NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL

B.Tech. in

Electronics and Communication Engineering

SCHEME OF INSTRUCTION AND SYLLABI

Department of

Electronics and Communication Engineering

(Effective from 2021-22)

NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL

VISION

Towards a Global Knowledge Hub, striving continuously in pursuit of excellence in Education, Research, Entrepreneurship and Technological services to the society

MISSION

- Imparting total quality education to develop innovative, entrepreneurial and ethical future professionals fit for globally competitive environment.
- Allowing stake holders to share our reservoir of experience in education and knowledge for mutual enrichment in the field of technical education.
- Fostering product-oriented research for establishing a self-sustaining and wealth creating Center to serve the societal needs.

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

VISION

Create an educational environment to mould the students to meet the challenges of modern Electronics and Communication industry through state of the art technical knowledge and innovative experimental approaches

MISSION

- To create learning, development and testing environment to meet ever challenging needs of the electronic industry
- To create entrepreneurial environment and industry interaction for mutual benefit
- To become a global partner in training human resources in the fields of chip design, instrumentation and networking
- To associate with internationally reputed Institutions for academic excellence and collaborative research

Department of Electronics and Communication Engineering:

Brief about the Department:

National Institute of Technology Warangal was established in 1959, and the department of Electronics and Communication Engineering has been one of the key departments of the institute since its inception in the year 1971. The department has expanded steadily over the last few decades and is now recognized as one of the leading academic and research Centre's in India.

The Department maintains very good industry-institute linkages. Majority of the students are placed in reputed companies, Government organizations and Higher Educational Institutes in India and abroad. The alumni who are important stakeholders of the Department, actively guide and provide valuable inputs. They constantly peer review the syllabus and curriculum to make students industry ready.

The faculty of the Department are actively involved in sponsored projects and have prestigious projects like-SPARC, IMPRINT, DST, SERB, DRDO to name a few. The faculty is actively engaged in providing solutions to industry problems as consultants. The academic programs of the department are rated among the top in the country.

List of Programs offered by the Department:

Name of the Program	Title of the Program
B.Tech	Electronics and Communication Engineering
M.Tech	Electronic Instrumentation and Embedded Systems
	VLSI System Design
	Advanced Communication Systems
Ph.D	Electronics and Communication Engineering

Note: Refer to the following weblink for Rules and Regulations of B.Tech. program:
https://www.nitw.ac.in/media/uploads/2021/08/27/btech_rules-and-regulations-2021-22.pdf

PROGRAM EDUCATIONAL OBJECTIVES

PEO1	Analyze, plan and apply the acquired knowledge in basic sciences and mathematics in solving Electronics and Communication Engineering problems with technical, economic, environmental and social contexts.
PEO2	Design, build and test analog and digital electronic systems for given specifications
PEO3	Architect modern communication systems to meet stated requirements.
PEO4	Work in a team using technical knowhow, common tools and environments to achieve project objectives.
PEO5	Communicate effectively, demonstrate leadership qualities and exhibit professional conduct in their career.
PEO6	Engage in lifelong learning, career enhancement and adapt to changing professional and societal needs

Program Articulation Matrix

Mapping of Mission statements with program educational objectives

Mission Statement	PEO1	PEO2	PEO3	PEO4	PEO5	PEO6
MS1	3	3	2	1	1	3
MS2	1	2	1	3	3	2
MS3	1	2	1	3	3	2
MS4	1	2	2	3	1	1

1-Slightly, 2-Moderately, 3-Substantially.

Department of Electronics and Communication Engineering

PROGRAM OUTCOMES

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and Electronics and Communication Engineering to the solution of complex engineering problems.
PO2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions**: Design solutions for complex engineering problems anddesignsystemcomponentsorprocessesthatmeetthespecifiedneedswithappropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability**:Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities
	and norms of the engineering practice.
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
PO10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehended write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance**: Demonstrate knowledge and understanding of the engineeringandmanagementprinciplesandapplythesetoone'sownwork,asamember and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

PSO1	Analyze and design of electronic circuits and Communication systems to enhance the quality of human life
PSO2	Develop innovative and environment-conscious technologies to sustain human life

Mapping of Program Outcomes with Program Educational Objectives

PEO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PEO1	3	1	1	1	1	1	1	2	1	1	1	1
PEO2	2	3	3	3	1	1	1	1	2	1	1	1
PEO3	1	2	1	1	3	3	3	1	1	1	1	2
PEO4	1	1	3	1	1	1	1	3	3	3	1	1
PEO5	1	1	1	1	1	1	1	3	3	2	2	3
PEO6	2	1	1	1	2	2	2	3	2	2	3	3

SCHEME OF INSTRUCTION

B.Tech. Electronics and Communication Engineering - Course Structure

I – Year: I –Semester

S. No	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	MA134	Matrix Theory, Calculus and Ordinary Differential Equations	3	0	0	3	BSC
2	HS132	English for Technical Communication	2	0	2	3	HSC
3	PH133	Engineering Physics	3	0	0	3	BSC
4	CY133	Engineering Chemistry	3	0	0	3	BSC
5	EC101	Electronic Devices and circuits	3	0	0	3	PCC
6	EC102	Electronic Devices and circuits Laboratory	0	1	2	2	PCC
7	MA144	Problem solving and Computer Programming	3	0	2	4	ESC
8	IC001	Induction Programme*				0	MNC
9	IC101	Extra Academic Activity-I *	0	0	2	0	MNC
		Total				**21**	

* MNC weblink: https://www.nitw.ac.in/media/uploads/2021/10/22/mnc_1st-year.pdf

I – Year: II–Semester

S.No	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	MA184	Integral Calculus and Laplace Transforms	3	0	0	3	BSC
2	CS182	Data Structures	3	0	2	4	ESC
3	EE181	Electrical circuits and Machines	3	0	0	3	ESC
4	EC151	Electronic Circuits Analysis and Design	3	0	0	3	PCC
5	EC152	Electronic circuit design and Simulation lab	0	1	2	2	PCC
6	EC153	Joy of Electronics	0	0	2	1	ESC
7	EC154	Programming usingPython	0	0	2	1	ESC
8	IC151	Extra Academic Activity-II *	0	0	2	0	MNC
		Total				17	

* MNC weblink: https://www.nitw.ac.in/media/uploads/2021/10/22/mnc_1st-year.pdf

Note: BSC – Basic Science Courses
ESC – Engineering Science Courses
PCC – Professional Core Courses
PEC – Professional Elective Courses
OEC – Open Elective Courses
HSC – Humanities and Social Science Courses
MNC – Mandatory Non-credit Courses

SCHEME OF INSTRUCTION

B.Tech. Electronics and Communication Engineering - Course Structure

II – Year: I – Semester

S.No	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	MA234	Complex Variables and Special Functions	3	0	0	3	BSC
2	EE234	Control Systems Engineering	3	0	0	3	ESC
3	EC201	Digital Circuit Design	3	0	0	3	PCC
4	EC202	Signals and Systems	3	0	2	4	PCC
5	EC203	Networks and Transmission Lines	3	0	0	3	PCC
6	EC204	Introduction to Artificial Intelligence and Machine Learning	3	0	0	3	ESC
7	EC205	Digital Circuit Design Lab	0	1	2	2	PCC
8	EC206	Design Thinking Lab	0	1	2	2	ESC
9	IC2XX	Mandatory Non-credit Course*	1	0	0	0	MNC
		Total				23	

* MNC weblink:https://www.nitw.ac.in/media/uploads/2021/10/22/mnc_2nd-year.pdf

II – Year: II–Semester

S.No	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	EC251	Linear IC Applications	3	0	0	3	PCC
2	EC252	FPGA based System Design	3	0	0	3	PCC
3	EC253	Electromagnetic Fields and Waves	3	0	0	3	PCC
4	EC254	CMOS VLSI Design	3	0	2	4	PCC
5	EC255	Probability Theory and Stochastic Processes	3	0	2	4	PCC
6	EC256	IC Applications Lab	0	1	2	2	PCC
7	EC257	FPGA based design Lab	0	1	2	2	PCC
8	BT281	Design Principles Living Systems	2	0	0	2	ESC
		Total				23	

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SCHEME OF INSTRUCTION
B.Tech. Electronics and Communication Engineering - Course Structure

III – Year: I– Semester

S.No	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	EC301	Digital Signal Processing	3	0	0	3	PCC
2	EC302	Analog Communications	3	0	0	3	PCC
3	EC303	Electronic Instrumentation	3	0	0	3	PCC
4	EC304	Advanced Microcontrollers	3	0	0	3	PCC
5	EC305	DSP and Electronic Instrumentation Lab	0	1	2	2	PCC
6	EC306	Microcontrollers lab	0	1	2	2	PCC
7		Dept. Elective -I	3	0	0	3	PEC
8	SM344	Industrial Systems and Management	3	0	0	3	HSC
9	IC3XX	Mandatory Non-credit Course*	1	0	0	0	MNC
		Total				22	

* MNC weblink:https://www.nitw.ac.in/media/uploads/2021/10/22/mnc_3rd-year.pdf

III – Year: II–Semester

S.No	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	EC351	Antennas and Propagation	3	0	2	4	PCC
2	EC352	DigitalCommunications	3	0	0	3	PCC
3	EC353	Data Networks	3	0	2	4	PCC
4	EC354	Embedded and Real Time Operating Systems	3	0	0	3	PCC
5	EC355	Communications Systems Lab	0	1	2	2	PCC
6	EC356	Innovation and Start-up activity	0	1	2	2	ESC
7		Dept. Elective -II	3	0	0	3	PEC
8		Open Elective –I#	3	0	0	3	OEC
		Total				24	

OEC weblink: https://www.nitw.ac.in/media/uploads/2021/10/22/open-elective-1_vi-sem.pdf

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MNC – Mandatory Non-credit Courses

SCHEME OF INSTRUCTION
B.Tech. Electronics and Communication Engineering - Course Structure

IV– Year: I– Semester

S.No	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	EC401	Microwave and Light Wave Technologies	3	0	0	3	PCC
2	EC402	Microwave and Light Wave Technologies Lab	0	1	2	2	PCC
3		Dept. Elective –III	3	0	0	3	PEC
4		Dept. Elective –IV	3	0	0	3	PEC
5		Dept. Elective –V	3	0	0	3	PEC
6		Open Elective –II	3	0	0	3	OEC
7	EC430	Design Project	0	0	2	1	PW
8	EC449	Summer internship /EPICS	0	1	2	2	PCC
		Total				20	

OEC weblink: https://www.nitw.ac.in/media/uploads/2021/10/22/open-elective-2_vii-sem.pdf

IV– Year: II– Semester

S.No	Course Code	Course Title	L	T	P	Credits	Cat. Code
1		Dept. Elective -VI	3	0	0	3	PEC
2		Dept. Elective -VII	3	0	0	3	PEC
3	EC499	Project Work@	0	0	8	4	PW
4							
5							
6							
7							
8							
		Total				10	

@ NOTE: Refer to the following link for the guidelines to prepare dissertation report:
https://www.nitw.ac.in/media/uploads/2021/08/27/ug_project-report-format_55vW5pL.pdf

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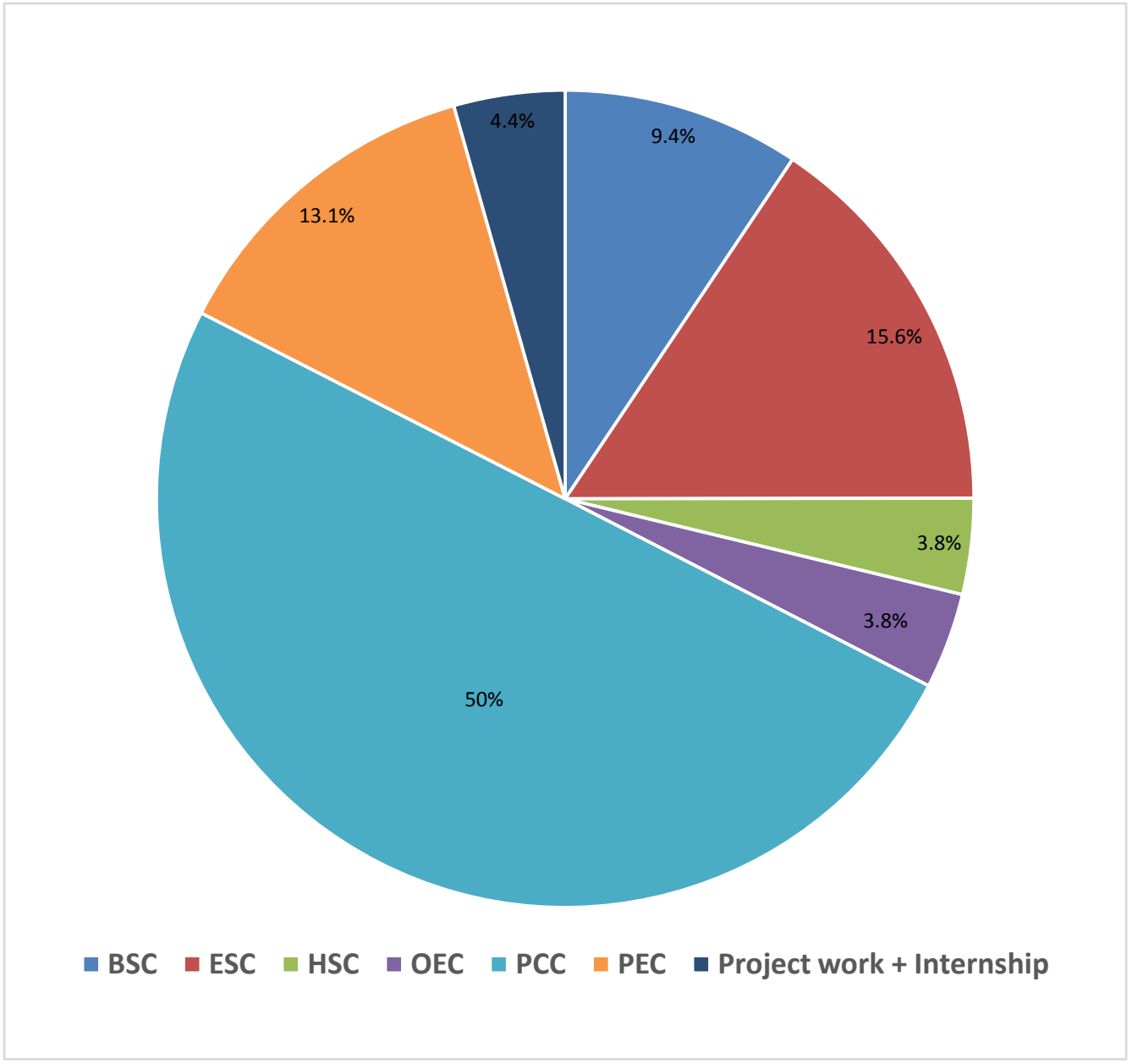
OEC – Open Elective Courses
HSC – Humanities and Social Science Courses
MNC – Mandatory Non-credit Courses

Special Notes/Instructions:

The grade of “summer internship / EPICS” taken up during summer after IV semester or VI semester, will reflected in the grade sheet of VII semester.

Semester wise Curriculum Components

Semester / Cat Code	I	II	III	IV	V	VI	VII	VIII	Credits offered
BSC	9	3	3						**15**
ESC	4	9	8	2		2			**25**
HSC	3				3				**6**
OEC						3	3		**6**
PCC	5	5	12	21	16	16	5		**80**
PEC					3	3	9	6	**21**
Project work							1	4	**5**
Internship							2		**2**
Total	21	17	23	23	22	24	20	10	**160**



Program Elective Courses

Semester	Elective Number	Course Code	Course Title
V	I	EC315	Low Power VLSI
		EC316	Computer Architectures
		EC317	Internet of Things
		EC318	Web Technologies
VI	II	EC365	RFIC Design
		EC366	Digital Switching and Multiplexing
		EC367	Advanced Digital Signal Processing
		EC368	Software Defined Radio
VII	III	EC415	Electronic Packaging
		EC416	Satellite Communications
		EC417	Computer Vision
		EC418	Biomedical instrumentation and Signal Processing
VII	IV	EC419	FPGA Design
		EC420	Cellular and Mobile Communications
		EC421	Optimization Techniques
		EC422	Radar Engineering
VII	V	EC423	Image and Video Processing
		EC424	IPR and Cyber Laws
		EC425	Cryptography and Network Security
		EC426	Optical switching and networks
VIII	VI	EC465	Organic Electronics
		EC466	5G Communications and MIMO
		EC467	Speech Processing
		EC468	Hardware-Software Co-Design
VIII	VII	EC469	Intelligent CAD
		EC470	Secured Communications
		EC471	Wireless Sensor Networks
		EC472	Cloud Computing

DETAILED SYLLABUS

B. Tech.

Electronics and Communication Engineering

I – Year: I Semester

Course Code: MA134	MATRIX THEORY, CALCULUS AND ORDINARY DIFFERENTIAL EQUATIONS	Credits 3-0-0: 3

Pre-Requisites: NIL

Course Outcomes: At the end of the course, the student will be able to:

CO1	Solve the consistent system of linear equations
CO2	Apply orthogonal and congruent transformations to a quadratic form
CO3	Find the maxima and minima of multivariable functions
CO4	Solve arbitrary order linear differential equations with constant coefficients
CO5	Apply the concepts in solving physical problems arising in engineering

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1									2	1
CO2	3	3	2	1									2	1
CO3	3	3	2	1									2	1
CO4	3	3	2	1									2	1
CO5	3	3	2	1									2	1

Syllabus:

Matrix Theory: Linear dependence and independence of vectors; Rank of a matrix; Consistency Of The System Of Linear Equations;Eigenvalues andeigenvectorsofa Matrix;Caley- Hamilton theorem and its applications; Reduction to diagonal form; Reduction of a quadratic form to canonical form - orthogonal transformation and congruent transformation; Properties of complex matrices - Hermitian, skew-Hermitian and Unitary matrices

Differential Calculus: Taylor's theorem with remainders; Taylor's and Maclaurin's expansions; Asymptotes; Curvature; Curve tracing; Functions of several variables - partial differentiation; total differentiation; Euler's theorem and generalization; Change of variables - Jacobians; maxima and minima of functions of several variables (2 and 3 variables) - Lagrange's method of multipliers

Ordinary Differential Equations: Geometric interpretation of solutions of first order ODE $y' = f(x, y)$; Exact differential equations; integrating factors; orthogonal trajectories; Higher order linear differential equations with constant coefficients - homogeneous and non- homogeneous; Euler and Cauchy's differential equations; Method of variation of parameters; System of linear differential equations; applications in physical problems – forcedoscillations, electric circuits,etc.

