Stepper Motor interfacing – concept	Register set of 8051	8051 serial port, and
	SLO-2	Segmentation of memory used with 8086	Example programs	Example programs	Operational features of 8051	its programming
S-7	SLO-1	Methods of generating physical address in 8086	String instructions	Programmable Interval Timer 8254	Memory and I/O addressing by 8051	Interfacing program memory with 8086
	SLO-2	Pin signals of 8086: Common signals	Example programs	Interfacing 8254 with 8086 and programming	Interrupts and Stack of 8051	Interfacing data memory with 8086
S-8	SLO-1	Minimum mode signals	Branch Instructions	Programmable Interrupt Controller 8259	Addressing modes of 8051	Interfacing input devices: push-button / matrix keypad
	SLO-2	Maximum mode signals	Example programs	Interfacing 8259 with 8086 and programming	Example programs	Example programs
S 9-10	SLO-1	Lab-2: General Purpose Programing in 8086	Lab-5: Simulation of 8086 using MASM Software / 8086 Emulator	Lab-8: Interfacing DC motor / stepper motor / servo motor with 8086 / 8051	Lab-11: Programming interrupts in 8086 / 8051	Lab-14: Model Practical Exam
	SLO-2					
S-11	SLO-1	Minimum mode 8086 system, and	Assembly Language Programming of 8086	Programmable Keyboard / Display Controller 8279	8051 Instruction Set: Arithmetic and Logical Instructions	Interfacing display devices: LED / 7-segment / LCD displays
	SLO-2	Timings	Assembly Language Programming of 8086	Interfacing 8279 with 8086 and programming	Example Programs	Example programs
S-12	SLO-1	Maximum mode 8086 system, and	Stack structure, and	Programmable Communication Interface 8251 USART	Data Transfer Instructions	Interfacing DAC
	SLO-2	Timings	related programming	Interfacing 8251 with 8086 and programming	Example Programs	Interfacing ADC
S-13	SLO-1	Intel 8088 Microprocessor: Pins signals and Architecture	Interrupt structure, and	DMA Controller 8257	Boolean Variable Instructions and Branch Instructions	Interfacing DC motor / stepper motor / servo motor
	SLO-2	Differences between 8086 & 8088 microprocessors	related programming	Interfacing 8257 with 8086 and programming	Example Programs	Example programs
S 14-15	SLO-1	Lab-3: General Purpose Programing in 8086	Lab-6: Interfacing 8255 with 8086 / 8051	Lab-9: General Purpose Programming in 8051	Lab-10: Programming serial communication in 8086 / 8051	Lab-15: End-Semester Exam
	SLO-2					

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

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	30%	15%	15%	15%	15%	15%	15%	15%	15%
Level 2	Understand										
Level 3	Apply	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 4	Analyze										
Level 5	Evaluate			15%	15%	15%	15%	15%	15%	15%	15%
Level 6	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

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

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Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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Course Code	18ECC204J	Course Name	DIGITAL SIGNAL PROCESSING	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

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

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

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning Level of Thinking (Bloom)	Program Outcomes (PO) 1	2	3	4	5	6	7	8	9	10	11	12	Program Specific Outcome (PSO) 1	2	3
			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	Professional Achievement	Project Management Techniques	Analyze & Research
CO-1 :	Summarize the concepts of A//D and D/A converters.	2	3	-	-	`1	-	-	-	-	-	-	-	-	-	-	2
CO-2 :	Explain the concepts of DFT with its efficient computation by using FFT algorithm.	4	-	2	-	-	-	-	-	-	-	-	-	-	-	1	
CO-3 :	Develop FIR filters using several methods	3	-	2	3	-	-	-	-	-	-	-	-	-	-	-	3
CO-4 :	Construct IIR filters using several methods	3	-		3	-	-	-	-	-	-	-	-	-	-	-	3
CO-5 :	Discuss the basics of multirate DSP and its applications.	5	-	2	-	-	-	-	-	-	-	-	-	-	-	1	-
CO-6 :	Design digital filter and multi rate signal processing for real time signals	6	-	2	-	-	-	-	-	-	-	-	-	-	2	-	-

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

S-5	*SLO-1*	***Lab 2: Unit step, ramp and impulse***	***Lab 8: Circular convolution***	***Lab14: Design of digital FIR Band Pass and Band Stop filter using rectangular window***	***Lab 20: Design of analog Chebyshev filter***	***Lab 26: Effect of interpolation in frequency domain***
	SLO-2					
S-6	*SLO-1*	*Sampling of analog signals Sampling theorem*	*Circular convolution*	*Frequency response of antisymmetric FIR filter*	*Analog IIR filter design*	*Polyphase structure of decimator* *Polyphase decimation using z transform*
	SLO-2	*Aliasing Quantization of continuous amplitude signals*	*Matrix method and concentric circle method*	*N is odd and N is even*	*Design of low pass Chebyshev filter*	*Polyphase structure of interpolator* *Polyphase interpolation using z transform*
S-7	*SLO-1*	*Analog to digital conversion Sample and hold,*	*Efficient Computation of the DFT*	*Design of FIR filters Fourier series method*	*Design of digital filters Impulse invariance method*	*Advantages of multirate DSP*
	SLO-2	*Quantization and coding*	*Divide and Conquer Approach to Computation of the DFT Using FFT*	*Need for filter design using window* *Comparison of various windowing techniques*	*Design of digital filters Bilinear transformation*	*Applications of multirate DSP*
S-8	*SLO-1*	*Oversampling A/D converters*	*N Point DFT Decimation-in-Time FFT Radix-2 FFT Algorithm*	*Filter Design using windowing technique*	*Design of digital filters Impulse invariance method*	*Practical Applications of multirate DSP*
	SLO-2	*Digital to analog conversion Sample and hold*	*N Point DFT Decimation-in-Frequency FFT*	*Rectangular window*	*Design of digital filters Bilinear transformation*	*interfacing of digital systems with different sampling rates*
S-9	*SLO-1*	*Lab 3: Generation of waveforms*	*Lab9: Autocorrelation and cross correlation*	*Lab 15: Design of digital FIR Low Pass and High Pass filter using Hanning and Hamming window*	*Lab 21: Design of digital Butterworth filter using impulse invariance method*	*Lab 27: Decimation*
	SLO-2					
S-10	*SLO-1*	***Lab 4: Continuous and discrete time***	***Lab10: Spectrum analysis using DFT***	***Lab 16: Design of digital FIR Band Pass and Band Stop filter using Hanning and Hamming window***	***Lab 22: Design of digital Butterworth filter using bilinear transformation***	***Lab 28: Effect of decimation in frequency domain***
	SLO-2					
S-11	*SLO-1*	*Oversampling D/A converters*	*Radix-2 FFT Algorithm* *Implementation of FFT Using DIT*	*Filter Design using windowing technique Hanning window*	*Design of digital Chebyshev filters*	*Practical Applications of multirate DSP* *Sub band coding of speech signals*
	SLO-2	*Quantization noise*	*Implementation of FFT Using DIF*	*Filter Design using windowing technique Hamming window*	*Impulse invariance method*	*Filter banks* *Analysis filter bank*
S-12	*SLO-1*	*Errors due to truncation*	*IDFT*	*Filter Design using windowing technique*	*Design of digital Chebyshev filters*	*Synthesis filter bank*
	SLO-2	*Probability of error*	*Using DIT FFT*	*Blackmann window*	*Bilinear transformation*	*Subband coding filterbank*
S-13	*SLO-1*	*Errors due to rounding*	*IDFT*	*Design of FIR filters*	*Frequency transformation in analog domain*	*Quadrature Mirror Filter*
	SLO-2	*Probability of error*	*Using DIF FFT*	*Frequency sampling method*	*Frequency transformation in digital domain*	*Alias free filter bank*
S-14	*SLO-1*	***Lab 5: Study of sampling theorem***	***Lab 11: Efficient computation of DFT using FFT***	***Lab 17: Design of digital FIR Low Pass, High Pass, Band pass and band stop filter using Blackmann window***	***Lab 23: Design of digital Chebyshev filter using impulse invariance method***	***Lab 29: Design of anti-aliasing filter***
	SLO-2					
S-15	*SLO-1*	***Lab 6: Aliasing effects***	***Lab12: Computation of IDFT***	***Lab 18: Design of digital FIR filter using frequency sampling method***	***Lab 24: Design of digital Chebyshev filter using bilinear transformation***	***Lab 30: Design of anti-imaging filter***
	SLO-2					

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

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	20%	*5 %*	*5 %*	*5 %*	*5 %*	*5 %*	*5 %*	*5 %*	*5 %*
Level 2	Understand	30%	30%	10%	5%	10%	5%	10%	5%	10%	5%
Level 3	Apply			*20%*	*15%*	*20%*	*15%*	*15%*	*10%*	*15%*	*15%*
Level 4	Analyze			15%	20%	10%	15%	10%	15%	10%	15%
Level 5	Evaluate				-	*5 %*	*10%*	*5 %*	*10 %*	*10 %*	*10 %*
Level 6	Create							*5 %*	*5 %*	-	-
	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. M.S. Vasanthi,,SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Course Outcomes (CO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Program Outcomes (PO) 1	2	3	4	5	6	7	8	9	10	11	12	Program Specific Outcomes(PSO) 1	2	3
			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
CO-1 :	Design and implement the digital circuits using Verilog HDL	6	-	3	3	-	3	-	-	-	-	-	-	-	2	-	-
CO-2 :	Analyze the area and delay of data processing elements of CMOS subsystem design.	4	-	3	3	-	3	-	-	-	-	-	-	-	2	-	-
CO-3 :	Examine the characteristics of MOS transistors	4	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-4 :	Evaluate switching threshold of CMOS inverter and comparative analysis of different CMOS logic styles	4	-	2	2	-	-	-	-	-	-	-	-	-	2	-	-
CO-5 :	Explain CMOS manufacturing process, and numerous circuit styles to implement a given logic functions.	3	-	1	1	-	-	-	-	-	-	-	-	-	2	-	-
CO-6 :	Demonstrate HSPICE computer analysis program and Verilog HDL for simulation and analysis of MOS circuits and building blocks	6	-	2	3	-	3	-	-	-							2

Duration (hour)		Learning Unit / Module 1: Introduction to Verilog HDL & Coding	Learning Unit / Module 2: Subsystem Design	Learning Unit / Module 3: MOS Transistor	Learning Unit / Module 4: CMOS Inverter and Circuit Design Styles	Learning Unit / Module 5:
		15	15	15	15	15
S-1	SLO-1	Introduction to HDL & Verilog HDL	General VLSI System Components: Multiplexers	Generic overview of the MOS device: MOS transistor symbols	CMOS Inverter Characteristics: **Operation and properties of static CMOS inverter**	Properties of basic materials used in microelectronics: Silicon, Silicon dioxide
	SLO-2	Introduction to Verilog HDL, modules and ports	Decoders	MOS structure demonstrating (a) accumulation, (b) depletion, and (c) inversion; nMOS transistor demonstrating cutoff, linear, and saturation regions of operation	VTC of static CMOS inverter	Polysilicon and Silicon Nitride
S-2	SLO-1	Lexical Conventions: White Space and Comments, Operators	Comparators	MOS Transistor under Static Conditions: The threshold voltage	DC Inverter Calculations	Basic Processes in Integrated-Circuit Fabrication: Wafer Formation, Photolithography, Well and Channel Formation
	SLO-2	Numbers, Strings, Identifiers, System Names, and Keywords	priority encoder	Resistive operation	Symmetrical Inverter	Silicon Dioxide (SiO_2), Isolation, Gate Oxide

S-3	**SLO-1**	Verilog Data Types: Nets, Register Variables, Constants	shift and rotate operations	Saturation region	Inverter switching characteristics	Gate and Source/Drain Formations, Contacts and Metallization, Passivation, Metrology
	SLO-2	Referencing Arrays of Nets or Regs	Adders: Standard adder cells	Current-voltage characteristics	Output capacitance	Some Recurring Process Steps: Diffusion and Ion Implantation, Deposition, Etching, Planarization
S-4, 5	**SLO-1** **SLO-2**	Lab-0: Verilog Operators: Arithmetic Operators, Bitwise Operators, Reduction Operators, Logical Operators, Relational Operators, Shift Operators, Conditional Operator, Concatenation Operator, Expressions and Operands, Operator Precedence	Lab-3: Design using FSM and ASM charts	Lab-6: Realization of VLSI multipliers - I	Lab-9: Design and Analysis of CMOS Inverter using HSPICE	Lab-12: Design and Analysis of 4-input Dynamic NAND gate using HSPICE
S-6	**SLO-1**	Verilog modelling: Gate-level modelling	Ripple Carry Adder (RCA)	Dynamic behavior: MOSFET Capacitances, viz., MOS structure capacitances	Secondary Parasitic Effects: Leakage Currents, Parasitic Resistances	Simplified CMOS Process flow
	SLO-2	Realization of Combinational and sequential circuits	Carry Look-Ahead Adder (CLA)	Channel capacitance and Junction (or, depletion) capacitances	Inverter layout	
S-7	**SLO-1**	Compilation and simulation of Verilog code	Carry Select Adder (CSL)	Parasitic Resistances, viz., Drain and Source Resistance, Contact Resistance	Power-Delay Product: Static Power Consumption	Layout design rules: Well rules, transistor rules
	SLO-2	Test bench	Carry Save Adder (CSA)	Non-ideal I-V effects: Mobility Degradation, Velocity Saturation	Dynamic Power Consumption, Total Power Consumption, PDP	Contact rules, metal rules, via rules and other rules
S-8	**SLO-1**	Dataflow modelling	Carry Skip Adder (CSK)	Channel Length Modulation, Threshold Voltage Effects	CMOS Circuit Design Styles: Static CMOS logic styles	Gate Layouts
	SLO-2	Realization of Combinational and sequential circuits	Carry Bypass Adder (CBA)	Leakage, Temperature Dependence, Geometry Dependence, Subthreshold Current	CMOS circuits, pseudo-nMOS, tristate circuits, clocked CMOS circuits	Stick diagrams
S-9, 10	**SLO-1** **SLO-2**	Lab-1: Realization of combinational and sequential circuits using gate-level and dataflow modeling	Lab-4: Realization of VLSI adders - I	Lab-7: Realization of VLSI multipliers - II	Lab-10: (a) Design and Analysis of complex CMOS gate using HSPICE (b) Design and Analysis of Pseudo-NMOS gates using HSPICE	Lab-13: Model Practical Examination
S-11	SLO-1	Behavioral modelling	Multipliers: Overview of multiplication (unsigned multiplication, shift/add multiplication algorithms, multiplication of signed numbers, types of multiplier architectures)	Short-channel MOSFETS: Hot carriers, Lightly-Doped Drain (LDD)	Differential Cascade Voltage Switch Logic (DCVSL), Pass Transistor Logic (PTL)	CMOS Process Enhancements: Transistors (Multiple Threshold Voltages and Oxide Thicknesses, Silicon-on-Insulator, High-k Gate Dielectrics, Higher Mobility, Plastic Transistors,)
	SLO-2	Realization of Combinational and sequential circuits	Braun multiplier	MOSFET scaling	Dynamic CMOS logic styles: Basic dynamic logic	
S-12	SLO-1	Switch-level modelling	Baugh-Wooley multiplier	Short-channel effects: Negative Bias Temperature Instability (NBTI), oxide breakdown	Signal integrity issues in dynamic design	Interconnects
	SLO-2	Realization of MoS circuits	Wallace Tree multiplier	Drain-Induced Barrier Lowering (DIBL), Gate-Induced Drain Leakage (GIDL), Gate Tunnel Current	Signal integrity issues in dynamic design	Circuit elements

S-13	*SLO-1*	*Design using FSM*	*Booth multiplier*	*Tutorials*	***Domino Logic Circuits:** Differential Domino logic, multiple-output domino*	*Beyond conventional CMOS*
	SLO-2	***Realization of sequential circuits***	*Booth multiplier*	*Tutorials*	*Compound domino, NORA, TSPC*	***Tutorials***
S-14, 15	*SLO-1*	*Lab-2: (a) Realization of digital circuits using behavioral modeling*	***Lab-5: Realization of VLSI adders - II***	*Lab-8: Realization of RAM & ROM*	***Lab-11:** (a) Design and Analysis of AND/NAND gate in DCVSL using SPICE*	*Lab-14: End-Semester Practical Examination*
	SLO-2	*(b) Realization of MOS circuits using switch-level mdeling*			*(b) Design and Analysis of Pass-Transistor gates and CPL gates using HSPICE*	

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	5%	5%	5%	10%	5%	5%	5%	5%	5%	5%
Level 2	Understand	20%	20%	20%	20%	10%	10%	10%	10%	10%	10%
Level 3	Apply	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
Level 4	Analyze	5%	5%	10%	5%	10%	10%	10%	10%	10%	10%
Level 5	Evaluate					3%	3%	5%	5%	3%	3%
Level 6	Create					2%	2%	5%	5%%	2%	2%
	Total	100 %		100 %		100 %		100 %		100 %	

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

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning
CLR-1 :	Identify the elements of wireless communication and mobile communications	Blooms level (1-6)
CLR-2 :	Perceive the significance of Mobile Radio Wave Propagation - Large Scale Fading	
CLR-3 :	Analyze small scall fading in Radio Wave Propagation	
CLR-4 :	Investigate the Capacity and Diversity concepts in wireless communications	
CLR-5 :	Apply the knowledge of Wireless System and Standards	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)
CO-1 :	Interpret the concepts of Wireless communication and basic cellular networks	4
CO-2 :	Analyze different Radio wave propagation models for cellular communication	4
CO-3 :	Apply different multipath propagation channel models in wireless systems	3
CO-4 :	Illustrate the Link performance improvement techniques	3
CO-5 :	Summarize different wireless communication standards and systems	2

Program Outcomes (PO)												Program Specific Outcomes(PSO)		
1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
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	Professional Achievement	Project Management Techniques	Analyze & Research
3	-	-	3	-	-	-	-	-	-	-	2	-	-	-
-	3	-	3	-	-	-	-	-	-	-	-	-	-	3
-	3	3	-	-	-	-	-	-	-	-	-	-	-	2
-	3	-	-	-	-	2	-	-	-	-	-	-	-	3
-	-	2	-	-	2	-	-	-	-	-		2	-	-

Duration (hour)		Wireless communication: Mobile communications	Large Scale Fading	Small Scale Fading	Improvement on Link performance	Wireless systems and standards
		12	12	12	12	12
S-1	SLO-1	Introduction to wireless communication and mobile radio communication	Introduction to Radio wave Propagation	Introduction Small scale multipath propagation	Introduction to diversity, equalization and capacity	AMPS Voice modulation Process
	SLO-2	**Classification of wireless communications - simplex, half duplex, dull duplex**	Large scale and small scale fading	Impulse response model of multipath channel		
S-2	SLO-1	**Paging and Cordless systems**	Friis transmission equation- Free space propagation model - pathloss model	Impulse response model of multipath channel	Space diversity	GSM system architecture and its interfaces
	SLO-2	**Cellular telephone systems**		Small scale multipath measurements - Direct Pulse measurement	Scanning diversity	
S-3	SLO-1	**Timing diagram - landline to mobile**	Two Ray model	Small scale multipath measurements - Sliding correlator measurement	Maximal ratio combiner	GSM frame structure
	SLO-2	**Timing diagram - mobile to mobile**		Small scale multipath measurements - Swept frequency measurement	Equal gain diversity	
S-4	SLO-1	**Basic antenna parameters, Far field and near field**	Simplified pathloss model	Parameters of mobile multipath channels - Time dispersion and Coherent bandwidth	Rake Receiver	GSM speech operations input - output

	SLO-2	Frequency reuse, sectored and omni-directional antennas	Emperical model - Okumara			
S-5	**SLO-1**	Channel assignment strategies	Emperical model - Hata model	Parameters of mobile multipath channels - Doppler spread and Coherent time	Capacity in AWGN	Forward CDMA process
	SLO-2	Handoff and its types	Emperical model - Walfish and bertoni model			
S-6	**SLO-1**	Interference and system capacity	**Piecewise linear model - log normal model**	Types of fading: Flat and Frequency selective fading	Capacity of flat fading channels	**Reverse CDMA Process**
	SLO-2					
S-7	**SLO-1**	Trunking and Grade of Service	**Shadowing**	Types of fading: Flat and Frequency selective fading	Equalizer and its mode	Multicarrier modulation
	SLO-2		**Combined pathloss and shadowing**			
S-8	**SLO-1**	**Cell splitting**	**Outage Probabilty**	Types of fading: Fast and Slow fading	Adaptive equalizer block diagram	OFDM Transmitter Block diagram
	SLO-2					
S-9	**SLO-1**	**Sectoring**	**Cell Coverage Area**	Types of fading: Fast and Slow fading	Types of Equalizers - elementary level only	OFDM Receiver Block diagram
	SLO-2					
S-10	**SLO-1**	Microcell zone concepts	*Solving problems – Brewster angle*	**Ricean distribution**	Introduction to MIMO antennas	**Importance of Cyclic Prefix**
	SLO-2					
S-11	**SLO-1**	*Umbrella cells*	*Solving problems –empirical model*	Rayleigh distribution	Introduction to MIMO antennas	Case study - Modern antennas
	SLO-2					
S-12	**SLO-1**	*Solving Problems*	*Solving problems – friis transmission formula*	*Solving problems – Doppler effect*	*Case study :Recent trends in Diversity and MIMO antennas*	Case study - Modern antennas
	SLO-2					

Learning Resources

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	30 %	-	-	-	20%	-
Level 2	Understand	25 %	-	25 %	-	40 %	-	-	-	25 %	-
Level 3	Apply	35 %	-	35 %	-	30 %	-	50%	-	35 %	-
Level 4	Analyze	20 %	-	20 %	-	-	-	50%	-	20 %	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers

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

Course Code	18ECC302J	Course Name	Microwave & Optical Communications	Course Category	C	*Professional Core*	L	T	P	C
							3	0	2	4

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

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

Course Outcomes (CO):	*At the end of this course, learners will be able to:*		**Program Outcomes (PO)**												**PSO**		
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
			Engineering	Problem Analysis	Design &	Analysis, Design,	Modern Tool	Society & Culture	Environment &	Ethics	Individual & Team	Communication	Project Mgt. &	Life Long Learning	PSO–1: Professional	PSO – 2: Project Management	PSO – 3: Analyze & Research
CO-1 :	Demonstrate the knowledge on the theory of microwave transmission, microwave generators and associated components.	*4*	*3*	-	-	*3*	-	-	-	-	-	-	-	-	-	-	*1*
CO-2 :	Analyse the microwave passive devices and components.	*4*	-	*2*	-	*3*	-	-	-	-	-	-	-	-	*2*	-	-
CO-3 :	Incorporate microwave measurements and associated techniques with equipment	*6*	-	-	*3*	*2*	-	-	-	-	-	-	-	-	-	-	*3*
CO-4 :	Gain knowledge of the fundamentals on light transmission through fiber	*4*	-	*3*	-	*2*	-	-	-	-	-	-	-	-	-	-	*1*
CO-5 :	Develop a basic optical communication system.	*6*	-	*3*	-	-	*3*	-	-	-	-	-	-	-	*2*	-	-
CLO-6:	Implement the working principle of microwave components , Microwave measurements, optical sources, detector and fibers	*6*	-	-	*3*	-	*3*	-	-	-	-	-	-	-	-	-	*3*

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

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

Learning Resources

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Level 2	Understand	20%	20%	10%	10%	10%	10%	10%	10%	15%	15%
Level 3	Apply	20%	20%	15%	15%	15%	15%	15%	15%	20%	20%
Level 4	Analyze	5%	5%	10%	10%	10%	10%	10%	10%	10%	10%
Level 5	Evaluate			10%	10%	10%	10%	5%	5%		
Level 6	Create							5%	5%		
	Total	100 %		100 %		100 %		100 %		100 %	

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

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Course Code	18ECC303J	Course Name	Computer Communication Networks	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

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

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

Course Outcomes (CO):	At the end of this course, learners will be able to:	Bloom's level (1-6)	Program Outcomes (PO) 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	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze &
CO-1:	Express the basic services and concepts related to internetworking.	2	-	-	-	-	-	-	3	-	-	-	-	2	-	-	-
CO-2:	Define the basic OSI model architecture and its lower layer functions.	2	-	-	2	-	-	-	1	-	-	-	-	-	-	-	3
CO-3:	Apply the various Network Layer concepts, mechanisms and protocols.	3	-	-	3	-	-	1	2	-	-	-	-	-	-	-	-
CO-4:	Analyze the services and techniques of Transport Layer.	4	-	-	-	-	-	-	2	-	-	-	-	-	-	-	3
CO-5:	Produce the various services and protocols in Application Layer.	2	-	-	2	-	-	-	-	-	-	-	-	-	-	-	3
CO-6:	Evaluate the various Networking concepts and Routing protocols.	5	-	-	-	-	1	-	-	-	-	-	-	2	-	-	3

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

	SLO-2	Switching Types- Message switching, Comparison of switching types	Error Correction	***Internet Protocol(IP)-IPV4***	***TCP Services & Features***	***Compression Techniques***
S-7	**SLO-1**	LAN, MAN & WAN	Data link control-LLC	***Internet Protocol(IP)-IPV6***	***Congestion Control***	***Introduction to Cryptography***
	SLO-2	LAN, MAN & WAN	Data link control-LLC	***Internet Protocol(IP)-IPV6***	***Congestion Control***	***Types, Attacks and Services***
S-8	**SLO-1**	Network topologies-Types	Data link control-MAC	***Routing Protocols- Distance Vector& Link State***	***Congestion Control***	***DES***
	SLO-2	**Comparison of topologies**	Data link control-MAC	*Routing Issues-Delivery, Forwarding and Routing*	***Congestion Control***	***DES***
S 9-10	**SLO-1**	**Lab 2: *To simulate star and bus network topologies.***	**Lab 5: Implementation of Error detection and Correction scheme.**	***Lab 8: Implementation and study of stop and wait protocols***	***Lab 11: To configure a network using Link State Routing protocol .***	***Lab 14: Implementation of Data Encryption and Decryption.***
	SLO-2					
S-11	**SLO-1**	*IEEE standards for LAN-Ethernet*	*Flow & Error Control Protocol*	**Routing Information Protocol-RIP**	*QOS-Quality of Service*	*RSA*
	SLO-2	*Types of Ethernet*	*Flow & Error Control Protocol*	**Routing Information Protocol-RIP**	*QOS-Quality of Service*	*RSA*
S-12	**SLO-1**	*Token Bus*	*ARQ Schemes*	*Open Shortest Path First-OSPF*	*Techniques to improve QOS*	*Email*
	SLO-2	*Token Ring*	*ARQ Schemes*	*Open Shortest Path First-OSPF*	*Techniques to improve QOS*	FTP
S-13	**SLO-1**	*FDDI*	*HDLC*	*Border Gateway Protocol-BGP*	*Techniques to improve QOS*	*HTTP*
	SLO-2	*FDDI*	*HDLC*	*Border Gateway Protocol-BGP*	*Techniques to improve QOS*	*SNMP*
S 14-15	**SLO-1**	***Lab 3: To simulate token bus protocol and to study its performance.***	**Lab 6:To simulate CSMA/CD protocol and to study its performance**	***Lab 9: Implementation and study of Go back N protocol.***	***Lab 12: To configure a network using Distance Vector Routing protocol.***	***Lab 15: Mini Project***
	SLO-2					

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	25%	25%					5%	5%	5%	5%
Level 2	Understand	25%	25%	25%	25%	5%	5%	5%	5%	15%	10%
Level 3	Apply			25%	25%	10%	10%	10%	10%	10%	20%
Level 4	Analyze					15%	15%	5%		15%	10%
Level 5	Evaluate					20%	20%		5%	5%	5%
Level 6	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers

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

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

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1 :	*Acquire skills to solve real world problems in Analog and Digital Electronics (Discrete & IC)*	1
CLR-2 :	*Acquire skills to solve real world problems in Analog and Digital Communication*	Level of Thinking (Bloom)
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 Outcomes (CO):	*At the end of this course, learners will be able to:*	Level of Thinking (Bloom)
CO-1 :	*Solve and gain confidence to solve problems in Analog and Digital Electronics (Discrete & IC)*	*3*
CO-2 :	*Practice and gain confidence to solve problems in Analog and Digital Communication*	*3*
CO-3 :	*Apply the fundamentals of systems to solve problems in Signals & Systems and DSP*	*4*
CO-4 :	*Design of novel systems using Microprocessors & Microcontrollers, and VLSI Design*	*4*
CO-5 :	*Interpret and solve problems in electromagnetics and Transmission Lines*	*3*
CO-6 :	*Plan and develop the various aspects in Microwave and Optical Communications*	*2*

		Program Outcomes (PO)												Program Specific Outcome(PSO)		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
		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	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CO-1				*3*							*1*					
CO-2			*3*								*1*					
CO-3			*3*	*2*												
CO-4		*3*		*2*												
CO-5				*3*							*1*					
CO-6			*3*								*1*					

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

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

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)							
		CLA – 1 (20%)		CLA – 2 (30%)		CLA – 3 (20%)		CLA – 4 (30%)#	
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	30%	-	20%	-	20%	-	10%
Level 2	Understand	-	30%	-	25%	-	25%	-	25%
Level 3	Apply	-	40%	-	30%	-	25%	-	30%
Level 4	Analyze				25%		30%		35%
Level 5	Evaluate								
Level 6	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*	*Mr. Manikandan AVM, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*Dr. V. Nithya, SRMIST*

B. Tech in Electronics and Communication Engineering

2018 Regulations

Professional Elective Courses (E)

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

Course Code	18ECE201J	Course Name	PYTHON AND SCIENTIFIC PYTHON	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning Bloom Level (1-6)
CLR-1 :	Understanding the python language construct and apply them for scientific computation	
CLR-2 :	Apply python vector, list and plot concept to solve curve fitting	
CLR-3 :	Applying Dictionary concept to model Polynomials	
CLR-4 :	Create insights to difference equation-based system model and solving them with python	
CLR-5 :	Analyze Monte Carlo Simulation for computing Probabilities	
CLR-6 :	Create insights to the concepts and programming of SciPy, NumPy, matplotlib to solve scientific problem	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Program Outcomes (PO)														
			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	PSO–1: Professional Achievement	PSO – 2: Project Management	PSO – 3: Analyze & Research
CO-1:	Restate python language to compute formula and scientific problem	3	3	-	-	-	2	-	-	-	-	-	-	-	-	-	1
CO-2:	Translate mathematical models and system using difference equations	4	3	2	-	-	2	-	-	-	-	-	-	-	-	-	1
CO-3:	Examine time sequence concept for generation and processing of audio signal by python	3	2	-	-	3	2	-	-	-	-	-	-	-	-	-	2
CO-4:	Demonstrate python language to solve Polynomials, File access and web programming	3	2	3	-	-	2	-	-	-	-	-	-	-	-	-	1
CO-5:	Apply python language to compute probability by Monte Carlo Simulation, game design and dynamic random motion creation	6	3	-	3	-	2	-	-	-	-	-	-	-	-	-	3
CO-6:	Implement statistical analysis, correlation coefficient analysis, solving equations- Linear least squares solutions and signal processing problems using SciPy, NumPy, matplotlib	4	-	2	-	-	3	-	-	-	-	-	-	-	-	-	3

Duration (hour)		Solving Simple Formula and Scientific Problem	Plots, Array and Difference Equation Modelling	File I/O, Polynomials and Web Programming	Random Process and Game Programming	SciPy, Numpy and Signal Processing
		12	12	12	12	12
S-1	SLO-1	Computing with Formulas- Using a Program as a Calculator	Vectors, Mathematical Operations on Vectors, Vector Arithmetics and Vector Function	Reading Data from File- Line by Line, Reading a Mixture of Text and Numbers	Drawing Random Numbers- Uniformly Distributed Random Numbers	SciPy, numpy, matplotlib
	SLO-2	Using Variables, Formatting Text and Numbers	Arrays in Python Programs-Using Lists for Collecting Function Data	Making Dictionaries	Computing the Mean and Standard Deviation	Basic array methods in numpy, Changing the shape of an array
S-2	SLO-1	Celsius-Fahrenheit Conversion,	Curve Plotting-The SciTools and Easyviz Packages	Dictionary Operations	The Gaussian or Normal Distribution- Drawing a Random Element from a List	Maximum and minimum values
	SLO-2	Evaluating Standard Mathematical Functions, Type Conversion	Plotting a Single Curve, Decorating the Plot, Plotting Multiple Curves, Controlling Line Styles	Polynomials as Dictionaries, File Data in Dictionaries, File Data in Nested Dictionaries	Drawing random interger	Reading and writing an array to a fle

S-3-4	**SLO-1** **SLO-2**	***Lab 1:programming on formula and Standard Mathematical Functions- Evaluate a Gaussian function, Compute the air resistance on a football***	***Lab 4:*** *Curve Plotting*	***Lab 7: reading student marks file into a dictionary data with the student name as key and computing the average grades***	***Lab 10: real card games***	***Lab 13: numpy file reading and data analysis***
S-5	**SLO-1**	*Complex Numbers, Complex Arithmetic's in Python*	*Numerical Python Arrays manipulations*	*Strings- Common Operations on Strings*	*Computing Probabilities- Principles of Monte Carlo Simulation*	*Statistical methods in numpy*
	SLO-2	*Input Data-Reading Keyboard Input- Reading from the Command Line*	*Higher-Dimensional Arrays- Two-Dimensional Numerical Python Arrays*	*Reading Coordinates*	*Throwing Dice, Rolling Two Dice game*	*Statistical methods in numpy*
S-6	**SLO-1**	*Making Modules, Collecting Functions in a Module File*	*Matrix Objects*	*Reading Data from Web Pages- About Web Pages*	*Drawing Balls from a Hat*	*Histograms*
	SLO-2	*Using Modules*	*Mathematical Models Based on Difference Equations- Interest Rates*	*Access Web Pages in Programs- Reading Pure Text Files,*	*Simple Games- Guessing a Number*	*Solving equations- Linear least squares solutions- Beer-Lambert Law*
S-7-8	**SLO-1** **SLO-2**	***Lab 2: program on Making Modules and using them***	***Lab 5: Animating a Function-temperature on earth***	***Lab 8:reading web temperature text file into Dictionaries and computing average Temperature***	***Lab 11: Simple Games***	***Lab 14: the correlation coefficient between pressure and temperature***
S-9	**SLO-1**	*while loops and for loops*	*the Factorial as a Difference Equation*	*Extracting Data from an HTML Page*	*Random Walk in One Space Dimension*	*One-Dimensional Fast Fourier Transforms*
	SLO-2	*Lists and list manipulation*	*Growth of a Population, Payback of a Loan, Making a Living from a Fortune*	*Writing a Table to File, Reading and Writing Spreadsheet Files*	*Basic Implementation, visualization and Computing Statistics of the Particle Positions*	*Matplotlib basics- Plotting on a single axes object, scatter plot, Bar charts and pie charts*
S-10	**SLO-1**	*Loops with List Indices, Nested Lists*	*Logistic Growth, Programming with Sound Writing Sound to File, Reading Sound from File,*	*Representing a Function as a Class and manipulation*	*Random Walk in Two Space Dimensions*	*Choosing the Length of the DFT*
	SLO-2	*Tuples, Functions, Lambda Functions, If Tests*	*Playing Many Notes*	*Bank Accounts as class, A Class for Solving ODEs*	*Basic Implementation, visualization and Computing Statistics of the Particle Positions*	*Filters in Signal Processing*
S-11-12	**SLO-1** **SLO-2**	***Lab 3: Programming on list and loops***	***Lab 6: Sound generated by formula and difference equation***	***Lab 9: Programming on class***	***Lab 12: Random Walk in One Space Dimension or Two Space Dimensions***	***Lab 15: Numpy signal processing***

Learning Resources	1. *Hans Petter Langtangen," A Primer on Scientific Programming with Python", Springer, 2000.* 2. *Christian Hill, "Learning Scientific Programming with Python", Cambridge University Press, 2015.*	3. *Juan Nunez-Iglesias, Stéfan van der Walt, and Harriet Dashnow Elegant SciPy Te Art of Scientific Python, O'Reilly Media, 2017.*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	20%	5%	5%	5%	5%	5%	5%	5%	5%
Level 2	Understand	20%	20%	10%	10%	10%	10%	10%	10%	10%	10%
Level 3	Apply	10%	10%	20%	20%	20%	20%	15%	15%	20%	20%
Level 4	Analyze			15%	15%	15%	15%	10%	10%	10%	10%
Level 5	Evaluate										
Level 6	Create							10%	10%	5%	5%
	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	18ECE202T	Course Name	Micro- and Nano-Fabrication Technologies	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 :	*Provide learners a systematic overview of micro and nano fabrication processes*
CLR-2 :	*Gain understanding of lithography, etching and ion implantation methods to fabricate, structure and modify the layer*
CLR-3 :	*Understand thin film fabrication techniques including PVD and CVD and to apply the knowledge to film formation*
CLR-4 :	*Apply the knowledge of microfabrication technology to the fields of general microelectronics systems*
CLR-5 :	*Learn the significant advances in molecular engineering*
CLR-6 :	*Embark on building micro/ nano structures applicable to their needs.*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Learning Level of Thinking (Bloom)	Program Outcomes (PO) 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	Program Specific Outcomes (PSO) 1 Professional Achievement	2 Project Management Techniques	3 Analyze & Research
O-1 :	*Express the various layering Technologies*	*4*	*3*	-	-	*2*	-	-	-	-	-	-	-	-	-	2	-
CO-2 :	*Implement the pattern generation using Lithography Techniques*	*5*	3	-	*2*	-	-	-	-	-	-	-	-	-	-	-	1
CO-3 :	*Demonstrate the knowledge on fabrication processes of nano-particles*	*4*	3	-	*2*	-	-	-	-	-	-	-	-	-	-	-	1
CO-4 :	*Analyze the device and circuit fabrication Techniques*	*4*	3		*2*	-	-	-	-	-	-	-	-	-	-	-	1
CO-5 :	*Evaluate the limitations and tools of micro and nanofabrication.*	*5*	3	-	-	*2*	-	-	-	-	-	-	-	-	-	2	-

Duration (hour)		Crystal Growth, Epitaxy, Oxidation	Lithographic Processes	Deposition, Diffusion, Ion implantation	Device Circuit Fabrication	Molecular Nanotechnology
		9	9	9	9	9
S-1	SLO-1	Starting Materials	*Photoreactive Materials*	*Vacuum Evaporation*	*Isolation*	*Directed Self Assembly*
	SLO-2	Growth from Melt (Czochralski Technique)	*Image Reversal*	*Sputter Deposition*	*Self-alignment*	*Device Assembly*
S-2	SLO-1	Considerations for Paper Crystal Growth	*Pattern Generation*	*Chemical Vapour Deposition*	*Local Oxidation-Trench Technique*	*Electrostatic*
	SLO-2	Crystal Orientation, Crystal hardening Techniques	*Mask Making*	*Growth Habit*	Planarization	*Templated self-assembly*
S-3	SLO-1	Doping, Dislocation	*Pattern Transfer*	*Films for protection & Masks*	Metallization	*Colloids & Nanoparticles*
	SLO-2	*Molecular Beam Epitaxy*	*Optical Printing*	*Self-aligned Masks*	Gettering	*Block Copolymers*
S-4	SLO-1	*Gas Source MBE*	*Advanced Techniques*	*Films for Doping*	NIOS-based Micro Circuits	*DNA Nanostructures*
	SLO-2	*Vapour Phase Epitaxy*	*Short Wave lengths*	*Dopant Sources*	p, n Channel Transistors	*Scanning probe lithography Techniques*
S 5-6	SLO-1	VPE Process to Silicon	*Multilayer Resists*	*Films for Ohmic contacts*	Complementary Transistors	*Local Anodic Oxidation*
	SLO-2	*VPE Process for GaAs*	*Phase Shifting Masks*	*Wet Chemical etching*	Memory Devices	*Scribing*
S-7	SLO-1	*Liquid Phase Epitaxy*	*Electron Beam Techniques*	*Anisotropic Effects*	SOI Devices	*Atomic Manipulation*
	SLO-2	*LPE System*	*Lon-Beam Techniques*	*Dry Physical Etching*	BJT based Silicon Micro Circuits	*SPM Scanning Probe Microscopy*
S-8	SLO-1	*Thermal Oxidation of Silicon*	*X Ray Printing*	*Dry Chemical Etching*	The buried layer	*Erasable Electrostatic Lithography*

	SLO-2	*Kinetics of Oxide Growth*	*Problem areas- defects*	*Reactive Lon Etching*	p-n-p Transistor	*Limits to Nano Fabrication*
S-9	SLO-1	*Oxidation System*	*Feature size control & anisotropic Etch Mechanism*	*Penetration range &Transverse effects*	Field Effect Transistor	*Limits to MSO Devices*
	SLO-2	*Halogenic Oxidation*	*Lift off Techniques*	*Annealing*	*BICMOS Integrated Circuits*	*Limits for Pattern Generation*
	SLO-2	Anodix Oxidation Plasma Processes	Plasma reactor Relative Plasma etching Technique	Ion Implantation systems High energy, high current Implants	Self-aligned Technology The Hetero junction Bipolar Transistor	Nanofabrication Tools

Learning Resources	1. *Sorab. K. Gandhi, "VLSI Fabrication and Principles", McGraw Hill, 2005* 2. *Sami Franssila, "Introduction to Microfabrication", Wiley Publications, 2010* 3. *Richard C.Jaeger, "Introduction to Microelectronic Fabrication", Prentice hall, 2002* 4. *Ivor Brodie & Julius J. Muray,"The Physics of Micro/ Nano- Fabrication" Springer, 1992*	5. *Bo Cui, "Recent advances in Nanofabrication Techniques and Applications", InTech Publisher, 2011* 6. *A G Davies and J M T Thompson, "Advances in Nanoengineering Electronics, Materials and Assembly",Imperial College Press, 2007* 7. *Michael Pycraft Hughes , "Nanoelectromechanics in Engineering and Biology", by CRC Press LLC, 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	30%	-	10%	-	10%	-	10%	-	20%	-
Level 2	Understand	30%	-	30%	-	30%	-	30%	-	30%	
Level 3	Apply	20%	-	30%	-	30%	-	30%	-	30%	-
Level 4	Analyze	20%	-	20%	-	20%	-	20%	-	20%	
Level 5	Evaluate	-	-	10%	-	10%	-	10%	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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Course Code	18ECE203T	Course Name	SEMICONDUCTOR DEVICE MODELING	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:	Learning
CLR-1 :	Understand *the properties of semiconductor materials*	
CLR-2 :	Understand *the mechanisms that occur in a PN junction*	
CLR-3 :	Understand *the characteristics and modeling of BJT*	
CLR-4 :	Understand *the modeling aspects of MOSFET*	
CLR-5 :	*Identify the effects of MOSFET scaling and special MOSFETs*	
CLR-6 :	*Understand the fundamental physical processes of semiconductor devices to meet the challenge of these dynamic fields.*	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Program Outcomes (PO)												PSO		
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
			Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Teamwork	Communication	Project Mgt. & Finance	Lifelong Learning	Professional Achievement	Project Management Techniques	Analyze & Research
CO-1 :	*Understand semiconductor materials for various applications*	2	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2 :	*Evaluate the steady state and transient characteristics of junction devices*	5	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3 :	*Evaluate second order effects of BJT parameters for better performance*	5	3	3	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-4 :	*Develop MOS Diode and MOSFET model*	6	3	-	-	3	-	-	-	-	-	-	-	-	-	-	3
CO-5 :	*Demonstrate new devices with small channel and secondary effects*	6	3	-	-	3	-	-	-	-	-	-	-	-	-	-	3

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Electron, Hole Densities In Equilibrium: Distribution of quantum states in energy band*	*PN Junction under thermal equilibrium: Built in potential, concept of space charge layer*	*Current components, Basic BJT parameters,*	*MOS diode*	*Scaling of MOSFETS*
	SLO-2	*Fermi – Dirac Statistics*	***Problem Solving***	*Limitations on the junction voltage*	*Operation of Ideal MOS diode (at VGB >0)*	*Effect of gate voltage on carrier mobility*
S-2	SLO-1	*Electron concentration in conduction band*	*Distribution of electric filed and potential within the space charge layer for abrupt junctions at zero bias*	*Capacitances in a BJT,*	***Operation of ideal MOS diode** (at VGB <0)*	*Effect of drain voltage on carrier mobility*
	SLO-2	*Hole concentration in valence band*	*Distribution of electric filed and potential within the space charge layer for abrupt junctions at zero bias*	*Switching of BJT*	***Operation of ideal MOS diode with and without oxide charge***	*Effect of drain voltage on carrier mobility*
S-3	SLO-1	*Carrier concentration in intrinsic semiconductors*	*Distribution of electric filed and potential within the space charge layer for linearly graded junctions at zero bias*	*Ebers-Moll model*	*Effects of mobile Ionic charges*	*Channel length modulation*
	SLO-2	*Position of Fermi level in extrinsic semiconductors*	*Distribution of electric filed and potential within the space charge layer for linearly graded junctions at zero bias*	***Problem Solving***	***Problem Solving***	*Breakdown and punch through*
S-4	SLO-1	*Ionization of impurities, Equilibrium electron and hole concentration*	*PN Junction under applied bias: Depletion layer capacitance in an abrupt PN junctions*	*Early effect (CB & CE)*	*Oxide charges and interface states*	*Sub threshold current*

	SLO-2	***Problem Solving***	***Problem Solving***	*Operation of BJT at high frequencies: Charge control model*	*C-V characteristics*	*Sub threshold current*
S-5	**SLO-1**	*Fermi level at thermal equilibrium*	*Depletion layer capacitance with arbitrary doping profiles*	*Small signal equivalent circuit,*	***Problem Solving***	*Short channel effects*
	SLO-2	***Problem Solving***	*Static current voltage characteristics of PN junction,*	***Problem Solving***	*Threshold voltage of MOSFET*	*Short channel effects*
S-6	**SLO-1**	*Excess Carriers: Generation and recombination of carriers*	*Current-voltage relationship in an infinitely long diode,*	*Design of high frequency transistors*	*Bulk charge model*	*Meyer's model*
	SLO-2	*Mobility of carriers*	*Quasi Fermi level under bias condition*	***Problem Solving***	***Problem Solving***	*Small signal model*
S-7	**SLO-1**	*Charge transport in semiconductors: Drift current*	*Current –voltage relation in practical diodes having finite lengths*	*Second order effects in BJT: Non-uniform doping in the base*	*Square law method (Level 1 in SPICE)*	*MOSFET scaling*
	SLO-2	*Hall effect*	*Ideality factor*	*Non-uniform doping in the base*	*Square law method (Level 1 in SPICE)*	*Non-uniform doping in channel*
S-8	**SLO-1**	*Diffusion current*	*Transient analysis: Time variation of stored charge*	*Variation of β with collector current*	*Level 3 model in SPICE*	*SOI MOSFET*
	SLO-2	***Problem Solving***	***Problem Solving***	*High injection in collector*	*BSIM models*	*SOI MOSFET*
S-9	**SLO-1**	*Current density equations*	*Reverse recovery of a diode, charge storage capacitance*	*Heavy doping effects in the emitter*	***Comparison of models***	*Buried channel MOSFET*
	SLO-2	*Current density equations*	***Problem Solving***	*Emitter crowding in bipolar transistors*	***Comparison of models***	*Fin FET*

Learning Resources	1. *Nandita Das Gupta, Amitava Das Gupta, Semiconductor devices, modeling and Technology, Prentice Hall of India, 2004* 2. *Philip. E. Allen Douglas, R. Hoberg, CMOS Analog circuit Design, 2nd ed., Oxford Press, 2002*	3. *S.M. Sze, Semiconductor Devices-Physics and Technology, John Wiley and Sons, 1985.* 4. *Kiat Seng Yeo, Samir R.Rofail, Wang-Ling Gob, CMOS/BiCMOS VLSI-Low Voltage, Low Power, Pearson 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	50%	-	20%	-	10%	-	10%	-	*20%*	-
Level 2	Understand	50%		30%		10%		10%		20%	
Level 3	Apply	-	-	30%	-	30%	-	10%	-	*20%*	-
Level 4	Analyze	-		10%		30%		30%		20%	
Level 5	Evaluate	-	-	10%	-	10%	-	20%	-	*10%*	-
Level 6	Create	-		-		10%		20%		10%	
	Total	100 %		100 %		100 %		100 %		100 %	

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

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Course Code	18ECE204J	Course Name	ARM-based Embedded System Design	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

Pre-requisite Courses	18ECC203J	Co-requisite Courses	Nil	Progressive Courses	18ECE305J, 18ECE306J
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 (Bloom)
CLR-1 :	Explore software development tools of ARM processor	1
CLR-2 :	Acquire knowledge about peripherals for ARM chip such as A/D, PWM	
CLR-3 :	Obtain exposure towards timers and serial interfacing.	
CLR-4 :	Explore effective use of memory; network interfacing, Ethernet and wireless protocol supports	
CLR-5 :	Address ARM processor based audio signal processing.	
CLR-6 :	Develop ARM Cortex-M based embedded systems for networking and signal processing applications	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Program Outcomes (PO) 1	2	3	4	5	6	7	8	9	10	11	12	Program Specific Outcomes (PSO) 1:	2	3
			Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design,	Modern Tool Usage	Society & Culture	Environment &	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Professional Achievement	Project Management	Analyze & Research
CO-1 :	Relate "mbed" software and C language application for ARM Cortex-M processors.	2	3		2	1									3		
CO-2 :	Develop codes to interface A/D converter, PWM generation and digital input / output.	2			3										3		
CO-3 :	Experiment with program System timer, serial interface and LCD display.	3			3										3		
CO-4 :	Demonstrate the use of memory and program network interface	4	1		3											3	
CO-5 :	Analyze audio signal processing applications on embedded platform.	5	1		2	3											3
CO-6 :	Formulate the use of "mbed" software pack on ARM Cortex-M processor for networking and simple signal processing.	6	1		3	2										3	

Duration (hour)		Learning Unit / Module 1 Cortex-M processor	Learning Unit / Module 2 Peripheral Interfacing-I	Learning Unit / Module 3 Peripheral Interfacing-II	Learning Unit / Module 4 Network Interfacing	Learning Unit / Module 5 Audio Signal Processing
		15	15	15	15	15
S-1	SLO-1	***Introducing embedded systems and mbed***	*Starting to Program Digital Input and Output*	*Introducing Synchronous Serial Communication*	*Memory organization*	*An Introduction to Digital Audio*
	SLO-2	***Introducing embedded systems and mbed***	*Voltages as Logic Values*	*I2C bus*	*Memory organization*	*USB MIDI on the mbed*
S-2	SLO-1	***ARM Cortex assembly language basics.***	*Introducing Analog output Data Conversion*	*Communicating With I2C-Enabled Sensors*	*Using Data Files With the mbed*	*Digital Audio Processing*
	SLO-2	***ARM Cortex assembly language basics.***	*Digital Output on the mbed*	*Asynchronous Serial Data Communication*	*Example mbed Data File Access*	*Digital Audio Filtering Example*
S 3-4	SLO-1	***Lab-1:Assembly language program, simulation -1***	***Lab 4: A/D conversion program***	***Lab 7: Multinode I2C Bus***	***Lab 10: Data logging***	***Lab 13: Audio signal generation***
	SLO-2					
S-5	SLO-1	***Cortex-M processor architecture and Basics : Programming exercises***	*Digital Input and Output.*	*LCD interfacing*	*Using External SD Card Memory With the mbed*	*Delay/Echo Effect*
	SLO-2	***Cortex-M processor architecture and Basics : Programming exercises***	*Digital Input and Output.*	*Using the mbed TextLCD Library*	*Using External USB Flash Memory With the mbed*	*Working With Wave Audio Files*

S-6	SLO-1	*Development Environment using the mbed*	*Switching Larger DC Loads*	*Time and Tasks in Embedded Systems*	*Introduction to Internet Communication*	*High-Fidelity Digital Audio With the mbed*
	SLO-2	*Development Environment using the mbed*	*Switching Larger DC Loads*	*Responding to External Events*	*The Ethernet Communication Protocol*	*High-Fidelity Digital Audio With the mbed*
S 7-8	**SLO-1**	***Lab 2: Assembly language program,***	***Lab 5: Mini Project: Letter***	***Lab 8: A/D output on LCD***	***Lab 11: Ethernet***	***Lab 14: Model lab examination***
	SLO-2	***simulation-2***	***Counter(3.8)***		***communication***	
S-9	SLO-1	*Keil IDE and Debugging tools*	*Another Form of Analog Output: Pulse Width Modulation*	*An Introduction to Timers*	*Introducing Wireless Data Communication*	*Summary on Digital Audio and Digital Signal Processing*
	SLO-2	*Keil IDE and Debugging tools*	*Pulse Width Modulation on the mbed*	*Using the mbed Timer*	*Wireless Data Communication : Bluetooth and Zigbee*	*Summary on Digital Audio and Digital Signal Processing*
S-10	SLO-1	*C- language review*	*Design of PWM problem*	*Using the mbed Timeout* ***and Ticker***	*Local Area Network Communications With the mbed*	*Review and discussions*
	SLO-2	*Embedded C , introduction*	*Design of PWM problem*	*The Real-Time Clock*	*Using RPC*	*Review and discussions*
S 11-12	**SLO-1**	***Lab 3: Parallel port programming,***	***Lab 6: PWM waveform generation***	***Lab 9: Experimenting Interrupts, Timers***	***Lab 12: RPC communication***	***Lab 15: Final lab examination***
	SLO-2	***simulation***			***through ethernet***	

Learning Resources	1. *Tim Wilmshurst, "Fast and effective embedded system design, Applying the ARM mbed", ARM Education Media, 2018.* 2. *Andrew Sloss, Dominic Symes, Chris Wright, "ARM System Designers Guide: Designing and optimizing System Software", The Morgan Kaufmann Series in Computer Architecture and Design, 2004.*	3. ***Theory/Lab teaching materials, "Efficient embedded system design kit", ARM Education media.***

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	*25%*	*25%*	*15%*	*15%*	*05%*	*05%*	*05%*		*05%*	*05%*
Level 2	Understand	*25%*	*25%*	*20%*	*20%*	*10%*	*10%*	*10%*		*10%*	*10%*
Level 3	Apply			*15%*	*15%*	*20%*	*20%*	*10%*		*20%*	*20%*
Level 4	Analyze					*10%*	*10%*	*10%*		*10%*	*10%*
Level 5	Evaluate					*05%*	*05%*	*10%*	*20%*	*05%*	*05%*
Level 6	Create							*05%*	*30%*		
	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, Bombard*ier Transportation, Ahmedabad, *kumaranuj.anii@gmail.com*	1. *Dr. Meenakshi, Professo*r of ECE, CEG, Anna University, *meena68@annauniv.edu*	*1.Mr. Nivash. S, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai,* venkat@niot.res.in	*2. Prof. V. Natarajan, SRMIST*

Course Code	18ECE205J	Course Name	FPGA-based Embedded System Design	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

Pre-requisite Courses	18ECC203J	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 :	Explore high volume embedded systems which are function specific
CLR-2 :	Relate FPGA knowledge to design circuits
CLR-3 :	Select Xilinx FPGA IDE and design practice
CLR-4 :	Recall FPGA platforms
CLR-5 :	Examine FPGA system design and practical issues
CLR-6 :	Develop designs using FPGAs/ Prog.SoCs for specific embedded modules and low-power designs

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning Level of Thinking (Bloom)	Program Outcomes (PO)												Program Specific Outcomes (PSO)		
		Bloom Level (1-6)	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
			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	Professional Achievement	Project Management Techniques	Analyze & Research
CO-1 :	Demonstrate Micro controller subsystems	2	3	-	2	-	1	-	-	-	-	-	-	-	3	-	-
CO-2 :	Build system design with Prog.SoC	3	-	-	3	-	2	-	-	-	-	-	-	-	-	3	-
CO-3 :	Classify Platform FPGAs	2	3	-		-	-	-	-	-	-	-	-	-	3	-	-
CO-4 :	Analyze the design of FPGA architecture	3	-	-	3	-	-	-	-	-	-	-	-	-	-	3	-
CO-5 :	Utilize Platform FPGA designs	3	-	-	3	-	2	-	-	-	-	-	-	-	-	3	-
CO-6 :	Develop simple FPGA based systems	4	1	-	3	-	2	-	-	-	-	-	-	-	-	3	-

Duration (hour)		Learning Unit / Module 1 Basics of Peripherals	Learning Unit / Module 2 Prog.SoC Design	Learning Unit / Module 3 Xilinx Virtex 5 IDE	Learning Unit / Module 4 Platform FPGA Designs	Learning Unit / Module 5 Designing Simple FPGA based Systems
		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.*	*Communication: Coprocessor model*
	SLO-2	*Embedded systems performance criteria - Interrupts*	*PSoC3 architecture details and 8051 instructions*	*Metrics: measures of success*	*Modules and interfaces*	*Network on chip model*
S-2	SLO-1	*Embedded systems performance criteria - DMA*	*Interrupts and interrupt lines*	*Spectrometer example using Xilinx IDE*	*Abstraction and state,*	*Transfer of state*
	SLO-2	*Latency and its problems*	*Interrupt priority and nesting*	*Spectrometer example using Xilinx IDE*	*Cohesion and coupling and control flow graph*	*Practical issues: profiling issues*
S 3-4	SLO-1	*Lab 1: Embedded sensors and sensing -1*	*Lab 4: PSoC Design -1*	*Lab 7: VHDL, Verilog Practice session -1*	*Lab 10: Sample design implementation*	*Lab 13: On-chip memory access, FIFOs*
	SLO-2					

S-5	SLO-1	***Embedded system subsystems: A/D conversion***	***The concept of memory and its connectivity to CPU***	***Xilinx Virtex 5 IDE***	***Origin of Platform FPGA Designs***	***Spatial design: Principles of parallelism***
	SLO-2	***Digital ports & its current capacity***	***Different DMA modes***	***Xilinx Virtex 5 IDE***	***Platform FPGA components***	***Granularity, degree of parallelism***
S-6	SLO-1	***Introduction to other digital interfaces***	***Clocking system: Internal master oscillator***	***PLD basics***	***Adding to platform FPGA systems***	***Spatial organizations***
	SLO-2	***Introduction to other digital interfaces***	***IMO, and sleep/wake up modes***	***FPGA configurations***	***Assembling custom compute cores***	***Spatial organizations***
S 7-8	**SLO-1** **SLO-2**	***Lab 2: Embedded sensors and sensing - 2***	***Lab 5: PSoC Design -2***	***Lab 8: VHDL, Verilog Practice session -2***	***Lab 11: Building base systems***	***Lab 14: Model lab examination***
S-9	SLO-1	***Sensors and sensing principles. Optical, capacitive sensors***	***Clock distribution***	***Various slices in Virtex 5***	***Software design :root file system, cross-developmental tools***	***Managing bandwidth: Balancing***
	SLO-2	***Magnetic, RF sensors***	***Power management: Internal regulators***	***Various slices in Virtex 5***	***Monitors and boot loaders***	***Khan process network***
S-10	SLO-1	***Processing: Mathematical views.***	***Types of reset***	***Bit stream***	***Overview of partitioning platform***	***Platform FPGA bandwidth techniques***
	SLO-2	***Programmable logic and mixed signal design fundamentals***	***Intro to PSoC creator IDE***	***Programming FPGA***	***Analytical solution to partitioning***	***On-chip, off-chip memory***
S 11-12	**SLO-1** **SLO-2**	***Lab 3: Programmable logic design***	***Lab 6: PSoC Design - 3***	***Lab 9: Sample design implementation***	***Lab 12: Creating IP core***	***Lab 15: Final lab examination***

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 Shmidt, "Embedded system design with Platform FPGAs", Morgan Kaufmann, 2010.*** 4. ***Theory/Lab Session Teaching Materials, ARM Educational Media.***

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	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%
Level 2	Understand	15%	15%	20%	20%	10%	10%	10%	10%	10%	10%
Level 3	Apply	25%	25%	20%	20%	20%	20%	20%	20%	20%	20%
Level 4	Analyze	-	-	-	-	15%	15%	15%	15%	15%	15%
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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, 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 / 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:	Learning Blooms level(1-6)
CLR-1 :	Understand advanced Boolean theorems for logic simplification and implementation	Level of Thinking (Bloom)
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 Outcomes (CO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Program Outcomes (PO) 1	2	3	4	5	6	7	8	9	10	11	12	Program Specific Outcomes (PSO) 1	2	3
			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	Professional Achievement	Project Management	Analyze & Research
CO-1 :	Apply advanced theorems to simplify the design aspects of various practical circuits	3	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-2 :	Analyze synchronous sequential circuits and write VHDL Code	3	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-3 :	Analyze Asynchronous sequential circuits and construct circuit using VHDL	4	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-4 :	Implement various digital circuits using Programmable Logic Devices	3	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-5 :	Demonstrate FPGAs and Construct digital circuits using VHDL.	4	-	3	3	-	3	-	-	-	-	-	-	-	-	-	2
CO-6 :	Perform experiments in the laboratory with hardware and software to simulate and verify the design	6	-	-	-	-	3	-	-	-	2	-	-	3	3	-	2

Duration (hour)		Advanced theorem in Boolean algebra and FSM	Sequential Circuit Design and Introduction to VHDL	Design and Analysis of Asynchronous Sequential Circuit	Design With Programmable Logic Devices	Digital Design with VHDL
		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	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
	SLO-2					
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, McGrawHil, 2014*	1. *Jayaram Bhasker, A VHDL Primer, 3rd ed., Prentice Hall, 2011* 2. *Charles. H. Roth, Jr, Digital Systems Design using VHDL, CENGAGE Learning, 2010* 3. *Morris Mano M, Michael D. Ciletti, Digital Design with an Introduction to the Verilog HDL, th 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	*15%*	*15%*	*10%*						*5%*	
Level 2	Understand	*20%*	*20%*	10%	15%	*15%*	*15%*	*15%*	5%	5%	5%
Level 3	Apply	*15%*	*15%*	*20%*	*25%*	*20%*	*20%*		10%	*20%*	*20%*
Level 4	Analyze			10%	10%	*15%*	*15%*	*20%*	*25%*	10%	15%
Level 5	Evaluate										
Level 6	Create							*15%*	10%	10%	10%
	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. Mr. B. Viswanathan, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*2.*

Course Code	18ECE207J	Course Name	Real Time Operating Systems	Course Category	E	Professional Elective	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
CLR-1 :	Summarize concepts of C, assembly programming and IDE.	
CLR-2 :	Acquire knowledge of programming, the peripherals.	
CLR-3 :	Outline different RTOS principles	
CLR-4 :	Infer various advanced RTOS principles	
CLR-5 :	Develop sample projects using application programming	
CLR-6 :	Inspect how OS can be implemented on ARM processor.	

Course Learning Outcomes (CO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)
CO-1 :	Recall microprocessor instruction sets and their use.	2
CO-2 :	Construct codes in assembly and C for embedded applications.	3
CO-3 :	Illustrate the concepts and requirements of RTOS, in general basic OS principles.	4
CO-4 :	Analyze the use RTOS in embedded programming	4
CO-5 :	Apply the knowledge in related sample use cases.	4
CO-6 :	Develop processor based embedded systems along with RTOS implementation.	6

Program Learning Outcomes (PO)												pso		
1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design,	Modern Tool Usage	Society & Culture	Environment &	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Professional Achievement	Project Management	Analyze & Research
2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
-	3	-	3	2	-	-	-	-	-	-	-	-	-	-
2	-	3			-	-	-	-	-	-	-	-	-	-
-	-	-	3	2	-	-	-	-	-	-	-	-	-	-
-	2	3		2	-	-	-	-	-	-	-		-	-
-	-	3	2	2	-	-	-	-	-	-	-	-	-	-

Duration (hour)		Cortex-M processor & 'C'	Peripheral Programming in 'C'	Concepts of RTOS	RTOS Implementation	RTOS Applications
		15	15	15	15	15
S-1	SLO-1	***Cortex-M processor architecture***	***Parallel I/O programming***	***Introduction to RTOS***	***Process management***	***Real time systems: Data acquisition system***
	SLO-2	***Cortex-M processor architecture***	***Sample programs***	***Introduction to RTOS***	***Dynamic linking and loading***	***Real time systems: Data acquisition system***
S-2	SLO-1	***ARM Cortex assembly language – part1***	***Interrupt processing basics***	***Concurrent programming***	***Spin-lock semaphore, cooperative scheduling***	***Performance metrics***
	SLO-2	***ARM Cortex assembly language – part2***	***System tick; periodic interrupts***	***Thread fundamentals***	***Thread rendezvous***	*Examples and discussions*
S 3-4	**SLO-1** **SLO-2**	***Lab 1: Arm Assembly language programming***	***Lab 4: Interrupts and timers in C and assembly***	***Lab 7: Simple thread programming in RTOS – Wave form simulation***	***Lab 10: Semaphore implementation experiment in RTOS***	***Lab 13: Any application program using RTOS.***
S-5	SLO-1	***ARM Cortex microcontroller interface standards***	***UART programming***	***Shared resources and Critical sections***	***FIFO & Little's theorem***	***Solid state disk***
	SLO-2	***IDE software tools***	***UART programming***	***Consumer producer problem***	***Three semaphore implementation***	***Flash device driver***
S-6	SLO-1	***Pointers in C***	***Digital signal time measurement***	***Switching threads***	***Thread sleeping***	***SD card interface***

	SLO-2	***Arrays, structures and unions, Linked lists***	***Use of timers and compare, capture registers.***	***Profiling the OS***	***Deadlocks, monitors***	***Communication systems with Ethernet***
S 7-8	**SLO-1**	***Lab 2: C & assembly programming using Keil IDE and kit***	***Lab 5: Debugging hardware with target board – UART interface programming***	***Lab 8: Multi threaded application in RTOS – LED blinking with multi threads***	***Lab 11: Multi threaded application with communication -1***	***Lab 14: Model lab examination***
	SLO-2					
S-9	SLO-1	***Embedded debugging tools in Keil IDE***	***SSI interface***	***Semaphores and implementation***	***Fixed scheduling***	***Application layer protocols for embedded systems***
	SLO-2	***Embedded debugging example with simulation***	***SSI programming with interrupt***	***Operations on semaphores***	***Fixed scheduling***	***CoAP, MQTT***
S-10	SLO-1	***Memory management -1***	***Analog I/O; A/D converter interfacing***	***Resource sharing***	***Kahn process networks***	*Discussions & Reviews*
	SLO-2	***Memory management -2***	***OS considerations of I/O devices***	***Thread communications***	*Review*	*Discussions & Reviews*
S 11-12	**SLO-1**	***Lab 3: Practice: C & assembly programming using Keil IDE and kit***	***Lab 6: Debugging hardware with target board – Analog I/O programming***	***Lab 9 :Multi threaded application in RTOS, with semaphores***	***Lab 12: Multi threaded application with communication -2***	***Lab 15: Final Lab Examination***
	SLO-2					

Learning Resources	1. ***Jonathan Valvano, "Real time operating systems for ARM Cortex-M Microcontrollers, Embedded systems - Volume 3", ARM Educational Media, 2017.*** 2. ***Andrew Slosset 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. ***Theory/Lab Session teaching materials, " RTOS kit", ARM Educational media***

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	25%	25%	10%	10%	5%	5%	5%	5%	5%	5%
Level 2	Understand	25%	25%	20%	20%	5%	5%	5%	5%	10%	10%
Level 3	Apply	-	-	15%	15%	15%	15%	10%	10%	20%	20%
Level 4	Analyze	-	-	5%	5%	15%	15%	15%	15%	10%	10%
Level 5	Evaluate	-	-	-	-	10%	10%	10%	10%	5%	5%
Level 6	Create	-	-	-	-			5%	5%		
Total	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. Prof. V. Natarajan, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*2.*

Course Code	18ECE301J	Course Name	CMOS ANALOG IC DESIGN	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

Pre-requisite Courses	18ECC206J	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 (1-6)	Learning Level of Thinking (Bloom)
CLR-1 :	Identify Analog IC Design process flow and IC biasing techniques		
CLR-2 :	Analyze the operation and frequency response of CMOS single stage amplifiers		
CLR-3 :	Analyze operation and frequency response of the Differential amplifiers and Op-amp		
CLR-4 :	Create insights to the concepts of noises in amplifiers		
CLR-5 :	Utilize the concepts of oscillators and switched capacitor circuits		
CLR-6 :	Use commercial design tools for schematic entry, simulation, and layout		

Course Outcomes (CO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Program Outcomes (PO) 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	PSO 1 Professional Achievement	2 Project Management	3 Analyze & Research
CO-1:	Identify IC Biasing techniques	2	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Analyze the characteristic parameters of CMOS Single stage amplifiers	4	3	3	-	2	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Demonstrate the concepts of Differential Amplifiers and Op-amp circuits	4	3	2	-	2	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Categorize the different types of noises in CMOS Amplifiers	4	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Construct oscillators and switched capacitors circuits	5	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-6:	Design CMOS Analog Circuits and solve analog IC design problems using EDA tools.	5	-	3	-	2	3	-	-	-	-	-	-	-	3	-	-

Duration (hour)		IC Biasing Techniques	CMOS Single Stage Amplifiers	Differential Amplifiers	Noise in Amplifiers	Oscillators & Switched Capacitor Circuits
		12	12	12	12	12
S-1	SLO-1	IC Design Philosophy : Introduction to MOSFET scaling	CMOS Single stage Amplifiers: Analog Design Octagon	Differential Amplifier: MOS Differential Pair- Operation with Common mode input	Noise in Amplifiers: Statistical characteristics of noise	Oscillators: General Considerations
	SLO-2	Analog IC design process flow, Typical values of IC MOSFET parameters	Common Source stage with resistive load	Operation with differential input	Statistical characteristics of noise-contn	Ring oscillators
S-2	SLO-1	IC Biasing: MOSFET current source	CS stage with diode connected load	Small signal operation of MOS differential pair- Differential gain	Types of Noises- Thermal Noise, flicker noise	LC oscillators
	SLO-2	Effect of the output resistance of the current source load	CS stage with current source load	Common mode gain, CMRR	Noise Model- MOSFET, Resistor	Cross coupled oscillators
S 3-4	SLO-1	Lab 1: Basic MOS Circuits: MOSFET as a switch & Inverter using HSPICE	Lab 4: Common source amplifier with resistive load and diode connect load	Lab 7: Differential amplifier	Lab 10: Noise analysis and a measure of noise figure in CS, CG and CD amplifier	Lab 13: Switched capacitor circuits
	SLO-2					
S-5	SLO-1	Basic MOSFET current mirror-operation	CS stage with triode load	Differential amplifier with current source load	Representation of noise in circuits	One port oscillator
	SLO-2	Study on the effects which deviates performance of the current mirror	CS stage with source degeneration	Cascode Differential amplifier	Representation of noise in circuits-Contn	Colpitt oscillator

S-6	**SLO-1**	*Cascode Current mirror*	*Source Follower*	*Frequency response of the differential amplifier*	*Noise Analysis of CS stage*	*Voltage Controlled oscillators*
	SLO-2	*Cascode Current mirror- contn. and problem solving*	*Common gate stage*	*Frequency response of the differential amplifier- contn..*	*Noise Analysis of CD stage*	*Voltage Controlled oscillators-contn*
S 7-8	**SLO-1**	*Lab 2: Basic MOS current mirror, Current mirror circuit to overcome the channel length modulation effect*	*Lab 5: Common gate amplifier and Source follower*	*Lab 8: One stage op-amp*	*Lab 11: Ring oscillator*	*Lab 14: Pre and Post layout simulation of CMOS inverter using Cadence EDA (Virtuoso tool)*
	SLO-2					
S-9	**SLO-1**	*Wilson MOS current mirror*	*Cascode Amplifier*	*Multistage Amplifiers: Performance parameters of Op-Amp*	*Noise Analysis of CG stage*	*Switched Capacitors circuits: Basic principles*
	SLO-2	*MOS current steering circuits*	*Folded Cascode amplifier*	*One stage op-amp*	*Noise Analysis of Cascode stage*	*Sampling switches*
S-10	**SLO-1**	*Band gap reference circuits*	*Frequency response of CS amplifier*	*Two stage op-amp*	*Noise Analysis of Differential amplifier*	*Switched capacitor amplifier*
	SLO-2	*Band gap reference circuits-contn.*	*Frequency response of CS amplifier - Contn*	*Two stage op-amp with gain boosting*	*Noise Bandwidth, Noise Figure Concepts*	*Switched capacitor integrator*
S 11-12	**SLO-1**	*Lab 3: Cascode current mirror, Wilson current mirror*	*Lab 6: Cascode amplifier*	*Lab 9: Two stage op-amp*	*Lab 12: Voltage Controlled oscillators*	*Lab 15: Pre and Post layout simulation of CMOS Amplifier using Cadence EDA (Virtuoso tool)*
	SLO-2					

Learning Resources	*1. Adel S. Sedra, Kenneth C.Smith, "Microelectronic Circuits-Theory and Applications "– 6th Edition, Oxford University Press, 2011.* *2. Behzad Razavi, "Design of Analog CMOS Integrated Circuits", Mc Graw Hill, 2001*	*3. Allen Holberg, "CMOS Analog Circuit Design", Oxford University Press, 2004* *4. Gray, Meyer, Lewis, Hurst, "Analysis and Design of Analog Integrated Circuits", 4th edition, Willey International, 2002.*

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	15%	10%	10%	10%	5%	5%	5%	5%	5%	5%
Level 2	Understand	15%	10%	10%	10%	5%	5%	5%	5%	5%	5%
Level 3	Apply	10%	10%	15%	15%	10%	10%	10%	10%	15%	15%
Level 4	Analyze	10%	20%	15%	15%	15%	15%	15%	15%	15%	15%
Level 5	Evaluate	-	-	-	-	15%	15%	15%	15%	10%	10%
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

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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. Mr. Manikandan AVM, SRMIST*

Course Code	18ECE302T	Course Name	MEMS TECHNOLOGIES	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 :	Identify the characteristics and various technology adopted in MEMS fabrication	Blooms Level (1- 6)
CLR-2 :	Understand the electrical and mechanical phenomenon used in MEMS design	
CLR-3 :	Analyze how to apply electrostatic and thermal principles in MEMS components design	
CLR-4 :	Study the application of piezoresistive, piezoelectric principle and the design of microfluidic devices	
CLR-5 :	Classify the application of polymer material in MEMS application, also to explore the principle and application of optical, RF MEMS devices, MEMS Packaging and testing methodologies.	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning
CO-1 :	Express the knowledge of MEMS devices principles and microfabrication techniques	3
CO-2 :	Apply the essential concepts of electrical and mechanical applicable to MEMS.	4
CO-3 :	Develop the electrostatic and thermal sensing principles and actuating technique.	5
CO-4 :	Demonstrate MEMS devices using piezoresistive, piezoelectric and magnetic sensing and actuating technique and microfluidic devices	5
CO-5 :	Evaluate the application of polymers material used in MEMS application, also the design of optical, RF MEMS components and packaging methods.	5

Program Learning Outcomes (PO)												PSO		
1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
Engineering Knowledge	Problem Analysis	Design &	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment &	Ethics	Individual & Team	Communication	Project Mgt. &	Life Long Learning	Professional	Project Management	Analyze & Research
3	-	1	-	-	-	-	-	-	-	-	-	1	-	-
3	2	-	-	-	-	-	-	-	-	-	-	1	-	-
3	2	-	-	-	-	-	-	-	-	-	-	1	-	
1	3	-	-	-	-	-	-	-	-	-	-	2	-	
1	-	3	-	-	-	-	-	-	-	-	-	2	-	

Duration (hour)		INTRODUCTION TO MEMS AND MICRO FABRICATION	ELECTRICAL AND MECHANICAL CONCEPTS OF MEMS	ELECTROSTATIC AND THERMAL PRINCIPLE SENSING AND ACTUATION	PIEZORESISTIVE, PIEZOELECTRIC AND MAGNETIC PRINCIPLE SENSORS AND ACTUATOR	POLYMER, OPTICAL, RF MEMS AND ITS APPLICATION
		9	9	9	9	9
S-1	SLO-1	History of MEMS Development	Conductivity of semiconductors	Electrostatic sensing - Parallel plate capacitor	Piezoresistive sensors - piezoresistive sensor material	Polymers in MEMS- polymide,SU-8, Liquid crystal polymer (LCP)
	SLO-2		Problems on conductivity of semiconductors	Problems on electrostatic sensing		
S-2	SLO-1	Characteristics of MEMS – Miniaturization,	Crystal plane and orientation- Single crystal Si (FCC, Miller Indices and notation, crystal planes & characteristics, flats & wafer identification)	Electrostatic actuation Parallel plate capacitor	Stress in flexural cantilever and membrane	Polymers in MEMS- PDMS, PMMA , Parylene, Fluorocarbon
	SLO-2	Microelectronics integration - Mass fabrication with precision		Problems on electrostatic actuation		
S-3	SLO-1	Miniaturization and scaling	Stress and strain - definition , Relationship between tensile stress and strain	Electrostatic sensing and actuation- Application - Inertial, pressure and tactile sensor	Piezoelectric sensing and actuation- piezoelectric material properties	Optical MEMS-passive MEMS optical components-lenses-mirrors
	SLO-2	Sensors and Actuators- Energy domains and example devices for each				
S-4	SLO-1				Quartz - PZT-	Actuation for active optical MEMS.