Learning Resources:

Text Books:

1. Advanced Engineering Mathematics, **R. K. Jain and S. R. K. Iyengar**, Narosa Publishing House, 2019, Fifth Edition
2. Advanced Engineering Mathematics, **Erwin Kreyszig**, John Wiley and Sons, 2015, 10th Edition
3. Calculus and Analytic Geometry, **George B.Thomas and Ross L. Finney**,Pearson,2020, Ninth Edition

Reference Books:

1. Advanced Engineering Mathematics, **Dennis G. Zill**, Jones & Bartlett Learning, 2018, Sixth Edition
2. Higher Engineering Mathematics, **B. S. Grewal**, Khanna Publishers, 2012, Forty-second Edition

Course code: HS132	ENGLISH FOR TECHNICAL COMMUNICATION	Credits 2-0-2: 3

Pre-requisites: Nil

Course outcomes: After the completion of the course the student will be able to:

CO1	Understand basic grammar principles
CO2	Write clear and coherent passages
CO3	Write effective letters for job application and complaints
CO4	Prepare technical reports and interpret graphs
CO5	Enhance reading comprehension
CO6	Comprehend English speech sound system, stress and intonation

Course articulation matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	2	-	3	1	-
CO2	-	-	-	-	-	-	-	-	-	3	-	3	1	-
CO3	-	-	-	-	-	-	-	-	-	3	-	3	1	-
CO4	-	-	-	-	-	-	-	-	-	3	-	3	1	-
CO5	-	-	-	-	-	-	-	-	-	3	2	3	1	-
CO6	-	-	-	-	-	-	-	-	-	3	2	3	1	-

Syllabus:

1. **Grammar Principles** (Correction of sentences, Concord) and Vocabulary Building (synonyms and antonyms): Idioms and Phrasal verbs--patterns of use and suggestions for effective employment in varied contexts
2. **Effective Sentence Construction** - strategies for bringing variety and clarity in sentences- removing ambiguity - editing long sentences for brevity and clarity
3. **Reported speech;-**contexts for use of reported speech - its impact on audiences and readers- active and passive voice- reasons for preference for passive voice in scientific English-
4. **Paragraph-writing:** Definition of paragraph and types- features of a good paragraph - unity of theme- coherence- linking devices- direction- patterns of development.
5. **Note-making** - definition- the need for note-making - its benefits - various note formats- like tree diagram, block or list notes, tables, etc.
6. **Letter-Writing:** Its importance in the context of other channels of communication- qualities of effective letters-types -personal, official, letters for various purposes- emphasis on letter of application for jobs - cover letter and resume types -examples and exercises
7. **Reading techniques:** Definition- Skills and sub-skills of reading- Skimming and Scanning - their uses and purposes- examples and exercises.
8. **Reading Comprehension** - reading silently and with understanding- process of comprehension- types of comprehension questions. (technical paper reading, patents)
9. **Features of Technical English** - description of technical objects and process- Report-Writing- definition- purpose -types- structure- formal and informal reports- stages in

developing report- proposal, progress and final reports-examples and exercises.

10. **Book Reviews**- Oral and written review of a chosen novel/play/movie- focus on appropriate vocabulary and structure - language items like special vocabulary and idioms used

Language laboratory:

1. **English Sound System** -vowels, consonants, Diphthongs, phonetic symbols- using dictionary to decode phonetic transcription-- Received Pronunciation, its value and relevance- transcription of exercises-
2. **Stress and Intonation** –word and sentence stress - their role and importance in spoken English
3. **Intonation in spoken English** -definition, patterns of intonation- –falling, rising, etc.- use of intonation in daily life-exercises
4. **Introducing oneself in formal and social contexts**- Role plays.- their uses in developing fluency and communication in general.
5. **Oral presentation** - definition- occasions- structure- qualities of a good presentation with emphasis on body language and use of visual aids.
6. **Listening Comprehension** -Challenges in listening, good listening traits, some standard listening tests- practice and exercises.
7. **Debate/ Group Discussions**-concepts, types, Do's and don'ts- intensive practice.

Text Books:

1. English for Engineers and Technologists (Combined edition, Vol. 1 and 2) Orient Blackswan2010.
2. Ashraf, M Rizvi. Effective Technical Communication. Tata McGraw-Hill,2006
3. Meenakshi Raman and Sangeetha Sharma. Technical Communication: Principles and Practice 2nd Edition, Oxford University Press,2011

Software:

1. Clear Pronunciation – Part-1 Learn to Speak English.
2. Clear Pronunciation – Part-2 Speak Clearly with Confidence
3. Study Skills
4. English Pronunciation

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc20_hs56/preview
2. https://nptel.ac.in/courses/109/106/109106094/
3. https://freevideolectures.com/course/3430/communication-skills
4. https://onlinecourses.swayam2.ac.in/cec21_lg13/preview

Course Code: PH133	ENGINEERING PHYSICS	Credits 3-0-0: 3

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Apply the concepts of wave and particle nature of matter and energy for solving problems radiant energy
CO2	Understand the physics of optical fibers, diode lasers and their applications in communication
CO3	Understand the basics of dielectric and functional materials and their applications in electrical engineering.
CO4	Comprehend the working of solar cells and emerging photovoltaic technologies
CO5	Understand temperature measurement using thermocouples and thermistors

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1									2	1
CO2	3	3	2	1									2	1
CO3	3	3	2	1									2	1
CO4	3	3	2	1									2	1
CO5	3	3	2	1									2	1

Syllabus:

Electronic Materials

Dielectric Materials: Introduction to Dielectrics, Dielectric constant, polarizability, properties and types of insulating materials, polarization mechanisms in dielectrics (Qualitative), frequency and temperature dependence of polarization, dielectric loss, Clausius-Mossotti equation (qualitative), dielectric breakdown, applications in electrical engineering (electrolytic capacitor)**.**

Piezoelectric materials: Properties, production and detection of ultrasonic, applications in electrical engineering.

Functional Materials: Fiber reinforced plastics, fiber reinforced metals, surface acoustic wave materials, high temperature materials and smart materials, properties and applications.

Quantum Mechanics

Introduction to quantum theory, concepts and experiments led to the discovery, wave particle duality- Davisson-Germer experiment, Heisenberg uncertainty principle, Schrodinger time independent wave equation, the free particle problem-particle in an infinite and finite potential well, quantum mechanical tunneling - applications.

Optical Fibers and Devices

Principle and working of optical Fiber, structure, Classification and advantages of optical fiber, Light guiding mechanism in Optical Fibers -Numerical Aperture, Dielectric Slab wave Guide and Modes, Maxwell's Equations-Waveguide Equations and solutions (qualitative) under weekly guiding approximation -Modes in Step-Index fibers-LP Modes and their designation-Signal Degradation in optical fibers-Attenuation: Absorption-Scattering-bending-and Core-Cladding losses, Material, Waveguide, Inter and intra modal Dispersions

Light Sources: Basics of Semiconductor Physics-PN Junctions-LEDs and LED Structures-Quantum efficiency and LED Power and modulation of LED; Laser Diodes - Laser Diode Rate Equations and Quantum Efficiency (qualitative treatment).

Solar Cells

Solar spectrum, photovoltaic effect, structure and working principle of solar cell, I-V characteristics, power conversion efficiency, materials for PV, emerging PV technologies for alternative energy devices**.**

Thermal Physics

Thermo electric laws - Seebeck effect, Peltier effect, Thompson effect, Thermocouples – types, characteristics and laws, Thermistors, Resistance Temperature Detector

Learning Resources

Text Books:

1. Fundamentals of Physics by Halliday, Resnic and Walker, John Wiley, 10thEdition,2013.
2. Concepts of Modern Physics by Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, McGraw Hill Publications, Seventhedition,2017.
3. Optical Fiber Communications, by Gerd Keiser, McGraw Hill Education, 5th Edition,2017.

Reference Books:

1. Optics by Ajoy K. Ghatak,Tata McGraw Hill, Sixth Edition,2017
2. Understanding Lasers An Entry-Level Guide, by Jeff Hecht, Wiley Publications, Fourth edition,2018.
3. A Text Book of Engineering Physics by M.N. Avadhanulu, P.G. Khirsagar, 11th edition, 2018.
4. University Physics with modern physics by Hugh D. Young, Roger A. Freedman Pearson 14th Education, 2017.

Online Resources:

1. https://nptel.ac.in/courses/122/107/122107035/

Course Code: CY133	ENGINEERING CHEMISTRY	Credits 3-0-0: 3

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand the basic concept of physical chemistry and apply the concepts in developing batteries
CO2	Understand the chemistry involved in the synthesis and characterization of Nanomaterials and apply the knowledge in developing various electrical engineering materials
CO3	Understand the concepts of spectroscopy and apply the knowledge in characterizing the material using spectroscopic methods.
CO4	Apply the knowledge to protect different metals from corrosion
CO5	Apply the concepts learned in designing materials for green energy harvesting and storage to reduce the environmental pollution and develop greener methods to replace the existing non-eco-friendly process for industrial production of materials.

CO-PO/PSO mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2		2			3	2				2	1	
CO2	3	2		2			1					2	1	
CO3	2	1		1								1	1	
CO4	3	2		1			2					1	1	
CO5	3	3		3			3	3				3	1	

Syllabus:

1. **Thermochemistry:** Heat of Reaction, Types of Heats of Reaction, Kirchhoff's Equation, Laws of Thermochemistry, Bond Energy and Bond Enthalpy.
2. **Nanomaterials and Engineering Applications:** Introduction, classification, properties, Nanotechnology applications, Material self-assembly, Molecular vs material self-assembly, synthesis - top down and bottom up, synthesis, properties & potential applications of carbon nanotubes, fullerenes and grapheme, Nano catalysis
3. **Spectroscopic Methods of Analysis:** UV-Vis spectroscopy, Infrared spectroscopy, NMR spectroscopy
4. **Electrochemistry:** Electrical conductance, migration of ions, theories of ionization, redox potentials and Nernst's law and its applications.
5. **Batteries and Corrosion:** Batteries: Electrode potential, primary cell-Leclanche cell, Secondary cell - Lead-acid storage cell, Lithium ion battery, Methanol oxygen fuel cell. **Corrosion:** Introduction, Dry corrosion, Wet corrosion, Factors influencing the rate of corrosion – Temperature, pH and Dissolved oxygen, Corrosion prevention by Cathode protection.
6. **Engineering Materials:** Semiconductors, Insulators, Superconductors, Conducting

Polymers, LEDs, Liquid Crystals, **P**hotovoltaic cell, Materials used for fabric sensors, Organo Electronics, Molecular Switches, Chemical Sensors, and Transducers

7. **Green Chemistry:** Principles of Green Chemistry. Green methods in electronic production. Green Materials for Electronics and Advanced Technologies (Aluminium Borosilicate, Glass Iron Alloys Graphene Biomaterials). Electronic-Waste: Plastics in Electronic-Waste, Impact of Electronic-Waste on Environmental PublicHealth.

Text Books:

1. A Text Book of Engineering Chemistry, Shashi Chawla, Danpathrao& Co. Publications, 6th India reprint edition,2017
2. Text Book of Engineering Chemistry, AshutoshKar, ED-Tech Publications,2018

Reference Books:

1. Inorganic Chemistry, Huheey, Pearson Publications India, 4th Edition2006
2. Molecular Quantum Mechanics, Peter Atkins, Oxford University Press, 5th Edition,2012
3. Advanced Organic Chemistry: Reaction Mechanism and Structure, Jerry March, John Wiley Publications, 6th Edition,2007

Online Resources:

1. https://nptel.ac.in/courses/122/101/122101001/
2. https://nptel.ac.in/courses/122/106/122106028/
3. https://nptel.ac.in/courses/104/101/104101130/

Course Code: EC 101	ELECTRONIC DEVICES AND CIRCUITS	Credits 3-0-0: 3

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the working of diode and transistors
CO2	Analyse the basic circuits using diodes and transistors
CO3	Analyse the characteristics of various diodes, transistors and rectifiers
CO4	Learn the importance of biasing of transistors

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	3								1	2	2	
CO2	2	2	3	2							1	2	2	
CO3	2	2	3	2	3						1	2	2	
CO4	2	2	3								1	2	2	

Syllabus:

Solid-State Electronics: Semiconductor materials and properties: charge carriers in solids, bandgap energy, intrinsic and extrinsic semiconductors, transport of carriers, mobility and resistivity, drift and diffusion currents. Introductory knowledge to semiconductor devices process flow.

Diodes: the band-structure of p-n junction, p-n junction in equilibrium, depletion region, built-in potential, p-n junction under reverse bias, junction capacitance, p-n junction under forward bias, I/V characteristics, reverse breakdown: Zener and avalanche breakdown. Ideal diode, p-n junction as a diode, temperature effects and breakdown voltages, Transition and diffusion capacitance of p-n junction diodes, diode models.

Diode circuits: Half wave, full wave, bridge rectifiers, Capacitor, Inductor, L-section and π-section filters. Zener diode as voltage regulator. **Linear wave Shaping:** High pass, low pass RC circuits, their Response for Sinusoidal, Step, Pulse, Square, and Ramp inputs. Clipping and clamping circuits. **Special Diodes:** Tunnel Diode, IMPATT diode, Gunn diode, p-n-p-n diode, and Schottky diode.

Bipolar Junction Transistors and Biasing: PNP and NPN transistors, Characteristics of the current flow across the base regions, Minority and majority carrier profiles, Transistor as a device in CB, CE and CC configurations, and their characteristics.

Biasing and Thermal Stability: The operating Point, DC and AC load lines, Fixed Bias, Collector Feedback Bias, Emitter Feed Back Bias, Voltage divider Bias, Stabilization, stabilization circuits, Thermal runaway, and thermal stability.

Field-Effect Transistors: JFET and its characteristics, Pinch off voltage and drain saturation current. **MOSFET:** the MOS capacitor, n-channel enhancement-mode MOSFET: transistor structure, I-V characteristics, PMOS, MOSFET dc circuit analysis, basic MOSFET applications: switch, digital logic gate and amplifier. Biasing of FETs and MOSFETs.

Learning Resources:

Text Books:

1. Microelectronics Circuit Analysis and Design, Donald Neamen, McGraw Hill, 2010, 4th Edition.
2. Fundamentals of Semiconductor Fabrication, Gary S May ad Simon M Sze, Wiley, 2003, 1st Edition.

Reference Books:

1. Electronic Devices and Circuit Theory, Robert L Boylestad and Louis Nashelsky, Pearson, 2018, 11th Edition.
2. Microelectronic Circuits: Theory and Applications, Adel S Sedra, KC Smith and ANChandorkar, Oxford University Press, 2017, 7th Edition.
3. VLSI Technology, S M Sze, 2003, 2nd Edition.
4. Microelectronic Circuit Design, Richard C Jaeger and Travis N Blalock, McGraw Hill, 2016, 5th Edition.
5. Solid State Electronic Devices, Ben Streetman, Pearson, 2015, 7th Edition.

Online Resources:

1. https://nptel.ac.in/courses/117/105/117105147/
2. https://nptel.ac.in/courses/117/108/117108038/
3. https://onlinecourses.nptel.ac.in/noc21_ee86/preview

Course code: EC102	ELECTRONIC DEVICES AND CIRCUITS LABORATORY	Credits 0–1–2: 2

Course Outcomes: After completion of the course student will be able to:

CO1	Plot the characteristics of semiconductor diodes and transistors to understand their behavior.
CO2	Design, construct and test amplifier circuits and interpret the results.
CO3	Operate electronic test equipment and hardware/software tools to characterize the behavior of devices and circuits.
CO4	Design and test the diode clippers, clampers and rectifiers

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	-	-	-	-	-	-	2	-	-	2	1	1
CO2	-	3	-	2	-	-	-	-	2	-	-	2	1	1
CO3	-	3	-	2	-	-	-	-	2	-	-	2	1	1
CO4	-	3	-	2	-	-	-	-	2	-	-	2	1	1

List of Experiments:

1. Study of Instruments and components
2. V-I Characteristics of Si and Ge Diodes
3. Zener Diode Characteristics and Zener Diode as Voltage Regulator
4. Clippers and clampers
5. Half Wave and Full Wave Rectifiers
6. BJT Characteristics
7. FET Characteristics
8. BJT Biasing
9. FET Biasing
10. BJT as an Amplifier
11. UJT characteristics

Learning Resources:

Text Books:

1. Microelectronics Circuit Analysis and Design, Donald Neamen, McGraw Hill, 2010, 4th Edition.
2. Fundamentals of Semiconductor Fabrication, Gary S May ad Simon M Sze, Wiley, 2003, 1st Edition.

Reference Books:

1. Electronic Devices and Circuit Theory, Robert L Boylestad and Louis Nashelsky, Pearson, 2017, 11th Edition.
2. Microelectronic Circuits: Theory and Applications, Adel S Sedra, KC Smith and ANChandorkar, Oxford University Press, 2017, 7th Edition.
3. VLSI Technology, S M Sze, 2003, 2nd Edition.

4. Microelectronic Circuit Design, Richard C Jaeger and Travis N Blalock, McGraw Hill, 2016, 5th Edition.
5. Solid State Electronic Devices, Ben Streetman, Pearson, 2015, 7th Edition.

Online Resources:

1. https://nptel.ac.in/courses/117/105/117105147/
2. https://nptel.ac.in/courses/117/108/117108038/
3. https://onlinecourses.nptel.ac.in/noc21_ee86/preview

Course Code: MA144	PROBLEM SOLVING AND COMPUTER PROGRAMMING	Credits 3-0-2: 4

Pre-Requisites: NIL

Course Outcomes: At the end of the course, the student will be able to:

CO1	Design algorithms for solving simple mathematical problems including computing, searching and sorting
CO2	Compare and contrast algorithms in terms of space and time complexity to solve simple mathematical problems
CO3	Explore the internals of computing systems to suitably develop efficient algorithms
CO4	Examine the suitability of data types and structures to solve specific problems
CO5	Apply control structures to develop modular programs to solve mathematical problems
CO6	Apply object oriented features in developing programs to solve real world problems

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	2	-	-	2	-	-	-	-	-
CO2	3	3	2	2	-	2	-	2	2	-	-	-	-	-
CO3	3	3	2	2	-	-	-	2	2	-	-	-	-	-
CO4	2	3	2	1	-	2	-	-	2	-	-	-	-	-
CO5	2	3	2	2	-	2	-	-	2	-	-	-	-	-
CO6	2	3	2	2	-	2	-	-	2	-	-	-	-	-

Syllabus:

Fundamentals of Computers: Historical perspective, Early computers, Components of a computers, Problems, Flowcharts, Memory, Variables, Values, Instructions, Programs.

Problem solving techniques: Algorithmic approach, characteristics of algorithm, Problem solvingstrategies:Top-downapproach,Bottom-upapproach,Timeandspacecomplexitiesof algorithms.

Numbersystemsanddatarepresentation:BasicsofC++,Basicdatatypes,Numbers,Digit separation, Reverse order, writing in words, Development of Elementary School Arithmetic Testing System, Problems on Date and factorials, Solutions using flow of control constructs,

Conditional statements: If-else, Switch-case constructs, Loops - while, do-while, for.

Functions: Modular approach for solving real time problems, user defined functions, library functions, parameter passing - call by value, call by reference, return values, Recursion,

Introduction to Pointers and Arrays: Sorting and searching algorithms, Large integer arithmetic, Single and Multi-Dimensional Arrays, passing arrays as parameters to functions, Magic square and matrix operations using Pointers and Dynamic Arrays, Multidimensional Dynamic Arrays

String processing, File operations.

Structures and Classes: Declaration, member variables, member functions, access modifiers,functionoverloading,ProblemsonComplexnumbers,Date,Time,LargeNumbers.

PSCP LAB:

1. Programs on conditional control constructs.
2. Programs on loops (while, do-while, for).
3. Programs using user defined functions and library functions.
4. Programs on arrays, matrices (single and multi-dimensional arrays).
5. Programs using pointers (int pointers, char pointers).
6. Programs on structures.
7. Programs on classes and objects.

Learning Resources:

Text Books:

1. Problem Solving with C++, **Walter Savitch**, Pearson, 2014, Ninth Edition
2. Big C++, **Cay Horstmann**, Wiley, 2009, Second Edition

ReferenceBooks:

1. How to Solve it by Computer, **R.G. Dromey**, Pearson,2008

Online Resources:

1. https://nptel.ac.in/courses/106/105/106105151/
2. https://onlinecourses.nptel.ac.in/noc21_cs38/preview

I – Year: II Semester

Course Code: MA184	INTEGRAL CALCULUS AND LAPLACE TRANSFORMS	Credits 3-0-0: 3

Pre-Requisites: MA134

Course Outcomes: At the end of the course, the student will be able to:

CO1	Analyze improper integrals
CO2	Evaluate multiple integrals in various coordinate systems
CO3	Apply the concepts of gradient, divergence and curl to formulate engineering problems
CO4	Convert line integrals into surface integrals and surface integrals into volume integrals
CO5	Apply Laplace transforms to solve physical problems arising in engineering

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1									2	1
CO2	3	3	2	1									2	1
CO3	3	3	2	1									2	1
CO4	3	3	2	1									2	1
CO5	3	3	2	1									2	1

Syllabus:

Integral Calculus: Convergence of improper integrals; Beta and Gamma integrals; Differentiation under integral sign; Double and Triple integrals – computation of surface areas and volumes; change of variables in double and triple integrals

Vector Calculus: Scalar and vector fields; vector differentiation; level surfaces; directional derivative; gradient of a scalar field; divergence and curl of a vector field; Laplacian; Line and Surface integrals; Green's theorem in a plane; Stoke's theorem; Gauss Divergence theorem

Laplace Transforms: Laplace transforms; inverse Laplace transforms; Properties of Laplace

transforms; Laplace transforms of unit step function, impulse function, periodic function; Convolution theorem; Applications of Laplace transforms-solving certain initial value problems, solving system of linear differential equations, finding responses of systems to various inputs viz. sinusoidal inputs acting over a time interval, rectangular waves, impulses etc.

Text Books:

1. Advanced Engineering Mathematics, **R. K. Jain and S. R. K. Iyengar**, Narosa Publishing House, 2016, Fifth Edition
2. Advanced Engineering Mathematics, **Erwin Kreyszig**, John Wiley and Sons, 2015, Eighth Edition
3. Calculus and Analytic Geometry, **George B. Thomas and Ross L. Finney**, Pearson, 2020, Ninth Edition

Reference Books:

1. Advanced Engineering Mathematics, **Dennis G. Zill**, Jones & Bartlett Learning, 2018, Sixth Edition
2. Higher Engineering Mathematics, **B. S. Grewal**, Khanna Publishers, 2012, Forty-second Edition

Course Code: CS182	DATA STRUCTURES	Credits 3–0–2: 4

Prerequisites: Problem Solving and Computer Programming

Course Outcomes: After completion of the course student will be able to:

CO1	Understand the basic techniques of algorithm analysis and assess how the choice of data structures impact the performance of programs.
CO2	Solve problems using data structures such as linear lists, stacks, queues, hash tables, binary trees, heaps, binary search trees, AVL trees and writing programs for these solutions.
CO3	Implement graphs as adjacency matrix, adjacency list, Searching technique - Breadth First Search and Depth First Search.
CO4	Analyze, evaluate and choose appropriate data structures and algorithms for a specific application.

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-		
CO2	3	-	-	-	-	-	-	-	-	-	-	2		
CO3	2	-	-	-	-	-	-	-	2	-	-	-		
CO4	3	-	-	-	-	-	-	-	2	-	-	1		

Syllabus:

Introduction to Data Structures, Asymptotic Notations, Theorems and Examples based on Asymptotic Notations, Stack Data Structure and its Applications, Queue Data Structure and its Applications, Linked Lists, Trees and tree traversals, Dynamic Sets and Operations on Dynamic Sets, Binary Search Tree and its Operations, Heap Data Structure

Priority Queue, AVL Trees., Direct Addressing; Introduction to Hashing, Collision Resolution by Chaining, Collision Resolution by Open Addressing, Lower Bound for Comparison based Sorting Algorithms, Insertion Sort, Merge Sort, Quick Sort.

Heap Sort and Counting Sort, Radix Sort, Introduction to Graphs and Representation of Graphs, Depth First Search (DFS), Breadth First Search (BFS), Applications: BFS and DFS.

Prim's Algorithm for finding Minimum Spanning Tree (MST), Kruskal's Algorithm for finding MST, Dijkstra's Algorithm for Single Source Shortest Paths

Floydd-Warshall Algorithm for All-Pairs Shortest Path Problem

Laboratory Experiments:

1. Write a program to implement stack using arrays.
2. Write a program to evaluate a given postfix expression using stacks.
3. Write a program to convert a given infix expression to postfix form using stacks.
4. Write a program to implement circular queue using arrays.
5. Write a program to implement double ended queue (de queue) using arrays.
6. Write a program to implement a stack using two queues such that the *push* operation runs in constant time and the *pop* operation runs in linear time.

7. Write a program to implement a stack using two queues such that the *push* operation runs in linear time and the *pop* operation runs in constant time.
8. Write a program to implement a queue using two stacks such that the *enqueue*operation runs in constant time and the *dequeue*operation runs in linear time.
9. Write a program to implement a queue using two stacks such that the *enqueue*operation runs in linear time and the *dequeue*operation runs in constant time.
10. Write programs to implement the following datastructures:
    (a) Single linked list
    (b) Double linked list
11. Write a program to implement a stack using a linked list such that the *push* and *pop* operations
12. Write a program to implement a queue using a linked list such that the *enqueue*and *dequeue*operations
13. Write a program to create a binary search tree(BST) by considering the keys in given order and perform the following operations on it.
    (a) Minimum key
    (b) Maximum key
    (c) Search for a given key
    (d) Find predecessor of anode
    (e) Find successor of anode
    (f) delete a node with given key
14. Write a program to construct an AVL tree for the given set of keys. Also write function for deleting a key from the given AVL tree.
15. Write a program to implement hashing with (a) Separate Chaining and (b) Open addressing methods.

Text Books:

1. Thomas H. Cormen, Charles E Leiserson, Ronald L. Rivest and Clifford Stein, I*ntroduction to Algorithms*, PHI, 2nd Edition, 2009.
2. Mark Allen Weiss, *Data Structures and Algorithm Analysis in C++*, Third Edition, Pearson Education, 2006
3. Ellis Horowitz, SartajSahni and SanguthevarRajasekaran, *Fundamentals of Computer Algorithms*, Universities Press, 2nd Edition, 2011.
4. Michael T.Goodrich and Roberto Tamassia, *Algorithm Design: Foundations, Analysis and Internet Examples*, Wiley India, 2nd Edition, 2006.

Online Resources:

1. https://nptel.ac.in/courses/106/106/106106130/
2. https://nptel.ac.in/courses/106/106/106106145/
3. https://nptel.ac.in/courses/106/102/106102064/

Course Code: EE181	ELECTRICAL CIRCUITS AND MACHINES	Credits 3-0-0 :3

Course Outcomes: At the end of the course, the student will be able to

CO1	Simplify DC networks and analyze them using loop and node equations and determine the dual of a given network
CO2	Analyze magnetic circuits, and electric circuits with sinusoidal excitation along with the phenomenon of resonance
CO3	Formulate the dynamic equations of electric circuits using differential equations and simplify their solutions using Laplace.
CO4	Simplify the analysis of electric circuits using network theorems, and Identify the type of electrical machines for a given application.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2				1		1			1	1	1
CO2	2	1	2				1		1			1	1	1
CO3	2	1	2				1		1			1	1	1
CO4	2	1	2				1		1			1	1	1

Syllabus:

Circuit Elements and Relations: Types of circuit components, Types of Sources and Source Transformations, Star-delta transformation, KVL and KCL with dependent and independent Sources, DC circuit analysis, Formation of loop and node equations.

Magnetic Circuits: Concept of MMF, flux and magnetic reluctance, self and mutual inductances, Dot convention, coefficient of coupling and coupled circuits.

Steady State Analysis of Circuits for Sinusoidal Excitations: Concept of phasor, Single phase Series, Parallel, Series Parallel circuits, Concept of power factor, Solution of AC networks using mesh and nodal analysis, Phasor diagrams.

Resonance- Series and Parallel resonance, Bandwidth, Q-factor and selectivity.

Time Domain Analysis: Solution of network equations in time domain, Classical differential-equations approach, Initial conditions & evaluation, applications to simple RLC circuits only.

Applications of Laplace Transforms in Circuit Theory: Laplace transforms of various signals of excitation, Laplace transformed networks.

Network Theorems: Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, Millman's theorem, Tellegen's theorem.

Single Phase Transformers: Principle of Operation of a Single Phase Transformer, EMF Equation, Phasor Diagram, Equivalent Circuit of a 1-phTransformer, Regulation & Efficiency of a Transformer (Qualitative)

DC and AC Machines: Principle of Operation, Classification, EMF and Torque Equations, Speed Control Methods and Applications;

Three Phase Induction Motor: Principle of Rotating Magnetic Field, Principle of Operation of 3-ph Induction Motor, Torque – Speed Characteristics of 3-ph Induction Motor, Applications of 3-ph Induction Motor.

Synchronous Motors: Principle of operation, Construction and applications.

Learning Resources:

Text Books:

1. Network Analysis, M.E. Van Valken Burg, PHI, 2015, 3rd edition.
2. Engineering Circuit Analysis, William H. Hayt, Jack Kemmerly, Steven M. Durbin, Tata McGraw-Hill, 2013, 8th Edition.
3. Electrical Technology, Edward Hughes, ELBS, 2001, 6th Edition.

Reference Books:

1. A Course in Electrical Circuit Analysis, M.L.Soni and J.C. Gupta, Dhanpat Rai & Co. (P),2001.
2. Network Analysis, G.K Mittal & Ravi Mittal, Khanna Publications, 2003, 14th Edition.
3. Engineering Network Analysis and Filter Design, Gopal G Bhise, Prem R Chadha &Durgesh C. Kulshreshtha Gopal, Umesh Publications,2012.
4. Electrical Engineering Fundamentals, Vincent Del Toro, PHI, 2003, 2nd Edition.
5. Basic Electrical Engineering, V N Mittle, TMH, Edition2000.
6. Linear circuit Analysis, De Carlo & Lin: Oxford University Press, 2010, 2nd Edition.

Online Resources:

1. https://nptel.ac.in/courses/108/104/108104139/
2. https://nptel.ac.in/courses/108/102/108102097/
3. https://nptel.ac.in/courses/108/105/108105155/

Course Code: EC151	ELECTRONIC CIRCUITS ANALYSIS AND DESIGN	Credits 3-0-0: 3

Course Outcomes: At the end of the course, the student will be able to:

CO1	Learn the fundamentals of various amplifiers
CO2	Understand the high-frequency models of BJT and FETs
CO3	Develop analytical capability to analyze the feedback in amplifiers
CO4	Determine the key parameters responsible for the performance of amplifiers and oscillators

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	3								1	2	2	
CO2	2	2	3	2							1	2	2	
CO3	2	2	3	2	3						1	2	2	
CO4	2	2	3								1	2	2	

Syllabus:

Low-Frequency Transistor Amplifier Circuits: Small-signal equivalent circuit of the transistors (BJT & MOSFET) using re model and 'h'-parameters, Analysis of single stage BJT amplifier circuits (CE, CB & CC), Analysis of single stage MOSFET amplifier circuits (CS, CG & CD), Low frequency response of amplifier circuits, Effect of bypass and coupling capacitors on the low frequency response of the amplifier.

High-Frequency Response Transistor Amplifier Circuits: Classification of amplifiers, Distortion in amplifiers, Frequency response of an Amplifier, Bode plots, Step response of an amplifier, CE short circuit current gain, Internal capacitance effect, High frequency model of the MOSFET and BJT, High frequency response of CS and CE amplifiers. Miller's theorem, High frequency response of source and emitter follower, Gain bandwidth product. Cascode stage: cascode as a current source, cascode as an amplifier. Current mirrors.

Differential and Multistage Amplifiers (MOS and BJT case): differential pair, common mode and differential mode operation. Small and large signal operation, CMRR, current mirror load. Analysis of Multistage amplifier, Design of two stage amplifier, Frequency response of cascaded stages, Analysis of 2-stage differential amplifier.

Feedback Amplifiers: Classification and representation of amplifiers, Feedback concept, and transfer gain with feedback, General Characteristics of negative feedback amplifiers. Impedance in feedback amplifiers. Properties of feedback amplifier topologies, approx. analysis of feedback amplifiers, Method of analysis of a feedback amplifier. The shunt feedback triple, Shunt-series pair, Series shunt pair, series triple, general analysis of multistage feedback amplifiers.

Oscillators and Multivibrators: Sinusoidal oscillators, Barkhausen Criterion, Analysis and design of RC phase shift (FET/ BJT) oscillator, Wien bridge oscillators. Resonant circuit oscillators, General form of oscillator circuit (Hartley &Colpitts), Crystal oscillators. Design and Analysis of Bistable, Monostable and AstableMultivibrators, and Schmitt Trigger using Transistors.

Learning Resources:

Text Books:

1. Microelectronics Circuit Analysis and Design, Donald Neamen, McGraw Hill, 2010, 4th Edition.
2. Microelectronic Circuit Design, Richard C Jaeger and Travis N Blalock, McGraw Hill, 2016, 5th Edition.