	SLO-2	Micro fabrication process - Bulk and Surface Micromachining	Stress and strain - definition , Relationship between tensile stress and strain	Electrostatic sensing and actuation- Application - parallel plate actuator comb drive	PVDF -ZnO -Applications	
S-5	**SLO-1**	Silicon based MEMS processes- processing anisotropic wet etching	Flexural beam bending analysis under single loading condition	Problems on electrostatic sensing and actuation	Magnetic actuation- Principles- Deposition of magnetic materials	RF MEMS: Switches
	SLO-2	Isotropic wet etching				
S-6	**SLO-1**	Dry etching (plasma etching, ion milling, RIE, DRIE)	Types of beam, longitudinal strain under pure bending	Thermal sensing and Actuations- sensors and actuators based on thermal expansion	Design and fabrication of magnetic coil	RF MEMS - Filters, oscillators
	SLO-2	Photolithography,				
S-7		Thin film deposition -sputtering, evaporation,	Deflection of beam- Spring constant	Thermocouples	Microfluidics – Concepts of fluid mechanics	MEMS Packaging
		Thin film deposition - LPCVD, PECVD	Problems: Deflection of beam- Spring constant	Thermal resistors		
S-8	**SLO-1**	Thin film deposition - sputtering, evaporation, LPCVD, PECVD	Torsional deflection, intrinsic stress	Application of thermal sensors – Inertial, Flow, Infrared.	Microfluidics –Application: Channels, valves	MEMS Testing
	SLO-2	Thin film deposition - plating, spin-on				
S-9	SLO-1	New material and fabrication processing techniques	Resonance and quality factor	Problems on thermal sensing and actuation	Microfluidics – Application valves	Reliability issues in MEMS packaging
	SLO-2	Points of consideration for processing structural and sacrificial material.				

Learning Resources	1. Chang Liu, "Foundations of MEMS", Second Edition, Pearson , 2017 2. Tai-Ran Hsu, MEMS & Microsystem Design and Manufacturing, McGraw Hill Education (India) 1st Edition , 2015. 3. Gaberiel M. Rebiz, "RF MEMS Theory,Design and Technology", John Wiley & Sons, 2010. 4. Microsystem Design - by S. Senturia; Publisher: Springer.,	5. Charles P. Poole and Frank J. Owens, "Introduction to Nanotechnology", John Wiley & Sons, 2009. 6. Julian W.Gardner and Vijay K Varadhan, "Microsensors, MEMS and Smart Devices", John Wiley & sons, 2013. 7. Fundamentals of Microfabrication - by M. Madou; Publisher: CRC Press; 2 edition.

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	25%	-	10%	-	10%	-	-	-	10%	-
Level 2	Understand	40%	-	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	35%	-	30%	-	30%	-	30%	-	30%	-
Level 4	Analyze	-	-	25%	-	25%	-	30%	-	25%	-
Level 5	Evaluate	-	-	15%	-	15%	-	20%	-	15%	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers

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

Course Code	18ECE303T	Course Name	*Nanoelectronic Devices and Circuits*	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:*	Learning		
		1	*2*	*3*
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	*Identify the need and effects of device miniaturization*			
CLR-2 :	*Understand the principles of nano devices*			
CLR-3 :	*Learn about new devices at nano scale*			
CLR-4 :	*Create insights to the concepts of nano CMOS circuits*			
CLR-5 :	*Analyze the design considerations of the circuits*			
CLR-6 :	*Utilize the design procedure in circuits*			

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	PSO – 3: Analyze & Design
CLO-1 :	*Realize the importance of scaling of devices.*	*2*	*80*	*70*	*H*	*M*	-	-	-	-	-	-	-	-	-	-	-	-	*M*
CLO-2 :	*Identify the difference of nano devices from conventional devices.*	*2*	*85*	*75*	*H*	-	-	-	-	-	-	-	-	-	-	-	*M*	-	-
CLO-3 :	*Analyze the performance measures of various devices*	*2*	*75*	*70*	*H*	-	-	-	*H*	-	-	-	-	-	-	-	-	-	*H*
CLO-4 :	*Choose appropriate application of the device*	*2*	*85*	*80*	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-	-	*H*
CLO-5 :	*Understand the design considerations of nano circuits*	*2*	*85*	*75*	*H*	-	-	-	*M*	-	-	-	-	-	-	-	-	-	*M*
CLO-6 :	*Apply the design concepts of nano circuits in real time applications*	*2*	*80*	*70*	*H*	*M*	-	-	-	-	-	-	-	-	-	-	*M*	-	*M*

Duration (hour)		Introduction to Nano Devices	Silicon MOSFETs- Novel Materials and Alternative Concepts	Nano Devices – Principles and Techniques	Nano- CMOS scaling Problems and Implications	Mixed Signal Circuit Design
		9	9	9	9	9
S-1	**SLO-1**	MOS transistor- A First Glance at the Device	SOI MOSFET, partially depleted	Classical transport: classical resistance and conductance	Design Methodology in the Nano-CMOS Era	Design Considerations – Device Modeling
	SLO-2	The MOS Transistor under Static Condition	fully depleted SOI	Quantum ballistic transport: quantum Resistance and conductance	Innovations needed to continue performance scaling -	Passive Components
S-2	**SLO-1**	MOS Transistor Capacitances-Channel Capacitance	Strained channel MOSFET,	Coulomb blockade effect	Sub-100-nm Scaling Challenges- Back-End-of-Line Challenges (Metallization)-	Design Using Thin Oxide Devices – Design Using Thick Oxide Devices
	SLO-2	Junction Capacitance	Hi-k gate dielectric, Metal gate electrode	Single Electron Transistor	Interconnect scaling-copper wire technology	Low-Voltage Techniques
S-3	**SLO-1**	The Actual MOS Transistor—Some Secondary Effect	Double gate MOSFET	Performance of the single-electron transistor	Low –k dielectric challenges-future global interconnect technologies	Design Procedures
	SLO-2	Challenges in Nanoscale MOSFETs	FinFET	SET technology and Field effect transistors	Front-End-of-Line Challenges (Transistors)-Quantum effects model	Electrostatic Discharge Protection
S-4	**SLO-1**	Scaling of transistor dimensions	Tunnel Effect	Carbon Nano Tube(CNT)	Polysilicon gate , Metal gate electrodes,	Multiple-Supply Concerns
	SLO-2	Moore's law	Tunneling through a potential barrier	Electronic properties of CNT	Direct tunneling gate leakage-Parasitic capacitance	Noise Isolation
S 5-6	**SLO-1**	Short Channel Effects (SCE) : Sub-threshold Conduction,	Potential energy profiles for material interfaces	Geometrical structure, Electronic structure of CNT Transport properties	Reliability concerns	Guard Ring Structures Isolated NMOS Devices
	SLO-2					

S-7	**SLO-1**	Drain Induced Barrier Lowering	Metal -insulator, metal -semiconductor	CNTFET, comparison of Si MOSFET with CNTFET	Process Control Reliability	Epitaxial Material versus Bulk Silicon –
	SLO-2	Velocity Saturation, Hot electrons	Metal –insulator -metal junctions	FeFET	Lithographic Issues	Decoupling
S-8	**SLO-1**	Emergence of new materials,	Tunneling Diode	Principle of Spintronics	Mask Data Explosion	Power Busing
	SLO-2	Hi-k materials and its issues	Resonant Tunneling diode	Spin valves, SpinFET	New Breed of Circuit	Integration Problems
S-9	SLO-1	metal gate, copper interconnect and	Three-terminal resonant tunneling devices	Magnetic Tunnel Junctions	– Physical Design – Modeling Challenges	Corner Regions
	SLO-2	low-k interlayer dielectric	inverter and logic OR gates based on RTD	MRAM	Need for Design Methodology Changes	Neighboring Circuitry

Learning Resources	1. *Rainer Waser (Ed.), "Nanoelectronics and Information Technology",Wiley-VCH, Third, Completely Revised and Enlarged Edition, 2012.* 2. *Jan M. Rabaey, Anantha Chandrakasan, and Borivoje Nikolic," Digital Integrated Circuits 2nd edition", Pearson, 2000.* 3. *Ban P. Wong, Anurag Mittal, YuCao, Gren Starr, "Nano- CMOS Circuit and Physical Design", John Willey and sons Publication, 2005*	4. *George W. Hanson, "Fundamentals of Nanoelectronics", Prentice Hall, 20073.Karl Goser, Peter GlÖsekötter,Jan Dienstuhl, "Nanoelectronics and Nanosystems", Springer, 2004* 5. *Vladimir V. Mitin, Viatcheslav A. Kochelap, Michael A. Stroscio, "Introduction to Nanoelectronics: Science, Nanotechnology, Engineering, and Applications", Cambridge University Press, 2012*

Learning Assessment

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

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auditoru

Course Code	18ECE304T	Course Name	Microwave Integrated Circuits	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18ECC105T	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 microwave circuits	Bloom's level(1-6)
CLR-2 :	Analyze matching networks and filter design	Level of Thinking (Bloom)
CLR-3 :	Identify and implement amplifiers and oscillators	
CLR-4 :	Layout the types of mixers and control circuits	
CLR-5 :	Understand techniques used to fabricate and measurement of MICs	
CLR-6 :	Introduce Analyze and realize microwave circuits and its techniques	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning
CO-1 :	Illustrate the detailed considerate on different types of MICs, devices and parameters to be used in MICs	4
CO-2 :	Discover the concept of frequency parameters, ZY smith chart and its interpretation in the analysis and design of matching circuits	3
CO-3 :	Familiarize the methodologies on the design of Amplifiers and Oscillators	3
CO-4 :	Identify different types of Mixer and Microwave diodes	4
CO-5 :	Offer in depth knowledge on the fabrication of MIC devices and to provide different measurement techniques of MICs	4

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

Duration (hour)		Introduction to MIC	Matching Circuits	Microwave Amplifiers and Oscillators	Mixers and Microwave Diodes	MIC Measurement Techniques
		9	9	9	9	9
S-1	SLO-1	Introduction to MICs	Circuit Representation of two port RF/Microwave Networks	Introduction to amplifiers	Introduction to Mixers	Microwave Integrated Circuits : Introduction to SOC, SOP
	SLO-2			Stability considerations in active networks		
S-2	SLO-1	Frequency Bands	Low Frequency Parameters	Gain Consideration in Amplifiers	Mixer Types	MIC Materials.
	SLO-2	Lumped versus Distributed Circuits	High Frequency Parameters			
S-3	SLO-1	Behavior of finite length transmission lines	Transmission Matrix	Noise Consideration in active networks	Conversion Loss	Hybrid versus Monolithic MICs
	SLO-2					
S-4	SLO-1	General Characteristics of PC Boards	ZY Smith Chart	Broadband Amplifier design	SSB Mixers	Multichip Module Technology
	SLO-2			Low Noise Amplifier Design	DSB Mixers	
S-5	SLO-1	Transmission Lines on PC Boards	ZY Smith Chart	Introduction to oscillators	Design of Mixers: Single Ended Mixers	Fabrication Techniques
	SLO-2					
S-6	SLO-1	Passives made from Transmission Lines	Design of Matching Circuits using Lumped Elements	Oscillator versus Amplifier Design	Single Balanced Mixers	Miniaturization techniques
	SLO-2					

S-7	**SLO-1**	Resonators	Design of Matching Circuits using Lumped Elements	Oscillation conditions	Sub Harmonic Diode Mixers	Test fixture measurements
	SLO-2		Matching Network Design using Distributed Elements			
S-8	**SLO-1**	Combiners and Splitters	Matching Network Design using Distributed Elements	Design and stability considerations of Microwave Transistor Oscillators.	Microwave Diodes	probe station measurements
	SLO-2					
S-9	**SLO-1**	Couplers	Filter design	Design and stability considerations of Microwave Transistor Oscillators.	Phase Shifters and PIN Diode Attenuators	thermal and cryogenic measurements
	SLO-2					

Learning Resources	1. Thomas H.Lee, "Planar Microwave Engineering", Cambridge University Press, 2004 2. Matthew M. Radmanesh, "Radio Frequency and Microwave Electronics", Pearson Education, II Edition 2002 3. Guillermo Gonzalez, "Microwave Transistor Amplifiers – Analysis and Design", II Edition, Prentice Hall, New Jersy. 4. Ravender Goyal, "Monolithic MIC; Technology & Design", Artech House, 1989. 5. Gupta K.C. and Amarjit Singh, "Microwave Integrated Circuits", John Wiley, New York, 1975.	6. Hoffman R.K. "Handbook of Microwave Integrated Circuits", Artech House, Boston, 1987. 7. Ulrich L. Rohde and David P.N., " RF / Microwave Circuit Design for Wireless Applications", John Wiley, 2000. 8. C. Gentili, "Microwave Amplifiers and Oscillators", North Oxford Academic, 1986. 9. Samuel. Y. Liao, "Microwave Circuit Analysis and Amplifier Design", Prentice Hall. Inc., 1987.

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%	
Level 2	Understand	*20 %*		20%		20%		*20 %*		20%	
Level 3	Apply	*40 %*		60%		40%		*30 %*		40%	
Level 4	Analyze	*20 %*				20%		*30 %*		20%	
Level 5	Evaluate										
Level 6	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

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

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

Course Code	18ECE305J	Course Name	ARM -SoC	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

Pre-requisite Courses	18ECE204J	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 (Bl	Expected Proficiency (%	Expected Attainment (%
CLR-1 :	Acquire knowledge on hardware architecture of ARM Cortex-M core			
CLR-2 :	Explore the AHB architecture			
CLR-3 :	Select AHB peripherals for interfacing			
CLR-4 :	Experiment with high speed peripherals			
CLR-5 :	Develop applications with CMSIS			
CLR-6 :	Understand and learn to use ARM Cortex-M processor architecture, and deice level programming.			

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 (Bl	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	PSO – 3: Analyze & Research
CLO-1 :	Explain hardware and register architecture of ARM Cortex-M based processors	1	65	60	-	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-2 :	Classify AHB and its signals	1	65	60	-	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-3 :	Choose and program high speed peripherals	2	65	60	-		-	H	M	-	-	-	-	-	-	-	H		-
CLO-4 :	Assess high speed peripherals with case study.	3	65	60	-	L	-	H	M	-	-	-	-	-	-	-	-	H	-
CLO-5 :	Interpret program device driver and create libraries.	3	65	60	-		-	H	-	-	-	-	-	-	-	-	-	H	-
CLO-6 :	Survey system programming of ARM Cortex-M based processor.	2	65	60	-	L	-	H	M	-	-	-	-	-	-	-	H	-	-

Duration (hour)		12 ARM Cortex-M architecture	12 ARM Internal bus	12 ARM pheripherals	12 SOC programming	12 Case studies
S-1	SLO-1	*Introduction to Programmable SoC*	*AMBA 3 AHB Lite architecture*	*AHB UART peripheral*	*Programming an SOC using C language*	*Graphics LCD interfacing*
	SLO-2	*Introduction to Programmable SoC*	*AMBA 3 AHB Lite architecture*	*AHB UART peripheral*	*Programming an SOC using C language*	*Graphics LCD interfacing*
S-2	SLO-1	*ARM architecture*	*AMBA 3 AHB Lite architecture*	*AHB UART peripheral*	*APB Bus*	*Board support package*
	SLO-2	*ARM architecture*	*AMBA 3 AHB Lite architecture*	*AHB UART peripheral*	*APB Bus*	*Board support package*
S 3-4	SLO-1 SLO-2	***Lab-1:ARM Keil IDE usage – sample ARM program.***	***Lab 4: Study of AHB peripheral***	***Lab 7:*** *Multinode I2C Bus*	***Lab 10: Making a device driver***	***Lab 13: Case study – 2***
S-5	SLO-1	*ARM Register architecture*	*AHB SRAM controller*	*AHB timer*	*ARM CMSIS*	*Ethernet interfacing*
	SLO-2	*ARM Register architecture*	*AHB SRAM controller*	*AHB timer*	*ARM CMSIS*	*Ethernet interfacing*
S-6	SLO-1	*ARM assembly language*	*AHB SRAM controller*	*AHB-APB bridge*	*Device drivers*	*Ethernet interfacing*
	SLO-2	*ARM assembly language*	*Review and discussions*	*AHB-APB bridge*	*Device drivers*	*Ethernet interfacing*
S 7-8	SLO-1 SLO-2	***Lab 2: Assembly language programming of ARM processor using Keil IDE***	***Lab 5: ARM memory management***	***Lab 8: Application of timers***	***Lab 11: Using CMSIS***	***Lab 14: Model lab examination***
S-9	SLO-1	*ARM Cortex-M Architecture -1*	*AHB VGA peripheral*	*Fast GPIO programming*	*Application programming*	*Student Seminar / discussions*
	SLO-2	*ARM Cortex-M Architecture -1*	*AHB VGA peripheral*	*Fast GPIO programming*	*Application programming*	*Student Seminar / discussions*
S-10	SLO-1	*ARM Cortex-M Architecture -2 (pipelines)*	*AHB VGA peripheral*	*Interrupt mechanism of ARM*	*Case study - 1*	*Student Seminar / discussions*
	SLO-2	*ARM Cortex-M Architecture -2*	*AHB VGA peripheral*	*Interrupt mechanism of ARM*	*Case study - 2*	*Student Seminar / discussions*

S 11-12	SLO-1 SLO-2	***Lab 3: Parallel port programming***	***Lab 6: Graphics application***	***Lab 9: Experimenting*** *Interrupts, Timers*	***Lab 12: Study of USB interface***	***Lab 15: Final lab examination***

Learning Resources	1. *Steve Furber, "ARM System on a Chip Architecture – 2nd Edition", Pearson Education, 2000.* 2. *"AMBA -3 APB Protocol", ARM Limited, 2003. "*	3. *AMBA -3 AHB Lite Protocol", ARM Limited, 2003.T* 4. *heory/Lab teaching materials, "Introduction to SoC kit", ARM Education media, 2018.*

Learning Assessment

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

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

Course Code	18ECE306J	Course Name	ARM based Digital Signals Processing	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

Pre-requisite	18ECE204J	Co-requisite	Nil	Progressive	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 (1-6)	Program Outcomes (PO)												PSO		
				1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design,	5 Modern Tool Usage	6 Society & Culture	7 Environment &	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	1 Professional Achievement	2 Project Management Techniques	3 Analyze & Research
CLR-1 :	Explore the concepts of Digital signal processing and its properties																	
CLR-2 :	Apply transforms in solving digital signal processing																	
CLR-3 :	Develop FIR filters for various applications																	
CLR-4 :	Implement the use of IIT filters for various applications																	
CLR-5 :	Experiment the adaptive filter techniques with standard libraries																	
CLR-6 :	Test the DSP applications in the embedded ARM Cortex-M processor platform																	
Course Outcomes (CO):	At the end of this course, learners will be able to:																	
CO-1 :	Define the theory and application of discrete time signals and processing		1		3											3		
CO-2 :	Analyze problems using Z-transforms, DFT and FFT.		2		3		3	2								3		
CO-3 :	Apply the FIR filter concepts in C programming.		3		1		3	2									3	
CO-4 :	Investigate the IIR filter concepts in C programming		3		1		3	2									3	
CO-5 :	Demonstrate the adaptive filter design theory, methods and its uses.		5		2		3	1										3
CO-6 :	Incorporate the concepts of DSP in ARM Cortex-M based processor		3				3	2								3		

Duration (hour)		Learning Unit / Module 1Basics of digital signals	Learning Unit / Module 2 Transforms for DSP	Learning Unit / Module 3FIR filters	Learning Unit / Module 4IIR filters	Learning Unit / Module 5DSP applications
		12	12	12	12	12
S-1	SLO-1	DT Signals-basics properties &Operations on DT signals	Z-Transform Properties	Design of Finite Impulse Response Filters-Symmetric and Antisymmetric FIR filters	Frequency Response and Characteristics of Analog Filters	Introduction-Steepest Descent Method-Least Mean Squares Method
	SLO-2	DT Signals-basics properties &Operationson DT signals	Z-Transform Properties	Design of Finite Impulse Response Filters-Symmetric and Antisymmetric FIR filters	Frequency Response and Characteristicsof Analog Filters	Introduction-Steepest Descent Method-Least Mean Squares Method
S-2	SLO-1	DT systems-Properties of DT Systems – LTI system	Inverse Z-Transform-solving DifferenceEquation	Design of Linear- Phase FIR filters Using window methods	IIR Filter Design by Impulse Invariance	Adaptive Filters: Prediction and System Identification
	SLO-2	DT systems-Properties of DT Systems –LTI system	Inverse Z-Transform-solving Difference Equation	Design of Linear- Phase FIR filters Usingwindow methods	IIR Filter Design by Impulse Invariance	Adaptive Filters: Prediction and SystemIdentification
S3-4	SLO-1	***Lab 1: Introduction- Keil MDK-ARM application development Environment.***	***Lab 4: LTI System Implementation***	***Lab 7: Filter Structures in the CMSIS-DSP Library***	***Lab 10: IIR Filter Structures in the CMSIS-DSP Library***	***Lab 13: CMSIS Implementation of theLMS and Normalized LMS methods***
	SLO-2					
S-5	SLO-1	*Convolution and Correlation*	*DFT-review; problems*	*Design of Linear- Phase FIR filters Using window methods*	*Design of Butterworth filter using Bilinear Transformation*	*Adaptive Filters: Equalization and Noise Cancellation*
	SLO-2	*Convolution and Correlation*	*DFT-review; problems*	*Design of Linear- Phase FIR filters Using window methods*	*Design of Butterworth filter using Bilinear Transformation*	*Adaptive Filters: Equalization and Noise Cancellation*

S-6	SLO-1	*CT-to DT Conversion Sampling Theorem*	*DIT-FFT Radix 2 butterfly derivation -problems*	*Design of Optimum Equiripple Linear- Phase FIR filters*	*Chebyshev Filter Designs based on the*	*Adaptive Filters: Adaptive FIR Filter*

		in the Time Domain			*Bilinear Transformation*	
	SLO-2	*CT-to DT Conversion Sampling Theorem in the Time Domain*	*DIT-FFT Radix 2 butterfly derivation - problems*	*Design of Optimum Equiripple Linear-Phase FIR filters*	*Chebyshev Filter Designs based on the Bilinear Transformation*	*Adaptive Filters: Adaptive FIR Filter*
S7-8	**SLO-1**	***Lab 2: Digital Signals-operations onDigital Signals***	***Lab 5: Calculating the DFT-FFT***	***Lab 8: FIR Filter Design***	***Lab 11: IIR Filter Design***	***Lab 14: Model Practicals***
	SLO-2					
S-9	**SLO-1**	Sampling Theorem in the Frequency Domain-Aliasing	Filtering in the FD-Circular & Convolution	Design of Optimum Equiripple Linear-Phase FIR filters	Chebyshev Filter Designs based on the Impulse Invariance	Review, Problems and Discussions
	SLO-2	Sampling Theorem in the Frequency Domain-Aliasing	Filtering in the FD-Circular & Convolution	Design of Optimum Equiripple Linear-Phase FIR filters	Chebyshev Filter Designs based on the Impulse Invariance	Review, Problems and Discussions
S-10	**SLO-1**	Reconstruction in the Frequency Domain &time Domain	Filtering in the FD-Linear Convolution	Filter Design using Software	Filter Design using Software	*Review, Problems and Discussions*
	SLO-2	Reconstruction in the Frequency Domain & time Domain	Filtering in the FD-Linear Convolution	Filter Design using Software	Filter Design using Software	*Review, Problems and Discussions*
S 11-12	**SLO-1**	***Lab 3: A-D & D-A conversion-Changingthe Sampling Frequency***	***Lab 6: Filtering in the Frequency Domain***	***Lab 9: Implementing a FIR Filter usingDifferent Structures***	***Lab 12: Implementing a Filter usingDifferent Structures***	***Lab 15: University practicals***
	SLO-2					

Learning Resources	1. *Cem Unsalan, M. Yerkin Yuccel, H. Deniz Gurham, "Digital Signal Processing Using ARM Cortex-M based microcontrollers, Theory and Practice", ARM Education Media, 2018.*	2. *Theory/Lab teaching materials, ARM Educational Media.*

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.,

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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. Mr. U. Hari, SRMIST*

Course Code	18ECE307J	Course Name	Applied Machine Learning	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning
CLR-1 :	Define the Machine Learning concept and types	
CLR-2 :	Illustrate usage of Multiplayer Perceptron and Decision Tree models	
CLR-3 :	Demonstrate Clustering, SOM and HMM applications	
CLR-4 :	Develop Bayes Network, Reinforcement Learning and CNN model using python	
CLR-5 :	Infer Genetic Algorithm and ML Applications	
CLR-6 :	Create insights to the concepts and programming of machine learning algorithms	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Program Outcomes (PO)												PSO		
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
			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
CO-1 :	Define linear machine learning models and its programing	2	3	2	-	-	2	-	-	-	-	-	-	-	3	-	-
CO-2 :	Construct Multiplayer Perceptron and Decision Tree model using python code	3	3	-	2	-	2	-	-	-	-	-	-	-	-	-	2
CO-3 :	Evaluate Clustering, SOM and HMM model application using python code	4	3	-	2		2	-	-	-	-	-	-	-	2	-	-
CO-4 :	Apply Bayes Network, Reinforcement Learning and CNN for classification problem using python code	3	3	-	2	-	2	-	-	-	-	-	-	-	2	-	-
CO-5 :	Implement Genetic Algorithm and ML Applications using python code	5	3	-	2	-	2	-	-	-	-	-	-	-	2	-	-
CO-6 :	Write python code for linear / nonlinear machine learning models and deep learning models	6	3	-	2	-	2	-	-	-	-	-	-	-	2	1	-

Duration (hour)		Introduction to Machine Learning and Linear Model	Multiplayer Perceptrons and Decision Tree	Clustering, SOM and HMM	Bayes Network, Reinforcement Learning and CNN	Genetic Algorithm and Application of ML
		12	12	12	12	12
S-1	SLO-1	Introduction to Machine learning: Types of Machine Learning - Supervised Learning – Unsupervised, Learning	Multiplayer, Perceptrons	Clustering	Bayesian decision theory	The Genetic Algorithm
	SLO-2	reinforcement learning , The Curse of dimensionality	Multiplayer, Perceptrons	K-Means clustering	Bayesian decision theory	The Genetic Algorithm
S-2	SLO-1	Bias and Variance, Learning Curve	Multiplayer, Perceptrons	Hierarchical clustering	Bayesian estimation	Facial Expression Recognition
	SLO-2	Classification, Error and noise, linear regression	Multiplayer, Perceptrons	Agglomerative clustering	Bayes network	Human Emotion Research
S-3,4	SLO-1	***Lab 1: Linear Regression***	***Lab 4: Multiplayer, Perceptrons***	***Lab 7: K-Means clustering***	***Lab 10: Bayes Network***	***Lab 13: Genetic Algorithm***
	SLO-2					
S-5	SLO-1	Support Vector Machines	example of using MLP	Vector Quantization	Reinforcement learning	Facial Expression Recognition System
	SLO-2	Support Vector Machines	example of using MLP	Vector Quantization	Reinforcement learning	Facial Expression Recognition System
S-6	SLO-1	Support Vector Machines	example of using MLP	The Self-Organizing Feature Map	Reinforcement learning	Speech Emotion Recognition

	SLO-2	*Support Vector Machines*	*example of using MLP*	*The Self-Organizing Feature Map*	*Reinforcement learning*	*Speech Emotion Recognition*
S-7,8	**SLO-1**	***Lab 2: Support Vector Machines***	***Lab 5: MLP application***	***Lab 8: SOFM***	***Lab 11: Reinforcement learning***	***Lab 14: Speech Emotion Recognition Basic classification***
	SLO-2					
S-9	**SLO-1**	*basics of neural network*	*Decision Trees- classification*	*HMM*	*Understanding Convolutions*	*Neural Network Multi-Layer Perceptron Modeling For Surface Quality Prediction in Laser Machining*
	SLO-2	*Perceptrons*	*regression tree,*	*HMM*	*Understanding Convolutions*	
S-10	**SLO-1**	*LINEAR SEPARABILITY*	*pruning, rule from tree and data*	*HMM*	*CNN Building Blocks*	*Machine Learning in Cybersecurity- Supervised Learning for Misuse/Signature Detection*
	SLO-2	*Perceptrons and introduction to Multiplayer, Perceptrons*	*multivariate tree*	*HMM*	*CNN Building Blocks*	*Machine Learning in Cybersecurity- Supervised Learning for Misuse/Signature Detection*
S-11,12	**SLO-1**	***Lab 3: Perceptrons***	***Lab 6: Decision Trees***	***Lab 9: HMM***	***Lab 12: CNN***	***Lab 15: Mini project***
	SLO-2					

Learning Resources	1. *Ethem Alpaydin, "Introduction to Machine Learning", 3rd edition, MIT Press, 2014.* 2. *Stephen Marsland, "Machine Learning –An Algorithmic Perspective", 2nd edition, CRC Press, 2015.* 3. *Sumeet Dua and Xian Du , "Data Mining and Machine Learning in Cybersecurity", CRC Press, 2011.* 4. *Aurélien Géron Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems. O'Reilly Media, 2017.*	5. *Yagang Zhang, "Application of Machine Learning", Published by In-Tech, 2010.* 6. *Starter Bundle, "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017.* 7. *Dr. Adrian Rosebrock, "Deep Learning for Computer Vision with Python", Packt Publisher, 2018.* 8. *Ankur A Patel, "Hands-On Unsupervised Learning Using Python: How to Build Applied Machine Learning Solutions from Unlabeled Data", O'Reilly media, 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	*20 %*	*20%*	*5 %*	*5 %*	*5 %*	*5 %*	*5 %*	*5 %*	*5 %*	*5 %*
Level 2	Understand	30%	30%	10%	5%	10%	5%	10%	5%	10%	5%
Level 3	Apply	-	-	*20%*	*15%*	*20%*	*15%*	*15%*	*10%*	*15%*	*15%*
Level 4	Analyze			15%	20%	10%	15%	10%	15%	10%	15%
Level 5	Evaluate	-	-		-	*5 %*	*10%*	*5 %*	*10 %*	*10 %*	*10 %*
Level 6	Create							*5 %*	*5 %*	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

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

Course Code	18ECE220T	Course Name	Advanced Mobile Communication Systems	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning
CLR-1 :	Acquire the fundamental knowledge of all 4G standards	
CLR-2 :	Learn the fundamentals of the multicarrier modulation techniques	
CLR-3 :	Analyze the techniques involved in MIMO communication system	
CLR-4 :	Study the concept of Cognitive radio(CR) techniques	
CLR-5 :	Provide strong foundation for millimeter wave communication	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Bloom's level (1-6)
CO-1 :	Describe the basic concept of 4G WiMAX and LTE standards	3
CO-2 :	Analyze the various concepts of OFDM standards in wireless systems	3
CO-3 :	Apply the concepts of MIMO system, diversity concept and various channel model	4
CO-4 :	Gain the knowledge of essential concepts of Cognitive Radio(CR) technology, spectrum sensing and sharing	3
CO-5 :	Familiarize about the millimeter wave communication specification and standards	3