Reference Books:

1. Electronic Devices and Circuit Theory, Robert L Boylestad and Louis Nashelsky, Pearson, 2013, 11th Edition.
2. Microelectronic Circuits: Theory and Applications, Adel S Sedra, K C Smith and A N Chandorkar, Oxford University Press, 2017, 7th Edition.
3. Solid State Electronic Devices, Ben Streetman, Pearson, 2015, 7th Edition.

Online Resources:

1. https://nptel.ac.in/courses/117/105/117105147/
2. https://nptel.ac.in/courses/117/108/117108038/
3. https://onlinecourses.nptel.ac.in/noc21_ee86/preview

Course Code: EC152	ELECTRONIC CIRCUIT DESIGN AND SIMULATION LABORATORY	Credits 0-1-2: 2

Course Outcomes: After completion of the course student will be able to:

CO1	Synthesize and evaluate single stage and two stage amplifiers
CO2	Design and test differential amplifier
CO3	Realize the given performance using feedback amplifiers
CO4	Design and test Oscillator circuits using BJT and FET.

Course Articulation matrix**:**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	-	-	-	-	-	-	2	-	-	2	1	1
CO2	-	3	-	2	-	-	-	-	2	-	-	2	1	1
CO3	-	3	-	2	-	-	-	-	2	-	-	2	1	1
CO4	-	3	-	2	-	-	-	-	2	-	-	2	1	1

LIST OF EXPERIMENTS:
All the experiments must be performed on Hardware and Simulation platform.

1. Single stage BJT amplifier
2. Two stage BJT amplifier
3. FET amplifier
4. Differential amplifier
5. Voltage series feedback amplifier
6. Voltage shunt feedback amplifier
7. Current series feedback amplifier
8. Current shunt feedback amplifier
9. RC phase shift oscillator
10. Wein bridge oscillator
11. LC/ crystal oscillator

Learning Resources:

Text Books:

1. MicroelectronicsCircuitAnalysisandDesign,DonaldNeamen,McGrawHill,2010,4th Edition.
2. Microelectronic Circuit Design, Richard C Jaeger and Travis N Blalock, McGraw Hill, 2016, 5thEdition.

Reference Books:

1. Electronic Devices and Circuit Theory, Robert L Boylestad and Louis Nashelsky, Pearson, 2013, 11thEdition.
2. Microelectronic Circuits: Theory and Applications, Adel S Sedra, K C Smith and A N Chandorkar, Oxford University Press, 2017, 7thEdition.
3. Solid State Electronic Devices, Ben Streetman, Pearson, 2015, 7thEdition.

Online Resources:

1. https://nptel.ac.in/courses/117/105/117105147/
2. https://nptel.ac.in/courses/117/108/117108038/
3. https://onlinecourses.nptel.ac.in/noc21_ee86/preview

Course Code: EC153	JOY OF ELECTRONICS	Credits 0-0-2: 1

Pre-Requisites: NIL

Course Outcomes: At the end of the course, the student will be able to

CO1	Identify various electronics components with their specifications and measure them
CO2	Work with printed circuit boards and the tools and design simple circuits
CO3	Understand and operate different laboratory instruments, component testers
CO4	Work with various types of sensors and transducers
CO5	Work with different types of microcontrollers boards

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1						1					2		
CO2	2		2		2							2	2	2
CO3	1						1		2			2		
CO4			3					1	2	2	1	2	3	3
CO5			3		2				2	2	1	2	3	3

1 -Slightly; 2 -Moderately; 3 –Substantially

Syllabus:

1. Introduction to Resistors, inductors, Capacitors, ICs, Breadboards, PCBs, ICs, IC sockets, cables and connectors, Diodes, Transistors, FETs, 7-segmentdisplays
2. Soldering and de-soldering, Bread boarding, General purpose PCBs, PCB art work , Design of PCBs for simple circuits, PCB Drillers, Hand tools
3. Common Instruments and their working: CROs, DSOs, DVMs, DMMs, Frequency counters, Waveform generators, working with power supplies, Assembling and Disassembling a gadget/ simple instrument
4. Component testers: Active & Passive components testing, IC testers,
5. Working with different types of sensors and components: Temperature, Moisture, Gas, Light, Ultrasonic, pH, Relays, IR, Accelerometers, DC motors, motor drivers, solar panels, smoke and Fire sensors, LCD and LED displays
6. Working with Microcontroller boards: Aurdino, RasberryPi
7. Training Workshops: Microcontrollers, Robotics, IoT, Machine learning, Computer vision, Drones
8. Take home project: LED Blink Pattern, Gas Sensing, Alcohol Sensing, Motor Operation by Timing, Fire Alarm, Burglar Alarm, Plant Moisture Monitoring, Android Controlled Caretc.,

Resources:

1. Lab charts/manuals
2. Equipment manuals
3. Datasheets
4. Internet resources

Course Code: EC154	PROGRAMMING USING PYTHON	Credits 0-0-2: 1

Pre-Requisites:

Course Outcomes: At the end of the course, the student will be able to

CO1	Develop the application specific codes using python
CO2	Understand Strings, Lists, Tuples and Dictionaries in Python
CO3	Verify programs using modular approach, file I/O, Python standard library
CO4	Implement Digital Systems using Python

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1									1		
CO2	1		1									1		
CO3		2	1		1						1	1		
CO4			2		2							1	3	3

1 -Slightly; 2 -Moderately; 3 –Substantially

Syllabus:

Expressions, Data types, Variables, Flow Control concepts, While Loops, For Loops Functions: Built-in functions, Writing own functions, Global and local scopes, Error handling Lists, For loops with lists, multiple assignment and augmented operators, List methods Dictionary Datatype and Data structures, string syntax, string methods, String formatting

Regular expressions: Basics, Groups, Character classes, Repetition in Regex patterns, Regex method Files Reading and writing, copying and moving, deleting, Directory tree

Debugging: raise and assert statements, logging, debugger

Web scraping: Web browser, downloading with web requests, Parsing HTML Reading and editing of spreadsheets, PDFs and Word documents

Numpy, Pandas, Data visualization libraries, Jupyter Notebook, Python IDEs

Exercise 1 Basics

Running instructions in Interactive interpreter and a Python Script Write a program to purposefully raise Indentation Error and correct it

Exercise 2 Operations

Write a program to compute GCD of two numbers by taking input from the user
Write a program add.py that takes 2 numbers as command line arguments and prints its sum.

Exercise - 3 Control Flow

Write a Program for checking whether the given number is even number or not. Write a program using for loop that loops over a sequence.
Python Program to Print the Fibonacci sequence using while loop
Python program to print all prime numbers in a given interval (use break)

Exercise – 4 Lists

Find mean, median, mode for the given set of numbers in a list. Write a program to convert a list and tuple into arrays.
Write a program to find common values between two arrays.

Exercise – 5 Dictionary
Write a program to count the numbers of characters in the string and store them in a dictionary data structure
Write a program combined lists into a dictionary.

Exercise – 6 Strings
Write a program to check whether a string starts with specified characters. Write a program to check whether a string is palindrome or not
Exercise -7 Strings Continued
Python program to split and join a string
Python Program to Sort Words in Alphabetic Order

Exercise -8 Files
Write a program to print each line of a file in reverse order.
Write a program to compute the number of characters, words and lines in a file. Write a program to count frequency of characters in a given file.

Exercise - 9 Functions
Simple Calculator program by making use of functions
Find the factorial of a number using recursion
Write a function dups to find all duplicates in the list.
Write a function unique to find all the unique elements of a list.

Exercise - 10 Functions - Problem Solving
Write a function cumulative_ product to compute cumulative product of a list of numbers.
Write a function reverse to print the given list in the reverse order.
Write function to compute GCD, LCM of two numbers

Exercise- 11 Multi-D Lists
Write a program that defines a matrix and prints
Write a program to perform addition of two square matrices Write a
program to perform multiplication of two squarematrices

Exercise - 12 - Modules
a) Install NumPypackage with pip and explore it.

Exercise - 13
Write a program to implement Digital Logic Gates – AND, OR, NOT, EX-OR
Write a program to implement Half Adder, Full Adder, and Parallel Adder

Text Books:
1. Python Programming: A Modern Approach, VamsiKurama,Pearson
2. Learning Python, Mark Lutz, Orielly

ReferenceBooks:
1. Think Python, Allen Downey, Green TeaPress
2. Core Python Programming, W.Chun,Pearson
3. Introduction to Python, Kenneth A. Lambert,Cengage

Online Resources:
1. Website reference links

II – Year: I Semester

Course Code: MA234	Complex variables and Special Functions	Credits 3–0–0 :3

Prerequisites:

Course Outcomes: After completion of the course student will be able to:

CO1	Evaluate contour integrals of functions of complex variables
CO2	Examine improper integrals using complex variables
CO3	Determine the series solutions of Legendre and Bessel equations
CO4	Assess series solution of ordinary differential equations at a singular point
CO5	Construct a function for data using cubic splines

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	-	-	-	-	-	-	-	-		
CO2	3	1	-	-	-	-	-	-	-	-	-	-		
CO3	3	1	-	-	-	-	-	-	-	-	-	-		
CO4	3	1	-	-	-	-	-	-	-	-	-	-		
CO5	3	1	-	-	-	-	-	-	-	-	-	-		

Detailed Syllabus:

Review of complex numbers, nth roots of complex number, Regions in the complex plane, Functions of a complex variable, Limit and continuity, Functions of a complex variable, Limit and continuity, Derivative, CR-equations, analytic functions, Contour integrals, anti-derivatives, Contour integrals, anti-derivatives, Cauchy-Goursat Theorem, Cauchy Integral Formula.

Taylor's and Laurent's series expansions, Zeros and singularities, Residues, Residue theorem, Evaluation of improper integrals, Mapping by Elementary functions, Linear fractional transformations (Bilinear transformation), conformal mapping, Schwartz Christoffel transformation.

Ordinary points, Classification of singular points of an ordinary differential equation Series solutions-Power series method, Legendre equation, Legendre polynomials and their orthogonal property, Generating function, Regular Singular Points, Method of Frobenius.

Bessel equation, Bessel function of first kind, Generating function, orthogonal property of Bessel functions, Sturm-Liouvelle Problems, Splines and cubic spline functions, Properties and applications, Piecewise approximation with M's and m's

Reading:

1. R.V. Churchill, *Complex variables and its applications*, McGraw Hill, 8th Edition,2017.
2. S.S. Sastry, *Introductory methods of Numerical Analysis*, PHI, 5th Edition 2012.
3. W.W. Bell, *Special Functions For Scientists and Engineers*, Dover Publications, 2004.
4. Erwin Kreyszig: *Advanced Engineering Mathematics*, John Wiley and Sons, 10th Edition, 2010.
5. B.S. Grewal: Higher Engineering Mathematics, Khanna Publications, 43th Edition, 2014.

Reference Books:

1. Advanced Engineering Mathematics: by C. R. Wylie & L. C. Barrett, McGraw Hill, 6th Edition
2.Advanced Engineering Mathematics: by R. K. Jain & S. R. K Iyengar, Narosa Pub. House, 6th Edition, 2019
3. Complex variables and Applications: by R. V. Churchill, T. J. Brown & R. F. Verhey, McGraw Hill, 9th Edition, 2013

Course Code: EE234	Control System Engineering	Credits 3–0–0: 3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Analyze electromechanical systems using mathematical modeling
CO2	Determine Transient and Steady State behavior of systems using standard test signals
CO3	Analyze linear and non-linear systems for steady state errors, absolute stability and relative Stability
CO4	Design a stable control system satisfying requirements of stability and reduced steady state error

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	1	1
CO2	3	2	-	-	-	-	-	-	-	-	-	-	1	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-	1	1
CO4	2	3	2	-	-	--	-	-	--	-	-	1	1	1

Detailed Syllabus:

Introduction: Concepts of Control Systems- Open Loop and closed loop control systems and their differences- Different examples of control systems- Classification of control systems, Feed-Back Characteristics, Effects of feedback.

Transfer Function Representation: Block diagram representation of systems considering electrical systems as examples -Block diagram algebra – Representation by Signal flow graph - Reduction using mason's gain formula.

Time Response Analysis: Standard test signals - Time response of first order systems – Characteristic Equation of Feedback control systems, Transient response of second order systems-Time domain specifications – Steady state response - Steady state errors and error constants – Effects of proportional derivative, proportional integral systems.

Stability Analysis in S-Domain: The concept of stability – Routh's stability criterion – qualitative stability and conditional stability – limitations of Routh's stability.

Root Locus Technique: The root locus concept - construction of root loci-effects of adding poles and zeros to G(s) H(s) on the root loci.

Frequency Response Analysis: Introduction, Frequency domain specifications-Bode diagrams- Determination of Frequency domain specifications and Phase margin and Gain margin- Stability Analysis from Bode Plots. Polar Plots, Nyquist Plots Stability Analysis.

Compensation techniques – Lag, Lead, and Lead-Lag Controllers design in frequency Domain, PID Controllers.

State Space Analysis of Continuous Systems: Concepts of state, state variables and state model, derivation of state models from block diagrams, Diagonalization- Solving the Time invariant state Equations-StateTransitionMatrixandit'sProperties–Concepts Controllability and Observability.

Reading:

1.Control Systems Theory and Applications - S. K. Bhattacharya, Pearson, 3rd Edition, 2013.

2.B.C. Kuo, Automatic Control Systems, 9th Edition, Prentice Hall of India, 9th Edition, 2014.

3.I.J. Nagarath and M. Gopal: Control Systems Engineering, 6thEdition, New Age Pub.Co. 2018.

4.Control Systems - N. C. Jagan, BS Publications, 3rd Edition, 2015.

5.Control Systems - A. AnanadKumar,PHI, 2nd Edition, 2014.

6.Control Systems Engineering - S. Palani,TMH, 3rd Edition, 2016.

Reference Books**:**

1. K. Ogata, “Modern Control Engineering”, Prentice Hall, 5thEdition 2009

2.Control Systems - Dhanesh N. Manik, Cengage Learning.

3.Control Systems - N. K. Sinha, New Age International (P) Limited Publishers, 4th Edition, 2013.

Course Code: EC201	Digital Circuit Design	Credits 3-0-0:3

Prerequisites: None

Course outcomes: After completion of the course student will be able to:

CO1	design of combinational and sequential logic circuits and develop Verilog models
CO2	understand characteristics of the TTL/CMOS logic families and realize Boolean equation using CMOS logic
CO3	understand fault detection techniques for digital logic circuits
CO4	understand SRAM/DRAM organization and periphery circuitry, operation of SRAM cell, DRAM cell, DDR2/DDR4 and SD card

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	-	-	-	-	-	-	-	-	-	1	-
CO2	2	3	-	-	-	-	-	-	-	-	-	-	1	-
CO3	-	2	-	-	-	-	-	-	-	-	-	-	1	-
CO4	2	2	1	-	-	-	-	-	2	-	-	-	1	-

Detailed Syllabus:

Number Systems and Codes, Representation of unsigned and signed integers, Floating Point representation of real numbers, Laws of Boolean Algebra, Theorems of Boolean Algebra, Realization of functions using logic gates, Canonical forms of Boolean Functions, Minimization of Functions using Karnaugh Maps.

Combinational circuit design: Design with basic logic gates, comparators, data selectors, priority encoders, decoders, full adder, serial binary adder, parallel binary adders-ripple-carry adder, carry-look ahead adder; Parallel prefix adders- Carry select Adder, Conditional sum adder, Kogge-stone Adder, Brent-kung adder, Verilog models.

Testing of Combinational circuits: Fault models, structural testing: path sensitization
Logic families: TTL and CMOS Logic circuits, Transfer characteristics, fan-in, fan-out, noise margin, rise time and fall time analysis, realization of Boolean equations using CMOS logic

Sequential circuit design: Memory elements and their excitation functions SR, JK, T, and D latches and flip-flops, master slave JK flip-flop, edge-triggered flip-flop, synchronous and asynchronous counters, finite-state machine, sequence detector, minimization and transformation of sequential machines, Registers, Verilog models

Memory: Types of memories, MOS SRAM cells, DRAM, SDRAM, DDR SDRAM, DDR2 SDRAM, DDR4 SDRAM, organization of a SRAM, Organization of SDRAM, Periphery circuitry of Memory, Flash memory, SD card

Reading:

1. William J. Dally and John W. Poulton, Digital Systems Engineering, Cambridge University

Press, 2008.

2. Schilling, Herbert Taub and Donald, Digital Integrated Electronics, Tata McGraw-Hill, 2008.

3. JayaramBhasker, Verilog Primer, 3rd edition, Prentice-Hall India, 1998.

4. Sameer Palnitkar, Verilog HDL: A guide to digital Design and Synthesis, 2nd edition, Pearson, 2003.

5. John F Wakerly, Digital Design Principles and Practices, 3rd Edition, Prentice Hall India, 2001.

6. Franklin P. Processor, David E. Winkel, The Art of Digital Design: An Introduction to Top-Down Design, 2nd Edition, PTR Prentice Hall, 1987.

Course Code: EC202	Signals and Systems	Credits 3-0-2:4

Pre-requisites:

Course Outcomes: After the completion of the course the student will be able to:

CO1	Classify the signals as Continuous time and Discrete time
CO2	Analyze the spectral characteristics of signals using Fourier analysis.
CO3	Classify systems based on their properties and determine the response of LTI system using convolution.
CO4	Understand the process of sampling to convert an analog signal into discrete signal and Apply Z- transform of continuous-time and discrete-time signals for stability analysis.
CO5	Demonstrate the principles of signals& systems through simulation.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO2	3	-	-	-	-	2	-	-	-	-	-	1	2	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO4	2	3	-	-	-	-	-	-	-	-	-	-	2	-
CO5	2	3	-	-	-	3	-	-	-	-	-	1	2	-

Syllabus:

SIGNALS AND SYSTEMS: Continuous Time and Discrete Time signals, Exponential and Sinusoidal Signals, Unit Impulse and Unit Step Functions, Continuous and Discrete Time Systems, basic System Properties.

LINEAR TIME INVARIANT SYSTEMS: Discrete Time LTI Systems, Continuous Time LTI Systems, properties of LTI Systems, causal LTI Systems Described by Difference equations.

FOURIER SERIES REPRESENTATION OF PERIODIC SIGNALS: Response of LTI systems to Complex Exponentials, Fourier series Representation of CT periodic Signals, properties of CT Fourier Series, Fourier Series representation of DT periodic Signals, properties of DFS, Fourier series and LTI Systems, Filtering, Examples of CT filters, Examples of DT filters.

CONTINUOUS TIME FOURIER TRANSFORM: Representation of a periodic Signals by continuous FT, FT of periodic signals, convolution and multiplication property of continuous FT, systems characterized by Linear Constant Coefficient Differential Equations.

TIME AND FREQUENCY CHARACTERIZATION OF SIGNALS AND SYSTEMS: Magnitude and phase representation of FT, Magnitude and phase response of LTI systems, Time domain and Frequency domain aspects of ideal and non-ideal filters.

DISCRETE TIME FOURIER TRANSFORM (DTFT) and DISCRETE FOURIER TRANSFORM (DFT): Properties of DTFT and DFT, convolution property, multiplication property, Duality, Systems characterized by Linear Constant Coefficient Difference Equations.

SAMPLING: Sampling theorem, Proof of Sampling theorem, Effect of under sampling- Aliasing, Types of sampling Techniques, Data reconstruction-ideal reconstruction filter, zero order Hold.

Z-TRANSFORMS: Z-transforms, Region of convergence and its properties, Inverse Z transform, properties of ZT, Analysis and characterization of LTI systems using ZT.

Lab Experiments:

1. Introduction to MATLAB
2. Generation of continuous time signals.
3. Basic operations on the signals.
4. Transformation of signals into time and frequency domains.
5. Convolution between signals and sequences
6. Write a MATLAB program to Calculate and plot Fourier Transform and Z-Transform of a given signal.
7. Write a MATLAB program to Verify Sampling theorem.

Text Books:

1.Signals and Systems: AV Oppenheim, AS Willsky, S Hamid Nawab, PHI, 2nd edition, 2000.

2 Signals and Linear Systems: Robert A. Gable, Richard A. Roberts, John Wiley, 3rd edition,1995.

3 Digital Signal Processing, Principles, Algorithms, and Applications: John G. Proakis, Dimitris G. Manolakis, PHI, 4th Edition,2007.

* * * *

Course Code: EC203	Networks and transmission lines	Credits 3-0-0:3

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the concept of impedance matching and its significance
CO2	Design filters and equalizers for given applications
CO3	Analyze and interpret the voltage and current distributions on the transmission lines
CO4	Use the smith chart as a graphical tool to solve impedance matching issues

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1			1										2	
CO2		2	2										2	
CO3	3			3									2	
CO4	2												2	

Syllabus:

NETWORKS: Image and iterative impedances. Image and iterative transfer constants. Insertion loss. Attenuators and pads. Lattice network and its parameters. Impedance matching networks. Networks designed for specified phase shift.

FILTERS: Filter fundamentals, Low pass, high pass, band pass and band elimination filters. Constant K and M derived sections. Composite filters.

EQUALISERS: Inverse impedances. Series and shuntequalisers. L typeequalisers. T and Bridged T equalisers. The Lattice equalisers.

TRANSMISSION LINE THEORY: Primary and secondary constants. Phase and Group velocities. Transmission line equations. Distortion. Loading of lines. Characteristics of LF lines.

RF LINES:RF lines, lossless lines, reflection coefficient and VSWR. Quarter-wave, half-wave and 1/8 wave lines. Smith chart - Impedance matching with single and double stub.

Learning Resources:

Text Books:

1. JOHN D RYDER - Networks, Lines and Fields - Prentice Hall, 2nd Edition, 2015.
2. JOHNSON - Transmission Lines and Networks, Mc-Graw Hill, 1950.

Reference Books:

1. Transmission and Propagation, E.V.D. Glazier and H.R.L. Lamont, The Services' Textbook of Radio Volume 5, 1958, 1st Indian Edition.

Online Resources:

1. https://nptel.ac.in/courses/108/106/108106157/
2. https://nptel.ac.in/courses/117/101/117101057/

Course Code: EC204	Introduction to Artificial Intelligence and Machine Learning	Credits 3–0–0: 3

Course Outcomes:

At the end of the course, the student will be able to:

CO1	Understand the key concepts of Artificial intelligence.
CO2	Design and implement machine learning solutions to classification, regression, and clustering problems
CO3	Understand and implement the Artificial Neural Networks
CO4	Evaluate and interpret the results of the algorithms.
CO5	Analyze working of convolutional neural networks

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1									2		3	2		
CO2									2		3	2		
CO3									2		3	2		
CO4									2		3	2		
CO5									2		3	2		

Syllabus:

1. **Introduction to AI**: Introduction, history, intelligent systems, foundations of AI, applications, development of AI languages, current trends.
2. **Supervised Machine Learning:** Basics of linear regression, its assumptions, limitations and industry applications. Least square based and Gradient Descent Based Regression, Multiple linear regression, Polynomial regression, Logistic regression
3. **Artificial Neural Networks:** Biological neurons and artificial neurons. Model of an ANN. Activation functions used in ANNs. Typical classes of network architectures. Mathematical Foundations and Learning mechanisms**,** Feed forward ANN: Structures of Multi-layer feedforward networks. Back propagation algorithm. Back propagation – training and convergence. Functional approximation with back propagation.
4. **Unsupervised Machine Learning:** Different clustering methods (Distance, Density, Hierarchical) , Iterative distance-based clustering; K-Means Clustering Algorithm and Image Quantization, basics of Principal Component Analysis
5. **Introduction to Deep learning:** Analyze the key computations underlying deep learning, Convolutional Neural Network, Building blocks of CNN- Convolutional layers, Pooling layers Dense layers.

Learning Resources:

Text Books:

1. Pattern Recognition and Machine Learning, Christopher Bishop, Springer 2010.

Reference Books:

1. Introduction to Statistical Learning, Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, Springer, 2017.
2. Deep Learning- Ian Goodfelllow, YoshuaBenjio, Aaron Courville, The MIT Press,2016
3. Pattern Classification- Richard O. Duda, Peter E. Hart, David G. Stork, John Wiley & Sons Inc.Second Edition, 2003

Course Code: EC205	Digital Circuit Design Lab	Credits 0–1–2: 2

Prerequisites: None

Course outcomes: After completion of the course student will be able to:

CO1	Develop data flow, behavioral and structural Verilog models for digital circuits
CO2	Compile and Simulate Verilog models of digital circuits using CAD tool
CO3	Synthesize subsystems/ modules using CAD tool
CO4	Implement digital circuits on FPGA prototype boards

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	2	3	-	-	-	-	-	-	-	-	-	1	1
CO2	-	2	3	-	-	-	-	-	-	-	-	-	1	1
CO3	-	3	2	-	-	-	-	-	-	-	-	-	1	1
CO4	-	3	2	-	-	-	-	-	-	-	-	2	1	1

List of Experiments:

1. Develop dataflow Verilog modelsfor
a) 2-to-4decoder
b) 8-to-3encoder
c) 4:1 mux
d) fulladder/subtractor
e) 8-bit parity generator/checker
f) 8-bit Kogge-stone adder

Develop structural Verilog modelsfor
16:1 mux realization using 4:1mux

4-bit ripple carry adder using full adder

8-bit adder using 4-bit ripple carry adder

8-bit carry select adder using 4-bit ripple carry adder

16-bit adder by cascading an 8-bit Kogge-stone adder/Ripple carry adder

4-bit asynchronous up/down counter

2. Develop behavior Verilog modelsfor

a) 4-bit carry look-ahead adder

b) 4-bit ripple carry adder

c) Edge triggeredT-FF/D-FF

d) 16-bit synchronous up/down counter with asynchronous/synchronous load andclear

e) 16-bit Universal shiftregister

3.Develop Verilog models for implementation of the following modules using top-down design style
a) SerialAdder b) 16-bit Modified Booth's multiplier c) 16-bit Vedic multiplier d) 32-bit MIPS Processor.

Course Code: EC206	Design Thinking Lab	Credits 0–1–2: 2

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify design principles from an engineering perspective
CO2	Cultivate sensitivity towards design aspects of Activities, Environments, Interactions, Objects, and Users (A-E-I-O-U) in daily life
CO3	Validate problem statements through user empathization with societal and environmental consciousness
CO4	Devise visual design and documentation to communicate more effectively
CO5	Develop project management skills in a multidisciplinary environment

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	2	2	1	3								
CO2	1	1	1	2	2	1	2	1		1	1	1	2	1
CO3	2	2	3	3	1	2	3	1	1	1	1	1	1	3
CO4	2	2	2	2	1	2			2	3	2	1		1
CO5	2	1	1			1					3	1		1

MODULE-1: Design Overview and Motivation
Design is Every where – Various perspectives including history; Design Vocabulary; Design in Indian Context; Art and Design; Importance of Design in Career

MODULE-2: Understanding Design
Design Engineering vs. Engineering Design; Good and Bad Design — Case Studies, Introduction to the Design Double Diamond: Discover-Define-Develop-Deliver; Importance of user-centricity for design

MODULE-3: Doing Design: Discover Phase
Looking for problems: SDGs; Identifying Stakeholders and Defining User Personas; User Empathisation and Tools; Data collection from users and for users: Surveys, Questionnaires, Statistics, Interactions
Need Analysis: Types of Users, Types of Needs; Market Size; Value Proposition to the Users; Identifying Addressable Needs and Touchpoints; Data Validation; Structuring, Need Statements

MODULE-4: Designing Customer Service Experience
Enhancing Customer Experience in Services through Innovation and Design Thinking; Service Development Process and Case Studies; Service Experience Cycle and Case Studies

MODULE-5: Communication Skills for Design
Communicating using various media to express an idea in print, electronic, mobile, web, and social media: Visuals, Text, Voice and Audio, Infographics
General Guidelines for a Good Presentation: Target Audience, Slideshow Templates, Appropriate Visual Elements and Aesthetics, Typography, Presentation Styles,

General Guidelines for a Good Report: Documentation Classification, Standards, Styles, and Templates

MODULE-6: Sustainable Design Approaches
Concern for Environment and Sustainability in Design, Case Studies to understand good Design For Environment (DFE) Decisions; Design Considerations in the five stages of the Product Life Cycle

STUDENTS' RESPONSIBILITIES:

1. Forming diverse teams of 3–5 members each to work collaboratively throughout the semester.
2. Proactively engaging to observe the objects and interactions in their daily life and society from a design perspective.
3. Identifying general societal and social problems that may be effectively addressed using design thinking principles
4. Presenting and reporting the tasks to the concerned faculty members using their creative communication and people skills.

Course Objectives:

- To create awareness of design among students of engineering
- To teach a systematic approach to identifying and defining a problem before brainstorming for a solution
- To instill a sense of significance towards applying creativity to product and service design
- To motivate students to apply design thinking while implementing a project focusing on local or global societal problems

ACTIVITIES :

1. Introduction and briefing (15 minutes)

2. Ice-breaker activity (20 minutes)

3. Introduction to Design Thinking (20 minutes)

4. Building empathy for the user (1 hour)

5. Define a problem statement (1 hour)

6. Ideation part 1: Generate ideas and potential solutions (1 hour)
   Presentation (5 minutes): What is ideation?
   Activity—worst possible idea (10 minutes)
   Activity—coming up with solutions (10 minutes)
   Activity—sharing ideas and getting feedback (10 minutes)
   Activity—refining your solution (10 minutes)
   Reflection and discussion (5 minutes)

7. Ideation part 2: User journey mapping (1 hour)
   Presentation (10 minutes): What is a user journey map?
   ctivity—define the activities and steps in the customer's experience (15 minutes)
   Activity—group the steps into phases (10 minutes)
   Activity—adding goals and pain-points (15 minutes)
   Sharing user journey maps, reflection and discussion (10 minutes)

8. Prototype and test ideas (1 hour)
   Presentation (5 minutes):
   Activity—create mobile screens (15 minutes)
   Activity—add functionality to mobile screens (15 minutes)
   Activity—user testing (15 minutes)
   Activity—decide on a winning approach (10 minutes):

9. Debrief and outline next steps (15 minutes)

Exercises :

1) The Pin-Up Exercise
2) The Systems Thinking Exercise
3) The 48-Hour Crash Course Exercise
4) The Design with Empathy Exercise
5) The Tinker Toy Exercise
6) The Wallet Exercise
7) The Pitch Competition Exercise
8) “Yes, but” vs. “Yes, and” exercise
9) “Five whys” or “Nine Whys” exercise
10) The “Six Thinking Hats” exercise

Resources :

1. Tim Brown, “Change by Design”, Harper Business, 2012 (ISBN: 978-0062337382)
2. Donald A. Norman, “The Design of Everyday Things”, MIT Press, 2013 (ISBN: 978-0262525671)
3. Daniel Ling, “Complete Design Thinking Guide for Successful Professionals”, Create Space Independent Publishing, 2015 (ISBN: 978-1514202739)
4. Design Thinking: A guide to creative problem solving for everyone, Andrew Pressman, Routledge Taylor and Francis group, 2019, 1st edition.
4. Engineering Design, George E. Dieter, Linda C. Schmidt, McGraw-Hill Education, 2019, 5th edition.
5. Product design and development, Ulrich, K., Eppinger, S. and Yang, M., 2020, 7th edition.

References:

1. Bruno Munari, “Design As Art”, Penguin UK, 2009 (ISBN: 978-0141035819)
2. Tom Kelly, Jonathan Littman, “The Art of Innovation”, HarperCollins Business, 2002 (ISBN: 978-0007102938)
3. Thomas Lockwood, “Design Thinking: Integrating Innovation, Customer Experience, and Brand Value”, Allworth Press, 2009 (ISBN: 978-1581156683)
4. Joost Groot Kromelink, “Responsible Innovation: Ethics, Safety and Technology”, 2nd ed., TU Delft, Faculty of Technology, Policy and Management, 2019 (e-Book ISBN: 978-9463662024)
5. Jimmy Jain, “Design Thinking for Startups: A Handbook for Readers and Workbook for Practitioners”, Notion Press, 2018 (ISBN: 978-1642495034)

Online Resources:

1. https://www.arvindguptatoys.com/
2. https://honeybee.org/
3. https://dschool.stanford.edu/resources/getting-started-with-design-thinking
4. https://designthinking.ideo.com/

II – Year: II Semester

Course Code: EC251	Linear IC Applications	Credits 3-0-0:3

Pre-requisites:

Course Outcomes: After the completion of the course the student will be able to:

CO1	Design op-amp circuits to perform arithmetic operations.
CO2	Analyze and design linear and non-linear applications using op-amps.
CO3	Analyze and design oscillators and filters using functional ICs.
CO4	Choose appropriate A/D and D/A converters for signal processing applications.

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	-	-	-	-	-	-	-	-	-		
CO2	2	3	2	-	-	-	-	-	-	-	-	-		
CO3	1	2	2	-	-	-	-	-	-	-	-	-		
CO4	1	2	-	-	2	-	-	-	-	-	-	2		

Detailed Syllabus:

Introduction to op-amps, ideal Characteristics, Pin configuration of 741 op-amp. Bias, offsets and drift, bandwidth and slew rate. Offset and Frequency compensation. Exercise problems. Inverting and non-inverting amplifiers and their analysis, Applications: inverting and non- inverting summers, difference amplifier, differentiator and integrator, Voltage to current converter, Exercise problems. Instrumentation amplifier, Log and antilog amplifiers. Precision rectifier, Non-linear function generator, solving differential equations using analog computing blocks.
Analog IC Multipliers and applications Comparators, regenerative comparators, input - output Characteristics, Astable and Monostablemultivibrator, Triangular wave- generators,
RC-phaseshift oscillator, Wein's bridge oscillator, Active Filters, Low pass, High pass, Band pass and Band Reject filters, Butterworth, Chebychev filters, Different first and second order filter Topologies, Frequency Transformation.
555 Timer functional diagram, monostable and astable operation, applications.
Voltage Regulator Series op amp regulator, Three terminal IC voltage regulator exercise problems. IC 723 general purpose regulator, Switching Regulator.
PLL- basic block diagram and operation, capture range and lock range; applications of PLL IC 565, AM detection, FM detection and FSK demodulation. VCO IC 566,
Weighted resistor DAC, R-2R and inverted R-2R DAC. IC DAC-08. counter type ADC, successive approximation ADC, Flash ADC, dual slope ADC, conversion times of typical IC ADC.