Program Outcomes (PO)											Program Specific Outcomes (PSO)			
1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment &	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Professional Achievement	Project Management	Analyze & Research
	-	-	3	-	-	-	-	-	-	-	3	-	-	-
-	-	-	3	-	-	-	-	-	-	-	3	-	-	-
-	-	-	3	-	-	-	-	-	-	-	3	-	-	-
-	-	-	2	-	-	-	-	-	-	-	2	-	-	-
-	-	-	2	-	-	-	-	-	-	-	2	-	-	-

Duration (hour)		Advanced cellular mobile communication systems	Multicarrier modulation technique OFDM	MIMO systems	Cognitive Spectrum management	Millimeter wave communication
		9	9	9	9	9
S-1	SLO-1	Overview of the legacy 3GPP cellular systems	Introduction to OFDM	Introduction to MIMO	Cognitive transceiver Introduction	Millimeter Wave Characteristics
	SLO-2	Overview of the legacy 3GPP cellular systems	Multicarrier Modulation Introduction	Introduction to MIMO Channel Capacity	Cognitive transceiver architecture	Introduction to Channel Performance at Mm wave communication
S-2	SLO-1	WiMAX systems: Introduction	Multicarrier Modulation	MIMO Channel Estimation	Interweaving	Channel Performance at Mm wave communication
	SLO-2	WiMAX systems: Architecture	Cyclic Prefix	MIMO Channel Estimation	Principle of interweaving	Modulation for Millimeter Wave communication
S-3	SLO-1	WiMAX systems: Architecture	Channel model	MIMO Spatial Multiplexing	Principle of interweaving	Modulation for Millimeter Wave communication
	SLO-2	WiMAX systems : Frame structure	SNR	MIMO Spatial Multiplexing	Introduction to Spectrums	Millimeter wave transmitter
S-4	SLO-1	WiMAX systems : Frame structure	SNR Performance	V- BLAST 2	Types of Spectrum	Millimeter wave Receiver
	SLO-2	WiMAX systems : Applications	SNR Problems	V- BLAST 2	Spectrum sensing	Millimeter wave Antenna

S 5-6	**SLO-1**	*LTE systems: Introduction*	*OFDM Introduction*	*MIMO Diversity*	*Disadvantages of Spectrum sensing*	*Introduction Mm wave Communications*
	SLO-2					
S-7	**SLO-1**	*LTE systems: Architecture*	*OFDM Issues*	*MIMO Diversity*	*Disadvantages of Spectrum sensing*	*Emerging applications of Mm wave Communications*
	SLO-2	*LTE systems: Architecture*	*OFDM Issues*	*Alamouti*	*Disadvantages of Spectrum sensing*	*Emerging applications of Mm wave Communications*
S-8	**SLO-1**	*LTE systems: Frame structure*	*PAPR*	*Alamouti*	*Spectrum Management*	*Millimeter Wave Standards.*
	SLO-2	*LTE systems: Frame structure*	*Frequency and timing*	*OSTBC*	*Spectrum Management*	*Introduction to Millimeter Wave Standards*
S-9	**SLO-1**	*LTE systems: application*	*Frequency offset issues*	*MIMO :OFDM system Introduction*	*Spectrum Management*	*Development of Millimeter Wave Standards.*
	SLO-2	*LTE systems: application*	*Timing offset issues.*	*MIMO :OFDM system*	*Spectrum Management*	*Development of Millimeter Wave Standards.*

Learning Resources	1. Andrea Molisch, "Wireless Communication", Cambridge University Press, 2nd edition, 2013. 2. Theodre Rappaport, "Wireless Communication: Principle and Practice", Prentice Hall, 2nd edition, 2014. 3. Kao-Cheng Huang, Zhaocheng Wang, "Millimeter Wave Communication System", Wiley IEEE Press, 2nd edition, 2011. 4. Ezio Bigleri, "MIMO Wireless Communications", Cambridge University Press, 1stedition, 2007.	5. Arslan, Hüseyin, ed. Cognitive radio, software defined radio, and adaptive wireless systems. Springer Science & Business Media, 2007.(263-284) 6. Thomas W.Rondeau, Charles W. Bostain, "Artificial Intelligence in Wireless communication", ARTECH HOUSE .2009. 7. Andrew Goldsmith, Wireless Communications, Cambridge University Press, 2005. *8.* Mischa Dohler, Jose F. Monserrat Afif Osseiran " 5G Mobile and Wireless Communication Technology", Cambridge University Press 2016.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	50%	-	25%	-	25%	-	40%	-	20%	-
Level 2	Understand	25%		25%		25%		40%		20%	
Level 3	Apply	*25%*	-	*25%*	-	*50%*	-	*10%*	-	*40%*	-
Level 4	Analyze	-		25%		-		10%		20%	
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-		-		-		-		-	
	Total	100 %		100 %		100 %		100 %		100 %	

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

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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	18ECE221T	Course Name	RADAR AND NAVIGATIONAL AIDS	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18ECC205J	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 :	Get introduced to basics of Radar System	1
CLR-2 :	Impart the knowledge of different types of Radar	
CLR-3 :	Analyze the various detection schemes	
CLR-4 :	Understand the functions of Radar transmitters and Receivers	
CLR-5 :	Understand the fundamentals of navigation system	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)
CO-1 :	Describe the principle operation of radar with the help of range equation and parameters	2
CO-2 :	Apply Doppler principle to radars and hence comprehend the features of different types of radar	4
CO-3 :	Analyze the reception of Radar signals under noise and different propagation modes	4
CO-4 :	Illustrate the functions of various parts of Radar transmitters and Receivers	3
CO-5 :	Outline the principle of navigation with aids of various navigation systems	4

Program Outcomes (PO)												Program Specific outcomes (PSO)			
1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
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
3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	3	-	-	-	-	-	-	-	-	-	-	1
3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	2	-	-	-	-	-	-	-	-	-	-	1

Duration (hour)		Introduction To Radar Equation	MTI And Pulse Doppler Radar	Detection Of Signals In Noise	Radar Transmitter And Receiver	Radio Navigation
		9	9	9	9	9
S-1	SLO-1	Introduction-Basic Radar	Introduction to Doppler Radar	Detection of Signals in Noise -Detection Criteria	Radar Transmitters and Receivers.	Introduction - Four methods of Navigation .- Positioning- Errors in Direction Finding
	SLO-2	Radar Frequencies -Applications of Radar	Introduction to MTI Radar	Probabilities of Detection and False Alarm	Linear Beam Power Tubes- Reflex Klystron	Line of sight Distance measurement
S-2	SLO-1	The Simple form of Radar Equation	Delay –Line Cancellers	Matched Filter Receiver	Linear Beam Power Tubes- TWT	Terrestrial Radio Navigation systems
	SLO-2	Tutorials	Delay –Line Cancellers	Derivation of Matched filter frequency response	Solid State RF Power Sources	Radio transmission and Reception
S-3	SLO-1	Radar Block Diagram	Doppler Filter Banks	Automatic Detector	Magnetron - Crossed Field Amplifiers	System design considerations-System Performance Parameters
	SLO-2	Receiver Noise	Digital MTI Processing	Constant-False-Alarm Rate Receivers	Magnetron - Crossed Field Amplifiers	The Loop Antenna - Adcock Direction Finders
S-4	SLO-1	Signal-to-Noise Ratio	Block Diagram of Digital MTI Doppler Signal Processor	Signal Management	Other RF Power Sources	Direction Finding at Very High Frequencies - Automatic Direction Finders
	SLO-2	Integration of Radar Pulses	Moving Target Detector - Limitations to MTI Performance	Propagation Radar Waves- Atmospheric Refraction	Other aspects of Radar Transmitter	VHF Omni Directional Range(VOR) - VOR Receiving Equipment - Range and Accuracy of VOR
S-5	SLO-1	Radar Cross Section of Targets-Simple Targets	Pulse Doppler Radar	Standard propagation	The Radar Receiver	Hyperbolic Systems of Navigation-Loran

	SLO-2	*Radar Cross Section of Targets-Complex Targets Transmitter Power*	*High, Medium and Low prf Doppler*	Nonstandard Propagation	Receiver noise Figure	Loran-C
S-6	**SLO-1**	Radar cross Section Fluctuations	*Other Doppler Radar Topics*	Ambiguity Diagram	Receiver noise Figure	The Decca Navigation System -Decca Receivers
	SLO-2	*Swerling Target Model*	*Tracking with Radar*	Ambiguity Diagram	Super heterodyne Receiver	Range and Accuracy of Decca
S-7	SLO-1	*Transmitter Power*	*Mono pulse Tracking*	Pulse compression	LNA and Mixers	TACAN
	SLO-2	*Pulse Repetition Frequency*	*Two Coordinate amplitude comparison monopulse tracking*	Linear FM pulse compression	Duplexers	TACAN Equipment
S-8	SLO-1	*Antenna Parameters*	*Conical Scan and Sequential Lobing*	Binary Phase Coded pulse compression	Receiver Protectors	Case study on Airborne Tactial networks- Instrument Landing System
	SLO-2	*System losses-Microwave plumbing loss, Antenna loss, Signal Processing loss*	*Limitations to Tracking Accuracy*	***Questionnaire***	Receiver Protectors	Case study on Airborne Tactial networks- Instrument Landing System
S-9	SLO-1	*System losses-Doppler processing, Collapsing, Operator loss, propagation Effects*	*Case study on weather radars*	Introduction to clutter	Radar Displays	Introduction to satellite Radio Navigation-
	SLO-2	*Other Radar Equation Considerations*	*Case study on weather radars*	Surface Clutter Radar equation	*Surprise Test*	Navstar Global Positioning System (GPS)

Learning Resources	*1. Merrill I. Skolnik," Introduction to Radar Systems", 3rd Edition Tata Mc Graw-Hill 2008* *2. R.B. Underdown and David Cockburn, "Ground Studies for Pilots: Radio Aids", sixth Edition, Blackwell Publishing, 2011.* *3. Myron Kayton, Walter R.Fried, "Avionics Navigation Systems", second Edition, Wiley- India Edition, 2010.* *4. N.S.*Nagaraja, "Elements of Electronic Navigation Systems", 2nd Edition, TMH, 2000.	5. Mark, Richards.A, "Fundamentals of radar signal processing", Mc-Graw Hill, Electronic Engineering, 1st Edition, 2005. 6. Jenny L. Reed, Aaron D. Lanterman, John M. Trostel," Tutorial: Weather Radar: Operation and Phenomenology", IEEE Aerospace and Electronic Systems Magazine, Vol: 32, 7, 2017. 7. Bow-Nan Cheng, Frederick J. Block, B. Russ Hamilton, David Ripplinger, Chayil Timmerman, Leonid Veytser, and Aradhana Narula-Tam," Design Considerations for Next-Generation Airborne Tactical Networks, IEEE Communications Magazine , May 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	50%	-	*20 %*	-	*20 %*	-	*20 %*	-	*25%*	-
Level 2	Understand	*50%*	-	*30%*	-	*30%*	-	*30%*	-	*25%*	-
Level 3	Apply		-	*30%*	-	*30%*	-	*30%*	-	*25%*	-
Level 4	Analyze		-	*20%*	-	*20%*	-	*20%*	-	*25%*	-
Level 5	Evaluate		-	-	-	-	-	-	-	-	-
Level 6	Create		-	-	-	-	-	-	-	-	-
	Total	100 %	-	100 %	-	100 %	-	100 %	-	100 %	-

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

Course Designers

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Course Code	18ECE222T	Course Name	ADHOC AND SENSOR 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:	Utilize the Ad hoc Networks and its various routing protocols	Blooms Level (1-6)
CLR-2:	Learn the MAC Layer and the concept of Quality of Service	
CLR-3:	Analyze energy management in Ad hoc Networks	
CLR-4:	Identify insights of Sensor network	
CLR-5:	Analyze various aspects Hybrid networks and routing configuration	
CLR-6:	Expose the different types of adhoc network routing protocols and sensor networks	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Program Outcomes (PO)														
			1	2	3	4	5	6	7	8	9	10	11	12			
			Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design,	Modern Tool Usage	Society & Culture	Environment &	Ethics	Individual & Teamwork	Communication	Project Mgt. & Finance	Lifelong Learning	PSO1- Professional Achievement	PSO2- Project Management	PSO3- Analyze &
CO- 1:	Define the Ad hoc Networks and various routing protocols used in Ad hoc networks	3	1			3											
CO-2:	Express the various functional areas such as MAC Layer and QOS	3	3		2												2
CO-3:	Analyze the energy management protocols in Ad hoc Networks	3		1		3											2
CO-4:	Write about the insights of Sensor network and its associated protocols.	4	1			3											2
CO-5:	Outline the various types of hybrid networks and adhoc network routing Scheme.	4	2			3											2

Duration (hour)		Ad hoc Wireless Networks	Quality of service in Ad hoc wireless networks	Energy Management	Wireless Sensor Network	Hybrid wireless network
		9	9	9	9	9
S-1	SLO-1	Cellular and Ad hoc Wireless Networks	Quality of service in Ad hoc wireless networks, Real-Time Traffic support	Energy Management-Needs	Sensor Networks, Applications. Comparison with Ad hoc network.	Hybrid wireless network, Introduction, classification
	SLO-2	Applications of Ad hoc Wireless Networks	Issues and challenges in providing QoS	Classifications of Energy Management Schemes	Issues, challenges in designing sensor network Sensor Network Architecture	Multi-hop cellular network (MCN) Architecture
S-2	SLO-1	Issues in Ad hoc Wireless Networks	Classifications of QoS solutions	Battery Management Scheme-Overview,	Layered Architecture, Clustered Architecture	Mobile assisted data forwarding (MADF) Architecture
	SLO-2	MAC Protocol for Ad hoc Networks Issues in Designing and Design Goals	MAC Layer solution-cluster TDMA, IEEE 802.11e, DBASE	Data link layer solution-Lazy packet scheduling scheme,	Data Dissemination, Flooding, Gossiping, Rumor Routing, Sequential Assignment Routing	Hybrid wireless Network (HWN) Architecture
S-3	SLO-1	Classifications of MAC protocols-Floor Acquisition Multiple Access protocols	Network Layer solution-QOS routing protocols,	Battery Aware MAC protocol	Cost field approach	Routing in Hybrid wireless network Base assisted ad hoc routing (BAAR)
	SLO-2	Collision Avoidance Time Allocated Protocol	Ticket Based QOS Routing protocols,	Network Layer solution	Data Gathering, Direct Transmission, Binary scheme	Operation of BAAR protocol
S-4	SLO-1	Routing Protocol for Ad hoc wireless network-Classification	Predictive location-based QOS routing	Transmission Power Management Schemes-Data link layer solution	Chain Based Three level scheme	Base driven multi-hop bridging protocol (BMBP)-Message used

	SLO-2	*Table driven Routing Protocols-Wireless Routing Protocol*	*QOS framework*	*Dynamic power adjustments policies, Distribute topology control Algorithm*	*MAC protocols for sensor Networks-Self organizing MAC, CSMA Based MAC*	*BMBP procedure*
S-5	SLO-1	*On demand routing protocols-Dynamic Source Routing protocol*	*QOS models*	*Construct distributed power control loop, Centralized Topology control Algorithm*	*Location discovery-Indoor and sensor network localization*	*Issues in pricing multi-Hop wireless networks*
	SLO-2	*Multicast Routing Architecture Reference model*	*QOS Resource Reservation Signaling*	*Network layer solution-common power protocol*	*Quality of Sensor Networks-coverage,*	*Pricing in Multi-Hop wireless WANs*
S-6	SLO-1	*Tree Based Routing*	*INSIGNIA-QOS framework*	*Minimum power consumption Technique*	*Exposure*	*Pricing in Ad hoc Wireless Networks*
	SLO-2	*Mesh Based Routing*	*Operation of INSIGNIA framework, Advantages and disadvantages*	*Minimum battery cost Routing*	*Recent Trends in Sensor Networks-Energy Efficient Design, synchronization*	*Power control scheme in Hybrid Wireless Networks, Issues in using variable power in IEEE 802.11*
S-7	SLO-1	*Energy Efficient Multicasting-Routing protocols*	*INORA-Coarse feedback scheme,*	*Higher Layer solution*	*Transport Layer Issue*	*Power optimization scheme*
	SLO-2	*Cluster Adaptation of Multicast protocols*	*Class based fine feedback scheme*	*System power management scheme, Processor power management*	*Security-Localized Encryption and Authentication protocols (LEAP)*	*Load Balancing in Hybrid Wireless Networks*
S-8	SLO-1	*Multicast with QOS Guarantees-Real Time Multicasting Protocols*	*SWAN-Model*	*Power saving Mode Power Aware Multi-Access Signaling*	*Intrusion Tolerant Routing in Wireless Sensor Network (INSENS)*	*Preferred Ring Based Routing Scheme*
	SLO-2	*Priority Scheduling Protocols*	*Advantages and Disadvantages*	*Addition of separate signaling scheme*	*Real –Time communication*	*Preferred inner Routing Scheme (PIRS)*
S-9	SLO-1	*Application Dependent Multi Cast Routing-Role Based,*	*Proactive RTMAC framework*	*Device power Management Scheme-Low Power Design of Hardware*	*SPEED Protocol*	*Preferred outer Ring Routing Scheme (PORS)*
	SLO-2	*Content Based, Location Based*	*Advantages and Disadvantages*	*Hard Disk Drive (HDD) power consumption*	*RAP protocols*	*Preferred Destination/Source Ring Based Routing Scheme*

Learning Resources	1. *Siva Ram Murthy C., Manoj B.S, Ad hoc Wireless Networks – Architectures and Protocols, 2nd ed., Pearson, 2004* 2. *Feng Zhao, LeonidasGuibas,Wireless Sensor Networks, 1st ed., Morgan Kaufman Publishers, 2004*	3. *C.K.Toh, Ad hoc Mobile Wireless Networks, 7th ed., Pearson, 2002* 4. *Thomas Brag, Sebastin Buettrich, Wireless Mesh Networking, 3rd ed., O'Reilly Publishers, 2007*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%		30%		20%		30%		20%	
Level 2	Understand	40%		40%		30%		40%		30%	
Level 3	Apply	30%		30%		30%		30%		30%	
Level 4	Analyze					20%				20%	
Level 5	Evaluate										
Level 6	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

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

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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	18ECE223T	Course Name	Satellite Communication and Broadcasting	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18ECC205J	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
CLR-1 :	Understand the orbital and functional principles of satellite communication systems	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-2 :	Architect, interpret, and select appropriate technologies for implementation of specified satellite communication systems			
CLR-3 :	Analyze and evaluate a satellite link and suggest enhancements to improve the link performance			
CLR-4 :	Select an appropriate modulation, multiplexing, coding and multiple access schemes for a given satellite communication link			
CLR-5 :	Specify, design, prototype and test analog and digital satellite communication systems as per given specifications			
CLR-6 :	Utilize the concepts in optical communication for the understanding of engineering and technology			

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 :	Demonstrate the principles, concepts and operation of satellite communication systems	2	60	65
CLO-2 :	Discuss about the satellite orbits, link design, link availability and interference	2	60	65
CLO-3 :	Analyze the concepts of Satellite systems in relation to other terrestrial systems	2	65	65
CLO-4 :	Illustrate the performance of various channel access schemes for satellite communication	2	60	65
CLO-5 :	Explain the applications of satellites and compression standards adopted in satellite communication	2	60	65
CLO-6 :	Analyze the Satellite communication and Broadcasting systems.	2	60	65

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 &	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional	PSO – 2: Project	PSO – 3: Analyze &
M	-	-	-	-	-	H	-	-	-	-	-	-	-	-
-	-	M	-	-	-	H	-	-	-	-	-	-	-	-
-	-	M	-	-	-	H	-	-	-	-	-	-	-	-
-	-	M	-	-	-	H	-	-	-	-	-	-	-	-
-	-	M	-	-	-	H	-	-	-	-	-	-	-	-
-	-	M	-	-	-	H	-	-	-	-	-	-	-	-

Duration (hour)		Satellite Orbit	Link Design	Space and Earth Segment	Multiple Access Techniques for Satellite Communication	Broadcast and Services
		9	9	9	9	9
S-1	SLO-1	Satellite Orbit	Link Design	Space Segment	Concepts of Multiple Access techniques, types	Concept of Broadcasting satellites
	SLO-2	Kepler's law	EIRP	Basic concept of space segmen	Single Access	Direct Broadcasting Satellite
S-2	SLO-1	Earth - Orbiting satellites terms	Transmission Losses	Power Supply	Pre assigned FDMA	Orbital Spacing
	SLO-2	Types of satellites	Link Power Budget equation	Altitude control	Demand Assigned FDMA	Power ratings
S-3	SLO-1	Orbital elements	System Noise	Station keeping	SPADE system	Frequency and polarization
	SLO-2	Orbit Perturbations	Carrier to noise ratio	Thermal Control	TWT amplifier operation	Transponder Capacity
S-4	SLO-1	Inclined Orbits	Types of FEC	TT&C Subsystems	Downlink analysis	Bit rate
	SLO-2	Sun synchronous orbits	Computer-Aided Design	Antenna subsystem	TDMA	MPEG
S-5	SLO-1	Constellation:Geo stationary satellites	Uplink	Transponders	Reference bursts	Forward Error Correction
	SLO-2	Non geostationary constellation	saturation flux density, input backoff	Wideband Receiver	Preamble, Postamble	Outdoor Unit
S-6	SLO-1	Launching of Geostationary satellites	Down Link	Earth Segment	Carrier recovery	Indoor Unit

	SLO-2	*Launch vehicle Types*	*output backoff, TWTA output*	*Basic concept of Earth segment*	*Network synchronization*	*Downlink Analysis*
S-7	**SLO-1**	*Antenna Look angles*	*Effects of rain*	*Receive only home TV system*	*Pre assigned TDMA*	*Uplink Analysis*
	SLO-2	*Sun transit outage*	*Inter modulation Noise*	*Community antenna TV system*	*Demand assigned TDMA*	*Satellite Mobile services*
S-8	SLO-1	*Solving Problems*	*Solving Problems*	*Solving Problems*	*CDMA*	*VSAT*
	SLO-2	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Direct Sequence Spread Spectrum , CDMA throughput*	*GPS*
S-9	SLO-1	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*
	SLO-2	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*

Learning Resources	1. *Dennis Roddy, "Satellite Communications", Tata Mc-Graw Hill Publications, 4th Edition, 13th Reprint, 2014* 2. *TIMOTHY PRATT, CHARLES BOSTIAN JERMEY ALLNUTT, Satellite Communications, John Wiley, Singapore, 2nd Edition, reprint 2013.*	3. *MadhavendraRichharia, Leslie David, "Satellite Systems for Personal Applications Concepts and Technology", Wiley-Blackwell, 1st Edition, 2010.* 4. *Louis J. IppolitoJr, "Satellite Communications Systems Engineering", John Wiley and Sons , Ltd, Publication, 1st Edition, 2008*

Learning Assessment

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

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

Course Designers

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

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:
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: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design,	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment &	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PSO–1: Professional	PSO – 2: Project Management Techniques	PSO – 3: Analyze &
CLO-1 :	Explain the methods of classical and modern Encryption	2	60	65	M	-	-	-	-	-	H	-	-	-	-	-	-	-	-
CLO-2 :	Apply the concepts of Number theory in key generation and distribution standards	2	60	65	M	-	-	-	-	-	H	-	-	-	-	-	-	-	-
CLO-3 :	Discuss about the message authentication and digital signature algorithm.	1	60	70	-	-	M	-	-	-	H	-	-	-	-	-	-	-	-
CLO-4 :	Describe about the various forms of network security	1	60	70	-	-	M	-	-	-	H	-	-	-	-	-	-	-	-
CLO-5 :	Analyze the effects of intrusion, viruses, firewalls and various levels of system security	2	60	70	-	-	M	-	-	-	H	-	-	-	-	-	-	-	-
CLO-6 :	Paraphrase about various encryption techniques, standards and security aspects	2	60	65	-	-	M	-	-	-	H	-	-	-	-	-	-	-	-

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
	SLO-1	DES	RSA	Securities	Security Associations	Advanced Security

S-5	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 Understand	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

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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	18ECE225T	Course Name	Information Theory and Coding	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18MAB203T	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 Blooms level (1-6)
CLR-1 :	Introduce source coding in information theory	Level of Thinking (Bloom)
CLR-2 :	Impart the fundamentals of error control coding techniques and their applications	
CLR-3 :	Address the noisy channel coding problem	
CLR-4 :	Assess the performance of both block and convolutional coding schemes in different practical situations	
CLR-5 :	Derive Shannon's fundamental channel capacity results	
CLR-6 :	Know about channel and impairments channel and how to mitigate them	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Program Outcomes (PO)												PSO		
			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	1 Professional Achievement	2 Project Management Techniques	3 Analyze & Research
CO-1 :	Explain the various source coding and channel coding Techniques	3	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2 :	Develop variable length codes for source coding	4	-	3	-	2	-	-	-	-	-	-	-	-	-	-	2
CO-3 :	Apply linear block codes for error detection and correction	3	2	3	-	-	-	-	-	-	-	-	-	-	-		-
CO-4 :	Demonstrate convolutional codes and turbo codes for error detection and correction	4	-	3	-	2	-	-	-	-	-	-	-	-	-		2
CO-5 :	Illustrate the channel capacity for various channels..	4	3	2	-	-	-	-	-	-	-	-	-	-	-	-	2

Duration (hour)		Source coding	Variable-Length Codes	Error Detecting and Error Correcting Codes	Convolutional Codes	Entropy and Channel Capacity
		9	9	9	9	9
S-1	SLO-1	**Introduction to Information theory**	Unique decoding	Hamming codes Generation	Convolutional codes introduction	Entropy
	SLO-2	Model of signaling system	**Rules and construction of** Unique decoding	**Hamming code checking**	Convolutional codes generation	Mathematical properties
S-2	SLO-1	**Block Diagram**	Instantaneous codes	Hamming weight	Convolutional encoder	Entropy and coding
	SLO-2	Mathematical models for information sources	Construction of Instantaneous codes	Hamming distance	**Encoder for different rates**	System entropies
S-3	SLO-1	Encoding a source alphabet	The Kraft's inequality	Minimum distance decoding	code tree formation	Mutual information
	SLO-2	**Source coding**	Shortened block codes	Linear block codes Generator polynomial	code tree formation	**Example Problem solving-** Mutual information
S-4	SLO-1	ASCII code	The McMillan's Inequality	Linear block codes Generation	state diagram generation	Shannon-Fano coding
	SLO-2	**Code Formation for an information**	Huffman codes	Linear block codes Decoding	state diagram generation for different rates	**Example Problem solving-** Shannon-Fano coding
S-5	SLO-1	Radix r code	Huffman codes -special cases	**Example Problem solving-** Linear block codes	trellis diagram for decoding convolutional codes	Classification of channels

	SLO-2	**Different examples for different 'r'**	Extensions of a code	Cyclic codes Generator polynomial	trellis diagram for decoding convolutional codes	Channel Capacity
S-6	**SLO-1**	Simple parity checks – Generator	Huffman codes Radix r	Cyclic codes Generation	Maximum likelihood decoding of convolutional codes	Calculation of channel capacity
	SLO-2	Simple parity **Checker**	**Example Problem solving in Huffman coding**	Cyclic codes Decoding	Maximum likelihood decoding of convolutional codes	**Types of channel**
S-7	**SLO-1**	CRC codes-Generation	**Example Problem solving in Huffman coding-special cases**	**Example Problem solving -**Cyclic codes	Sequential decoding of convolutional codes-	Conditional mutual information
	SLO-2	CRC codes-Checking	Noise in Huffman coding probabilities	**Example Problem solving-** Syndrome calculation	Sequential decoding of convolutional codes	Random encoding
S-8	**SLO-1**	Single parity checks	Use of Huffman codes	Block encoders	Applications of Viterbi decoding	Average random code
	SLO-2	Double parity checks	Hamming coding	Block Decoders	Viterbi decoding	Fano bound
S-9	**SLO-1**	Miscellaneous codes	**Example Problem solving in Hamming coding**	**Assignment Problems in Linear Block codes**	Turbo codes	Converse of Shannon's theorem
	SLO-2	**Problems in source coding with different radix and parity**	**Assignment Problems in Huffman and Hamming coding**	**Assignment Problems in Cyclic codes**	**Assignment Problems in Convolutional codes**	**Assignment Problems in Channel capacity and mutual information**

Learning Resources	1. Kennedy, "Electronic Communication systems", McGraw Hill, 4th Ed., 1999 2. Daniel Costello, and Shu Lin, "Error Control coding fundamentals and applications", Prentice Hall Inc, 1983 3. Hamming, Richard W, "Coding and Information Theory", Prentice Hall Inc., NJ, 1986.	4. Proakis J. G., "Digital Communications", McGraw Hill Inc., 4th Edition, NY, 2001. 5. Simon Haykin, "Communication System", Wiley, 2008

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20 %*		10%		15%		30%		15%	
Level 2	Understand	*20 %*		30%		25%		40%		25%	
Level 3	Apply	60%		40%		40%		30%		40%	
Level 4	Analyze			20%		20%				20%	
Level 5	Evaluate										
Level 6	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

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

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Course Code	18ECE226T	Course Name	Optical Components, Systems and Networks	Course Category	E	Professional Elective	3	0	0	3

Pre-requisite Courses	18ECC302J	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 basics working principle of optical fibers, fiber modes configurations and structures.*	
CLR-2 :	*Learn the various optical source materials, LED structures, quantum efficiency, Laser diodes. To learn the fiber optical network components, switches, EDFA, SOA.*	
CLR-3 :	*Acquire the basic knowledge of fiber optical receivers such as PIN APD diodes, noise performance in photo detector, receiver operation and configuration.*	
CLR-4 :	*Get the knowledge on optical wave guides modulators and other signal degradation factors*	
CLR-5 :	*Understand the basic working principle of WDM, DWDM etc..*	
CLR-6 :	*Understand, the basic optical networks and their applications*	

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Blooms Level (1-6)	Program Outcomes (PO) 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	(PSO) 1 Professional Achievement	2 Project Management	3 Analyze & Research
CO-1 :	*Interpret the fundamentals of light transmission through an optical fiber and their attenuation mechanisms.*	*3*	*1*	*2*	-	*3*	-	-	-	-	-	-	-	-	-	-	-
CO-2 :	*Express the principle and operation of various display devices, light sources, amplifiers and various problems related to optical transmitters.*	*2*	*3*	*2*	-	-	-	-	-	-	-	-	-	-	*3*	-	-
CO-3 :	*Analyze various photodetectors with their noise performance, receiver operation and configuration.*	*4*	*1*	*3*	-	*2*	-	-	-	-	-	-	-	-	*3*	-	-
CO-4 :	*Examine the knowledge of various optical modulators and switches used in optical communication and acquaint with OEIC design*	*3*	*1*	*2*	*3*	-	-	-	-	-	-	-	-	-	*3*	-	-
CO-5 :	*Implement fiber optic links based on power budgets and multichannel optical communication system using WDM and DWDM techniques*	*5*	-	*1*	*2*	*3*	-	-	-	-	-	-	-	-	-	-	*3*

Duration (Hour)		Optical Fibers and transmission characteristics	Optical Sources, Amplifier and Transmitter	Optical Detectors and receivers	Optical modulators, switches and OEICs	Optical communication systems
		9	9	9	9	9
S-1	SLO-1	*Elements of Optical fiber communication, Optical spectral bands*	*Introduction to Luminescence: Photo, electro, cathode, injection luminescence*	*Photo detection principle*	*Electro optic modulators*	*Point to point links*
	SLO-2	*Optical fiber structure, Light Propagation in Optical fibers: Ray theory, Total Internal reflection, Skew rays, Fiber types: SI, GI, MM, SM*	*Plasma display, LCD*	*Photoconductor,*	*Acousto optic modulators*	*Digital and analog systems design considerations*
S-2	SLO-1	*Overview of Modes, Cutoff wavelength and V number,*	*LED: Choice of material,*	*Noise in photoconductors, SNR*	*Interferometry modulators*	*Digital link design,*
	SLO-2	*Problems on v-number*	*LED Structures; Surface and Edge emitters,*	*Response time*	*Semiconductor optical amplifiers*	*Links power budget*
S-3	SLO-1	*Wave Equations for Step index fiber, Modal equation, Modes in SI fibers*	*Quantum efficiency and power, LED Characteristics*	*Problems on response time and SNR*	*Optical switching and logic devices*	*Rise time budget*
	SLO-2	*Problems on V-number, modes*	*Problems on LED quantum efficiency*	*Problems on Photoconductor*	*Problems on modulators*	*Overview of analog links*
S-4	SLO-1	*Special Fibers introduction, Polarization Maintaining fibers,*	*Semiconductor Laser Diode, Operating principles,*	*Photodiode: PIN Photodiode*	*Optical switching*	*Radio over fibers*
	SLO-2	*Photonic Crystal fibers, Dispersion compensated fiber*	*Emission absorption and radiation*	*Avalanche photodiode*	*Logic devices*	*Key link parameters*

S-5	**SLO-1**	*Attenuation Introduction*	*Population inversion*	*Detector performance parameters*	*Hybrid integration*	*Multichannel systems*
	SLO-2	*Material Adsorption, Scattering, bending and core cladding losses*	*Optical feed- back, Threshold condition*	*Detectors for long wavelength operation*	*Monolithic integration*	*Need for multiplexing*
S-6	**SLO-1**	*Problems*	*External Quantum efficiency, LASER Characteristics*	*wavelength selective detection*	*Comparison of hybrid and monolithic*	*Operating principle of WDM*
	SLO-2	*Overview of Signal dispersion in fibers*	*Problems on LASER quantum efficiency*	*Fundamental receiver operation*	*Slab waveguides*	*Operating principle of DWDM*
S-7	**SLO-1**	*Dispersion limitations, Intermodal dispersion*	*Single mode Laser: VCSEL*	*Front end amplifier and decision circuit*	*Strip waveguides*	*WDM components*
	SLO-2	*Intra-Modal dispersion: Material dispersion,*	*Introduction to Fiber Amplifiers*	*Functional block diagram of receiver circuit*	*Guided wave devices*	*Couplers/splitters*
S-8	**SLO-1**	*Waveguide dispersion and PMD*	*EDFA*	*Measurement standards, basic test equipment*	*Active filters*	*Isolators and circulators*
	SLO-2	*Problems on Dispersion*	*SOA*	*Optical spectrum analyzer*	*Problems*	*Machzender interferometer*
S-9	**SLO-1**	*Non linear effects : Non linear scattering, Kerr effects*	*Modulation characteristics and Driver circuits*	*Oprtical power meter*	*Integrated Transmitter*	*Fabry perot filters*
	SLO-2	*Fiber alignment and Joint Loss, Fiber Splices Optical fiber connectors, Expanded Beam Connectors*	*Functional block diagram of a Transmitter module*	*OTDR*	*Integrated Receivers*	*Optical MEMS*

Learning Resources	1. *Gerd Keiser, "Optical Fiber Communication" McGraw –Hill International, Singapore, 3rd edition, 2000* 2. *J. Wilson and JF B Hawkes "Optoelectronics – An Introduction"' 3rd Edition PearsonEducation Taiwan Ltd 2010* 3. *Pallab Bhattachara "Semiconductors Optoelectronics Devices", 2nd Edition, Prentice Hall of India Pvt Ltd, New Delhi, 2009.* 4. *Jasprit Singh " Optoelectronics- An Introduction to Materials and Devices",Mc Graw HillEducation India 2014.* 5. *S C Gupta " Optoelectronics Devices and systems", 2nd Edition, Prentice Hall of India, 2015.*	6. *S O Kasap "Optoelectronics and Photonics: Principles and practices", 2nd Edition Person Education International, 2012.* 7. *Rajiv Ramaswami, Kumar N. Sivaranjan, "Optical Networks A practical perspective", 2nd edition, Elsevier, 2004* 8. *Djafar K. Mynbaev, Lowell L. Scheiner, "Fiber-Optic Communications Technology", 1st edition, Pearson Education, 2001.* 9. *John Powers, "An Introduction to Fiber optic Systems", 2nd edition, Irwin-McGraw Hill,1999.* 10. *J.Gowar, "Optical Communication System", 2nd edition, Prentice Hall of India, 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	*30 %*	-	*10 %*	-	*10 %*	-	*15 %*	-	*15 %*	-
Level 2	Understand	- *40 %*		20 *30 %*		*10 %*		*15 %*		*15 %*	
Level 3	Apply	*30 %*	-	*30 %*	-	*15 %*	-	*20%*	-	*20%*	-
Level 4	Analyze	-----		*30 %*		*35 %*		*20%*		*20%*	
Level 5	Evaluate	-	-	-	-	*30 %*	-	*30%*	-	*30%*	-
Level 6	Create	-									
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers

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

Course Code	18ECE320T	Course Name	SOFTWARE DEFINED NETWORKS	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18ECC303J	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 :	Understanding SDN- Evolution	
CLR-2 :	Understanding The Control Plane, Data Plane of SDN	
CLR-3 :	Analyze and understand various SDN controller	
CLR-4 :	Create insights to the standard OpenFlow for SDN	
CLR-5 :	understand the Network Programmability for SDN and SDN Open Source	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Program Outcomes (PO)													PSO		
			1 Engineering	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	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CO-1 :	Express the SDN architecture and its benefits	2	3	-	-	-	2	-	-	-	-	-	-	-	3	-	-
CO-2 :	Analyze SDN controllers and **D**evices functionality and architecture	2	3	-	2	-	-	-	-	-	-	-	-	-	2	-	-
CO-3 :	Evaluate the programming elements of SDN and OpenFlow	4	3	-	-	-	2	-	-	-	-	-	-	-	2	-	-
CO-4 :	Compile SDN Application and Use Case	4	3	-	2	-	-	-	-	-	-	-	-	-	-	2	-
CO-5 :	Implement SDN for **Mobile Networks**	5	3	-	2	-	-	-	-	-	-	-	-	-	-	-	1

Duration (hour)		Basics of SDN	SDN Devices and Controller	OpenFlow, Programmability and the Management Interface	SDN Application and Use Case	SDN Implementation and Mobile Networks
		9	9	9	9	9
S-1	SLO-1	Introduction to SDN- Evolution of Switches and Control Planes , Cost	How SDN Works- Fundamental Characteristics of SDN	OpenFlow Overview- The OpenFlow Switch, The OpenFlow Controller,	SDN in the Data Center - Data Center Definition, Data Center Demands	SDN Open Source-Chapter-Specific Terminology ,Open Source Licensing Issues
	SLO-2	Introduction to SDN - SDN Implications for Research and Innovation	SDN Operation, SDN Devices	The OpenFlow Protocol, The OpenFlow Protocol	Tunneling Technologies for the Data Center.	Profiles of SDN Open Source Users ,OpenFlow Source Code,
S-2	SLO-1	need of SDN- Data Center Innovation,	SDN Controller	OpenFlow 1.0 and OpenFlow Basics- Ports and Port Queues, Flow Table, Packet Matching,	Path Technologies in the Data Cente Ethernet Fabrics in the Data Center	Switch Implementations , Controller Implementations SDN Applications
	SLO-2	need of SDN- Data Center Needs	SDN Applications ,Alternate SDN Methods	Actions and Packet Forwarding, Messaging Between Controller and Switch	SDN Use Cases in the Data Center	Simulation, Testing, and Tools, OpenStack, Example: Applying SDN Open Source .
S-3	SLO-1	Genesis of SDN- The Evolution of Networking Technology	General Concepts of SDN Controller	Example: Controller Programming Flow Table ,Example: Basic Packet Forwarding, Example: Switch Forwarding Packet to Controller	Open SDN versus Overlays in the Data Center	SDN Futures-Current State of Affairs
	SLO-2	the Genesis of SDN- **f**orerunners of SDN	VMware	OpenFlow 1.3 Additions and OpenFlow Limitations	Real-World Data Center Implementations	Potential Novel Applications of Open SDN
S-4	SLO-1	the Genesis of SDN- **s**oftware Defined Networking is Born, Sustaining SDN Interoperability	Nicira	Introduction to Network Programmability and The Management Interface	SDN in Other Environments - Wide Area Networks. Service Provider and Carrier Networks	role of SDN in 5G- Drawback of hardware-based network functions., Network Functions Virtualization (NFV) and Software Defined Networking (SDN) in 5G

	SLO-2	*Open Source Contributions, Legacy Mechanisms Evolve Toward SDN , Network Virtualization*	*VMware/Nicira*	*The Application-Network Divide*	*Campus Networks, Hospitality Networks*	*optimization models that aim at finding the optimal design for a mobile core network based on SDN and NFV*
S-5	**SLO-1**	*The Control Plane, Data Plane*	*OpenFlow-Related ,*	*Modern Programmatic Interfaces- Publish and Subscribe Interfaces, XMPP*	*Mobile Networks. In-Line Network Functions,*	*SDN and NFV Mobile Network Architectures*
	SLO-2	*Moving Information Between Planes, Separation Importance*	*Mininet ,NOX/POX*	*Google's Protocol Buffers , Thrift ,JSON*	*Optical Networks*	*Dimensioning and Resource Allocation Problems*
S-6	**SLO-1**	*Distributed Control Planes- IP and MPLS, Creating the IP Underlay, Convergence Time*	*Trema, Ryu*	*I2RS 143 Modern Orchestration- OpenStack*	*SDN vs. P2P/Overlay Networks*	*Mobile Core Network Architecture*
	SLO-2	*Load Balancing ,High Availability, Creating the MPLS Overlay, Replication*	*Big Switch Networks/Floodlight,*	*CloudStack, puppet*	*SDN Applications- reactive versus Proactive Applications ,Analyzing Simple SDN Applications ,*	*SDN Mobile Core Network Architecture*
S-7	**SLO-1**	*Centralized Control Planes- Logical Versus Literal*	*Layer 3 Centric, L3VPN*	*Introduction to Network Function Virtualization, Virtualization and Data Plane I/O*	*A Simple Reactive Java Application, Background on Controllers*	*NFV Mobile Core Network Architecture*
	SLO-2	*ATM/LANE ,Route Servers*	*Path Computation Element Server*	*Services Engineered Path*	*Using the Floodlight Controller, Using the OpenDaylight Controller, Using the Cisco XNC Controller, Using the Hewlett-Packard Controller.*	*Data Plane Function Chains Analysis*
S-8	**SLO-1**	*Introduction to OpenFlow- Wire Protocol*	*Path Computation Element Server*	*Service Locations and Chaining*	*witch Considerations, Creating Network Virtualization Tunnels, Offloading Flows in the Data Center, Access Control for the Campus, Traffc Engineering for Service Providers*	*Control Plane Function Chains Analysis*
	SLO-2	*Replication ,FAWG (Forwarding Abstraction Workgroup)*	*Plexxi Plexxi Affinity*	*Non-ETSI NFV Work- Middlebox Studie*	*SDN Use Cases- Use Cases for Bandwidth Scheduling*	*requirements & challenges of SDN and NVF In 5G*
S-9	**SLO-1**	*Configuration and Extensibility, Architecture*	*Cisco OnePK*	Embrane/LineRate	*Big Data and Application Hyper-Virtualization for Instant CSPF*	*Existing Solutions*
	SLO-2	*Hybrid Approaches , Ships in the Night ,Dual Function Switches*	*Relationship to the Idealized SDN Framework*	*Platform Virtualization*	*use Cases for Input Traffic Monitoring, Classification, and Triggered Action*	*future directions*

Learning Resources	1. *Software Defined Networks: A Comprehensive Approach by Paul Goransson and Chuck Black, Morgan Kaufmann Publications, 2014* 2. *SDN - Software Defined Networks by Thomas D. Nadeau & Ken Gray, O'Reilly, 2013* 3. *Cho, Hsin-Hung, et al. "Integration of SDR and SDN for 5G." IEEE Access 2 (2014): 1196-1204.*	4. *Bouras, Christos, Anastasia Kollia, and Andreas Papazois. "SDN & NFV in 5G: Advancements and challenges." Innovations in Clouds, Internet and Networks (ICIN), 2017 20th Conference on. IEEE, 2017.* 5. *Arsany Basta; Andreas Blenk; Klaus Hoffmann; Hans Jochen Morper; Marco Hoffmann; Wolfgang Kellerer, Towards a Cost Optimal Design for a 5G Mobile Core Network Based on SDN and NFV,,IEEE Transactions on Network and Service Management, 2017, Volume: 14, Issue: 4 ,Pages: 1061 - 1075*

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	*50%*	-	*25 %*	-	*20 %*	-	*20 %*	-	*20 %*	-
Level 2	Understand	50%		30%		25%		25%		25%	
Level 3	Apply	-	-	*25 %*	-	*30 %*	-	*30 %*	-	*30 %*	-
Level 4	Analyze			20%		15%		15%		15%	
Level 5	Evaluate	-	-		-	*10%*	-	*10%*	-	*10%*	-
Level 6	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

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

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Course Code	18ECE321T	Course Name	RF AND MICROWAVE SEMICONDUCTOR DEVICES	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:	Learning
CLR-1:	Study microwave semiconductor materials and understand the fundamental of electronic components under microwave signal	Blooms level (1-6)
CLR-2:	Learn about negative resistance and transit time devices that are used in modern microwave radar and communication systems	
CLR-3:	Know the characteristics and operation of microwave transistor.	
CLR-4:	Know the fundamentals of RF power transistors and challenges	
CLR-5:	Discuss the main issues and challenges encountered in developing the products at microwave frequencies	

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning
CLO-1:	Summarize the properties of Semiconductor Junction Diodes under microwave signals	2
CLO-2:	Describe the characteristics of negative resistance and transit time devices	2
CLO-3:	Analyze the performance parameters of microwave transistors	4
CLO-4:	Compare the characteristics of HEMT and RF power transistors	4
CLO-5:	Interpret IC packaging issues and challenges involved at microwave frequencies	3

Program Learning Outcomes (PLO)												PSO		
1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
Engineering	Problem Analysis	Design &	Analysis, Design,	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team	Communication	Project Mgt. &	Life Long Learningm	PSO–1: Professional Achievement	PSO – 2: Project Management	PSO – 3: Analyze &
3	-	-	2	-	-	-	-	-	-	-	-	2	-	-
3	-	-	2	-	-	-	-	-	-	-	-	2	-	-
2	-	-	3	-	-	-	-	-	-	-	-	2	-	2
3	-	-	2	-	-	-	-	-	-	-	-	2	-	2
3	-	2	-	-	-	-	-	-	-	-	-	2	-	

		Semiconductor P-N Junction	Negative Resistance and Transit Time Devices	Microwave BJT Transistors	HEMT Transistors and RF Power Transistor	RF Package Design and Development
Duration (hour)		9	9	9	9	9
S-1	SLO-1	Review of properties of semiconductors	Negative Resistance Devices	Microwave Transistor	Introduction to HEMT	Introduction to RF Package
	SLO-2	Review of properties of semiconductors	Negative Resistance Devices	High frequency limitations of BJT	Short channel effects	Introduction to RF Package
S-2	SLO-1	Transient and ac behavior of p-n junctions	Tunnel Diode, Tunneling process in p-n junction	Microwave bipolar transistors – introduction	Device operation	Thermal Management
	SLO-2	Transient and ac behavior of p-n junctions	V-I characteristics and device performance	Microwave bipolar transistors – operation	Device operation	Thermal Management
S-3	SLO-1	Effect of doping profile on the capacitance of p-n junctions	MIS tunnel diodes	Hetero junction bipolar transistors	Device design	Mechanical Design
	SLO-2	Effect of doping profile on the capacitance of p-n junctions	V-I characteristics and device performance	Basic principle of operation	Scaling issues	Mechanical Design
S-4	SLO-1	Noise in p-n junctions	Backward Diode	Kirk effect	Material Systems for HEMT Devices	Package electrical and electromagnetic Modeling
	SLO-2	Noise in p-n junctions	V-I Characteristics	High frequency response	GaAs HEMT	Package electrical and electromagnetic Modeling
S-5	SLO-1	Varactor diode	Transferred Electron Devices	MESFET	InP HEMT	Design verification
	SLO-2	Construction and Operation of Varactor Diode	Impact ionization	Principle of operation	Technology comparisons	Design verification

S-6	SLO-1	*Applications of Varactor Diode*	*IMPATT*	*Properties of semiconductor materials used in MESFET*	*Technology comparisons*	*Materials testing*
	SLO-2	*Schottky effect*	*Small-signal analysis of IMPATT diodes*	*MESFET Technology*	*Introduction of RF power transistor*	*Reliability testing*
S-7	SLO-1	*Schottky barrier diode*	*TRAPATT, BARITT Diodes*	*MESFET Modeling*	*Figure of Merit for RF Power Transistor*	*computer integrated Manufacturing*
	SLO-2	*Applications of Schottky Diode*	*Two-valley model of compound semiconductors*	*I-V Characteristics*	*Common RF power devices*	*computer integrated Manufacturing*
S-8	SLO-1	*Hetero junctions*	*vd-E characteristics*	*High frequency performance*	*Material properties*	*Thermal modeling*
	SLO-2	*Hetero junctions*	*Gunn Effect, modes of operation*	*MISFET-Introduction*	*State-of-the-art-wide bandgap microwave transistor data*	*Thermal analysis of resistance networks*
S-9	SLO-1	*Construction and operation of microwave PIN diode*	*small-signal analysis of Gunn diode*	*Operating characteristics of MISFET*	*Challenges to production*	*Introduction to computer aided design*
	SLO-2	*Applications*	*Power-frequency limit.*	*Operating characteristics of MISFET*	*Challenges to production*	*Benefits, limitations and applications of CAD*

Learning Resources	1. *Golio, M., "RF and Microwave Semiconductor Devices Handbook", CRC Press (2002).* 2. *Sze, S.M., and Ng, K.K., "Physics of Semiconductor Devices", 3rd Ed., Wiley-Interscience (2006).*	3. *Glover, I.A., Pennoek, S.R. and Shepherd P.R., "Microwave Devices, Circuits and Sub-Systems", 4th Ed., John Wiley & Sons (2005)* 4. *Liao, S.Y., "Microwave Devices and Circuits", 4th Ed., Pearson Education (2002).*

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 %*	-	*10 %*	-	*10 %*	-	*20%*	-	*20%*	-
Level 2	Understand	*60 %*	-	*40 %*	-	*20 %*	-	*30%*	-	*30%*	-
Level 3	Apply		-	*20 %*	-	*40 %*	-	*30%*	-	*30%*	-
Level 4	Analyze			*30 %*		*30 %*		*20%*		*20%*	
Level 5	Evaluate										
Level 6	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers

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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	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:	Learning
CLR-1:	Identify the working and nature of optical wave and optical semiconductors	Level of Thinking (Bloom)
CLR-2:	Analyze the working principles of different photonic sources	
CLR-3:	Analyze the working principles of different photonic detectors	
CLR-4:	Create knowledge about various optoelectronic applications	
CLR-5:	Familiarize the concepts of optoelectronic integrated circuits	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning
CO-1:	Define the basic concepts of optics and semiconductor optics.	1
CO-2:	Demonstrate the working principle of various photonic sources and display devices.	3
CO-3:	Analyze the principle and operation of various detectors and noise associated with it.	4
CO-4:	Interpret the various optoelectronic modulators, switches, and interconnects.	3
CO-5:	Apply the concepts of integrated optoelectronic components and its application in various fields.	3

Program Outcomes (PO)													PSO		
1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Teamwork	Communication	Project Mgt. & Finance	Lifelong Learning	PSO–1: Professional Achievement	PSO – 2: Project Management	PSO – 3: Analyze & Research
3	-	-	-	-	-	-	-	-	-	-	-	-	-	1
3	3	-	2	-	-	-	-	-	-	-	-	-	-	3
-	3	2	3	-	-	-	-	-	-	-	-	-	-	3
3	2	3	-	-	-	-	-	-	-	-	-	-	-	2
3	-	3	3	-	-	-	-	-	-	-	-	-	-	3

Duration (hour)		Module 1 - Wave Nature Of Light And Semiconductor Optics	Module 2 - Semiconductor Photon Sources And Display Devices	Module 3 - Semiconductor Photon Detectors	Module 4 - Optoelectronic Modulators, Interconnects And Switches	Module 5 - Optoelectronic Integrated Circuits (Oeic) And Applications
		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	**Responsivity, 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

1. Kasap, "Optoelectronics & Photonics: Principles & Practices", 2nd edition, Pearson Education, 2013.
2. Pallab Bhattacharya "Semiconductor Optoelectronic Devices", 2nd Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2009.
3. B. E. A. Saleh and M.C. Teich, "Fundamentals of Photonics," 2nd edition, John Wiley & Sons, Inc. 2007.
4. Robert G. Hunsperger, "Integrated Optics- Theory and Technology", Springer, 2009
5. J. Wilson and J F B Hawkes "Optoelectronics- An Introduction", 3rd edition, Pearson Education Taiwan Ltd, 2010.
6. 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%	-	15%	-	25%	-		-	10%	-
Level 2	Understand	60%	-	30%	-	25%	-		-	35%	-
Level 3	Apply		-	15%	-	50%	-	50%	-	35%	-
Level 4	Analyze		-	40%	-		-	50%	-	20%	-
Level 5	Evaluate		-		-		-		-	-	-
Level 6	Create		-		-		-		-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

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Course Code	18ECE323T	Course Name	Advanced Optical Communication	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	18ECC302J	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 :	Introduce the advanced features of Fibers and light wave system	
CLR-2 :	Illustrate the basics of light wave system and multichannel system	
CLR-3 :	Understand the various dispersion compensation techniques	
CLR-4 :	Gain the information on advanced RoF Systems	
CLR-5 :	Improve the knowledge about the characterization of the Visible Light Communication	
CLR-6 :	Utilize the concepts in optical communication for the understanding of engineering and technology	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Program Outcomes (PO) 1	2	3	4	5	6	7	8	9	10	11	12	Program Specific Outcomes (PSO) 1	2	3
			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	Professional Achievement	Project Management Techniques	Analyze & Research
CO-1 :	Explain the various aspects associated with optical fiber and light wave system	3	3	2											1		
CO-2 :	Demonstrate the facets of Long-haul systems and WDM components & techniques	4	1		3											2	
CO-3 :	Illustrate the loss and dispersion managements devices, dispersion-equalizing filters and optical phase conjugation	5	1	2											3		
CO-4 :	Outline the different features and mechanism of RoF system	4	3	2											1		
CO-5 :	Summarize the concepts of FSO and VLC systems	3	1	2													3

Duration (hour)		Optical Fibers and Lightwave Systems	Lightwave Systems and Multichannel Systems	Loss Management and Dispersion Management	Radio Over Fiber Systems	Optical Wireless Communication
		9	9	9	9	9
S-1	SLO-1	Geometrical-Optics Description	System Architectures	Compensation of Fiber Losses	Trends in Wireless Communications	Free-space optical wireless communication
	SLO-2	Wave Propagation	Working Principles	Erbium-Doped Fiber Amplifiers les	Basic Transmission problems and solutions	Free-space optical OFDM communication
S-2	SLO-1	Dispersion in Single-Mode Fibers	Design Guidelines	Raman Amplifiers	Regulation	Wireless optical CDMA communication systems
	SLO-2	Dispersion Induced Limitations	Long-Haul Systems	Optical Signal-To-Noise Ratio	Standardization	Comparison of Free-space optical OFDM & CDMA communication
S-3	SLO-1	Fiber Losses	Sources of Power Penalty	Electrical Signal-To-Noise Ratio	System concepts for the central processing of signals	Indoor wireless optical communication
	SLO-2	Nonlinear Optical Effects	Forward Error Correction	Receiver Sensitivity and Q Factor	Wireless Trends	outdoor wireless optical communication
S-4	SLO-1	Fiber Design and Fabrication	Types of FEC	role of Dispersive and Nonlinear Effects	Architecture options,	Heterogeneous optical networks (HONs)
	SLO-2	multicore fibers	Computer-Aided Design	Periodically Amplified Lightwave Systems	global centralized Architecture	System Performance
S-5	SLO-1	multiclad fibers	WDM	Dispersion Problem	FUTON scenarios	VLC System Model
	SLO-2	advantages and its applications	DWDM	Its Solution	Optical Infrastructure	Advantages and its applications

S-6	**SLO-1**	*Advanced Modulation Formats*	*Light wave Systems*	*Dispersion-Compensating Fibers*	*Concepts of Radio over Fiber systems*	*(RF) sensor network system*
	SLO-2	*Demodulation Schemes*	*WDM Components*	*Fiber Bragg Gratings*	*Features of ROF*	*Advantages and its applications*
S-7	**SLO-1**	*Shot Noise*	*System Performance Issues*	*Dispersion Equalizing Filters*	*Categories RoF systems*	*(FSO) sensor network system*
	SLO-2	*Bit-Error Rate*	*Time-Division Multiplexing*	*Optical Phase Conjugation*	*Performances RoF systems*	*Advantages and its applications*
S-8	**SLO-1**	*Sensitivity Degradation Mechanisms*	*Subcarrier Multiplexing*	*Channels at High Bit Rates*	*Applications of RoF Technology*	*Recent Advancement in Optical Wireless Communication*
	SLO-2	*Impact of Nonlinear Effects*	*Code-Division Multiplexing*	*Electronic Dispersion Compensation*	*Advantages of RoF Technology*	*Advantages and its applications*
S-9	**SLO-1**	*Recent Progress*	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*
	SLO-2	*Ultimate Channel Capacity*	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*

Learning Resources	1. *Nathan J. Gomes, Paulo P. Monteiro and Atilio Gameiro "Next Generation wireless communications using Radio over Fiber" John Wiley & Sons, Ltd, 2012* 2. *G.P. Agarwal, Fiber optic communication systems, 4nd Ed, John Wiley & Sons, New York, 2010*	3. *ShlomiArnon, John R. Barry, George K. Karagiannidis, Robert Schober, Murat Uysal, "Advanced Optical Wireless Communication Systems" Cambridge University Press, 2012* 4. *Shlomi Arnon, "Visible light Communication", Cambridge University Press, 2015*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%) #			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*30 %*	-	*15%*	-	*20 %*	-	*20 %*	-	*15%*	-
Level 2	Understand	40%	-	*20 %*	-	*30 %*	-	*30 %*	-	*20 %*	-
Level 3	Apply	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-
Level 4	Analyze	-	-	*20 %*	-	*20 %*	-	*20 %*	-	*20 %*	-
Level 5	Evaluate	-	-	*15 %*	-		-	-	-	*15 %*	-
Level 6	Create	-	-		-		-	-	-		-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers

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

Course Code	18ECE240T	Course Name	WAVELETS AND SIGNAL PROCESSING	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18ECC104T	Co-requisite Courses	Nil	Progressive Courses	18ECE341T
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	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Summarize about multi resolution analysis and wavelet signal processing			
CLR-2 :	Identify the families of wavelets required to apply the transformation to various real time applications			
CLR-3 :	Discuss about discrete systems that employs wavelet transformation			
CLR-4 :	Outline various filter banks of discrete systems used in wavelet transformation			
CLR-5 :	Analyze various real time applications that employs filter banks			
CLR-6 :	Acquire knowledge about wavelet transforms, types and applications of multiresolution analysis			

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	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design &	Analysis, Design,	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. &	Life Long Learning	PSO–1: Professional	PSO – 2: Project	PSO – 3: Analyze &
CLO-1 :	Discuss about multi resolution analysis for discrete signals	2	80	75	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-2 :	Summarize the families of wavelets	1,2	80	70	H	-	M	-	-	-	-	-	-	-	-	-	H	-	M
CLO-3 :	Identify Discrete wavelet transform	2	75	70	M	M	M	-	-	-	-	-	-	-	-	-	M	-	-
CLO-4 :	Analyze and design filter banks	3	80	75	H	-	M	-	-	-	-	-	-	-	-	-	H	-	-
CLO-5 :	Utilize wavelet transformations on various applications	3	80	70	H	-	M	L	-	-	-	-	-	-	-	-	H	M	H
CLO-6 :	Provide an outline about wavelet transforms, types and applications of multiresolution analysis	2	80	70	M	H	-	-	-	-	-	-	-	-	-	-	M	-	-

		Multiresolution Analysis (MRA)	Families of wavelets	Discrete Wavelet Transform (DWT)	Filter banks	Applications
Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction to multiresolution/ multiscale analysis	Orthogonal	Discretization in steps	Introduction to Variants of the wavelet transform	Transient analysis
	SLO-2	Introduction to multiresolution/ multiscale analysis	Orthogonal	Discretization in steps	Introduction to Variants of the wavelet transform	Transient analysis
S-2	SLO-1	Time-frequency analysis and wavelets	Biorthogonal wavelets	Discretization of scale	Implementational structures	Singularity detection
	SLO-2	Time-frequency analysis and wavelets	Biorthogonal wavelets	Discretization of scale	Implementational structures	Singularity detection
S-3	SLO-1	Piecewise constant approximation	Daubechies' family of wavelets	Generalized filter bank	The wavepacket transform	Biomedical signal processing applications
	SLO-2	Piecewise constant approximation	Daubechies' family of wavelets	Generalized filter bank	The wavepacket transform	Biomedical signal processing applications
S-4	SLO-1	Haar wavelet	Daubechies' family of wavelets	Discretization of translation	Computational efficiency in realizing filter banks	Efficient signal design and realization
	SLO-2	Haar wavelet	Conjugate Quadrature Filter Banks (CQF) and their design	Discretization of translation	Computational efficiency in realizing filter banks	Efficient signal design and realization
S-5	SLO-1	Building up the concept of dyadic Multiresolution Analysis (MRA)	Conjugate Quadrature Filter Banks (CQF) and their design	Generalized output sampling	Computational efficiency in realizing filter banks	Wavelet based modulation and demodulation
	SLO-2	Building up the concept of dyadic Multiresolution Analysis (MRA)	Conjugate Quadrature Filter Banks (CQF) and their design	Generalized output sampling	Polyphase components	Wavelet based modulation and demodulation

S-6	SLO-1	*Relating dyadic MRA to filter banks*	*Data compression*	*Discretization of time/ space (independent variable)*	*Polyphase components*	*Applications in mathematical approximation*
	SLO-2	*Relating dyadic MRA to filter banks*	*Data compression*	*Discretization of time/ space (independent variable)*	*Polyphase components*	*Applications in mathematical approximation*
S-7	SLO-1	*A review of discrete signal processing*	*Fingerprint compression standards*	*Going from piecewise linear to piecewise polynomial*	*The lattice structure*	*Applications to the solution of some differential equations.*
	SLO-2	*A review of discrete signal processing*	*Fingerprint compression standards*	*Going from piecewise linear to piecewise polynomial*	*The lattice structure*	*Applications to the solution of some differential equations.*
S-8	SLO-1	*Elements of multirate systems*	*JPEG-2000 standards*	*The class of spline wavelets*	*Solving Problems*	*Solving Problems*
	SLO-2	*Elements of multirate systems*	*JPEG-2000 standards*	*The class of spline wavelets*	*Solving Problems*	*Solving Problems*
S-9	SLO-1	*Two-band filter bank design for dyadic wavelets.*	*Solving problems*	*A case for infinite impulse response (IIR) filter banks*	*The lifting scheme.*	*Solving Problems*
	SLO-2	*Two-band filter bank design for dyadic wavelets.*	*Solving problems*	*A case for infinite impulse response (IIR) filter banks*	*The lifting scheme.*	*Solving Problems*

Learning Resources	1. *M. Vetterli, J. Kovacevic, Wavelets and Subband Coding, Prentice Hall, 1995* 2. *S. Mallat, A Wavelet Tour of Signal Processing, 2nd ed., Academic Press, 1999* 3. *P.P. Vaidyanathan, Multirate Systems and Filter Banks, Pearson Education, 1993* 4. *C.S.Burrus, Ramesh A. Gopinath, and Haitao Guo, Introduction to Wavelets and Wavelet Transforms: A Primer, Prentice Hall, 1997*	5. *Gilbert Strang, Truong Nguyen, Wavelets and Filter Banks, 2nd ed., Wellesley-Cambridge Press,1998.* 6. *Ingrid Daubechies, Ten Lectures on Wavelets, SIAM, 1992* 7. *Howard L. Resnikoff, Raymond O. Wells, "Wavelet Analysis: The Scalable Structure of Information", Springer, 1998*

Learning Assessment

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

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Mr. Anuj Kumar, Bombardier* Transportation, Ahmedabad, *kumaranuj.anii@gmail.com*	1. *Dr. Meenakshi, Professor* of ECE, CEG, Anna University, *meena68@annauniv.edu*	*1. Dr. Sabitha Gauni, 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	18ECE241J	Course Name	SIGNAL PROCESSING FOR AUDITORY SYSTEMS	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

Pre-requisite Courses	18ECC104T	Co-requisite Courses	Nil	Progressive Courses	18ECE343T
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 :	Demonstrate the basics of signal processing			
CLR-2 :	Demonstrate the Feature Extraction technique used in Speech Processing			
CLR-3 :	Identify Frequency characteristics of Speech signal			
CLR-4 :	Construct the Digital model of speech signal			
CLR-5 :	Identify the Ethical issues of elements of music			
CLR-6 :	Develop the basic of speech signal processing and its model			

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,	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 :	Describe the functioning of the human vocal and auditory systems	1,2	80	75	M	-	H	-	H	-	-	-	-	-	-	-	M	-	H
CLO-2 :	Illustrate the function of feature extraction in speech and audio signal processing using Time Domain Characteristics	2	85	75	H	-	H	-	-	-	-	-	-	-	-	-	M	-	H
CLO-3 :	Explore the frequency characteristics of speech signal	3	80	70	H	-	H	H	-	-	-	-	-	-	-	-	M	-	H
CLO-4 :	Apply appropriate Digital models for speech signal	3	80	75	H	-	-	-	H	-	-	-	-	-	-	-	H	M	M
CLO-5 :	Analyze the elements of music	2	80	70	-	-	-	M	-	-	-	-	-	-	-	-	M	-	H
CLO-6 :	Provide an outline about speech signal processing and its model	2	80	70	H	-	H	-	H	-	-	-	-	-	-	-	M	-	M

		Basic Audio Processing using MATLAB	Speech Signal Analysis in Time Domain	Speech Signal Analysis in Frequency Domain	Digital Models for Speech Signal	Time Elements in Music
Duration (hour)		12	12	12	12	12
S-1	SLO-1	Introduction to Digital audio	Speech signal analysis	Short Time Fourier analysis	Introduction to Acoustic Phonetics	Sound vibrations – pure tones and perception of pitch
	SLO-2	Capturing and converting sound	Segmental analysis	Filter bank analysis	Introduction to Acoustic Phonetics	Sound vibrations – pure tones and perception of pitch
S-2	SLO-1	Sampling of sound wave	Sub-segmental	Formant extraction	Acoustic theory of speech production:- Sound propagation	Auditory coding in the nervous system
	SLO-2	Handling audio in MATLAB	Supra segmental levels	Pitch Extraction	Acoustic theory of speech production:- Sound propagation	Auditory coding in the nervous system
S 3-4	SLO-1	Lab 1: Read & write a speech signal, Record a speech signal, playback, convert into a wave file, plot the speech signal, and spectrogram plot.	Lab 4: Short-term energy of a speech signal	Lab 7 Estimation of pitch period using simplified inverse filter tracking (SIFT) algorithm 7	Lab 10: Phoneme-level segmentation of speech	Lab 13:Feature Extraction of speech signal
	SLO-2					
S-5	SLO-1	Normalization	Time domain parameters of speech signal	Homomorphic speech analysis	Vocal tract transfer function of vowels	Subjective pitch and role of nervous system

	SLO-2	*Audio processing*	*Time domain parameters of speech signal*	*Homomorphic speech analysis*	*Vocal tract transfer function of vowels*	*Subjective pitch and role of nervous system*
S-6	SLO-1	*Segmentation*	*Methods for extracting the parameters Energy*	*Formant and Pitch Estimation*	*Effect of nasal coupling*	*Acoustical energy –perception of loudness, pitch, timbre*
	SLO-2	*Analysis of window sizing*	*Methods for extracting the parameters Average Magnitude*	*Formant and Pitch Estimation*	*Excitation of sound in vocal tract*	*Pitch contour Musical Structure*
S 7-8	SLO-1 SLO-2	*Lab 2: Convert into a wave file, plot the speech signal, and spectrogram plot*	*Lab 5: Short-time Fourier transform magnitude spectrum*	*Lab 8: Estimation of pitch period using harmonic product spectrum*	*Lab 11: Estimation of sound in vocal tract*	*Lab 14: Speech production mechanism*
S-9	SLO-1	*Visualization*	*Zero crossing Rate*	*Linear Predictive analysis of speech*	*Vocal tract transfer function of vowels*	*Detecting beats, rhythm, meter*
	SLO-2	*Sound generation*	*Zero crossing Rate*	*Linear Predictive analysis of speech*	*Vocal tract transfer function of vowels*	*Recognizing pitch – melody*
S-10	SLO-1	*Speech production mechanism*	*Silence Discrimination using ZCR and energy*	*Autocorrelation method, Covariance method*	*Effect of nasal coupling*	*Auditory streaming*
	SLO-2	*Speech production mechanism*	*Silence Discrimination using ZCR and energy*	*Solution of LPC equations*	*Excitation of sound in vocal tract*	*Tonality and context – algorithms*
S 11-12	SLO-1 SLO-2	*Lab 3: Cepstrum smoothed magnitude spectrum*	*Lab 6: (i)Linear prediction magnitude spectrum (ii) Estimation of formant frequencies using linear prediction*	*Lab 9: Pitch and duration modification using time-domain pitch synchronous overlap and add (TD-PSOLA) method*	*Lab 12: Sound vibrations*	*Lab 15:Study of Feature extraction and SVM classifier*

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember 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. Mrs. K. HariSudha, 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	18ECE242J	Course Name	PATTERN RECOGNITION AND NEURAL NETWORKS	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

Pre-requisiteCourses	*Nil*	**Co-requisiteCourses**	*Nil*	**ProgressiveCourses**	*18ECE340T*
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
LR-1 :	*Learn the concepts of pattern recognition*	
CLR-2 :	*Analyze few parameter estimation methods for pattern recognition*	
CLR-3 :	*Acquire knowledge on the fundamental neural networks*	
CLR-4 :	*Apply the neural network recurrence for pattern recognition studies*	
CLR-5 :	*Utilize the practical applications of neural networks in pattern recognition*	
CLR-6 :	*Understand the pattern and apply neural network based learning algorithm to analyze the data from real world applications*	

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Level of Thinking (Bloom)	Program Outcomes (PO) 1	2	3	4	5	6	7	8	9	10	11	12			
			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	PSO – 2: Project Management	PSO – 3: Analyze & Research
CO-1 :	*Recognize the fundamentals of pattern recognition, data regularities and classifiers*	*3*	*1*	-	-	*3*	-	-	-	-	-	-	-	-	-	-	-
CO-2 :	*Summarize error estimation and training-set error estimation*	*3*	2	-	-	*3*	-	-	-	-	-	-	-	-	-	-	*3*
CO-3 :	*Analyze the fundamentals of Neural networks and develop the learning rules*	*4*	-	-	*3*	-	*1*	-	-	-	-	-	-	-	-	-	-
CO-4 :	*Demonstrate the error model and solve the deviation with back propagation networks*	*3*	-	-	*2*	*3*	-	-	-	-	-	-	-	-	-	-	*3*
CO-5 :	*Apply the neural network applications in the area of pattern recognition*	*5*	-	-	*2*	*3*	-	-	-	-	-	-	-	-	-	-	*3*
CO-6 :	*Implement the practical knowledge through laboratory experiments using pattern recognition algorithms to classify the techniques to real-world problems.*	*6*	-	-	-	*3*	*2*	-	-	-	-	-	-	-	-	-	2