Reading:

1. G B Clayton, Operational Amplifiers, 5th Edition, Elsevier science, 2003
2. Sergio Franco, Design With Operational Amplifier And Analog Integrated Circuits, 4th Edition, TMH, 2017.
3. Roy Choudary D. and Shail B. Jain, Linear Integrated circuits, 4th Edition, New Age International Publishers, 2017
4. RamakantA.Gayakward, Op-Amps and Linear Integrated Circuits, 4th Edition, PHI, 2015.

References Books:

1. Operational Amplifiers & Linear Integrated Circuits, R.F. Coughlin & Fredrick F. Driscoll, PHI, 6th Edition,2000.
2. Operational Amplifiers & Linear Integrated Circuits: Theory & Applications, Denton J. Daibey, TMH.

Course Code: EC252	FPGA Based System Design	Credits 3-0-0: 3

Prerequisites:

Course Outcomes: After completion of the course student will be able to:

CO1	Understand the FPGA based design flow
CO2	Explore the different FPGA Fabric architectures
CO3	Summarize various delays in combinational circuit and its optimization methods.
CO4	Construct combinational and sequential circuits of medium complexity that is based on VLSIs and programmable logic devices.
CO5	Summarize the advanced topics such as reconfigurable computing, partially reconfigurable and Pipeline reconfigurable architectures.

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1					1		3		2	1		2		
CO2					3		3		2			1		
CO3					2	1	1	1	2	1		2		
CO4					2		3		2					
CO5			2	3	2									

Detailed Syllabus:

Detailed Syllabus

Chapter 1 FPGA-based systems: Goals and Techniques, Hierarchical Design, Design abstractions, Methodologies, role of FPGAs, FPGA types, FPGA vs, Custom VLSI

Chapter 2 FPGA Fabrics: FPGA Architectures, SRAM based FPGAs, Flash based FPGAs, Circuit design of FPGA fabrics, Architecture of FPGA fabrics

Chapter 3 Combinational Logic: Logic design process, HDLs, Combinational network delay, Power and energy optimization, Arithmetic logic Adders, Multipliers, and combinational shifters, ALUs, Logic implementation for FPGAs, Syntax -directed translation, logic implementation by macro, logic synthesis, technology dependent logic optimization, Technology independent logic optimizations, Physical design for FPGAs.

Chapter 4Sequential Machines: Sequential machine design process, sequential design styles State transition and register transfer models, Algorithmic state Machines (ASM), ASM chart notations, Traditional synthesis for ASM charts and Multiplexer controller method, One -hot method and ROM based method. clocking disciplines, performance analysis, clock skew, retiming, and power optimization.

Chapter 5 Architecture: Datapath and controller architectures, Scheduling and allocation, power consumption reduction methods, pipeline design, Design methodologies ,Design processes, Design Standards, Design Verification, Design Examples: Shift and add multiplier, Booth's multiplier, Modified booth's multiplier, Restoring and Non-restoring divider, Barrel shifter ,and floating point arithmetic operations

.

Text Books

1. W.Wolf, FPGA- based System Design, Pearson,2004.

2. Franklin P. Processor, David E. Winkel, The Art of Digital Design: An Introduction to Top- Down Design, 2nd Edition, PTR Prentice Hall, 1987

Reference Books

1. *S. Hauck, A.DeHon, "Reconfigurable computing: the theory and practice of FPGA-based computation", Elsevier, 2008.*
2. John V. Old Field, Richrad C. Dorf, Field Programmable Gate Arrays, Wiley, 2008.
3. *R.F.Tinde," Engineering Digital Design", (2/e), Academic Press,2000.*
4. *C. Bobda, "Introduction to reconfigurable computing", Springer, 2007.*
5. *M. Gokhale, "Paul S. Graham, Reconfigurable computing: accelerating computation with field-programmable gate arrays", Springer,2005.*
6. *C.Roth, "Fundamentals of Digital Logic Design", Jaico Publishers, V ed.,2009.*

Course Code: EC253	Electromagnetic Fields and Waves	Credits 3-0-0:3

Prerequisites:

Course Outcomes:After completion of the course student will be able to:

CO1	Solve Maxwell's equations using vector calculus in three standard coordinate systems
CO2	Deduce EM wave propagation in free space and in dielectric medium
CO3	Analyze electromagnetic wave propagation in guiding structures under various matching conditions
CO4	Understand the power flow mechanism in guiding structures and in unbounded medium

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	1		
CO2	2	2	-	-	-	2	-	-	-	-	-	-		
CO3	2	2	-	-	-	-	-	-	-	-	-	-		
CO4	3	-	-	-	-	2	-	-	-	-	-	-		

Detailed Syllabus:

STATIC ELECTRIC FIELD: Introduction, Coulomb's law of forces, Principle of Superposition of fields, Electric scalar potential, Relation of Electric field lines and equi-potential contours, The electric dipole and dipole moment, Gauss's law, Characteristics of dielectrics. Boundary relations, Capacitance, Divergence of flux density, Divergence Theorem, Poisson's and Laplace Equations, Joule's law, Ohm's law at a point, Kirchoff's laws, Current and field at boundaries.

STATIC MAGNETIC FIELD: Magnetic field of current carrying element - Biot Savart law, Force between two parallel linear conductors, Magnetic flux and flux density, Magnetic field relations, Torque of a loop, Energy stored in a magnetic field, Inductance, Ampere's law, Maxwell's First curl equation, Comparison of divergence and curl, The vector potential, permeability, Analogies between electric and magnetic fields. MAXWELL'S EQUATIONS: The equation of continuity for time varying fields, Maxwell's equations, Conditions at a boundary surface, Applications of circuit and field theory, Comparison of field and circuit theory, Maxwell's equations as generalization of circuit equations.

ELECTROMAGNETIC WAVES: Plane waves: Wave equations, plane waves in dielectric media, Plane waves in conducting media, polarization, skin effect and surface impedance, direction cosines, reflection of plane waves: Reflection of normally and oblique plane waves from conductors and dielectrics, total reflection.

POYNTING VECTOR AND THE FLOW OF POWER: Poynting theorem, power flow for a plane wave and power loss in a plane conductor, GUIDED WAVES: Waves between parallel planes, TE and TM waves, Characteristics of TE and TM waves, TEM waves, Velocities of propagation, Attenuation in parallel plane guides, Wave impedance, Electric field and current flow within the conductor.

WAVE GUIDES: Rectangular wave-guides, TE and TM modes in wave-guides, Velocity, wavelength, impedance and attenuation in rectangular waveguides.

Reading**:**

1. E.C.Jordan and K.G.Balmain, Electromagnetic waves and Radiating Systems, Prentice Hall, Inc., Englewood Cliffs, New Jersey, 1968.
2. John D.Kraus, Electromagnetics, McGraw Hill Book Co., 5th Edition, 1998.

Reference Books:

1. Engineering Electromagnetics – Nathan Ida, 2ndEd., 2005, Springer (India) Pvt. Ltd., New Delhi.
2. Engineering Electromagnetics – William H. Hayt Jr. and John A. Buck, 8th Ed., McGrawHill,2017
3. Principles of Electromagnetics – Matthew N.O. Sadiku and S.V. Kulkarni, 6th Ed., Oxford University Press, Asian Edition, 2015.

Course Code: EC254	CMOS VLSI Design *	Credits 3-0-2: 4

Pre-requisites:

Course Outcomes:After the completion of the course the student will be able to:

CO1	Model the behavior of a MOS Transistor and understand effects of scaling on IC design
CO2	Understand the CMOS IC fabrication and design rules
CO3	Design combinational, sequential circuits and analog integrated circuits using CMOS technology.
CO4	Apply VLSI testing algorithms to diagnose IC faults.
CO5	To design CMOS IC sub systems and verify the functionality through simulation.

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	-		
CO2	-	3	2	-	-	-	-	-	-	-	-	-		
CO3	-	2	-	-	-	-	-	-	-	-	-	-		
CO4	-	3	-	-	-	-	-	-	-	-	-	1		
CO5	2	3	-	-	-	-	-	1	-	-	-	-		

Detailed Syllabus:

Principles of CMOS IC fabrication

Introduction to IC technology, Fabrication process: nMOS, pMOS and CMOS. I_{ds} versus V_{ds} Relationship, Aspects of MOS transistor, MOS Layers, Stick Diagrams, Design Rules and Layout, , Sheet Resistance concept applied to MOS transistors and Inverters, Area Capacitance of Layers, Scaling models and scaling factors, Scaling factors for device parameters, Limitations of scaling.

MOS FET current voltage characteristics , body bias, small signal model including channel length modulation and body bias, Oxide and junction capacitances associated with MOSFET, MOSFET as capacitor, switch.

CMOS IC Digital building blocks

CMOS logic, suitability of CMOS for digital IC design, Design of CMOS combinational building blocks for given propagation delay, power dissipation and noise margin, design of symmetric gates, techniques to drive large capacitive loads, efficient design approaches to optimize delay, pseudo NMOS logic, ratioed logic, pass transistor logic, transmission gates, CMOS sequential logic building blocks, dynamic logic circuits**.**

Analog IC building blocks

Significance of analog integrated circuits, Suitability of CMOS for analog IC design, , biasing styles, single stage amplifier with resistive load, single stage amplifier with diode connected load, CS, CD, CG amplifiers, current sources and sinks, limitations of single stage amplifier, gain boosting techniques, current mirror principles, introduction to differential amplifier

Testing and packaging

Role of testing in VLSI Design flow, Testing at different levels of abstraction, Fault, error, defect,

diagnosis, yield, Types of testing, Rule of Ten, Defects in VLSI chip. Various types of faults, Fault equivalence and Fault dominance in combinational sequential circuits. Fault simulation applications, General fault simulation algorithms- Serial, and parallel, Combinational circuit test generation, Structural Vs Functional test, ATPG, Difference between combinational and sequential circuit testing, five and eight valued algebra,.D-algorithm procedure, Design for Testability, Ad-hoc design, Generic scan based design, Classical scan based design, System level DFT approaches Test pattern generation for BIST. BIST Architecture. .

Lab Experiments:

1. Analyze the MOSFET I-V characteristics in different regions of operation.

2. Design CMOS inverter for given noise margin, power and propagation delay.

3. Design CMOS NAND , NOR, EX-OR/NOR gates

4. Implement a give function using CMOS logic and extract its figure of merits (FOMs).

5. Implement a CMOS full adder circuit and extract its power-delay product (PDP) and energy-delay product (EDP).

6. Implement D and SR flipflops using CMOS logic and extract its figure of merits (FOMs).

7. Design Single stage amplifier using current source load, diode connected load for given gain, bandwidth.

8. Design of Cascode amplifier using current source load for given gain and 3 dB bandwidth.

9. Design differential amplifier for a given CMRR, 3dB band width.

10. Demonstrate the principle of current mirror and develop a signal processing circuit using current mirror..

Reading:

1. Neil H.E. Weste, David Money Harris, CMOS VLSI Design – A Circuits and Systems Perspective, Addision – Wesley, 2011.
2. Jan M RABAEY, Digital Integrated Circuits, 2nd Edition, Pearson Education, 2016.
3. VLSI Design – M. Michael Vai, 2017, CRC Press.

Reference Books:

1.CMOS VLSI Design – A Circuits and Systems Perspective, Neil H. E Weste, David Harris, Ayan Banerjee, 3rd Ed, Pearson, 2009.
2. Modern VLSI Design - Wayne Wolf, Pearson Education, 4th Edition, 2015.
3.VLSI Design- K .Lal Kishore, V. S. V. Prabhakar, I.K International, 2013.
4.Introduction to VLSI – Mead & Convey, BS Publications, 2010.

Course Code: EC255	Probability Theory and Stochastic Processes	Credits 3-0-2: 4

Prerequisites:

Course Outcomes: After completion of the course student will be able to:

CO1	stinguish between random and stochastic processes.
CO2	odel communication system as a stochastic process
CO3	aracterize LTI systems driven by a stationary random process using autocorrelation and power spectral density functions.
CO4	derstand the probability distribution functions of noise in a communication link.
CO5	Model the Probability and Stochastic processes and Visualize their principles through simulation.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-		
CO2	2	2	-	-	-	-	-	-	-	-	-	2		
CO3	2	3	-	-	-	-	-	-	-	-	-	-		
CO4	3	2	-	-	-	-	-	-	-	-	-	-		
CO5	3	2	-	-	-	-	-	1	-	-	-	-		

Detailed Syllabus:

Scheme of Instructions, Introduction to Subject, Axioms of Probability, Probability Space, Conditional Probability, Bays Theorem, Repeated Trails , Bernoulli's Trails , Problems, Concept of a Random Variable, Distribution and density functions, Properties of distribution functions, Continuous type random variable, Normal, Exponential , chi-square, Rayleigh, Nakagami-m, uniform etc distributions , Problems, Bernoulli, Binomial, Poission distributions, Negative binomial distributions.

Conditional distributions, Total probability and bays theorem, passion approximation Problems, Functions of one random variable: Expectation, Variance, Moments, Characteristic functions Problems, One function of two random variable, joint moments, joint characteristic functions, conditional distributions, conditional expected values, Random Process concept, Stationarity and independence.

Distribution and density functions, statistical independence, First-order stationary processes, Second order and wide sense stationary process, Problems, N- order and strict- sense stationary process, Problems

Time averages and ergodicity , Mean ergodic process, Auto correlation function and its properties, Cross- correlation function and its properties, Covariance functions, discrete time processes and sequences, Power density spectrum and its properties, Problems, Problems, Linear systems with random inputs.

Random signal response, Auto correlation functions of the response, Cross correlation functions of input and output system, Power density spectrum of the response, Problems.

Lab Experiments:

1.Write a MATLAB program to find probability of tossing a coin and rolling a die through large no. of experimentation.

2.Generate Uniform, Gaussian and Exponential distributed random data for given mean and variance.

3.Write a MATLAB program to generate M trials of a random experiment having specific number of outcomes with specified probabilities.

4.To find estimated and true mean of Uniform, Gaussian and Exponential distributed data.

5.To find density and distribution function of a function of random variable Y = 2X + 1. Where X is Gaussian R.V.

6.Estimate the mean and variance of Y = 2X + 1, where X is a Gaussian random variable.

7.Plot Joint density and distribution function of sum of two Gaussian random variable (Z = X + Y).

8.Estimate the mean and variance of a R.V. Z = X+Y. Where X and Y are also random variables.

9.Simulation of Central Limit Theorem.

10.Write two MATLAB functions to generate samples of stationary Gaussian processes.

11.Write three MATLAB functions to generate samples of non-stationary Gaussian processes.

12.Verify relations between correlation and power spectral density using MATLAB simulation.

Reading:

1. P.Z. Peebles.Jr., PROBABILITY, RANDOM VARIABLES AND RANDOM SIGNAL PRINCIPLES, Tata McGraw Hill Education, 4rd edition, 2017.
2. A.Papoulis, Probability, Random variables and Stochastic Processes, McGraw Hill, 4th edition, 2017.
3. Probability and Random Processes – Scott Miller, Donald Childers, 2 Ed, Elsevier, 2012.

Reference Books:

1. Probability, Random Variables and Stochastic Processes – Athanasios Papoulis and S. Unnikrishna Pillai, 4 Ed.,2002, TMH.
2. Theory of Probability and Stochastic Processes- Pradip Kumar Gosh, University Press
3. Probability and Random Processes with Application to Signal Processing – Henry Stark and John W. Woods, 3 Ed., PE
4. Statistical Theory of Communication - S.P. Eugene Xavier, 1997, New Age Publications.

Course Code: EC256	IC Applications Lab	Credits 0-1-2:2

Prerequisites:

Course Outcomes:After the completion of the course the student will be able to:

CO1	easure the parameters of IC 741 Op-amp.
CO2	alize analog filters using Op-amp.
CO3	t the characteristics of TTL NAND Gate.
CO4	sign monostable and astablemultivibrators using 555 IC.
CO5	sign modulo-N counters using TTL ICs. .

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	2	-	-	-	-	-	-	-	-	-	-		
CO2	2	3	-	-	-	-	-	-	-	-	-	-		
CO3	-	2	-	-	-	-	-	-	-	-	-	-		
CO4	-	3	-	-	-	-	-	-	-	-	-	-		
CO5	-	3	-	-	-	-	-	-	-	-	-	-		

List of Experiments:

1: Study and Operation of IC testers, pulse generator and digital trainer.
2: Study of logic gate ICs and their applications
3: Frequency response of inverting and non-inverting amplifier.
4: Measurement of Op.amp parameters: (i) Offset voltage (ii) Offset current (iii) CMRR and (iv) Slew rate
5: Characteristics of TTL NAND gate: (i) Sourcing (ii) Sinking (iii) Transfer
6: Verify the functionality of Mux and Decoder ICs and their application.
7: Op.ampmonostable and astablemultivibrators.
8: Design 2's complement adder/subtractor using IC74283 and verify experimentally.
9: Verify the functionality of Flip-Flop ICs and its application.
10: Mod-N counter using 7490 and 74190.
11: 555 timer: Monostable and astablemultivibrators.
12: Mod-N counter using 7492 and 74192.
13: Shift register IC 7495.
14: Low voltage regulator IC 723.

Course Code: EC257	FPGA BASED DESIGN LAB	Credits 0-1-2: 2

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the Verilog HDL in different level of abstractions
CO2	Develop Verilog model for given combinational circuit
CO3	Develop Verilog model for given sequential circuit
CO4	Design and develop a Verilog model for a complex systems

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	-	-	-	-	-	-	-	-	-		
CO2	-	2	-	-	-	-	-	-	-	-	-	-		
CO3	-	3	2	-	-	-	-	-	-	-	-	-		
CO4	-	2	3	-	-	-	-	-	-	-	-	1		

Syllabus:

Module 1: Design and Implementation of the following Sequential HDL models on Xilinx Nexus 4DDR Artix7 FPGA

a) Sequence Detector
b) Synchronous/Asynchronous Counters
c) Universal Shift Register
d) Sequence Generator
e) Traffic Light Controller
f) Vending Machine Controller

Module 2: Top-down design and implementation of the following logic circuits data path and controller on Xilinx Nexus 4DDR Artix7 FPGA:

a) Serial Adder
b) Shift-and-add Multiplier
c) Booth's Multiplier
d) Array Multiplier
e) Restoring and Non-Restoring Division
f) Floating-Point Adder/Subtractor
g) Floating -Point Multiplier
h) Floating-Point Divider
i) 8-Bit ALU
j) 32-bit MIPS Processor

Learning Resources:

Text Books:

1. Samir Palnithkar, Verilog HDL Aguide to digital Design and Synthesis, 2nd edition, Pearson, 2003.
2. M. M. Mano and Michael D. Ciletti, Digital Design with an Introduction to the Verilog HDL, VHDL, and SystemVerilog, Sixth Edition, Pearson, 2018.
3. C. H. Roth, L. K. John, B. K. Lee Digital System Design using Verilog Fundamentals of Logic Design, Mindtap Cengage Publishers, 2016.
4. S. Brown and Z Vranesic, Fundamentals of Logic Design with Verilog Design, 2nd Edition, Tata McGraw-Hill,2017.

Online Resources:

1. https://nptel.ac.in/courses/106/105/106105165/

Course Code: BT281	DESIGN PRINCIPLES OF LIVING SYSTEMS (FOR ECE) B.Tech. II Year II Sem	L-T-P: Cr 2-0-0: 2

Prerequisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Realize the significance of biomolecules for sustaining life
CO2	Identify the difference between unicellular to multi-cellular organisms
CO3	Understand the central dogma of life
CO4	Apply the concepts of biology for engineering the cell

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1							1					1	1	2
CO2							1	1	1	1		1	1	2
CO3							1					1	1	2
CO4						1	1	1	1		1	1	1	2

Syllabus:

Biomolecular design - structure and functions: chemical basis of life, water, carbon, proteins, nucleic acids, carbohydrates, lipids and membranes and first cells. design principles of cell and organelles.

Information processing in living system: intra and inter cellular communication: central dogma, genetic code, gene and control of gene expression, cell cycle, cell–cell Interactions, biological signal transduction, concept of networks in the cell, interaction between cell and environment, quorum sensing and biofilm formation.

Biomolecular machines and motors: linear and rotary molecular motors: cytoskeletal motor proteins.

Bioengineering: biological data types; biocomputing; DNA based data storage, synthetic biology, synthetic gene regulatory circuit and application; biomolecules for sensor design, biomedical instrumentation in disease diagnosis, bioimaging techniques and analysis in clinical diagnosis.

Learning Resources:

Text Books:

1. Biological Science, Quillin, Allison Scott Freeman, Kim Quillin and Lizabeth Allison, Pearson Education, 2016, 5th Edition.
2. Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox Macmillan Higher Education, 2017, 7th edition,

Reference Books:

1. Biotechnology for Beginners, ReinhardRenneberg, Viola Berkling and VanyaLoroch, Academic Press, 2017, 1st Edition.
2. Molecular Diagnostics, Harald Seitz, Sarah Schumacher, Springer, 2013, 1st Edition

Online Resources:

1. DNA storage: research landscape and future prospects, National Science Review, Oxford academic, 2020 (https://academic.oup.com/nsr/article/7/6/1092/5711038)
2. DNA data storage: https://wyss.harvard.edu/technology/dna-data-storage.
3. Synthetic Biology: Integrated Gene Circuits, Science, 2011 (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4117316)
4. Synthetic biology: applications come of age, Nature Reviews Genetics, 2010 (https://www.nature.com/articles/nrg2775)

III – Year : I Semester

Course Code: EC301	Digital Signal Processing (DSP)	Credits 3-0-0: 3

Pre-requisites: Signals and Systems

Course Outcomes: After the completion of the course the student will be able to:

CO1	Analyze the discrete time signals in the frequency domain
CO2	Design FIR and IIR digital filters.
CO3	Identify various filter structures and evaluate the finite word length and the coefficient quantization effects
CO4	Understand the concepts of sample rate conversion techniques and its applications
CO5	Comprehendthe architectural features of digital signal processors.

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	-	-	-	-	-	-	-	-	-	2	2
CO2	-	3	-	-	-	-	-	-	-	-	-	-	2	2
CO3	1	3	-	-	-	-	-	-	-	-	-	-	2	2
CO4	2	1	-	-	-	-	-	-	-	-	-	-	2	-
CO5	-	2	-	-	-	-	-	-	-	-	-	1	2	2

Detailed Syllabus:

Review of signals and Systems:

DISCRETEFOURIERTRANSFORM(DFT): The DFT & its properties; Inverse DFT, Linear filtering methods based on DFT - Use of DFT in linear filtering, filtering of long data sequences, Efficient computation of DFT algorithms-Radix2 (DIT & DIF), Radix4, Split radix algorithms. Linear filtering approach to computation of DFT-Goertzel algorithm, Chirp z transform, Quantization effects in the computation of DFT - Direct & FFT method.

DIGITALFILTERS:Linear phase FIR filter, characteristic response, location of zeros, Design of FIR filter-Windowing, Frequency sampling, Design of IIR filters from Analog filters-Impulse in variance, Bilinear transformation, Matched z-transform. Quantization of filter coefficients - Sensitivity to Quantization of filter coefficients, Quantization of coefficients in FIR filters, Roundoff effects in digital filters - Limit cycle, scaling to prevent overflow.

DIGITAL FILTER STRUCTURES: FIR filters - Direct form, Cascade form, Frequency sampling, Lattice IIR filter - Direct form I, Direct form II cascade form parallel form Lattice & Lattice loader,

MULTIRATE DIGITAL SIGNAL PROCESSING: Decimation by a factor D, Interpolation by a factor I, Sampling rate conversion by a rational factor I/D, cascade equivalence, Filter design & Implementationforsamplingrateconversion,Applications:PhaseShifters,DigitalFilterBanks,Sub band Coding of Speech Signals, Quadrature Mirror Filters, Trans multiplexers, Over Sampling A/D and D/AConversion.

DSP PROCESSORS: TMS C6xxx, Features, Architecture and Applications. Harvard Architecture, pipelining, Multiplier-Accumulator (MAC) Hardware. Architectures of Fixed and Floating point DSP processors. Addressing modes, functional modes. Memory architecture, on-chip peripherals of a DSP processor

Reading:

1. J.G.PROAKIS & D.G.MANOLAKIS, Digital Signal Processing - Principles, algorithms & Applications, PHI,2000.B.Venkataramani, M.Bhaskar, "Digital Signal Processors, Architecture, Programmingand Application", Tata McGraw Hill, New Delhi,2003
2. A.V. Oppenheim and Ronald W. Schafer, Discrete Time Signal Processing, 2nd Edition, PHI,2000.
3. S.K.MITRA, Digital Signal Processing – A computer Based Approach, 4th Edition,MGH, 2010.
4. Multi Rate Systems and Filter Banks – P.P.Vaidyanathan – PearsonEducation.
5. Fundamentals of Digital Signal Processing using Matlab – Robert J. Schilling, Sandra L. Harris, Thomson,2nd Edition,2010

Course Code: EC302	Analog Communications	Credits 3-0-0: 3

Course Outcomes: At the end of the course, the student will be able to:

CO1	ɔmpare the performance of AM, FM and PM schemes with reference to SNR
CO2	Understand noise as a random process and its effect on communication receivers
CO3	aluate the performance of PCM, DPCM and DM
CO4	nderstand FDM & TDM multiplexing techniques

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	-	2	-	-	-	-	-	-	-		
CO2	-	-	-	-	2	-	-	-	-	-	-	-	1	
CO3	-	1	-	-	3	-	-	-	-	-	-	-	1	
CO4	-	1	-	-	3	-	-	-	-	-	-	1		

Detailed Syllabus:

Introduction : Introduction to Communication Process, Communication Channels, Modulation, Analog vs Digital signals, Review of Signals and Systems.

Modulation Techniques: Amplitude Modulation (AM), Envelop Detection, Limitations of AM, DSB-SC Modulation, Coherent Detection, SSB, Frequency Division Multiplexing, Angle Modulation, Frequency Modulation, Narrowband FM, Generation of FM, Detection of FM, Phased locked Loop ; FDM
Transmission of Random Process through an LTI filter, PSD, Properties of PSD. Noise Figure, Noise Bandwidth, Noise Temperature**.** Noise in AM Receivers, Noise in FM, Pre - emphasis, De-emphasis in FM.

Pulse Modulation – Sampling process, Sampling theorem, Pulse Amplitude Modulation. TDM, Pulse width Modulation, Pulse Position Modulation.

Analog-to-Digital signal conversion : Quantization Process, Quantization Noise, PCM. PCM encoding generation and decoding, Delta Modulation, Differential Pulse-code Modulation.

Reading:

1. Simon Haykin , Communication Systems , 5th Edition, 2009, Wiley India Pvt. Ltd.
2. Simon Haykin , An Introduction to Analog and Digital Communications, Wiley India Pvt. Ltd,2nd Edition, 2006
3. NPTEL links : https://nptel.ac.in/courses/117/105/117105143/
   https://nptel.ac.in/noc/courses/noc17/SEM2/noc17-ec11/
   https://onlinecourses.nptel.ac.in/noc21_ee74/preview

Course Code: EC303	Electronic Instrumentation	Credits 3-0-0: 3

Prerequisites: None

Course Outcomes: After completion of the course student will be able to:

CO1	Understand and estimate errors in a measurement system.
CO2	Identify the instrument suitable for specific measurements.
CO3	Estimate accurately the values of R,L and C employing suitable bridges.
CO4	Understand the basic principles of transducers for displacement, velocity, temperature and pressure.
CO5	Operate special measuring instruments such as Wave Analyzer, Harmonic Distortion Analyzer and Spectrum Analyzer.
CO6	Identify data acquisition system for a specific application

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO2	2	1	-	-	-	-	-	-	-	-	-	-	2	2
CO3	1	2	-	-	-	-	-	-	-	-	-	-	2	2
CO4	2	1	-	-	-	-	-	-	-	-	-	-	2	-
CO5	2	2	-	-	-	-	-	-	-	-	-	1	2	2
CO6	1	3	-	-	-	-	-	-	-	-	-	-	2	2

Detailed Syllabus:

Measurement And Error: Sensitivity, Resolution, Accuracy and Precision, Absolute and Relative types of errors, Statistical analysis, Probability of Limiting errors, Linearity.

Instruments: Current and Resistance in instruments, Analog and Digital Multimeters, Measurement of time and Frequency – Digital Frequency Meter and applications.

ImpedanceMeasurement:KelvinBridge;Megger;Maxwell,HayandSheringBridges.Q-meter; Noise and Interference reduction techniques in Measurement Systems, Wave Analyzer, Spectrum Analyzer, FFT Analyzer, Oscilloscopes: Pulse Measurements, Delayed Time Base, Analog Storage, Sampling and Digital StorageOscilloscopes.

Transducers: Classification and selection of Transducers, Introduction to Strain, Load, Force, Displacement, Velocity, Acceleration, Pressure and Temperature Measurements; Introduction to Smart sensors and MEMS.

Introduction to Data Acquisition Systems (DAS): Block Diagram, Specifications and various components of DAS, applications of DAS in various fields. General purpose Instrumentation Bus (GP-IB): Protocol, SCPI Commands and Applications to DSO and DMM.

Reading:

1. Electronic Measurements and Instrumentation, by Oliver and Cage, McGrawHill, 2017.
2. Electronic Instrumentation & Measurement techniques, by W.D.CooperFelbrigg,PHI.
3. Electronic Instrumentation and Measurements, by D.A. Bell,Reston, 3rdEdition,2013.
4. H S Kalsi, Electronic Instrumentation, McGraw Hill, 3rdEdition,2017.

Course Code: EC304	Advanced Microcontrollers	Credits 3-0-0: 3

Pre-requisites:Digital system design

Course Outcomes: After the completion of the course the student will be able to:

CO1	Understand the evolution of microprocessors and microcontrollers and its architectures
CO2	Understand the evolution and architectures of ARM processors.
CO3	Analyze and understand the instruction set and development tools of ARM
CO4	Understand the architectural features of ARM cortex M4 microcontrollers.
CO5	Understand the exception, interrupts and interrupt handling schemes
CO6	Understand the hardware and interfacing peripheral devices to ARM cortex M4

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	-	-	3	-	-	-	-	-	2	1	2	2
CO2	-	3	-	-	-3	-	-	-	1	-	2	1	2	2
CO3	-	3	-	-	-	-	-	-	1	-	2	1	2	2
CO4	-	2	-	-	3	-	-	-	1	-	2	1	2	2
CO5	-	2	-		3	-	-	-	1	-	-	-	-	-
CO6	2	2	-		-	-	-	-	-	-	-	-	-	-

Detailed Syllabus:

Introduction to Microprocessors and Microcontrollers:

Evolution and introduction of 80X86 microprocessor, Architecture of 8086, Memory organization, 8086 system connections and timing. Overview of 8051 microcontroller, Architecture, Instruction set and addressing modes, programming of I/O Ports, Interrupts, timer/ counter and serial communication.

Introduction to ARM Processors:

Introduction to ARM processors, Evolution of ARM processors, pipeline organization, ARM Processor cores and CPU cores. Introduction to ARM Cortex-M Processors, ARM Cortex-M4 processor's architecture, Programmer's model, Special registers, Operation Modes.

ARM Cortex-M4 programming: Assembly basics, Instruction set, Data transfer, Data processing, conditional and branch instructions, barrier and saturation operations, Cortex-M4-specific instructions,Thumb2 instructions, Keil Microcontroller Development Kit for ARM, Typical program compilation flow, Sample arithmetic and logical assembly language programs

ARM cortex-M4 Memory Systems and interrupts: Overview of memory system features, Memory map, Memory access attributes and permissions, Data alignment and unaligned data access support, Bit-band operations, Overview of exceptions and interrupts, Exception types, Overview of interrupt management, Definitions of priority, Vector table and vector table relocation, Software interrupts, Exception Handling.

Cortex-M4 Implementation and applications: Detailed block diagram, Bus interfaces on cortex-M4, External PPB interface, typical connections, reset types and signals. Getting started with µVision. Applications: Flashing of LEDS using Shift Register, Interfacing stepper motor, Interfacing temperature sensor, Interfacing ADC, Interfacing Real Time Clock, Interfacing of Analog Key pad

Reading:

1. Joseph Yiu, The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors, Newnes Publications; Third Edition, 2013.
2. Ata Elahi-Trever Arjeski, “ARM Assembly language with hardware experiment”, Springer Int. Publishing, 2015.
3. Steve Furber , “ARM system on chip Architecture”, Pearson Publications, Second Edition,2000.
4. D. V. Hall. Microprocessors and Interfacing, TMGH.Third Edition 2017.
5. Wrox, “ Professional Embedded ARM Development”
6. William hohl and Christoper Hinds, “ARM assembly language fundamentals and Techniques”CRC, Second Edition, 2015.
7. M.A. Mazidi, J.G. Mazidi, R.D. Mckinlay, “The 8051 Microcontroller and Embedded Systems”, Pearson Second Edition, 2007.

Course Code: EC305	DSP and Electronic Instrumentation Lab	Credits 0-1-2:2

Pre-requisites:

Course Outcomes: After the completion of the course the student will be able to:

CO1	Measure displacement using capacitive and resistive transducers.
CO2	Measure temperature and strain using appropriate transducers
CO3	Build a simple data acquisition system using DMM.
CO4	Control DMM and DSO via GP-IB and perform measurements of sensor signals

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	-	2	2
CO2	2	1	-	-	-	-	-	-	-	-	-	-	2	2
CO3	-	2	-	-	-	-	-	-	-	-	-	1	2	2
CO4	-	3	-	-	-	-	-	-	-	-	-	-	2	2

List of Experiments:

PART – A

1. Calibration and Study of DMM
2. Displacement measurement using resistive transducer (LDR) and LVDT(linear)
3. Temperature measurement using Thermistor, thermocouple and RTD
4. Load measurement using Load cell.
5. Pressure Measurement andrecording.
6. Development of signal condition circuit and interfacing toread.