		Introduction To Pattern Recognition	**Parameter Estimation Methods**	**Introduction to Neural Networks**	**ANN for Classification and Regression**	**ANN for Organization and Recognition**
Duration (hour)		**12**	**12**	**12**	**12**	**12**
S-1	SLO-1	*Introduction to Statistical Pattern Recognition*	*Introduction to parameter estimation*	*Introduction to neural Networks*	*Introduction to Hopfield networks*	*Self-organizing map*
	SLO-2	*Overview of Pattern Classifiers*	*Maximum-Likelihood estimation*	*Neuron model*	*Hop-field network- architecture*	*SOM algorithm*
S-2	SLO-1	*Process of Classifier Design, Decision making theory*	*Maximum a Posteriori estimation*	*Learning methods of ANN, Supervised, Unsupervised and reinforced*	*Recurrent networks*	*Learning vector quantization*
	SLO-2	*Bayesian decision making*	*Bayesian estimation*	*Basic learning rules of ANN-*	*Sample recurrent network structure*	*Kohonen self-organizing map*
S 3-4	SLO-1	*Lab1: Digitization of analog signals*	*Lab4: Programs on Estimation*	*Lab 7: Logic gate function description withHebb rule*	*Lab 10: Programs on training a Hopfield network*	*Lab 13: programs on orthogonality and evaluating input and output for association*
	SLO-2					
S-5	SLO-1	*Bayes Classifier*	*Unsupervised learning and clustering*	*McCulloh pitt neuron*	*Associative memories- Introduction:*	*Feature selection*
	SLO-2	*Bayes Classifier for minimizing Risk*	*Clustering vs. Classification-Supervised vs. unsupervised*	*Problems on McCulloh pitt*	*Auto and hetero associative memory*	*Feature map classifier, applications*
S-6	SLO-1	*Estimating Bayes Error*	*Criterion functions for clustering Algorithms for clustering*	*Hebb learning rule*	*Bi directional memories*	*Architecture of Adaptive Resonance Theory*
	SLO-2	*Effect of sample size in estimation*	*K-Means clustering*	*Problems on Hebb learning rule*	*XOR problem*	*ATR1 algorithm*

S 7-8	SLO-1 SLO-2	*Lab 2: Program to count the white pixelsfrom the image*	*Lab 5: Loading a data set and selectingpredictive features*	*Lab 8: Evaluating function with differentlearning rules*	*Lab 11: Programs on Auto and heteroassociation of memory*	*Lab 14: Character Recognition*
S-9	SLO-1	*Minimax Classifiers*	*Hierarchical methods of clustering*	*Single layer perceptron architecture Training algorithm*	*Back-propagation Algorithm*	*ART2 algorithm - Training*
	SLO-2	*Neymann Classifiers*	*Comparison of methods, cluster distance*	*Multilayer perceptron*	*Counter propagation networks-*	*ART2- network architecture*
S-10	SLO-1	*Pearson Classifiers*	*Sequential Pattern Recognition*	*Adaline architecture*	*Simulated annealing*	*Hand written digit recognition*
	SLO-2	*Applications*	*Sequential Pattern Recognition*	*Madaline architecture*	*Boltzmann machine*	*Character recognition networks*
S 11-		*Lab3: Analysis of a data set with classifiers*	*Lab 6: Programs on clustering technique*	*Lab 9 : XOR problem with Perceptron*	*Lab 12: Evaluation of error in BPN*	*Lab 15: Mini Project*

Learning Resources	1. *Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer Verlag, 2016* 2. *Dionisis Cavouras , S.Theodoridis , K. Koutroumbas , A. Pikrakis , An Introduction to Pattern Classification: A Matlab Approach, Elsevier Science Publishing Co Inc, 2010* 3. *Martin T.Hagan, Neural network design, Cengage publications, 2010*	4. *Simon O. Haykin, Neural Network and Learning Machines, 3rd ed., Pearson Education, 2009* 5. *Ke-Lin Du ,M. N. S. Swamy, Neural Networks and Statistical Learning, Publisher Springer, 2014* 6. *Kosko B, Neural Networks and Fuzzy Systems: A dynamical system approach to machine intelligence, Prentice Hall, 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	Knowledge	15%	15%	5%	5%	5%	5%	5%		5%	5%
Level 2	Understand	25%	25%	20%	20%	20%	20%	20%	10%	10%	10%
Level 3	Apply	10%	10%	15%	15%	15%	15%	10%	10%	15%	15%
Level 4	Analyze	-	-	10%	10%	5%	5%	5%	5%	10%	10%
Level 5	Evaluate	-	-	-	-	5%	5%	10%	5%	10%	10%
Level 6	Create	-	-	-	-				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*	*1. Dr. A. Ruhan Bevi, 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 or 18ECE311J18ECE322T	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-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 Blooms Learning Level	Program Outcomes (PO) 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 & Teamwork	10 Communication	11 Project Mgmt. & Finance	12 Lifelong Learning	PSO1 Design, prototype and test	PSO2 Apply project anagement	PSO3 Analyse and research
CO-1 :	Apply the fundamentals of digital image processing and the role of image transforms in the processing of images.	3	3	-	3	-	-	-	-	-	-	1	-	-	1	-	-
CO-2 :	Analyze and examine imaging 2D filters, as well as their role in image enhancement and restoration.	4	3	-	3	-	-	-	-	-	-	-	-	2	-	3	3
CO-3 :	Interpret image compression and segmentation methods on digital images	5	-	3	3	-	-	-	-	-	-	-	-	2	2	3	-
CO-4 :	Inspect the use video formation process along with transmission and compression and videos.	4	-	-	3	2	3	-	-	-	-	-	-	-	3	-	3
CO-5 :	Evaluate motion estimation techniques to video coding.	5	3	-	3	-	-	-	-	-	-	-	-	2	-	3	2
CO-6 :	Analyze the concepts of digital image and video processing, as well as their applications, to solve problems.	4	3	-	3	-	-	3	-	-	-	-	-	-	3	-	3

Module		Digital Image Fundamentals and Image Transforms	Image Enhancement and Restoration	Image Compression and Segmentation	Basic Steps of Video Processing	2D Motion Estimation
Duration (hour)		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**	*Neighbours 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 formation model*	*Sharpening spatial filters*	*Edge models, Basic edge detection*	*Photometric image formation*	*Hierarchical motion estimation*
S- 7-8	**SLO-1**	*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*
	SLO-2					
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**	*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*
	SLO-2					

Learning Resources	*1 afael 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).*

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
1	Remember	*25%*	*25%*	*15%*	*15%*	*15%*	*15%*	*25%*	*25%*	*20%*	*20%*
2	Understand	50%	50%	15%	15%	15%	15%	*25%*	*25%*	20%	20%
3	Apply	25%	25%	*20%*	*20%*	*20%*	*20%*	*25%*	*25%*	*20%*	*20%*
4	Analyze	-	-	20%	20%	20%	20%	*25%*	*25%*	20%	20%
5	Evaluate	-	-	*30%*	*30%*	*30%*	*30%*	-	-	*20%*	*20%*
6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %	-	100 %	-	100 %	-	100 %	-	100 %	-

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

Course Designers		
Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
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	18ECE244J	Course Name	DSP System Design	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

re-requisite Courses	18ECC204J	Co-requisite Courses	Nil	Progressive Courses	Nil

Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	IEEE 1641-2010, IEEE 754, IEEE Standard. 1149.1

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning
CLR-1 :	Acquire knowledge on Floating and Fixed point Processor such as TMS320C6X for complex signal	1
CLR-2 :	Learn and code TMS320C6x Assembly level programming for real time signal processing applications	
CLR-3 :	Design and coding DSP algorithm such as FFT, DFT, Convolution , IIR and FIR filters in TMS320C6x	
CLR-4 :	Gain knowledge on advance filter concepts and filter signal noise using Filter Bank, adaptive filters and analyzes such filters for high end designing.	
CLR-5 :	Design DSP system for real time applications.	
CLR-6 :	Utilize the concept of DSP for Engineering and Technology	

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Program Learning Outcomes (PLO)											(PSO)			
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
			Engineering	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 &
CLO-1 :	Demonstrate the knowledge on DSP architecture and instruction sets of TMS320C6X	2	3	-	3	-	-	-	-	-	-	-	-	-	2	-	-
CLO-2 :	Develop the assembly programming knowledge using TMS320C6x instruction sets	3	-	3	-	-	2	-	-	-	-	-	-	-	-	-	2
CLO-3 :	Apply the program concepts of DSP algorithm such as FFT, DFT, Convolution , IIR and FIR filters in TMS320C6x	3	-	3	-	-	3	-	-	-	-		-	-	-	1	-
CLO-4 :	Analyze on Filter Banks and adaptive filters and analyze such filters.	4	-	3	-	-	3	-	-	-	-	-	-	-	-	-	3
CLO-5 :	Review the knowledge on DSP system design based applications.	3	-	-	-	-	3	-	-	-	-	-	-	2	-	2	-
CLO – 6:	Create the real time applications with the concept of DSP system design	6	-	-	-	-	3	-	-	-	-	-	-	2	3	-	-

uration (hour)		Learning Unit / Module 1 – TMS320C6X Architecture	Learning Unit / Module 2 – TMS3206X Assembly Language	Learning Unit / Module 3 – Frequency Transforms	Learning Unit / Module 4 – Digital Filters	Learning Unit / Module 5 – DSP Applications
		15	15	15	15	15
S-1	SLO-1	***Architecture of TMS320C6X***	*TMS320C6X Assembly Language Operations*	*Digital filtering using the DFT*	*Filter banks – Decimation,*	*Dual tone Multi-Frequency (DTMF) Signaling*
	SLO-2	***Pipeline CPU***	*Individual Instruction Descriptions*	***Convolution and correlation***	*Inverse Decimation*	*Software Defined Radio (SDR)*
S-2	SLO-1	***VelociTI,*** *Functional Units,*	*Arithmetic operations, ,*	*Fast Fourier Transform –DIT*	*Perfect Reconstruction*	*QAM Transmitter and QAM Receiver*
	SLO-2	*Addressing modes,*	*logical operations,*	*Fast Fourier Transform –DIT*	*Analysis of M-Band filter Banks*	*Miscellaneous Projects--FSK Modem*
S-3	SLO-1	*Lab1: Generation of sequences (functional & random) (Matlab)*	*Lab 7: MAC operation using various addressing modes*	***Lab 13: Spectrum analysis using DFT(Matlab)***	***Lab 19: FIR Implementation using TMS Processor***	***Lab 25: Equalization (Matlab)***
	SLO-2					

S-4	**SLO-1**	***Lab 2: Correlation(Matlab)***	***Lab 8: MAC operation using various addressing modes***	***Lab 14: FFT Implementation(DSP processor)***	***Lab 20: FIR Implementation using TMS Processor***	***Lab 26: Equalization (Matlab)***
	SLO-2					
S-5	**SLO-1**	*TMS320C6X Instruction Sets,*	*Memory data operations*	*Fast Fourier Transform –DIF*	*Orthogonality and Biorthogonality in Filter banks*	*u-Law for Speech Companding,*
	SLO-2	*Assembler directives*	*Conditional Operations*	*Fast Fourier Transform DIF*	*QMF Filter banks and*	***Acoustic Direction Tracker***
S-6	**SLO-1**	*Multichannel Buffered Serial Ports*	*Floating Point –Data type operations,*	*IFFT*	*CQF Filter Banks*	*MultirateFilter,Neural Network for Signal Recognition*
	SLO-2	*Memory Considerations –Constraints*	*Floating Point –Data type operations*	*FIR filters*	*Transmultiplixers;*	***PID Controller,*** *Four-Channel Multiplexer for Fast Data Acquisition*
S-7	**SLO-1**	***Lab 3: Linear Convolution (Matlab)***	***Lab 9: MAC operation using various addressing modes***	***Lab 15: FIR filter design-Windowing Techniques(Matlab)***	***Lab 21: IIR implementation using TMS processor***	***Lab 27: Real time audio signal processing with Processor***
	SLO-2					
S-8	**SLO-1**	***Lab 4 :Circular convolution(Matlab)***	***Lab 10: Linear convolution(DSP processor)***	***Lab 16: FIR filter design-Windowing Techniques(Matlab)***	***Lab 22: IIR implementation using TMS processor***	***Lab 28: Real time audio signal processing with Processor***
	SLO-2					
S-9	**SLO-1**	*Instruction Operation and Execution notations*	*Fixed- Point Operations,*	*FIR filters*	*Structures and Programming Examples for Noise cancellation*	*Video Line Rate Analysis*
	SLO-2	*Overview of IEEE Standard single and Double Precision formats ,*	*Fixed- Point Operations*	*IIR filter*	*Adaptive Filters-Adaptive filters in DSP simulation software's and TMSC320C6x*	*DSP System Design*
S-10	SLO-1	*Q-format Number Representation on Fixed Point DSPs, Finite Word length effects on Fixed point DSPS*	*Pipeline Operations overview*	*IIR filter*	*Software simulation of FIR*	*MP3 Player*
	SLO-2	*Floating point number representation, , Overflow and Scaling*	*Interrupts-overview.*	*FIR and IIR filter design using TMS320C6x*	*IIRFilters and Filter banks*	*DSP Automotive application*
S-11	SLO-1	*Lab 5: Study of architecture of Digital Signal Processor*	***Lab 11: Circular convolution(DSP processor)***	*Lab 17: IIR filter design-Bilinear and Impulse Invariance Technique(Matlab)*	***Lab 23: Multirate filters***	***Lab 29:*** *Real time audio signal processing with Processor*
	SLO-2					
S-12	SLO-1	***Lab 6: Study of architecture of Digital Signal Processor***	***Lab 12: Waveform generation(DSP processor)***	***Lab 18: IIR filter design-Bilinear and Impulse Invariance Technique(Matlab)***	***Lab 24: Finite Word Length Effect***	***Lab 30: Real time audio signal processing with Processor***
	SLO-2					

Learning Resources	1. B Venkataramani, M Bhaskar, "Digital Signal Processors: Architecture, Programming and Applications", TMH Publishers, 2nd edition, 2017 2. Paulo S. R.Diniz Eduardo A. B. da Silva and Sergio L. Netto, "Digital Signal Processing System Analysis and Design", Cambridge University Press, 2nd Edition.2010 3. Nasser Kehtarnavaz, Namjin Kim, "Digital Signal Processing System-Level Design Using LabVIEW", Newgen Elsevier Publication, 2nd edition, 2014	4. Rulph Chassaing - "DSP Applications Using C and the TMS320C6x DSK" John Wiley & Sons, Inc. 2002. 5. Nasser Kehtarnavaz , "Real-Time Digital Signal Processing Based on the TMS320C6000", Newnes, 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%	10%	10%	*5%*	*5%*	10%		*5%*	*5%*
Level 2	Understand	30%	30%	20%	20%	5%	5%	*10%*	5%	10%	10%
Level 3	Apply			30%	30%	*20%*	*20%*	25%	10%	*20%*	*20%*
Level 4	Analyze					10%	10%	*15%*	5%	10%	10%
Level 5	Evaluate					*10%*	*10%*	5%	5%	*10%*	*10%*
Level 6	Create							10%			
	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 Code	18ECE245T	Course Name	ADAPTIVE SIGNAL PROCESSING	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18ECC204J	Co-requisite Courses	Nil	Progressive Courses	18ECE342T
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 :	Have an insight on basics of random processes	Bloom's level (1-6)
CLR-2 :	Gain knowledge on the applications of adaptive filters	
CLR-3 :	Acquire knowledge on LMS techniques	
CLR-4 :	Understand the types of LMS algorithm	
CLR-5 :	Acquire knowledge on RLS algorithm	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning
CO-1 :	Define the basics of statistical signal processing	2
CO-2 :	Analyze the adaptive filters and their applications.	4
CO-3 :	Compile LMS algorithm and constraints associated with it.	3
CO-4 :	Demonstrate the variants of LMS algorithm and lattice structures.	3
CO-5 :	Construct the RLS filters, Kalman filters and adaptive IIR filters.	4

Program Outcomes (PO)													PSO		
1	2	3	4	5	6	7	8	9	10	11	12				
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	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
-	2	2	-	-	-	-	-	-	-	-	-	-	-	-
-	3	3	-	-	-	-	-	-	-	-	-	-	-	-
-	2	-	2	-	-	-	-	-	-	-	-	-	-	-
-	2	2	-	-	-	-	-	-	-	-	-	-	-	-

Duration (hour)		Introduction to Stochastic Process	Adaptive Filters	Least Mean Square Algorithm	Variants of LMS Algorithm And Lattice Structures	Recursive Least Square Algorithm
		9	9	9	9	9
S-1	SLO-1	***Introduction to random process***	*Introduction to adaptive filters*	***Least mean square algorithm***	*Sign LMS algorithm*	***Recursive adaptive filters***
	SLO-2	***Variables, vectors***	*Block diagram of adaptive structure with shift variant filter*	***Derivation***	*Normalized LMS*	***Principle of RLS algorithm***
S-2	SLO-1	***Ensemble averages***	*Properties of adaptive filter*	***Properties of LMS adaptive filters***	*Leaky LMS*	***FIR RLS filter algorithm***
	SLO-2	***Time averages***	*Error sequence generation in adaptive filters*	***Properties of LMS adaptive filters***	*Block LMS*	***Derivation***
S-3	SLO-1	***Stationarity and Stationary random process***	***Channel Equalization- Block diagram of communication system with Channel equalization***	***Complex LMS algorithm***	***FFT based implementation of block LMS***	***Sliding window RLS***
	SLO-2	***Wide sense stationarity***	*Echo cancellation*	***Convergence of LMS algorithm***	***FFT based implementation of block LMS***	***Derivation***
S-4	SLO-1	***Power Spectral Density***	***Concept of adaptive noise cancelling***	***Learning curve for adaptive filters***	*Comparison of variants on LMS for some practical problem*	***Comparing variants of RLS using MATLAB program***
	SLO-2	***Properties of PSD***	***Beam forming with pilot signals***	***Sample MATLAB program for LMS convergence and plotting learning curve***	*Comparison of variants on LMS for some practical problem*	***Comparing variants of RLS using MATLAB program***
S-5	SLO-1	***Sample problems on WSS random process***	***System modeling using adaptive filters***	***Performance analysis of LMS adaptive filters by varying step size (MATLAB)***	***Lattice filters introduction***	***Kalman filters***
	SLO-2	***Sample problems on WSS random process***	***System Identification structure***	***Performance analysis of LMS adaptive filters by varying step size (MATLAB)***	***Advantages of Lattice structures***	***Kalman filters***

S-6	**SLO-1**	***Filtering of random process***	***System inversion using adaptive filters***	***Weight error correlation matrix***	***Forward linear prediction***	***Sample problems on RLS algorithms***
	SLO-2	***Filtering of random process***	***Interference cancellation in multi sensor systems***	***LMS misadjustment definition***	***Forward linear prediction***	***Sample problems on RLS algorithms***
S-7	**SLO-1**	***Autocorrelation Structures***	***Minimization of mean square error***	***Effects of misadjustment factor***	*Backward linear prediction*	***Non linear adaptive filters***
	SLO-2	***Covariance Structures***	***Derivation on MMSE***	***Sample problems for designing adaptive filters using LMS***	*Backward linear prediction*	***Introduction to Neural networks***
S-8	**SLO-1**	***Eigen value decomposition***	*Steepest Descent algorithm*	***Sample problems on step size***	***Reflection coefficients of forward and backward predictors***	***Neural networks and multilayer perceptorns***
	SLO-2	***Eigen value analysis of autocorrelation matrices***	***Linear prediction example***	***Sample problems on step size***	***Relation between forward and backward prediction coefficients***	***Neural networks and multilayer perceptorns***
S-9	**SLO-1**	***Ergodicity***	*Wiener filters*	***Stability analysis of LMS algorithms***	***Properties of Lattice structures***	***Adaptive IIR filtering***
	SLO-2	***Ergodic random process***	*Optimization solution in wiener filters*	***Stability analysis of LMS algorithms***	***Updating predictor coefficients***	***Adaptive IIR filtering***

Learning Resources	**1.** S. Haykin ,Adaptive Filter Theory, Prentice-Hall, 4-th edition, 2001. **2.** Ali H. Sayed ,Fundamentals of Adaptive Filtering, John Wiley, 2003. **3.** D. Manolakis, V. Ingle, S. Kogan,Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering and Array Processing, McGraw Hill, 1999.	4. B. Widrow, S. Stearns,Adaptive Signal Processing, Prentice-Hall, 1985 5. Monson H. Hayes,Statistical Digital Signal Processing and Modeling, Edition: 1st, 2008.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*50%*	-	*20 %*	-	*20 %*	-	*20 %*	-	*20 %*	-
Level 2	Understand	*50%*	-	*30 %*	-	*30%*	-	*30%*	-	*30%*	-
Level 3	Apply	-	-	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-
Level 4	Analyze	-	-	20%	-	20%	-	20%		20%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers

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

Course Code	18ECE340T	Course Name	MACHINE PERCEPTION WITH COGNITION	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18ECE242J	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 :	Have an insight on image and color fundamentals	1
CLR-2 :	Analyze the various shapes and regions for the image description	
CLR-3 :	Acquire knowledge on the texture analysis of an image	
CLR-4 :	Identify the relation between the templates to match the image requirements	
CLR-5 :	Know the practical applications of computer vision in images understanding	

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Program Learning Outcomes (PLO)											(PSO)			
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
			Engineering	Problem Analysis	Design &	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team	Communication	Project Mgt. &	Life Long Learning	PSO – 1: Professional Achievement	PSO – 2: Project Management	PSO – 3: Analyze
CLO-1 :	Understand the fundamentals of image Processing, camera and color models	2	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Analyze the binary shapes, region and boundary based image modeling	4	3	-	-	2	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Illustrate the various filter banks, shape and textures for image synthesis	2	-	-	-	2	-	-	-	-	-	-	-	3	-	-	-
CLO-4 :	Express the objects, frames based on template relations	2	3	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	Apply the concept of 2D and 3D face recognition	3	-	-	3	-	2	-	-	-	-	-	-	-	-	-	1
CLO – 6:	Implement the concept of image processing and machine vision in real time applications	3	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-

Duration (hour)		Learning Unit / Module 1 Computer Vision and Image Processing Fundamentals	Learning Unit / Module 2 Analysis of Shapes and Regions	Learning Unit / Module 3Texture Analysis	Learning Unit / Module 4 Image Recognition and Template Relations	Learning Unit / Module 5 Applications of Machine Vision
		12	12	12	12	12
S-1	SLO-1	Review of Image processing methods	Binary Shape analysis	Representing textures	Finding objects by voting on relation between templates	Face detection
	SLO-2	Review of Image processing methods	Binary Shape analysis	Representing textures	Interest points, Simple voting, Voting on relations.	Face detection
S-2	SLO-1	Introduction to image formation	Connectedness	Extracting image Structure with filter banks	Relational reasoning using probabilisticframework	Face recognition
	SLO-2	Introduction to image formation	Object labeling and counting	Extracting image Structure with filter banks	Growing Assemblies Incrementally, Detection, Pruning	Face recognition
S-3	SLO-1	Image models	Size filtering	Representing texture using statistics of filteroutput	Frames and probability models	Eigen faces
	SLO-2	Camera models	Distance functions	Representing texture using statistics of filter output	Representing coordinate frames	Active appearence
S-4	SLO-1	Sample programs for reading images, understanding pixels	Skeletons and thinning	Analysis using oriented pyramids	Using probability model for detecting the frames	3D shape models of face surveillance
	SLO-2	Sample programs for reading images, understanding pixels	Deformable shape analysis	Laplacian pyramids	Building probability models for frame invariant	3D shape models of face surveillance

S-5	**SLO-1**	*Shadows*	*Boundary tracking procedures*	*Filters in the spatial frequency domain*	*Classifiers to prune search*	*Foreground separation*
	SLO-2	*Color representation*	*Boundary tracking procedures*	*Filters in the spatial frequency domain*	*Identifying acceptable assemblies*	*Background separation*
S-6	**SLO-1**	*Human color perception*	*Shape models*	*Oriented pyramids*	*Sample examples for prune search*	*Particle filters*
	SLO-2	*Human color perception*	*Shape recognition*	*Oriented pyramids*	*Hidden Markov model*	*Particle filters*
S-7	**SLO-1**	*Image color*	*Centroidal profiles*	*Synthesizing textures for rendering*	*Computing, Maximizing parameters*	*Champer matching, tracking and occlusions*
	SLO-2	*Image color*	*Handling occlusions*	*Synthesizing textures for Homogeneity*	*Varieties of HMM*	*Champer matching, tracking and occlusions*
S-8	**SLO-1**	*Handling Color Images (MATLAB)*	*Boundary descriptors*	*Synthesis by sampling local models*	*Background subtraction*	*Combining views from multiple cameras*
	SLO-2	*Handling Color Images (MATLAB)*	*Boundary descriptors*	*Synthesis by sampling local models*	*Sample programs on background subtraction*	*Human gait*
S-9	**SLO-1**	*Surface Color*	*Region descriptors*	*Shape from texture planes*	*Hough transform*	*Constructing 3D models from image sequences*
	SLO-2	*Surface Color*	*Region descriptors*	*Texture from shape planes*	*Sample problems on Hough transforms*	*Scene modeling from registered andunregistered images*

Learning Resources	*1* E. R. Davies, "Computer & Machine Vision", Fourth Edition, Academic Press, 2012. ***2*** R. Szeliski, "Computer Vision: Algorithms and Applications", Springer 2011**.** *3* Simon J. D. Prince, "Computer Vision: Models, Learning, and Inference", Cambridge UniversityPress, 2012	4 Mark Nixon and Alberto S. Aquado, "Feature Extraction & Image Processing for Computer Vision", ThirdEdition, Academic Press, 2012 5 D. L. Baggio et al., "Mastering OpenCV with Practical Computer Vision Projects", Packt Publishing, 2012 6 Jan Erik Solem, "Programming Computer Vision with Python: Tools and algorithms for analyzing images",O'Reilly Media, 2012.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*50%*	-	*20%*	-	*30 %*	-	*30 %*	-	*20%*	-
Level 2	Understand	*50%*	-	*20%*	-	*40 %*	-	*40 %*	-	*30%*	-
Level 3	Apply		-	*20%*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 4	Analyze			4040%						2 *20%*	
Level 5	Evaluate										
Level 6	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

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

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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	18ECE341T	Course Name	Multimedia Compression Techniques	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18ECE240T	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 :	Summarize probability models and discuss on coding theory
CLR-2 :	Implement lossless compression
CLR-3 :	Discuss on Lossy data compression
CLR-4 :	Apply the encoding methods
CLR-5 :	Carry out the Compression Techniques and their 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	PSO – 2: Project Management	PSO – 3: Analyze
CLO-1 :	Summarize the fundamental concepts of probability model and to state the practical limits specified by coding theory	1,2	85	80	H														L
CLO-2 :	Outline rate-distortion theory and to discuss about efficient information transfer mechanism	2	85	75	H	H	M											L	H
CLO-3 :	Show the fundamental approaches towards lossy image compression	1,2	80	75	H	M	L										M	M	H
CLO-4 :	Analyze image, video and audio in the frequency domain to identify important components to be encoded	2	80	70	H	M	M	H									H		H
CLO-5 :	Analyze the Applications of various compression techniques	3	80	70	M	M	L	H									H	L	M
CLO-6:	Examine various data compression and encoding methods	3	85	80	H	M	M										H	M	H

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		9	9	9	9	9
S-1	SLO-1	The discrete memory less information source	Mathematical Preliminaries for Lossless	Rate distortion function	Vector Quantization	Transform Coding: Introduction, Karhunen-Loeve transform, , , , Image compression – EZW, SPIHT, JPEG 2000-Analysis/Synthesis Schemes.
	SLO-2	Kraft inequality; optimal codes	Mathematical Preliminaries for Lossless Compression	Rate distortion function	LBG algorithm	Karhunen-Loeve transform
S-2	SLO-1	Source coding theorem-Entropy	Huffman Coding	Properties of RD	Tree structured VQ	Karhunen-Loeve transform
	SLO-2	Joint Entropy and Conditional Entropy	Huffman Coding	Properties of RD	Structured VQ	discrete cosine transform,
S-3	SLO-1	Relative Entropy	Optimality of Huffman codes	Calculation of RD for the binary source and the Gaussian source	Variations of VQ	discrete cosine transform,
	SLO-2	Mutual Information	Extended Huffman Coding	Calculation of RD for the binary source and the Gaussian source	Gain shape VQ	discrete Walsh Hadamard transform
S-4	SLO-1	Chain Rules	Adaptive Huffman Coding	Rate distortion theorem	Mean removed VQ	discrete Walsh Hadamard transform

	SLO-2	Data-Processing Inequality	Arithmetic Coding	Rate distortion theorem	Classified VQ	Quantization and coding of transform coefficients
S-5	**SLO-1**	Fano's Inequality Symmetric Channels	Adaptive Arithmetic coding	Converse of the Rate distortion theorem	Multistage VQ	Quantization and coding of transform coefficients
	SLO-2	Fano's Inequality Symmetric Channels	Run Length Coding	Quantization problem	Adaptive VQ	JPEG
S-6	**SLO-1**	Properties of Channel Capacity, Jointly Typical Sequences	Dictionary Techniques	Scalar Quantization- Uniform Quantizer	Trellis coded quantization Transforms.	JPEG
	SLO-2	Properties of Channel Capacity, Jointly Typical Sequences	Lempel Ziv coding	Scalar Quantization- Uniform Quantizer	Trellis coded quantization Transforms.	MDCT
S-7	**SLO-1**	Channel Coding Theorem	Applications	Adaptive Quantization	Basic algorithm	MDCT
	SLO-2	Channel Coding Theorem	Predictive Coding	Adaptive Quantization	Prediction in DPCM	Image compression – EZW- Analysis/Synthesis Schemes
S-8	**SLO-1**	Fano's Inequality	Prediction with Partial Match	Non-uniform Quantization	Prediction in DPCM	Image compression – SPIHT- Analysis/Synthesis Schemes
	SLO-2	Fano's Inequality	Burrows Wheeler Transform	Non-uniform Quantization	Adaptive DPCM	Image compression – JPEG 2000- Analysis/Synthesis Schemes
S-9	**SLO-1**	Converse to the Coding Theorem	Dynamic Markov Compression	Entropy coded Quantization	Adaptive DPCM	Audio coding:-MPEG audio coding
	SLO-2	Converse to the Coding Theorem	Dynamic Markov Compression	Entropy coded Quantization	Delta Modulation	Audio coding:-MPEG audio coding

Learning Resources	1. K. Sayood, "Introduction to Data Compression",3rd Edition, Morgan Kaufmann Publishers, 2006. 2. N. Jayant and P. Noll, "Digital Coding of Waveforms: Principles and Applications to Speech and Video", ISBN10 0132119137, Prentice Hall, USA, 1984. 3. D. Salomon, "Handbook of Data Compression", 5th Edition, Springer-Verlag London Limited 2010.	4. Ze.Nian. Li and M.S. Drew, "Fundamentals of Multimedia",2nd Edition, Pearson Education (Asia) Pvt. Ltd., 2004. 5. M.Rabbani: "Digital image compression techniques", 1st Edition, SPIE Press Book, 1991.

Learning Assessment

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

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

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Course Code	18ECE342T	Course Name	ACOUSTICAL SIGNAL PROCESSING	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18ECE245T	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	ISO/TC 43/SC 1, ISO/TC 43/SC 2		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Discuss physics behind sound equations, characteristics of sound in various mediums.
CLR-2 :	Describe human auditory system and hearing function.
CLR-3 :	Express acoustic echo in a mathematical form, and to control or cancel echo that arises due to using various algorithm.
CLR-4 :	Summarize the various types of transducers used for acoustic measurements
CLR-5 :	Analysis of transducers for various applications of acoustics.

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	PSO – 3: Analyze & Research
CLO-1 :	Summarize the basics of acoustic and to paraphrase the mechanism like Transmission, Reflection, Absorption under various mediums	1,2	80	80	M	-	-	-											M
CLO-2 :	Explain human auditory system and hearing	1,2	85	75	M	-	-	-										M	H
CLO-3 :	Illustrate acoustic echo, noise control and cancel echo using various algorithms.	2	85	75	H	H	H	-									M	M	H
CLO-4 :	Demonstrate various types of transducers used for acoustic measurements	2	85	80	H	M	M	M									H	M	H
CLO-5 :	Outline on the various applications of acoustics.	2,3	85	70	H	-	-	H									H	M	M
CLO-6	Outline speech processing analysis in different environment	2	85	80	H	M	H	H	H								H	H	M

Duration (hour)		Basics of Acoustic Engineering	Auditory System and Hearing	Acoustic Echo and Noise control	Transducers for Acoustic Measurements	Applications of Acoustics
		9	9	9	9	9
S-1	SLO-1	Introduction to acoustic	Anatomy of the auditory systems	Human Perception of Echoes	Fundamental properties of Transducers	Architectural acoustics – Sound in enclosures
	SLO-2	Introduction to acoustic	Anatomy of the auditory systems	Human Perception of Echoes	Fundamental properties of Transducers	Reverberation time
S-2	SLO-1	Harmonic Plane Waves	Physiology of the auditory systems	Echo Problem	Condenser Microphones	Sound absorption materials
	SLO-2	Harmonic Plane Waves	Physiology of the auditory systems	Echo Problem	Condenser Microphones	Measurements of acoustic output in living rooms
S-3	SLO-1	Energy Density	Function of the auditory systems	Adaptive Filters for Echo Cancellation	Dynamic Pressure Microphones	Acoustic Factors in architectural design
	SLO-2	Energy Density	Function of the auditory systems	Adaptive Filters for Echo Cancellation	Dynamic Pressure Microphones	Environmental acoustics – Introduction
S-4	SLO-1	Acoustic Intensity	Physiological measures	*LMS algorithm*	Dynamic Pressure Microphones	Weighted sound level
	SLO-2	Specific Acoustic Impedance	Physiological measures	*NLMS algorithm*	Dynamic Pressure difference Microphone	speech interference
S-5	SLO-1	Spherical Waves	Physiological measures	Least Squares Algorithms	Dynamic Pressure difference Microphone	Highway noise
	SLO-2	Spherical Waves	Auditory processing models	Least Squares Algorithms	Piezo ceramic accelerometer	Aircraft noise rating
S-6	SLO-1	Decibel Scales	Auditory processing models	Recursive Least Squares Algorithms	Piezo ceramic accelerometer	Virtual Sound--
	SLO-2	; Rays and Waves	Auditory processing models	Recursive Least Squares Algorithms	Piezo ceramic accelerometer	Sound localization cues
S-70	SLO-1	Transmission-Incidence	Auditory processing models	Affine Projection algorithm	Laser Doppler velocimeter	synthetic 3D Audio
	SLO-2	Transmission-Incidence	Auditory processing models	Affine Projection algorithm	Laser Doppler velocimeter	synthetic 3D Audio

S-8	SLO-1	Reflection	Speech Intelligibility	Noise cancellation using Affine Projection algorithm	Laser Doppler velocimeter	Seismology- Signal Model in seismic processing
	SLO-2	Absorption	Speech Intelligibility	Noise cancellation using Affine Projection algorithm	Capacitive sensors	*Optical sensor* Signal Model in seismic processings
S-9	SLO-1	Viscosity	signal processing in hearing aids	Fast Affine Projection Algorithm (FAP).	Capacitive sensors	Underwater and Oceanographic acoustics
	SLO-2	Thermal conduction	signal processing in hearing aids	Fast Affine Projection Algorithm (FAP)	Capacitive sensors	Inverse Problems in underwater acoustics

Learning Resources	1. Lawrance E Kinseler, Fundamental of Acoustic, , Wiley 4th Edition. 2. Steven L. Gay, Jacob Benesty, Acoustic Signal Processing for Telecommunication, Springer; 2001 edition (March 31, 2000)	3. Havelock, David; Kuwano, Sonoko, Vorländer, Michael (Eds.), Handbook of Signal Processing in Acoustics, Springer; 2008 edition.

Learning Assessment

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

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

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Course Code	18ECE343T	Course Name	Automatic Speech Recognition	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18ECE241J	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
CLR-1 :	Summarize the basic Techniques of Speech Recognition			
CLR-2 :	Analyze the different Statistical models			
CLR-3 :	Model different speech recognition systems			
CLR-4 :	Illustrate of dialogue system design			
CLR-5 :	Analyze the Stochastic Approaches to dialogue			
CLR-6 :	Utilize the concepts in signal processing for the understanding of engineering and technology			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Program Learning Outcomes (PLO)														
					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
CLO-1 :	Express the basic techniques in speech signal processing broadly used in the area of speech recognition	2	75	60	H	-	-	-	-	-	-	-	-	-	-	-	-	-	M
CLO-2 :	Outline the use of hidden Markov models can be used as generative models for speech and how they can be trained	2	75	60	H	M	-	-	-	-	-	-	-	-	-	-	M	-	H
CLO-3 :	Describe commercial as well as research-oriented applications within speech recognition	2	75	60	H	-	-	H	-	-	-	-	-	-	-	-	M	L	M
CLO-4 :	Summarize the essentials of dialogue system design and evaluation	2	75	60	H	H	M	-	-	-	-	-	-	-	-	-	M	M	M
CLO-5 :	Implement simple dialogue systems and Stochastic Approaches	2	75	60	H	-	H	-	-	-	-	-	-	-	-	-	M	M	H
CLO-6 :	Apply the speech recognition techniques in real time applications.	2	75	60	H	-	-	-	-	-	-	-	-	-	-	-	H	L	M

Duration (hour)		Distance Measurements For Comparing Speech Patterns	Statistical Models For Speech Recognition	Architecture of Continuous Speech Recognition System	Understanding of Spoken Dialogue Systems	Natural Language Generation and Stochastic Process
		9	9	9	9	9
S-1	SLO-1	Feature, Feature Extraction and Pattern Comparison Techniques	Introduction to Perceptual Motivated Representations	Introduction to speech recognition	Simple models of dialogue structure:	Natural language generation for dialogue systems
	SLO-2	Feature, Feature Extraction and Pattern Comparison Techniques	Perceptual Motivated Representations	Introduction to speech recognition	Simple models of dialogue structure:	Natural language generation for dialogue systems
S-2	SLO-1	Speech Distortion measures-Mathematical	Formant Frequencies – Role of Pitch – Pitch Detection of Speech and Music	Large vocabulary continuous speech recognition	Trees and finite state approaches	Text-to-speech synthesis
	SLO-2	Speech Distortion measures-Mathematical	Formant Frequencies – Role of Pitch – Pitch Detection of Speech and Music	Large vocabulary continuous speech recognition	Trees and finite state approaches	Text-to-speech synthesis
S-3	SLO-1	Perpectual-Log spectral distance	Channel Vocoders and Predictive Coding Scalar Waveform Coders	Architecture of large vocabulary continuous speech recognition system	Dialogue acts, key phrase reactive approaches	Use of speech synthesizers in dialogue systems
	SLO-2	Perpectual-Log spectral distance	Channel Vocoders and Predictive Coding Scalar Waveform Coders	Architecture of large vocabulary continuous speech recognition system	Dialogue acts, key phrase reactive approaches	Use of speech synthesizers in dialogue systems
S-4	SLO-1	Cepstral Distances, Weighted Cepstral distances and Filtering	Scalar Frequency Domain Coders	Architecture of large vocabulary continuous speech recognition system	Information retrieval-based approaches	Dialogue system evaluation

	SLO-2	Likelihood Distortions	Code excited linear Prediction	Architecture of large vocabulary continuous speech recognition system	Information retrieval-based approaches	Dialogue system evaluation
S-5	**SLO-1**	Spectral distortion using a Warped Frequency scale	Low – Bit rate Speech coders Speech Recognition	Acoustics model	Voice XML	Stochastic approaches to dialogue
	SLO-2					
S-6	**SLO-1**	LPC, PLC and MFCC Coefficients	Hidden Markov Models (HMM) – Practical Issues in Using HMMs – HMM Limitations	Language model	Speech recognition	Dialogue policy design and training
	SLO-2	LPC, PLC and MFCC Coefficients	Hidden Markov Models (HMM) – Practical Issues in Using HMMs – HMM Limitations	Language model	Speech recognition	Dialogue policy design and training
S-7	**SLO-1**	Time Alignment and Normalization	Acoustic Modeling – Phonetic Modeling, Language Modeling	n-gram model	Use of speech recognizers in dialogue systems	MDP reinforcement learning
	SLO-2	Time Alignment and Normalization	Acoustic Modeling – Phonetic Modeling, Language Modeling	n-gram model	Use of speech recognizers in dialogue systems	MDP reinforcement learning
S-8	SLO-1	Dynamic Time warping	Speaker Recognition Algorithm	context dependent sub word units	Natural language understanding	POMDP reinforcement learning
	SLO-2	Dynamic Time warping	Speaker Recognition Algorithm	context dependent sub word units	Natural language understanding	POMDP reinforcement learning
S-9	SLO-1	Multiple Time-Alignment Paths	Signal Enhancement for Mismatched Conditions	Applications and present status	Natural language understanding	Simulated users
	SLO-2	Multiple Time-Alignment Paths	Signal Enhancement for Mismatched Conditions	Applications and present status	Natural language understanding	Simulated users

Learning Resources	1. Huang, A. Acero, H-W. Hon, "Spoken Language Processing: A guide to theory, algorithm and system development", Prentice Hall 2001 2. Rabiner and Juang, "Fundamentals of Speech Recognition", Prentice Hall, 1993 3. F. Jelinek, "Statistical Methods for Speech recognition", MIT Press, 1997	4. Jurafsky, Daniel, and James H. Martin, "Speech and Language Processing: An Introduction to Natural Language Processing, Speech Recognition, and Computational Linguistics", 2nd edition. Prentice-Hall, 2009. 5. Jokinen and McTear, "Spoken Dialogue Systems, Morgan & Claypool, Synthesis Lectures on Human Language Technologies", Morgan & Claypool Publishers, 2009

Learning Assessment

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

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

Course Designers

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

B. Tech in Electronics and Communication Engineering

2018 Regulations

Open Elective Courses (O)

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

Course Code	18ECO101T	Course Name	Short Range Wireless Communication	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

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

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

Course Outcomes (CO):	The purpose of this course is to introduce practically all aspects of radio communication including wave propagation, antennas, transmitters, receivers, design principles, telecommunication regulations	Learning	Program Outcomes (PO)												PSO		
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
		Level of Thinking (Bloom)	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	Professional Achievement	Project Management Techniques	:Analyze & Research
CO-1 :	Explore the various forms of signals used for information transmission and modulation, and overall wireless system properties.	2	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2 :	Perceive various antenna and modulation types to implement a short-range radio system.	2	-	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-3 :	Articulate the various kinds of RF transmitters and receivers.	3	-	-	3	2	-	-	-	-	-	-	-	-	-	-	-
CO-4 :	Interpret regulations and standards of ISM band communications	3	3	-	-	-	-	1	-	-	-	-	-	-	-	-	-
CO-5 :	Identify some of the new developments in short-range radio like UWB and Visible light.	2	-	-	2	3	-	-	-	-	-	-	-	-	-	-	-

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

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

Learning Resources

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

Learning Assessment

Bloom's Level of Thinking		Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	50%	-	30%	-	30%	-	30%	-	30%	-
Level 2	Understand	50%	-	40%	-	40%	-	40%	-	40%	-
Level 3	Apply	-	-	30%	-	30%	-	30%	-	30%	-
Level 4	Analyze	-	-	-	-	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
Total	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	18EC0102J	Course Name	Electronic Circuits and Systems	Course Category	O	Open Elective	L	T	P	C
							2	0	2	3

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

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

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

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

	SLO-2	*Clippers & Clampers*	*Operation*	*HWR & FWR*	*Colpitts Oscillator*	*Digital Transmission, Frequency Division MultiplexingTime Division Multiplexing*
S-6	**SLO-1**	*Basic operation of Zener diode and its VI characteristics*	*Characteristics*	*Clipper &Clamper*	*555 Timer IC: Basic Operation*	*Networks: RS-232, circuit switching*
	SLO-2	*Zener diode as a voltage regulator*	*Parameters*	*Log & Antilog amplifiers*	*Astable Operation*	*Message switching, TCP/IP*
S-7	**SLO-1**	*Lab-2: VI Characteristics of Zener Diode*	*Lab-5:* ***Design & Analysis of CS-JFET Amplifier***	*Lab-8: Op-amp Circuits-I*	*Lab-11: 555 Timer Operation & Applications*	*Lab-14: Demonstration of Pulse Modulation*
	SLO-2					
S-8	**SLO-1**					
	SLO-2					
S-9	**SLO-1**	*BJTs: Structure & Operation*	*MOSFET as an amplifier*	*Instrumentation amplifier*	*Monostable Operation*	*Radio Transmission: Electromagnetic Spectrum, ground waves, sky waves*
	SLO-2	*Characteristics & Parameters*	*MOSFET as a switch*	*Comparator*	*Applications of 555 Timer*	*antennas, directional transmissions,*
S-10	**SLO-1**	*CE BJT amplifier operation*	*MOSFET Biasing (Voltage-Divider Biasing)*	*Comparator applications*	*Applications of 555 Timer*	*Transmitters, Receivers*
	SLO-2	*Differential amplifier operation*	*CS-MOSFET amplifier operation*	*Schmitt trigger*	*Voltage-Controlled Oscillators*	*Mobile telephones*
S-11	**SLO-1**	*Lab-3: Applications of PN Junction diode and Zener diode*	*Lab-6:* ***Design & Analysis of CS-MOSFET Amplifier***	*Lab-9: Op-amp Circuits-II*	*Lab-12: VCO Operation*	*Mini Project / Model Practical Examination*
	SLO-2					
S-12	**SLO-1**					
	SLO-2					

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

Learning Assessment

	Bloom's Level of Thinking	**Continuous Learning Assessment (50% weightage)**								**Final Examination (50% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (15%)**		**CLA – 3 (15%)**		**CLA – 4 (10%)#**			
		Theory	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**
Level 1	Remember	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Level 2	Understand	30%	30%	30%	30%	20%	20%	30%	30%	15%	15%
Level 3	Apply	10%	10%	10%	10%	10%	10%	10%	10%	20%	20%
Level 4	Analyze					10%	10%			5%	5%
Level 5	Evaluate										
Level 6	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

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

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Course Code	18ECO103T	Course Name	Modern Wireless Communication System	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

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

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

Course Outcomes (CO):	At the end of this course, learners will be able to:	Bloom's level (1-6)
CO-1 :	Organize the impact of cellular generation and the basics of wireless communication systems	2
CO-2 :	Analyze the various networking concepts and multiple access techniques in wireless systems	2
CO-3 :	Compile the performance of the different generation technologies in Personal Communication systems	3
CO-4 :	Evaluate the advancements in 3G and beyond technologies	3
CO-5 :	Incorporate the features offered by Mobile data services and short range networks	2

Program Outcomes (PO)												Program Specific Outcomes (PSO)		
1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
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	Professional Achievement	Project Management Techniques	Analyze & Research
-	-	-	3	-	-	-	-	-	-	-	2	-	-	-
-	-	-	3	-	-	-	-	-	-	-	2	-	-	-
-	-	-	3	-	-	-	-	-	-	-	2	-	-	-
-	-	-	2	-	-	-	-	-	-	-	3	-	-	-
-	-	-	2	-	-	-	-	-	-	-	3	-	-	-

Duration (hour)		Transmission Fundamentals	Network Concepts	Personal Communication Services	3G and Beyond	Mobile Data Services and Short- Range Network
		9	9	9	9	9
S-1	SLO-1	Cellphone Generations	Communication Networks	Personal communication Introduction, HSCSD, GPRS, D-AMPS, CDMA One, CDMA Two, Packet Data Systems	3G Introduction	Mobile Data Services Introduction Messaging, wireless web, WAP, site design Short-Range Wireless Networks: Unlicensed spectrum, WLANs, cordless telephony, IrDA, Bluetooth Smart Phones: Future phones, mobile OSs, smart phone applications.
	SLO-2	1G and 2G	LANs	GSM	IMT-2000 Introduction	Data Services
S-2	SLO-1	2.5G	MANs	GSM	IMT-2000	Messaging
	SLO-2	3G	WANs	HSCSD	IMT-2000	Wireless web
S-3	SLO-1	4G Transmission Introduction	Circuit switching	HSCSD	W-CDMA Introduction	WAP
	SLO-2	4G Transmission Fundamentals	Packet switching	GPRS	W-CDMA	Site design
S-4	SLO-1	Time domain concepts	ATM Cellular Networks Introduction	GPRS	CDMA 2000 Introduction	Short-Range Wireless Networks
	SLO-2	Frequency domain concepts	Cells	D-AMPS	EDGE	Unlicensed spectrum
S 5-6	SLO-1	Radio Media	Duplexing	D-AMPS	EDGE	WLANs
	SLO-2					
S-7	SLO-1	Analog Vs Digital	Multiplexing	CDMA Introduction	Wi-Fi Introduction	Cordless telephony
	SLO-2	Channel capacity	Voice coding	CDMA One	Wi-Fi	IrDA
S-8	SLO-1	Transmission media	Multiple Access Techniques: FDMA	CDMA One	WiMAX Introduction	Bluetooth Smart Phones
	SLO-2	Signaling Schemes	TDMA, SDMA	CDMA Two	WiMAX	Future phones
S-9	SLO-1	Carrier-based signaling,	CDMA	CDMA Two	OFDM	Mobile OSs
	SLO-2	Spread-spectrum signaling	Spectral efficiency	Packet Data Systems	MIMO	Smart phone applications

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	50%	-	25%	-	25%	-	40%	-	20%	-
Level 2	Understand	50%		25%		25%		40%		20%	
Level 3	Apply	-	-	*50%*	-	*50%*	-	*20%*	-	*60%*	-
Level 4	Analyze	-		-		-		-		-	
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-		-		-		-		-	
	Total	100 %		100 %		100 %		100 %		100 %	

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

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Course Code	18ECO104J	Course Name	Audio and Speech Signal Processing	Course Category	O	Open Elective	L	T	P	C
							2	0	2	3

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

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

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Learning Level of Thinking (Bloom)	Program Outcome (PO) 1 Engineering	2 Problem Analysis	3 Design & Development	4 Analysis, Design,	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	(PSO) 1 Professional Achievement	2 Project Management Techniques	3 Analyze &Research
CO-1 :	*Express the functioning of the human vocal and auditory systems in terms of signal processing*	2	3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-2 :	*Analyze the function of feature extraction in speech and audio signal processing using Time Domain Characteristics*	4	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3 :	*Write the time domain characteristics of speech signal*	2	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4 :	*Develop the Digital models for speech signal*	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5 :	*Demonstrate the elements of music*	3	3	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-6:	*Implement the speech signal processing in time and frequency domain and their models.*	6	3	3	2	-	-	-	-	-	-	-	-	-	-	-	-

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

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

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	25%	25%	10%	10%	10%	10%	05%	05%	10%	05%
Level 2	Understand	25%	25%	20%	20%	15%	15%	10%	10%	10%	10%
Level 3	Apply			10%	10%	25%	25%	10%	10%	20%	10%
Level 4	Analyze			10%	10%			10%	10%	10%	10%
Level 5	Evaluate							10%	10%		10%
Level 6	Create							05%	05%		05%
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers

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

Course Code	18ECO105T	Course Name	Underwater Acoustics	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Understand what is Sound Navigation and Ranging (SONAR) and how it can be used in underwater applications.*
CLR-2 :	*Study about Ocean Acoustic Processing and sound wave propagation and analyze sea floor characteristics and ocean sounds.*
CLR-3 :	*Understand about Underwater reverberation and how types of noises affects the underwater acoustics signal data analysis.*
CLR-4 :	*Study about Acoustic transducers.*
CLR-5 :	*Know which transducers can be used for underwater applications.*
***CLR*-6 :**	*Understand the basic theory and signal processing application for underwater communication and navigation.*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	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	Expected Proficiency	Expected Attainment	Engineering	Problem Analysis	Design &	Analysis, Design,	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team	Communication	Project Mgt. &	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management	PSO – 3: Analyze & Research
CLO-1 :	*Acquire in-depth knowledge and analyze on Sound Navigation and Ranging (SONAR) equations and it characteristics.*	*L1*	*85*	*65*	M	-	-	-	-	-	-	-	-	-	-	M	L		
CLO-2 :	*Analyze Ocean Acoustic Processing and sound wave propagation.*	*L2*	*85*	*65*	M	H	H	H	H	-	-	-	-	-	-	L	H	H	H
CLO-3 :	*Acquire knowledge and analyze Underwater reverberation and various types of noises.*	*L1 &L 2*	*85*	*65*	M		H	H	H	-	-	-	-	-	-	L	H	M	H
CLO-4 :	*Acquire knowledge on working of underwater Acoustic transducers.*	*L1*	*85*	*65*	H	H	H	H	H	-	-	-	-	-	-	L	H	H	H
CLO-5 :	*Gain knowledge and apply SONAR concepts for underwater applications.*	*L1 & L3*	*85*	*65*	L		H	H	-	-	-	-	-	-	-	L	H	M	H
CLO-6 :	*Understand the development and dynamics of underwater acoustic engineering*	*L2 &L 3*	*85*	*65*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Duration (hour)		Learning Unit / Module 1 Sound Navigation and Ranging (SONAR)	Learning Unit / Module 2 Ocean Acoustic Processing and sound wave propagation	Learning Unit / Module 3 Reverberation and Noises	Learning Unit / Module 4 Acoustic Transduction	Learning Unit / Module 5 SONAR Application
		9	9	9	9	9
S-1	SLO-1	*Introduction to SONAR equation,*	*Processing ocean sound-Sampling rules*	*Reverberation-Scattering, back scattering strength and target strength*	*Piezoelectric transducer-Introduction*	*Echo sounder*
	SLO-2	*Source Intensity, Source Directivity*	*Spatial sampling and Temporal sampling*	*Surface and bottom scattering*	*Piezoelectric transducer-33-Mode longitudinal vibrator*	*Echo Sounder*
S-2	SLO-1	*Transmission loss*	*Filter operations-Finite Fourier transformation*	*Volume scattering, bottom scattering, reverberation target strength*	*Piezoelectric transducer-33-Mode longitudinal vibrator*	*Sub-bottom profiling*

	SLO-2	*Transmission loss*	*Filter operations-Time domain view of Band pass filtering. convolution operations, frequency domain*	*Calculation of reverberation for use in the sonar equation, Volume reverberation level*	*Electrostrictive transducers*	*Fishing sonars*
S-3	SLO-1	*Target Strength*	*Gated Signals-Dependence of Spectrum on ping carrier periodicity*	*Reverberation frequency spread and Doppler gain potential-Power spectral density of a CW pulse*	*Electrostrictive transducers*	*Side scan terrain mapping sonar*
	SLO-2	*Reflection Intensity Loss Coefficient*	*Power spectra of random signal-Signal having random characteristics, Spectral density,*	*Environmental frequency sampling*	*Magnetostrictive transducers*	*Side scan terrain mapping sonar*
S-4	SLO-1	*Sea-floor Loss,*	*Radom signal simulations-Intensity spectral density, Spectral smoothing*	*Frequency spreading due to transmitter and receiver motion*	*Magnetostrictive transducers*	*Acoustic positioning and navigation*
	SLO-2	*Sea-surface Loss*	*Matched filters and autocorrelation*	*Frequency spreading due to target, important observation with respect to reverberation*	*Electostatic Transducers*	*Acoustic positioning and navigation*
S-5	SLO-1	*Noise, Reverberation*	*Sounds in the oceans-natural physical sounds and biological sounds*	*Noise-Ambient noise models*	*Electostatic Transducers*	*3D Imaging Processing-data model*
	SLO-2	*Active and Passive Sonar Equations*	*Sound propagation in the ocean and underwater acoustic channel-Sound wave and vibration, velocity of sound*	*Ambient noise-seismic noise, ocean turbulence, shipping noise*	*Variable Reluctance Transducers*	*3D Imaging Processing-acquisition of 3D information*
S-6	SLO-1	*Passive Sonar Equations, Signal-to-Noise Ratio*	*Sound propagation in the ocean and underwater acoustic channel-Sound wave velocity of sound*	*Wave noise, thermal noise*	*Variable Reluctance Transducers*	*3D Imaging Processing-matrix approach and real time systems*
	SLO-2	*Signal Excess, Figure of Merit*	*Wave and ray theories of underwater sound fields*	*Rain noise, temporal variability of ambient noise, depth effects of noise*	*Moving coil transducers*	*3D Imaging Processing-Image representation, Acoustic image processing*
S-7	SLO-1	*Active SONAR target strength*	*Wave and ray theories of underwater sound fields*	*Under ice noise*	*Moving coil transducers*	*3D Imaging Processing-Segmentation and reconstruction of underwater tubular structures*
	SLO-2	*Active SONAR- reverberation, detection threshold*	*Wave and ray theories of underwater sound fields*	*Spatial coherence of ambient noise*	*Equivalent circuits-Basics Circuit Resonance*	*3D Imaging Processing-Segmentation and reconstruction of underwater tubular structures*
S-8	SLO-1	*Active Sonar Sources- Source Level, Cavitation*	*Sound absorption in sea water and its characteristics*	*Self-noise-Flow noise*	*Circuit Q and Bandwidth*	*Acoustic communication-Cross attributes of the received signal*
	SLO-2	*Near-Field Interactions Explosive Sources*	*Upper boundary of acoustic channel*	*Self-noise – Flow noise*	*Transducers as projectors-principle*	*Acoustic communication-channel transfer function*
S-9	SLO-1	*Physics of Shock Waves in Wate, Bubble Pulses*	*Lower boundary of acoustic channel and its characteristics*	*Self noise-turbulent noise coherence*	*Transducers as Hydrophones-principles of operations*	*Acoustic communication-combating multipath*
	SLO-2	*Pros and Cons of Explosive Charges, Parametric Acoustic Sources*	*sound field in shallow water*	*Self noise-strumming noise*	*Transducers as Hydrophones-simplified equivalent circuit*	*Acoustic communication-diversity reception, equalization*

Learning Resources

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

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

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

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

Course Code	18ECO106J	Course Name	PCB Design and Manufacturing	Course Category	O	Open Elective	L	T	P	C
							2	0	2	3

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

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

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning	Program Outcomes (PO)												PSO		
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
		Level of Thinking (Bloom)	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	Professional Achievement	Project Management Techniques	Analyze & Research
CO-1 :	Identify the various types of PCB and electronics components packaging	2	3	-	-	1	-	-	-	-	-	-	-	-	-	-	-
CO-2 :	Perceive appropriate parameters involved in PCB design	4	2	-	3	2	-	-	-	-	-	-	-	-	-	-	-
CO-3 :	Apply the design rules in designing PCB for special application circuits	4	2	-	3	1	-	-	-	-	-	-	-	-	-	-	-
CO-4 :	Develop a PCB layout using modern CAD tool	4	2	-	-	2	3	-	-	-	-	-	-	-	-	-	-
CO-5 :	Explore the required PCB manufacturing technology	6	1	-	-	-	3	-	-	-	-	-	-	-	-	-	-
CO-6 :	Analyze the various PCB Assembly process	4	-	-	2	3	-	-	-	-	-	-	-	-	-	-	-

		Terminologies of PCB Design	PCB Design Considerations	Design Rules for Special Application Circuits	PCB Layout Design	PCB Manufacturing Techniques
Duration (hour)		12	12	12	12	12
S-1	SLO-1	Nomenclature of a Printed Circuit Board	PCB Design Considerations - Important Design Elements	Design Rules for Analog Circuits	Schematic Capture - Introduction schematic capture tool	Image Transfer Techniques- Screen Printing, Pattern Transferring Techniques
	SLO-2	Classification of Printed Circuit Boards	PCB Design Considerations - Important Performance Parameters			
S-2	SLO-1	Manufacturing of basic PCB - Single- and Double-sided Plated Through-holes	PCB Design Considerations - Mechanical Design Considerations	Design Rules for Digital Circuits	Schematic Capture - Simulation of simple electronic circuit	Image Transfer Techniques- Printing Inks, Photo Printing, Laser Direct Imaging (LDI)
	SLO-2	Manufacturing of Multi-layer Boards - Flexible Boards, Challenges in modern PCB Design and Manufacture, PCB Standards	PCB Design Considerations - Mechanical Design Considerations		Schematic Capture - Schematic to layout transfer	Copper Clad Laminates - Properties of Laminates, Types of Laminates, Evaluation of Laminates
S-3	SLO-1	***Lab 1:Study of electronic components- Passive electronic components***	***Lab 4:Design and analysis of RL and RC time constants. Schematic in CAD tool***	**Lab 7: Schematic and PCB Layout in CAD tool.Regulated power supply design.- Full wave rectifier circuit design with fixed voltage regulator**	**Lab 10: PCB Layout Design of single digit pulse counter using PCB design tool.**	**Lab 13: Mini Project - PCB Layout Design of electronic turn ON/OFF timer using IC555 using PCB design tool.**
	SLO-2					
S-4	SLO-1					
	SLO-2					
S-5	SLO-1	Types, Symbols, Packaging shapes and terminal details of Electronic Components –Resistors, Thermistors Capacitors, Inductors	PCB Design Considerations - Electrical Design Considerations	Design Rules for High Frequency Circuits	PCB Layout Design - Conception Level Introduction	Etching Techniques – wet Etching chemicals

	SLO-2	*Diodes, Light Emitting Diodes (LED), Photodiode,*	*PCB Design Considerations - Conductor Patterns, Component Placement Rules*	*Design Rules for Fast Pulse Circuits*	*PCB Layout Design - Specifying Parts, Packages and Pin Names, Libraries*	*Etching Techniques - Mechanical Etching*
S-6	**SLO-1**	*Transistors, Field-effect Transistors, Insulated Gate Bipolar Transistor (IGBT), Thyristor*	*Fabrication and Assembly Considerations*	*Design Rules for Microwave Circuits*	*PCB Layout Design - Checking foot prints of the components, Part list, Net list, Making Net list Files*	*PCB Assembly Process - Through-hole*
S-7	**SLO-1**	***Lab 2: Study of electronic components- active devices, analog and digital integrated circuits (IC)***	***Lab 5: Design and analysis of RLC circuits.*** ***Schematic in CAD tool***	***Lab 8: Schematic and PCB Layout in CAD tool.*** ***Regulated power supply design. -Full wave rectifier circuit design with fixed voltage regulator***	***Lab11:PCB Design of single digit pulse counter: Schematic and PCB layout using PCB design tool.***	***Lab 14: Mini Project - Manufacture the PCB for electronic turn ON/OFF timer using IC555and construct and test the designed circuit.***
	SLO-2					
S-8	**SLO-1**					
	SLO-2					
S-9	**SLO-1**	*Digital Integrated Circuits, Random Access Memory*	*Environmental Factors, Cooling Requirements*	*Design Rules for High-density Interconnection Structures*	*PCB Layout Design - Mounting Holes, Adding Text, PCB Layout*	*PCB Assembly Process - Surface Mount, Mixed Technologies*
	SLO-2	*Read Only Memory*	*Packaging Density*			
S-10	**SLO-1**	*Microcontrollers, Surface Mount Devices*	*Layout Design*	*Electromagnetic Interference/Compatibility (EMI/EMC)*	*PCB Layout Design - DRC, Pattern Transfer, Layout printing*	*PCB Assembly Process - Soldering*
	SLO-2	*Transformer, Relays, Connectors*				
S-11	**SLO-1**	***Lab 3: Study of testing and measuring Instruments: Logic analyzer, spectrum analyzer, IC tester (Analog and Digital), LCR meters***	***Lab 6: PCB Layout Design - of RL, RC and RLC circuits***	***Lab 9: Schematic and PCB Layout in CAD tool.*** ***Regulated power supply design.*** ***Full wave rectifier circuit design with fixed voltage regulator***	***Lab 12: Mini Project - PCB Layout Design of electronic turn ON/OFF timer using IC555 using PCB design tool.***	***Lab 15: Mini Project - Manufacture the PCB for electronic turn ON/OFF timer using IC555and construct and test the designed circuit.***
	SLO-2					
S-12	**SLO-1**					
	SLO-2					

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

Learning Assessment

Bloom's Level of Thinking		Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	25%	25%	10%	10%	5%	5%	5%	5%	5%	5%
Level 2	Understand	25%	25%	20%	20%	5%	5%	5%	5%	5%	5%
Level 3	Apply	-	-	15%	15%	10%	10%	10%	10%	10%	10%
Level 4	Analyze	-	-	5%	5%	15%	15%	15%	15%	15%	15%
Level 5	Evaluate	-	-	-	-	10%	10%	10%	10%	10%	10%
Level 6	Create	-	-	-	-	5%	5%	5%	5%	5%	5%
Total	Total	100%		100%		100%		100%		100%	

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

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Course Code	18ECO107T	Course Name	Fiber Optics and Optoelectronics	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

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

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

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:			
CLO-1 :	Review the basic theorems related to fiber optic communication, and attain knowledge of types of optical fibers	2	80	70
CLO-2 :	Understand the optical signal distortion factors in optical fiber communication	2	85	75
CLO-3 :	Familiarize the principle and operation of various display devices, light sources and detectors	2	75	70
CLO-4 :	Acquire knowledge of various optoelectronic modulators and amplifiers	2	85	80
CLO-5 :	Understand the various optoelectronic integrated circuits	2	85	75
CLO-6:	Acquire fundamental concepts related to optical communication and optoelectronic devices	2	80	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 Techniques	PSO – 3: Analyze & Research
CLO-1 :	H	H	-	-	-	-	-	-	-	-	-	-	-		H
CLO-2 :	H	-	M	-	-	-	-	-	-	-	-	-	-	-	M
CLO-3 :	H	M	M	-	-	-	-	-	-	-	-	-	-	-	L
CLO-4 :	H	-	M	-	-	-	-	-	-	-	-	-	-	-	H
CLO-5 :	H	-	M	L	-	-	-	-	-	-	-	-	-	-	L
CLO-6:	H	M	M	L	-	-	-	-	-	-	-	-	-	-	H

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

	SLO-2	*Numerical aperture, Critical angle*	*Material dispersion, Waveguide dispersion*	*Quantum efficiency and LED power – Internal quantum efficiency derivation*	*Optical switching and logic devices – Bipolar controller modulator*	*Integrated transmitters and receivers – photoreceiver noise and bandwidth considerations*
S-5	**SLO-1**	*Solving Problems*	*Waveguide dispersion*	*Quantum efficiency and LED power – External quantum efficiency and total LED power*	*Optical switching and logic devices- tunable threshold logic gate – Switching speed and energy.*	*Integrated transmitters and receivers – PIN-HBT photoreceivers*
	SLO-2	*Solving Problems*	*Signal distortion in single mode fibers*	*Solving Problems*	*Optical Amplifiers – General applications of optical amplifiers*	*Integrated transmitters and receivers – OEIC transmitters – equivalent circuit for integrated receivers*
S-6	**SLO-1**	*Ray optics*	*Polarization mode dispersion*	*Semiconductor laser diode*	*Semiconductor optical amplifiers – Basic configuration*	*Integrated transmitters and receivers – Complex circuits and arrays*
	SLO-2	*Types of rays*	*Polarization mode dispersion, Intermodal dispersion*	*Modes and threshold condition*	*Semiconductor optical amplifiers – Optical gain - Limitations*	*Integrated transmitters and receivers - optical control and microwave oscillators*
S-7	**SLO-1**	*Optical fiber modes*	*Intermodal dispersion*	*Photo detection principle*	*Erbium doped fiber amplifiers – energy level diagram and amplification mechanism*	*Guided wave devices – Waveguide and couplers*
	SLO-2	*Optical fiber configurations*	*Solving Problems*	*PIN Photodiode*	*Erbium doped fiber amplifiers – EDFA configuration*	*Guided wave devices – Active guided wave devices*
S-8	**SLO-1**	*Single mode fibers*	*Solving Problems*	*PIN photodiode - Avalanche Photodiode*	*Solving Problems*	*Guided wave devices – Mach Zehnder Interferometers*
	SLO-2	*Multimode Fibers*	*Pulse Broadening in Graded Index Waveguides*	*Avalanche Photodiode*	*Solving Problems*	*Active couplers*
S-9	**SLO-1**	*Step Index Fibers*	*Mode Coupling*	*Noise mechanism in photodetectors*	*Fiber Raman Amplifiers – Configuration – Forward pumping*	*Active Couplers*
	SLO-2	*Graded Index Fibers*	*Design Optimization of Single Mode Fibers*	*Solving Problems*	*Fiber Raman Amplifiers – Backward pumping*	*Active Couplers*

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

Learning Assessment

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

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

Course Designers

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

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

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

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

Course Outcomes (CO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Program Outcomes (PO)												(PSO)		
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
			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	Professional Achievement	Project Management Techniques	Analyze & Research
CO-1 :	Demonstrate the fundamentals of Arduino Platform and Programming	*2*	*3*		-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2 :	Compile C programming to the core elements of Arduino	*3*	-	*2*	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-3 :	Apply Various communication protocols for Embedded Systems	*3*	-	-	2	-	3	-	-	-	-	-	-	-	-	-	-
CO-4 :	Analyze the timer delays and IO devices	*4*	*3*	*2*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5 :	Evaluate the real time operation using Arduino programming	*5*	-	-	-	1	-	-	-	-	2	-	3	-	-	-	
CO-6 :	Implement the Arduino C programming into real time applications for Embedded Systems	6	-	-	3	-	-	-	-	-	1	-	2	-	-	-	-

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

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

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	25%	25%	10%	10%	5%	5%	05%	05%	10%	05%
Level 2	Understand	25%	25%	10%	10%	5%	5%	10%	10%	10%	10%
Level 3	Apply			30%	30%	10%	10%	10%	10%	10%	10%
Level 4	Analyze					15%	15%	10%	10%	10%	10%
Level 5	Evaluate					15%	15%	10%	10%	10%	10%
Level 6	Create							05%	05%		05%
	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	18ECO109J	Course Name	Embedded System Design using Raspberry Pi	Course Category	O	Open Elective	L	T	P	C
							2	0	2	3

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

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

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning Level of Thinking (Bloom)	Program Outcomes (PO) 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	PSO 1 Professional Achievement	2 Project Management Techniques	3 Analyze & Research
CO-1 :	Remember the fundamentals of python Platform and Programming	2	3	-	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-2 :	Express the knowledge in data sheet and functioning sensors	2	-	2	3	-	1	-	-	-	-	-	-	-	-	-	-
CO-3 :	Write the GPIO and interfacing motor program in python using Raspberry Pi	3	1	-	2	3	-	-	-	-	-	-	-	-	-	-	-
CO-4 :	Analyze and handle the program on GPIO of raspberry Pi Interfacing	4	1	-	3	2	-	-	-	-	-	-	-	-	-	-	-
CO-5 :	Apply the concept of GPIO of Raspberry Pi to interfacing input and display device	3	-	-	1	2	-	-	-	-	-	-	3	-	-	-	-
CO-6 :	Construct the node js, cloud service and ***MQTT Protocol*** for moving sensor data to web	6	-	-	2	-	1	-	-	-	-	-	3	-	-	-	-

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

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

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

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	25%	25%	10%	10%	10%	10%	05%	05%	10%	05%
Level 2	Understand	25%	25%	10%	10%	10%	10%	10%	10%	10%	10%
Level 3	Apply			30%	30%	20%	20%	15%	10%	10%	10%
Level 4	Analyze					10%	10%	10%	10%	10%	10%
Level 5	Evaluate							10%	10%	10%	10%
Level 6	Create								05%		05%
	Total	100 %		100 %		100 %		100 %		100 %	

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

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Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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Course Code	18ECO110J	Course Name	3D Printing Hardware and Software	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

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

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

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

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

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

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

Learning Assessment

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

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

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

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

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

	SLO-2	*Neural Engineering*	*ECG system Block diagram and its uses*	*Ultrasound basics*	*Mechanics of Blood Vessels*	*Titanium, Hydroxyapatite*
S-6	**SLO-1**	*Telehealth*	*EEG Introduction*	*Ultrasound Imaging*	*Cardiac Biomechanics*	*Glass ceramics*
	SLO-2	*Bio signal processing*	*EEG system Block diagram and its uses*	*Ultrasound Application*	*Biomechanics of Chest and Abdomen*	*Introduction to polymers*
S-7	**SLO-1**	*Medical Imaging*	*EMG Introduction*	*fMRI Imaging*	*Cochlear Mechanics*	*Types of polymers*
	SLO-2	*Computational modelling*	*EMG system Block diagram and its uses*	*fMRI Imaging Application*	*Dynamics of Human Body Models*	*Biodegradable polymers and its applications*
S-8	**SLO-1**	*BioMEMS*	*Cardiac pacemakers and its uses*	*PET- Imaging*	*Gait analysis*	*Composites and its applications*
	SLO-2	*Mobile POCT*	*Cardiac Defibrillators and its uses*	*PET Imaging Application*	*Biomechanics in physical education*	*Wound-Healing process*
S-9	**SLO-1**	*Professional Status of Biomedical Engineering*	*Patient Monitoring System Introduction*	*SPECT Imaging*	*Biomechanics in strength and conditioning*	*Biomaterials for artificial valve, Ear*
	SLO-2	*Professional Societies*	*Patient Monitoring System Block diagram and its uses*	*SPECT Imaging Application*	*Biomechanics in sports medicine andrehabilitation*	*Biomaterials for artificial Skin, Eye*

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

Learning Assessment

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

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Sathyanarayanan J, Mindray Medical India Pvt Ltd, sathyanarayananjayagopal@mindray.com	*1.* Dr. S. Poonguzhali, Anna University, poongs@annauniv.edu	***1. Ms.** Oinam Robita Chanu**, SRMIST***
2. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*2. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	***2. Dr. D. Kathirvelu, SRMIST***
3. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*3. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

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

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking	Expected Proficiency	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1: Problem Solving at the	PSO-2: Design & Develop Medical	PSO-3: multidisciplinary
CLR-1 :	Utilize the planning and organizational activities of Hospitals																		
CLR-2 :	Analyze the concepts in clinical and diagnostic services																		
CLR-3 :	Utilize the policies and procedures about support services and material management																		
CLR-4 :	Utilize the features in staff and safety management in hospital																		
CLR-5 :	Analyze the reporting system and recent advancement in hospital administration																		
CLR-6 :	Apply all the advanced application the field of telemedicine																		
Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:																		
CLO-1 :	Analyze the role of hospitals and ensure proper healthcare delivery	2	85	75	L	-	-	-	-	M	-	-	-	-	-	-	L	-	-
CLO-2 :	Suggest appropriate technologies and services in clinical and diagnostic field	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	L	-	-
CLO-3 :	Analyze the supportive services and the use of proper material management	3	85	75	M	-	-	-	-	-	M	L	-	-	-	-	M	-	L
CLO-4 :	Identify objectives of staff management and ensure safety management in hospitals	3	85	75	M	-	-	-	-	-	-	L	-	-	-	L	L	-	-
CLO-5 :	Implement the advance technologies and effectively evaluate the healthcare information	3	85	75	L	-	-	-	-	M	-	L	L	-	-	-	L	L	L
CLO-6 :	Implement the various standards in hospital and healthcare services	3	85	75	L	-	-	-	-	M	-	-	-	-	-	-	L	-	-

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

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

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

Learning Assessment

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

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

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

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

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning			Program Learning Outcomes (PLO)														
		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	Problem Analysis	Design &	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1: Problem Solving at the	PSO-2: Design & Develop Medical	PSO-3: multidisciplinary research for health
CLR-1 :	Utilize the working principle of X-ray imaging																		
CLR-2 :	Analyze the principle behind tomographic imaging and the reconstruction techniques																		
CLR-3 :	Interpret the theory behind nuclear medicine and utilize the working of imaging modalities in nuclear medicine																		
CLR-4 :	Analyze the physics of ultrasound and the different imaging modes using ultrasound																		
CLR-5 :	Utilize the physical principle of nuclear magnetic resonance and magnetic resonance image reconstruction																		
CLR-6 :	The learner will be to gain knowledge in the working principle of imaging modalities using X-ray, computed tomography, nuclear medicine, ultrasound and magnetic resonance imaging.																		
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*																		
CLO-1 :	Analyze the physics and principle behind the working of X-ray imaging	2	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-2 :	Identify the principle behind working of tomographic imaging and reconstruction procedures.	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-3 :	Analyze the working principle of nuclear medicine imaging modalities	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-4 :	Identify the physics of ultrasound and the modes of ultrasound imaging	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-5 :	Explain the physical principle of magnetic resonance imaging and the instrumental components involved in MR imaging	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-6 :	Understand the basic principle and working of medical Imaging systems	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-

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

S-5	**SLO-1**	*Antiscatter grids Intensifying screens*	*Processing system*	*Multi-linear and phased array*	*Gradient recalled sequence*	*Non-imaging detector applications*
	SLO-2	*X-ray films*	*Iterative reconstruction, back projection reconstruction*	*Generation and detection of ultrasound*	*Proton density weighted images, pulse sequence for fast imaging*	*Counting statistics*
S-6	**SLO-1**	*Instrumentation for computed and digital radiography*	*Filtered back projection*	*Basic pulse echo apparatus: A-scan*	*Slice selection gradient*	*Nuclear imaging*
	SLO-2	*X-ray Image characteristics: Signal to Noise ratio*	*Helical /Spiral CT: Helical pitch*	*B-Mode*	*Frequency encode gradient*	*Anger scintillation camera*
S-7	**SLO-1**	*Spatial resolution, Contrast to Noise ratio*	*Basic reconstruction approaches*	*M-mode*	*Phase encode gradient*	*Basic principle :Emission computed tomography*
	SLO-2	*X-ray contrast agents, X-ray angiography*	*Slice sensitivity profile*	*Echocardiograph*	*2D spin echo data acquisition*	*Single photon emission computed tomography*
S-8	**SLO-1**	*X-ray Fluoroscopy*	*Multislice CT*	*Duplex scanner*	*Basic NMR components: Main magnet, RF transmitter/receiver*	*Positron emission tomography*
	SLO-2	*X-ray mammography*	*Detector configuration*	*Intravascular imaging*	*Body coils, gradient coils*	*Imaging techniques and scanner instrumentation*
S-9	**SLO-1**	*Dual energy Imaging*	*Measurement of X-ray dosage*	*Artefacts: Refraction, shadowing and enhancement*	*fMRI : Basic principle*	*Dual modality: PET/CT*
	SLO-2	*Abdominal X-ray scans*	*Methods for dose reduction*	*Reverberation*	*BOLD concept, MR spectroscopy*	*Working and applications*

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

Learning Assessment

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

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Sathyanarayanan J, Mindray Medical India Pvt Ltd, sathyanarayananjayagopal@mindray.com	*1.* Dr. S. Poonguzhali, Anna University, poongs@annauniv.edu	***1. Dr. T. Jayanthi, SRMIST***
2. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*2. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	***2. Dr. U. Snekhalatha, SRMIST***
3. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*3. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

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

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

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

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

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

	SLO-2	*EOG based voice controlled wheelchair*	*Internal Hearing Aid*	*GRAB*	*feedback in orthotic system*	*Vascular prosthesis*
S-6	**SLO-1**	*BCI based wheelchair*	*External Hearing Aid*	*mathematical Braille*	*Components of upper limb prosthesis*	*Artificial heart*
	SLO-2	*Fuzzy logic expert system for automatic tuning of myoelectric prostheses*	*Permanent Hearing Restoration*	*Blind mobility aids*	*Components of lower limb prosthesis*	*Intermittent positive pressure breathing (IPPB) type assistance for lungs*
S-7	**SLO-1**	*Intelligent prosthesis*	*Non-Permanent Hearing Restoration*	*Reading writing & graphics access,*	*Lower extremity- and upper extremity- orthoses*	*Dialysis for kidneys*
	SLO-2	*Intelligent prosthesis*	*Touch Tactile Haptic Technology*	*Orientation & navigation Aids*	*Lower extremity- and upper extremity- orthoses*	*Artificial Kidney*
S-8	**SLO-1**	*Future trends in assistive technology*	*Sound Coding Translation*	*Wearable Assistive Devices for the Blind*	*functional electrical stimulation*	*Haemodialysis*
	SLO-2	*virtual reality based training system for disabled children*	*Acoustic Transducers Hearing Quality*	*Wearable tactile display for the fingertip.*	*Sensory assist devices*	*Membrane dialysis*
S-9	**SLO-1**	*Information technology, telecommunications,*	*Electric Electronic Stimulation*	*Cortical implants*	*Sensory assist devices*	*Portable dialysis monitoring and functional parameter*
	SLO-2	*new media in assisting healthcare*	*Hearing Enhancement*	*Retinal implants*	*Slints – materials used*	*Latest use of assistive technology for chronic heart diseases and healthcare*

Learning Resources

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

Learning Assessment

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

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

Course Designers

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1. Sathyanarayanan J, Mindray Medical India Pvt Ltd, sathyanarayananjayagopal@mindray.com	*1.* Dr. S. Poonguzhali, Anna University, poongs@annauniv.edu	***1. Mrs. Lakshmi Prabha, SRMIST***
2. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*2. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	***2. Dr. U. Snekhalatha, SRMIST***
3. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*3. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

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

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

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

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

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

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

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

Learning Assessment

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

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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Course Code	18ECO126T	Course Name	Sports Biomechanics	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
CLR-1 :	Understand the fundamental muscle action and locomotion in biomechanical point of view			
CLR-2 :	Get an idea about the movement patterns and causes of movements			
CLR-3 :	Understand the qualitative and quantitative analysis of sports movements			
CLR-4 :	Acquire an idea about the basic concept of jumping & aerial movement and throwing & hitting			
CLR-5 :	Get an idea about the injury prevention, rehabilitation and special Olympic sports			
CLR-6 :	Get an overall idea about the applications of biomechanics in sports			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking	Expected Proficiency (%)	Expected Attainment (%)	Program Learning Outcomes (PLO)														
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
					Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1: Problem Solving at the	PSO-:2: Design & Develop Medical	PSO-3: multidisciplinary research for health
CLO-1 :	Illustrate the muscle action in sport and locomotion	1	80	70	M												L		
CLO-2 :	Analyze the movement patterns and its causes	1,2	80	70	M												M		
CLO-3 :	Describe the Qualitative and Quantitative analysis of sports movements	2	80	70	M												M		
CLO-4 :	Analyze the movement of action such as jumping, throwing, hitting and aerial movement	2	80	70			L										L	L	L
CLO-5 :	Identify the injury scenario and special Olympic sports	2	80	70													L	L	L
CLO-6 :	Outline the major concepts in sports biomechanics																		

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

	SLO-2	*Stretch–Shortening Cycle of Muscle Function*	*Fundamentals of movement*	*Identifying critical features of a movement*	*Determinants of Successful Ski-Jumping Performance*	*Induced Muscle Injury*
S-5	SLO-1	*Biomechanical Foundations of Strength*	*Linear motion and the centre of mass*	*The use of videography in recording sports movements*	*Principles of Throwing*	*Manual Wheelchair Propulsion*
	SLO-2	*Power Training*	*The geometry of angular motion and the coordination of joint rotations*	*The use of videography in recording sports movements*	*The Flight of Sports Projectiles*	
S-6	SLO-1	*Factors Affecting Preferred Rates of Movement in Cyclic Activities*	*Forces in sport*	*Recording the movement*	*Javelin Throwing: an Approach to Performance Development*	*Sports after Amputation*
	SLO-2	*The Dynamics of Running*	*Combinations of forces on the sports performer*	*Experimental procedures -Two dimensional videography*		
S-7	SLO-1	*Resistive Forces in Swimming*	*Momentum and the laws of linear motion*	*Experimental procedures -Three dimensional videography*	*Shot Putting*	*Biomechanics of Dance*
	SLO-2	*Propulsive Forces in Swimming*	*Force–time graphs as movement patterns*	*Data processing*	*Hammer Throwing: Problems and Prospects*	
S-8	SLO-1	*Performance-Determining Factors in Speed Skating*	*Determination of the centre of mass of the human body*	*Projectile motion*	*Hammer Throwing: Problems and Prospects*	*Biomechanics of Martial arts*
	SLO-2	*Cross-Country Skiing: Technique*	*Fundamentals of angular kinetics and Generation and control of angular momentum*	*Linear velocities and accelerations caused by rotation*	*Hitting*	
S-9	SLO-1	*Cross-Country Skiing: Equipment*	*Measurement of force*	*Rotation in three-dimensional space*	*Kicking*	*Biomechancis of YOGA*
	SLO-2	*Factors Affecting Performance*	*Measurement of pressure*	*Rotation in three-dimensional space*	*Simple concept problems*	

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

Learning Assessment

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

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

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. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*3. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

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

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

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

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

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		12	12	12	12	12
S-1	SLO-1	Historical perspective, Need of VI, Advantages of VI, Virtual Instruments versus Traditional Instruments	A/D Converters, Organization of the DAQ VI system -	Introduction to PC Buses	Introduction to Non continuous controllers in LabVIEW	PC based digital storage oscilloscope
	SLO-2	Review of software in Virtual Instrumentation ,Software environment Architecture of VI. Introduction to the block diagram and Front panel Pallets	D/A Converters, Types of D/A	Local Buses-ISA, PCI,	Introduction to continuous controllers in LabVIEW	Sensor Technology
S-2	SLO-1	Creating and saving a VI, Front Panel Tool Bar, Block diagram Tool Bar, Palettes	plug-in Analog Input/output cards - Digital Input and Output Cards.	RS232, RS422	Design of ON/OFF controller	Applications of sensor Technology
	SLO-2	Creating sub VI, Creating an ICON, Building a connector pane, Displaying VI'S, Placing and Saving Sub VI'S on block diagram, Example of full adder circuit using half adder circuit	Organization of the DAQ VI system -	RS485	Proportional controller for a mathematically described processes using VI software	Signal processing Techniques
S-3	SLO-1	***Lab-1:*** Front Panel controls and Indicator	***Lab-12:*** Measurement of diode I-V characteristics using LabVIEW	***Lab-17:*** Load cell Data acquisition using RS232	***Lab-22:*** On-off temperature controller using LabVIEW	***Lab-28:*** Design of DSO
	SLO-2	***Lab-2:*** Verification of Arithmetic Operations				
S-4	SLO-1	***Lab-3:*** Verification of Half Adder	***Lab-13:*** Temperature measurement using LabVIEW and DAQ hardware.		***Lab-23:*** Continuous Control of temperature using LabVIEW	***Lab-29:*** Analysis of different signal Filters using LabVIEW
	SLO-2	***Lab-4:*** Verification of Full adder.				
S-5	SLO-1	Loops-For Loop,	Opto Isolation need	Interface Buses-USB,PXI	Modeling of level process	Spectrum Analyzer
	SLO-2	While Loop	Performing analog input and analog output	VXI,	Basic control of level process in LabVIEW	Waveform Generator
S-6	SLO-1	Arrays,	Scanning multiple analog channels	SCXI	Modeling of Reactor Processes	Data visualization from multiple locations

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

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

Learning Assessment

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

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. D. Karthikeyan, Controlsoft Engineering India Pvt Ltd, karthikeyan.d@controlsoftengg.in	*1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com*	*1. Dr. K. A. Sunitha, SRMIST*
2. V. Venkateswaran, Instrumentation Consultant, vvenkat99@gmail.com	*2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com*	*2. Mrs. A. Brindha, SRMIST*

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

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

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

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

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

S-5	**SLO-1**	*Secondary Electrodes and Types*	*Oxygen analyzer Methods of oxygen analyzers and importance*	*Instrumentation or basic component of HPLC*	*Instruments of dispersive instrument , IR Radiation Sources and types*	*Time of flight analyzers, Quadrupole Mass analyzers*
	SLO-2	*Indicator electrodes*	*Paramagnetic oxygen analyzer Electro analytical method*	*Solvent reservoir and its treatment system*	*Importance of Monochromators and types of Monochromators*	*Application of mass spectrophotometers*
S-6	**SLO-1**	*pH meters direct reading type pH meter null detector type pH meter*	*CO monitor,Importance of measuring CO*	*Pumping system, Types of working systems and Importance*	*Samples And Sample Cells detectors*	*nuclear radiation detectors, importance of measurement*
	SLO-2	*ion selective electrodes Types of ion selective electrodes Glass membrane electrodes Liquid membrane electrodes Solid membrane Electrodes*	*Types of CO monitor*	*Pulse dampers*	*FTIR spectrometers, Main components Advantages, disadvantages*	*GM counter*
S-7	**SLO-1**	*Biosensors Features of Biosensor Block diagram of bio sensor*	*NO2 analyzer, Importance of NO_2 measurement*	*Sample injection system and types*	*Types of sources Selection factors*	*Working setup, advantages of GM Counter*
	SLO-2	*Applications of Biosensors in industries*	*Types of NO_2 measurement*	*Liquid chromatographic column working , Types of Column thermostats*	*Types of detectors Selection factors*	*proportional counter, Basic Principle*
S-8	**SLO-1**	*conductivity meters ,Importance in Chemical Industries*	*H_2S analyzer, Importance of H_2 S Measurement*	*Detection system types*	*atomic absorption spectrophotometer instruments for atomic absorption spectroscopy*	*Working setup, advantages of GM Counter*
	SLO-2	*Types of Conductivity meters*	*Types of H_2S measurement*	*Types of Recording system*	*radiation source chopper*	*solid state detectors, Basic Principle*
S-9	**SLO-1**	*Air pollution Monitoring Instruments*	*Dust and smoke measurement- dust measurement and Importance Types of dust measurement*	*Application of HPLC, Advantages of HPLC over gas chromatography*	*production of atomic vapor by flame, Parts by flame photometer Emission system*	*Working setup, advantages of Solid state detectors*
	SLO-2	*Estimation of Air pollution*	*Thermal analyzer , Importance of Thermal analyzers, Types of Thermal analyzer*	*Detectors types, Factors Influencing the Selection of Detectors*	*Monochromators And types, Types of Detectors and recording systems and their selection criteria*	*scintillation counter, Basic principle*

Learning Resources

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

Learning Assessment

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

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. D. Karthikeyan, Controlsoft Engineering India Pvt Ltd, karthikeyan.d@controlsoftengg.in	*1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com*	*Dr. K. A. Sunitha, SRMIST*
2. V. Venkateswaran, Instrumentation Consultant, vvenkat99@gmail.com	*2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com*	*Mrs. A. Brindha, SRMIST*

Course Code	18ECO133T	Course Name	SENSORS AND TRANSDUCERS	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

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

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

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction to sensors/ transducers, Principles	Introduction to Inductive sensor	Thermal sensors: Introduction	Magnetic sensors: Introduction	Measurement of Non-Electrical quantity: Introduction
	SLO-2	Classification based on different criteria	Sensitivity and linearity of the sensor	Thermal Expansion type.	Villari effect	Flow Measurement – Introduction.
S-2	SLO-1	Characteristics of measurement systems	Transformer type transducer	Acoustics temperature sensors.	Wiedmann effect	Ultrasonic Flow Meters.
	SLO-2	Static characteristics Accuracy, Precision, Resolution, Sensitivity	Electromagnetic transducer	Thermo-emf sensor.	Hall effect	Hot Wire Anemometers.
S-3	SLO-1	Dynamic characteristics.	Magnetosrtictive transducer	Materials for thermos-emf sensors.	Construction,	Electromagnetic Flow meters.
	SLO-2	Environmental Parameters	Materials used in inductive sensor	Thermocouple construction	performance characteristics,	Principle and types.
S-4	SLO-1	Characterization and its type	Mutual Inductance change type	Types.	and its Application	Measurement of Displacement.
	SLO-2	Electrical characterization.	LVDT: Construction.	Thermo-sensors using semiconductor device	Introduction to smart sensors	Introduction and types.
S-5	SLO-1	Mechanical Characterization.	Material, input output relationship,	Pyroelectric thermal sensors	Film sensors: Introduction	Measurement of Velocity/ Speed.
	SLO-2	Thermal Characterization	Synchros-Construction	Introduction	Thick film sensors	Introduction and types.

S-6	**SLO-1**	*Optical Characterization.*	*Capacitive sensor: Introduction*	*characteristics*	*Microelectromechanical systems*	*Measurement of Liquid Level.*
	SLO-2	*Errors and its classification.*	*Parallel plate capacitive sensor*	*Application*	*Micromachining.*	*Introduction and types.*
S-7	**SLO-1**	*Selection of transducers.*	*Variable thickness dielectric capacitive sensor*	*Radiation sensors.*	*Nano sensors*	*Measurement of Pressure.*
	SLO-2	*Introduction to mechanical sensors*	*Electrostatic transducer*	*Introduction*	*Applications: Industrial weighing systems: Link–lever mechanism.*	*Introduction and types.*
S-8	**SLO-1**	*Resistive potentiometer and types*	*Piezoelectric elements*	*Characteristics*	*Load cells – pneumatic, elastic and their mounting.*	*Measurement of Vibration.*
	SLO-2	*Strain gauge: Theory, type, design consideration, sensitivity.*	*Ultrasonic Sensors*	*Geiger counters*	*different designs of weighing systems.*	*Introduction and types.*
S-9	**SLO-1**	*Resistive transducer: RTD, materials used in RTD*	*Calculation of sensitivity.*	*Scintillation detectors*	*conveyors type.*	*Application of sensors in industries*
	SLO-2	*Thermistor: thermistor material, shape*	*Capacitor microphone, response characteristics*	*Application on radiation sensors*	*weighfeeder type.*	*Application of sensors in home appliances*

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

Learning Assessment

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

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. D. Karthikeyan, Controlsoft Engineering India Pvt Ltd, karthikeyan.d@controlsoftengg.in	*1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com*	*Mrs. K. Vibha, SRMIST*
2. V. Venkateswaran, Instrumentation Consultant, vvenkat99@gmail.com	*2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com*	*Dr. G. Joselin Retna Kumar, SRMIST*

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

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

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

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

S-9	**SLO-1**	*Relays*	*Math Operation*	*Redundant Controller Design*	*Low Level Engineering Interface,*	*Interoperability*
	SLO-2	*Solenoid valve*	*Program*	*One-On-One, One-On-Many Redundancy*	*High Level Engineering Interfaces*	*Interchangeability*

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

Learning Assessment

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

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. D. Karthikeyan, Controlsoft Engineering India Pvt Ltd, karthikeyan.d@controlsoftengg.in	*1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com*	*Mr. J. Sam Jeba Kumar, SRMIST*
2. V. Venkateswaran, Instrumentation Consultant, vvenkat99@gmail.com	*2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com*	*Dr. G. Joselin Retna Kumar, SRMIST*

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

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning			Program Learning Outcomes (PLO)														
CLR-1 :	Understand the importance of micro system technology	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	Learn the operating principle of various micro sensors and actuators	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO 1: Automatic control for	PSO-2: Utilize PLC & DCS for control of	PSO-3: Effective
CLR-3 :	Impart the applications of various micro fabrication techniques																		
CLR-4 :	Understand the differences and need for microfabrication																		
CLR-5 :	Operate MEMS design tools to design simple micro devices																		
CLR-6 :	Understand recent developments and challenges in MEMS																		
Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:																		
CLO-1 :	Appreciate the fundamental concepts in MEMS technology	2,3	80%	80%	H	-	-	-	-	H	-	-	-	-	-	H	H	-	H
CLO-2 :	Understand the fabrication and machining techniques of MEMS devices	1,2	80%	80%	H	-	-	-	-	H	-	-	-	-	-	H	-	-	H
CLO-3 :	Familiarize with the concepts of packaging of MEMS devices	1	80%	80%	H	-	-	H	-	H	-	-	-	-	-	H	H	-	H
CLO-4 :	Appreciate the significance of micro fabrication processes	3	80%	80%	H	-	-	H	-	-	-	-	-	-	-	H	-	-	H
CLO-5 :	Design and Simulate simple structures using MEMS software	3	80%	80%	H	-	H	H	H	-	-	H	H	-	-	H	H	-	H
CLO-6 :	Analyze recent trends and developments in MEMS technology	3	80%	80%	H	-	-	H	-	-	-	-	-	-	-	H	H	-	H

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

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

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

Learning Assessment

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

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. D. Karthikeyan, Controlsoft Engineering India Pvt Ltd, karthikeyan.d@controlsoftengg.in	*1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com*	*1. **Dr. A. Vimala Juliet**, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com*	*2. R.Bakiyalakshmi,SRMIST*

B. Tech in Electronics and Communication Engineering

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, Chengalpattu District, Tamilnadu

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	**Learning**			**Program Learning Outcomes (PLO)**														
CLR-1 :	Improve Student Academic Characteristics and learning goals through forums, discussion groups, and blogs	**1**	**2**	**3**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
CLR-2 :	Improve Student Personal Characteristics through self-learning habits	Level of Thinking	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO- 1	PSO - 2	PSO - 3
CLR-3 :	Characterize self-learning environment that includes pedagogy, tools, tasks, duration, feedback and assessments																		
CLR-4 :	Improve lifelong learning habits and Learning process																		
CLR-5 :	Characterize learning engagement methods and activities																		
CLR-6 :	Inculcate self-learning behavior and lifelong learning tendency																		

Course Learning Outcomes (CLO):	**At the end of this course, learners will be able to:**																		
CLO-1 :	Inculcate student characteristics: prior-knowledge, prior-experience, expertise, academic achievement and matriculation	3	95	85	H	M	M	H	H	H	-	H	H	H	-	H	-	-	-
CLO-2 :	Inculcate self-motivation, self-confidence, intrinsic motivation, participation, social economic statute, and task-orientation	3	95	85	H	M	M	H	H	H	-	H	H	H	-	H	-	-	-
CLO-3 :	Enhance self-learning through peer learning, learning groups, positive collaboration	3	95	85	H	M	M	H	H	H	-	H	H	H	-	H	-	-	-
CLO-4 :	Explore different learning styles and activities, identify self-learning pace, difficulties and remedial measures	3	95	85	H	M	M	H	H	H	-	H	H	H	-	H	-	-	-
CLO-5 :	Identify ways of students' engagement, achievement, and attrition	3	95	85	H	M	M	H	H	H	-	H	H	H	-	H	-	-	-
CLO-6 :	Identify ethical practices in self-learning and practice both individual and group learning dynamics	3	95	85	H	M	M	H	H	H	-	H	H	H	-	H	-	-	-

MOOC Course Selection: List of MOOC Courses that are Approved to be learned by the student in the respective semester will be displayed by the Department MOOC Committee. Student can pick any course from that list.

Learning Assessment	
MOOC Certification Obtained (80% weightage)	**Final Presentation (20% weightage)**

Note: Final Presentation by the student would be evaluated by the Department MOOC Committee.

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	Train oneself in finding the aspects in real-time work environment and prepare them to join the workforce in the future
CLR-2 :	Gain Exposure to the actual working conditions including rules, regulations and safety practices
CLR-3 :	Enhance and supplement the knowledge and skills of the students
CLR-4 :	Develop the students in terms of ability, competence and interpersonal relationship
CLR-5 :	Enhance students' knowledge in one particular technology
CLR-6 :	Provide learning platform that can enhance their employability skills

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 knowledge of Mathematics, Science, and Engineering Fundamentals in the real world of work	3	95	85	H	M	M	H	H	H	L	H	H	H	H	H	-	-	-
CLO-2 :	Demonstrate competency in relevant engineering fields through problem identification, formulation and solution	3	95	85	H	M	M	H	H	H	L	H	H	H	H	H	-	-	-
CLO-3 :	Effectively implement skills in professional communication, technical writing and using multimedia tools	3	95	85	H	M	M	H	H	H	L	H	H	H	H	H	-	-	-
CLO-4 :	Develop ability to work as an individual and in a group as an effective team member	3	95	85	H	M	M	H	H	H	L	H	H	H	H	H	-	-	-
CLO-5 :	Master the professional and ethical responsibilities of an engineer	3	95	85	H	M	M	H	H	H	L	H	H	H	H	H	-	-	-
CLO-6 :	Generate a report based on the experiences and projects carried out in a real-world work environment	3	95	85	H	M	M	H	H	H	L	H	H	H	H	H	-	-	-

Industrial Training Selection: List of Industries for Industrial Training for students would be finalized by the Department Internship/Industrial Training Committee.

Learning Assessment	
Industrial Training Certification Obtained (80% weightage)	**Final Presentation (20% weightage)**

Note: Final Presentation Evaluation would be done by the Internship/Industrial Training Committee formed by the Department.

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

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

		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking	Expected	Expected	Engineering	Problem Analysis	Design &	Analysis, Design,	Modern Tool	Society & Culture	Environment &	Ethics	Individual & Team	Communication	Project Mgt. &	Life Long Learning	PSO- 1	PSO - 2	PSO - 3
CLR-1 :	Utilize fundamental principles, generalizations, or theories and ability to present the same																		
CLR-2 :	Increase self-motivation, personal responsibility, understand one's role of being an informed participant																		
CLR-3 :	Create an environment that helps the student establish healthy relationships and support networks																		
CLR-4 :	State and explain some specific skills, competencies, and points of view																		
CLR-5 :	Identify, apply appropriate note-taking, test-taking, and time-management strategies to the academic studies																		
CLR-6 :	Develop critical thinking, information literacy, Interdisciplinary Inquiry, Engaging with Big Questions and Major Works																		
Course Learning Outcomes (CLO):	**At the end of this course, learners will be able to:**																		
CLO-1 :	Gaining factual knowledge (terminology, classifications, methods, trends)	3	95	85	H	M	M	H	H	H	L	H	H	H	-	H	-	-	-
CLO-2 :	Relate to their interests, abilities, career choices, and personal development	3	95	85	H	M	M	H	H	H	L	H	H	H	-	H	-	-	-
CLO-3 :	Develop a plan that demonstrates their responsibility for their own education	3	95	85	H	M	M	H	H	H	L	H	H	H	-	H	-	-	-
CLO-4 :	Explain the role of self-efficacy, personal goals, and motivation in improving academic life	3	95	85	H	M	M	H	H	H	L	H	H	H	-	H	-	-	-
CLO-5 :	Describe the behaviors and characteristics of an effective learner	3	95	85	H	M	M	H	H	H	L	H	H	H	-	H	-	-	-
CLO-6 :	Improve the Presentation Skills, Discussion Skills, Listening Skills, Argumentative Skills, Critical Thinking, Questioning	3	95	85	H	M	M	H	H	H	L	H	H	H	-	H	-	-	-

Seminar Selection: List of Seminar Topics that are Approved to be learned by the student in the respective semester will be displayed by the Department Seminar Selection/Evaluation Committee. Student can pick any topic from that list.

Learning Assessment	
Seminar Preparation Materials & Report (80% weightage)	Final Presentation (20% weightage)

Note: Final Presentation Evaluation would be done by the Seminar Evaluation Committee formed by the Department.

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Learn responsible and professional way of working
CLR-2 :	Practice development-oriented approach to work
CLR-3 :	Enhance students' knowledge in one particular technology
CLR-4 :	Create awareness of the social, cultural, global and environmental responsibility as an engineer
CLR-5 :	Grow more empathetic, become systems thinkers, become explorers, problem-solvers.
CLR-6 :	Learn project management.

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	Expected Proficiency	Expected Attainment	Engineering Knowledge	Problem Analysis	Design &	Analysis, Design,	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team	Communication	Project Mgt. &	Life Long Learning	PSO- 1	PSO - 2	PSO - 3
CLO-1 :	Develop capability to acquire and apply fundamental principles of engineering	3	95	85	H	M	M	H	H	H	L	H	H	H	H	H	-	-	-
CLO-2 :	Become updated with all the latest changes in technological world	3	95	85	H	M	M	H	H	H	L	H	H	H	H	H	-	-	-
CLO-3 :	Make deep connections between ideas	3	95	85	H	M	M	H	H	H	L	H	H	H	H	H	-	-	-
CLO-4 :	Learn to take creative risks	3	95	85	H	M	M	H	H	H	L	H	H	H	H	H	-	-	-
CLO-5 :	Be ready for the creative economy also engage in iterative thinking and divergent thinking	3	95	85	H	M	M	H	H	H	L	H	H	H	H	H	-	-	-
CLO-6 :	Identify, formulate and model problems and find engineering solution based on a systems approach	3	95	85	H	M	M	H	H	H	L	H	H	H	H	H	-	-	-

Project Work Selection: Project Work Titles for students would be finalized by the Department Project Work Evaluation Committee.

Learning Assessment	
Project Report (80% weightage)	Final Presentation (20% weightage)

Note: Final Presentation Evaluation would be done by the Department Project Work Evaluation Committee formed by the Department.

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	Understanding of industry/organization customs and practices
CLR-2 :	Demonstrate professional skills that pertain directly to the internship experience
CLR-3 :	Demonstrate effective verbal and written communication skills, Allocate time effectively
CLR-4 :	Demonstrate effective listening skills
CLR-5 :	Participate well as a team member and build professional network
CLR-6 :	Build a record of work experience, Develop work habits and attitudes necessary for job success

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	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design &	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 :	Adapt effectively to changing conditions	3	95	85	H	M	M	H	H	H	L	H	H	H	H	H	-	-	-
CLO-2 :	Demonstrate appropriate workplace attitudes	3	95	85	H	M	M	H	H	H	L	H	H	H	H	H	-	-	-
CLO-3 :	Demonstrate individual responsibility	3	95	85	H	M	M	H	H	H	L	H	H	H	H	H	-	-	-
CLO-4 :	Demonstrate effective management of personal behavior, ethics and attitudes	3	95	85	H	M	M	H	H	H	L	H	H	H	H	H	-	-	-
CLO-5 :	Practice ethical standards appropriate to the internship site	3	95	85	H	M	M	H	H	H	L	H	H	H	H	H	-	-	-
CLO-6 :	Explore career alternatives prior to graduation, Integrate theory and practice	3	95	85	H	M	M	H	H	H	L	H	H	H	H	H	-	-	-

Internship Training Selection: List of Industries / Research Centre's for Internship Training for students would be finalized by the Department Internship/Industrial Training Committee.

Learning Assessment	
Internship Certification Obtained (80% weightage)	**Final Presentation (20% weightage)**

Note: Final Presentation Evaluation would be done by the Internship/Industrial Training Committee formed by the Department.

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO- 1	PSO - 2	PSO - 3
CLR-1 :	Learn responsible and professional way of working																		
CLR-2 :	Practice development-oriented approach to work																		
CLR-3 :	Enhance students' knowledge in one particular technology																		
CLR-4 :	Create awareness of the social, cultural, global and environmental responsibility as an engineer																		
CLR-5 :	Grow more empathetic, become systems thinkers, become explorers, problem-solvers.																		
CLR-6 :	Learn project management.																		
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*																		
CLO-1 :	Develop capability to acquire and apply fundamental principles of engineering	3	95	85	H	M	M	H	H	H	L	H	H	H	H	H	-	-	-
CLO-2 :	Become updated with all the latest changes in technological world	3	95	85	H	M	M	H	H	H	L	H	H	H	H	H	-	-	-
CLO-3 :	Make deep connections between ideas	3	95	85	H	M	M	H	H	H	L	H	H	H	H	H	-	-	-
CLO-4 :	Learn to take creative risks	3	95	85	H	M	M	H	H	H	L	H	H	H	H	H	-	-	-
CLO-5 :	Be ready for the creative economy also engage in iterative thinking and divergent thinking	3	95	85	H	M	M	H	H	H	L	H	H	H	H	H	-	-	-
CLO-6 :	Identify, formulate and model problems and find engineering solution based on a systems approach	3	95	85	H	M	M	H	H	H	L	H	H	H	H	H	-	-	-

Project Work Selection: Project Work Titles for students would be finalized by the Department Project Work Evaluation Committee.

Learning Assessment	
Project Report (80% weightage)	*Final Presentation (20% weightage)*

Note: Final Presentation Evaluation would be done by the Department Project Work Evaluation Committee formed by the Department.

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	Become job ready along with real corporate exposure
CLR-2 :	Increase self-confidence and helps in finding their own proficiency
CLR-3 :	Cultivate leadership ability and responsibility to perform or execute the given task
CLR-4 :	Inculcate learners hands on practice within a real job situation
CLR-5 :	Create awareness of the social, cultural, global and environmental responsibility as an engineer
CLR-6 :	Become able to identify, formulate and model problems and find engineering solution based on a systems approach

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 :	Enhance capability to acquire and apply fundamental principles of engineering	3	95	85	H	M	M	H	H	H	L	H	H	H	H	H	-	-	-
CLO-2 :	Become master in one's specialized technology	3	95	85	H	M	M	H	H	H	L	H	H	H	H	H	-	-	-
CLO-3 :	Become updated with all the latest changes in technological world	3	95	85	H	M	M	H	H	H	L	H	H	H	H	H	-	-	-
CLO-4 :	Demonstrate hands on practice within a real job situation	3	95	85	H	M	M	H	H	H	L	H	H	H	H	H	-	-	-
CLO-5 :	Inculcate self-improvement through continuous professional development and life-long learning	3	95	85	H	M	M	H	H	H	L	H	H	H	H	H	-	-	-
CLO-6 :	Be a multi-skilled engineer with good technical knowledge, management, leadership and entrepreneurship skills	3	95	85	H	M	M	H	H	H	L	H	H	H	H	H	-	-	-

Internship Training Selection : List of Industries / Research Centre's for Internship Training for students would be finalized by the Department Internship/Industrial Training Committee

Learning Assessment	
Internship Certification Obtained (80% weightage)	**Final Presentation (20% weightage)**

Note: Final Presentation Evaluation would be done by the Internship/Industrial Training Committee formed by the Department.