PART-B

1. ToperformbasicarithmeticoperationsonDSPprocessor(TMS320C6748)usingCCS
2. To perform linear and circular convolution on DSPprocessor
3. To compute Discrete Fourier Transform (DFT) of discrete time sequence on DSP processor using CCS
4. To compute Fast Fourier Transform (FFT) of discrete time sequence on DSP processor
5. To design FIR and IIR digital filter on DSP processor using CCS and MATLAB
6. To perform enhancement of image brightness and contrast using CCS on DSP processor

Course Code: EC306	Microcontrollers lab	Credits 0-1-2: 2

Pre-requisites: knowledge of ARM architecture and programming
Course Outcomes: After the completion of the course the student will be able to:

CO1	write assembly language and C programs for arithmetic operations
CO2	Interface LED, ADC and DAC modules with microprocessor based system
CO3	Interface stepper motor, Keyboard and memory
CO4	Interface wi-fi and Bluetooth modules

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	-	-	-	-	-	-	-	2	1	2	2
CO2	-	2	-	-	-	-	-	-	-	-	2	1	2	2
CO3	-	2	-	-	-	-	-	-	-	-	2	1	2	2
CO4	2	2	-	-	-	-	-	-	-	-	2	1	2	2

List of Experiments:
1. Write a simple programs for arithmetic operations – addition, subtraction, multiplication and division of 16 or 32 – bit numbers
2. Flashing of LEDS using Shift Register
3. Interfacing ADC
4. Interfacing DAC
5. Interfacing 7-Segment LED.
6. Interfacing of Analog Key pad.
7. Interrupt using on board push button
8. Interfacing real time clock.
9. Interfacing stepper motor.
10. Interfacing temperature sensor.
11. Interfacing Bluetooth module.
12. Interfacing Real Time Clock
13. Interfacing of micro SD Card.
14. Interfacing Wi-Fi Module

Dept. Elective –I

Course Code EC315	Low Power VLSI Design	Credits 3-0-0:3

Prerequisites: EC303-CMOS VLSI Design (EC303)

Course Outcomes: At the end of the course the student will be able to:

CO1	Identify clearly the sources of power consumption in a given VLSI Circuit.
CO2	Design low power arithmetic circuits and systems.
CO3	Choose the types of SRAMs/ DRAMs for the given Low power applications.
CO4	Decide at which level of abstraction is advantageous to implement low power techniques in a VLSI system design.

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	-	1	1	-	-	-	-	-	--	-	2	2
CO2	-	-	-	3	-	-	-	-	-	-	-	-	2	2
CO3	-	2	-	2	3	-	-	-	-	-	-	1	2	2
CO4	-	-	-	1	-	-	-	-	-	-	-	-	2	2

Detailed Syllabus:

Introduction: Sources of Power Dissipation, Static Power Dissipation, Active Power Dissipation, Circuit Techniques for Leakage Power Reduction
Adders: Standard Adder Cells, CMOS Adders Architectures, Low Voltage Low Power Design Techniques, Current Mode Adders
Multipliers: Types Of Multiplier Architectures; Braun, Booth Multipliers and their performance comparison, Low Voltage Low Power Design Techniques
Memories: Sources of power dissipation in SRAMs, Low power SRAM circuit techniques, Sources of power dissipation in DRAMs, Low power DRAM circuit techniques
Wires: Increased delays of wires, new materials for wires and dielectrics

Basic background on testing, Low power and safely operating circuits, Case study – A Low power subsystem design

Reading:

1. Kiat Seng Yeo and Kaushik Roy, Low- Voltage, Low-Power VLSI Subsystems, Edition 2009, Tata Mc GrawHill
2. Soudris D, Piguet C and Goutis C, Designing CMOS Circuits for Low Power, Kluwer Academic Publishers,2002
3. Jan Rabaey, Low Power Design Essentials, Springer,2009.

Course Code: EC316	Computer Architectures	Credits 3-0-0:3

Pre-requisites:None.

Course Outcomes:After the completion of the course the student will be able to:

CO1	Understand the basic structure and operations of digital computer
CO2	Design arithmetic and logic unit
CO3	Evaluate performance of memory systems
CO4	Design and analyze pipelined control units
CO5	Understand parallel processing architectures.
CO6	Familiarize various ways of Communicating with I/O devises and standard interfaces

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	1	1	2	2	2	1	-	-	-	2	-
CO2	3	1	1	1	1	1	2	1	1	-	-	-	2	2
CO3	3	2	3	2	3	2	2	2	1	-	-	-	2	2
CO4	3	2	3	1	2	1	2	2	1	-	-	-	2	2
CO5	3	2	2	-	1	1	2	1	2	-	-	-	2	2
CO6	2	2	3	-	3	2	2	2	1	-	-	-	2	2

DetailedSyllabus:

OVERVIEW & INSTRUCTIONS : Eight ideas – Components of a computer system – Technology – Performance – Power wall – Uniprocessors to multiprocessors; Instructions – operations and operands – representing instructions – Logical operations – control operations – Addressing and addressingmodes.

ARITHMETIC OPERATIONS: ALU - Addition and subtraction – Multiplication – Division – Floating Point operations – Sub word parallelism.

PROCESSOR AND CONTROL UNIT

Basic MIPS implementation – Building data path – Control Implementation scheme – Pipelining – Pipelined data path and control – Handling Data hazards & Control hazards – Exceptions.

PARALLELISM

Instruction-level-parallelism – Parallel processing challenges – Flynn's classification – Hardware multithreading – Multicore processors

MEMORY AND I/O SYSTEMS:

Memory hierarchy - Memory technologies – Cache basics – Measuring and improving cache performance - Virtual memory, TLBs - Input/output system, programmed I/O, DMA and interrupts, I/O processors.

Reading:

1. David A. Patterson and John L. Hennessey, “Computer organization and design’,Morgan Kauffman / Elsevier, Fifth edition,2014.
2. V.CarlHamacher, Zvonko G. Varanesic and Safat G. Zaky, “Computer Organisation“, VI edition, Mc Graw-Hill Inc,2012.
3. William Stallings “Computer Organization and Architecture”, Ninth Edition, Pearson Education,2013.
4. VincentP.Heuring,HarryF.Jordan,“ComputerSystemArchitecture”,SecondEdition,Pearson Education,2005.
5. JohnP.Hayes,“ComputerArchitectureandOrganization”,ThirdEdition,TataMcGrawHill,1998

Course Code: EC317	Internet of Things (IOT)	Credits 3-0-0:3

Prerequisites: None

Course Outcomes: After completion of the course student will be able to:

CO1	Understand IOT design requirements
CO2	Compare various technologies and protocols
CO3	Study storage and intelligent analytics
CO4	Application of IOT in smart cities
CO5	Design and experiment various use cases

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	2
CO2	-	3	-	-	-	-	-	-	-	-	-	-	2	2
CO3	-	-	-	-	-	-	-	3	-	-	-	-	2	2
CO4	-	-	-	-	-	-	-	3	-	-	-	-	2	2
CO5	-	-	-	-	-	-	3	-	-	-	-	-	2	2

Detailed Syllabus:

Introduction to IOT: IoT and the connected world, Architecture of IoT, Security issues, Opportunities for IoT

The Web of Things: Linked data, Enterprise data, Importance of security, privacy, and authenticity, Industry standards, Web of Things layer as the driver for IoT systems

Lessons from the Internet: Relevance of Internet to network of Things, network management, security, mobility and longevity.

Technologies: Wireless protocols, Connectivity options.

Data storage and analysis: Managing high rate sensor data, Processing data streams, Data consistency in an intermittently connected or disconnected environment, Identifying outliers and anomalies.

Use cases: Smart Buildings, Smart health, Home automation, Location tracking

Smart Cities: Collection of information including opportunistic sensing, crowd sensing, and adhoc sensing Response of the system including analytics and optimization, distributed action, people as intelligent actuators, the risk for cyber-attacksincentralizedanddistributedsystems

Reading:

1. Designing the Internet of Things, by Adrian McEwen, Hakim Cassimally Wiley2013
2. Enterprise IoT Naveen Balani Create Space Independent Publishing Platform2016

Course Code: EC318	WEB TECHNOLOGIES	Credits 3-0-0:3

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand, analyze and build dynamic and interactive web sites
CO2	Install and manage server software and server side tools.
CO3	Understand current and evolving Web languages for integrating media and user interaction in both front end and back end elements of a Web site
CO4	Analysis and reporting of web data using web analytics
CO5	Applying different testing and debugging techniques and analyzing the web site Effectiveness.

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	3	1	2	1	2	1	-	-	-	2	-
CO2	-	2	2	2	1	1	2	-	-	-	-	-	2	2
CO3	2	2	2	1	1	1	-	1	1	-	-	-	2	2
CO4	-	1	1	2	3	1	1	1	1	-	-	-	2	2
CO5	2	2	2	2	1	1	-	-	1	-	-	-	2	2

Detailed Syllabus:

Creatinghomepages,IntroductiontoXHTML-EditingXHTML,FirstXHTMLExample,W3CXHTML Validation Service,Headers,Linking,Images,SpecialCharactersandMoreLineBreaks,Unordered Lists, Nested and Ordered Lists, Internet and World Wide WebResources.

DynamicHTML:ObjectModelandCollections-Introduction,ObjectReferencing,Collectionsalland children, Dynamic Styles, Dynamic Positioning, Using the frames Collection, navigator Object, Summary of the DHTML Object Model, Dynamic HTML: Event Model- Introduction-Event on click, Event on load, Error Handling with one error, Tracking the Mouse with Event on mouse move, Rollovers with on mouse over and on mouse out, Form Processing with on focus and on blur, More Form Processing with on submit and on reset , Event Bubbling, More DHTML Events. Dynamic HTML Filters and transitions, Dynamic HTML Databinding with tabular data control, structured graphics and active X control.

JavaScript: Functions-Introduction, Program Modules in Java Script, Programmer-Defined Functions, Function Definitions, Random-Number Generation, Example: Game of Chance, Duration of Identifiers, Scope Rules, JavaScript Global Functions, Recursion, Example Using Recursion: Fibonacci Series, Recursion vs. Iteration, JavaScript Internet and World Wide Web Resources. JavaScript arrays, Java Script objects.

Extensible Markup Language (XML)- Introduction, Structuring Data, XML Namespaces, Document TypeDefinitions(DTDs)andSchemas,DocumentTypeDefinitions,W3CXMLSchemaDocuments, XMLVocabularies,ChemicalMarkupLanguage(CML),OtherMarkupLanguages,DocumentObject Model (DOM), DOM Methods, Simple API for XML (SAX), Extensible Style sheet Language (XSL), Simple Object Access Protocol (SOAP), Internet and World Wide Web Resources

Web Servers (IIS, PWS and Apache) - Introduction, HTTP Request Types, System Architecture, Client-Side Scripting versus Server-Side Scripting, Accessing Web Servers, Microsoft Internet Information Services (IIS), Microsoft Personal Web.

Multimedia, PHP, String Processing and Regular Expressions, Form processing and Business logic, Dynamic content, Database connectivity, Applets and Servlets, JDBC connectivity, JSP and Web development Frameworks.

Reading:

1. Deitel, Deitel and Nieto, *Internet and Worldwide Web - How to Program*, Fifth Edition, PHI,2011.

2. Bai and Ekedhi, *The Web Warrior Guide to Web Programming*, Third Edition, Thomson,2008.

Course Code: SM344	Industrial Systems and Management	Credits 3-0-0: 3

Prerequisites:None.

Course Outcomes:After completion of the course student must be able to:

CO1	Understand the basic principles, approaches and functions of management and apply Concepts to specific situations.
CO2	Understand marketing management process and apply marketing mix in the formulation of marketing strategies during the life cycle of product.
CO3	Identify and utilize various techniques for improving productivity using work study.
CO4	Apply the concepts and tools of quality engineering in the design of products and process controls

Mapping of COs with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1	1	1	1	1	1	3	1	1	1	1	3
CO2	1	1	2	2	3	1	1	1	1	1	1	1	1	3
CO3	1	1	1	1	1	1	2	1	3	2	1	1	1	3
CO4	1	1	1	1	3	1	1	1	2	1	3	1	1	3

The course is an introductory one and details about organizations. The actions by the actors in the organizations is influenced by the significance of their actions, the norms, and the power and regulations. For better participation in the course, it is suggested that the participants read the suggested readings and come to the class.

Detailed Syllabus:

Part–1: Introduction - Overview of organizational theory and theoretical perspectives

Part–2: Rational and natural systems

The evolution of organizational theory - rational systems and Natural systems

- Work study: Productivity and its role in the economy; Techniques for improving productivity;
- Method study.
- Quality management: Dimensions of quality; Process control charts; Acceptance sampling;
- Taguchi's Quality Philosophy; Quality function deployment; Introduction to TQM. Process
- control charts both attributes and variables. Sampling Plan, LTPD and AOQL concepts.
- Quality management: Dimensions of quality; Process control charts; Acceptance sampling;
- Taguchi's Quality Philosophy; Quality function deployment; Introduction to TQM. Process
- control charts both attributes and variables. Sampling Plan, LTPD and AOQL concepts.

Part – 3: Organizational behavior

- The individual, The Group, Organization system (structure and culture)

Part–4: Open systems and behavioral decision-making

Part – 5: Other management topics

- Marketing management process; 4P's of marketing mix; Target marketing; Product life cycle and marketing strategies
- Project Management: Project activities; Network diagrams; Critical path method (CPM);
- Programme Evaluation and Review Technique (PERT). Project crashing. Slack computations, Resource leveling

Reading:

- Robbins, S. P., & Judge, T. A. Organizational behavior, 16th Edition 2016.
- Jones, G. R., & Jones, G. R. (2013). *Organizational theory, design, and change*. Upper Saddle River, NJ: Pearson, 7th Edition 2013.

- Taylor, F.W. 1916. Principles of Scientific Management, 30-144
- Roethlisberger, F.J. & Dickson, W.J. 1939. Management and the Worker. Cambridge, MA: Harvard University Press. Chapters 1, 17, 21-25, 3-18, 379-408, 493-589
- Mahajan,M. (2000). *Industrial engineering and production management*. Dhanpath Rai & Co.
- Besterfield (2015). Total Quality Management. Pearson Education India; 4 editions
- Khanna,O. P. (2018-2019). *Industrial engineering and management*. Dhanpat Rai.
- Meridith, J. R. (2011). Project Management. A Management Approach, 8th Edition.
- Stinchcombe, A. 1965. “Social Structure and Organizations” in James G. March (ed.) Handbook of Organizations. Chicago, IL: Rand McNally. 142-193.
- Cyert, R.M., & March, J.G. 1963. Chapter 7: A summary of basic concepts. From: A behavioral theory of the firm. 161-176
- Kottler, P., & Keller, K. L. (2015). Marketing Management 15e Global Edition.

Additional Readings

- Weber, M. Economy and Society 1978 pp.212-254, 956-975
- Roy, D.F. 1960. “Banana Time”: Job Satisfaction and Informal Interaction. Human Organization. 18.
- Selznick, P. 1948. “Foundations of the Theory of Organization” American Sociological Review, 13: 25-35.
- Olsen, J.P. 2001. Garbage cans, new institutionalism, and the study of politics. *Amer. Pol. Science Review*, 95: 191-198.

III – Year : II Semester

Course Code: EC351	Antennas and Propagation	Credits 3-0-2: 4

Course Outcomes: At the end of the course, the student will be able to:

CO1	Provide an understanding of antenna radiating principle and discuss the fundamental characteristics and parameters of antennas.
CO2	Develop the performance characteristics of antennas arrays, its operating principles, methods and concepts to design
CO3	Simulation and Measurement of antenna parameters
CO4	Understand the behavior of nature on EM wave propagation

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3						2						2	
CO2		2				1	1						2	2
CO3			2			1							2	2
CO4	3	1	1	1	1								2	

Syllabus:

Antenna Fundamentals: Introduction to antennas & their significance, Scalar electric potential, magnetic vector potential, radiation from an alternating current element, Induction field, radiation field, power radiated by a current element, Radiation mechanism of the infinitesimal dipole, power and its radiation resistance. Definition of an electric dipole, Power radiation and its radiation resistance of dipole, half-wave dipole, monopole and a quarter-wave monopole, Isotropic radiator, Radiation resistance of aerials and loop, related problems.

Antenna Parameters: Radiation pattern, power pattern, field pattern, Radiation intensity, beam width, field region, radiation power density, Directivity and gain, bandwidth, polarization, co polarization and cross-polarization level, input impedance, efficiency, antenna effective length and area, antenna temperature, scattering loss, network theorem, application of network theorem to antennas. Friss Transmission formula, Radar range equation.

Design of Arrays: Linear Array-Two element array, N-element linear array- broadside array, End fire array, Directivity, radiation pattern. Pattern multiplication, Effect of earth on vertical pattern mutual impedance effects. Non-uniform excitation- Binomial, Chebyshev distribution, planar array – Array factor, Circular array - array factor, Directivity (Qualitative study), related problems.

Practical Antennas: Resonant & non-resonant antennas, Travelling wave antenna, V antenna, Rhombic antenna, Folded dipole & Yagi-Uda antenna, Corner reflector, Parabolic reflector antenna, Horn antenna Microstrip patch Antennas.

Antenna Measurements: Radiation pattern measurements, Measurement of gain, Polarization measurements.

Wave Propagation: Types of wave propagation, space wave propagation and line of sight distance for flat and curved surfaces.

Lab Components: Design and Simulation of some basic and practical antennas Using CST/HFSS.etc, Antenna Array Design Using EM Simulator and MATLAB, Desgin of various Feed Lines.

Learning Resources:

Text Books:

1. E.C. Jordan & K.G. Balmain, Electromagnetic waves & Radiating Systems, PHI, 2nd Edition, 2015
2. Antenna Theory: Analysis and Design – Constantine A. Balanis, John Wiley & Sons, 3 rd Ed., 2009.

Reference Books:

1. John D. Kraus, Antennas, 3rd Edition, McGraw Hill, 2001.
2. R.E. Collins, Antennas and Radio Propagation, Singapore: McGraw Hill, 1985.
3. R.S.Elliot, “Antenna Theory and Design”, IEEE Press, John Wiley, 2005.

Online Resources:

1. https://nptel.ac.in/courses/108/105/108105114/
2. https://nptel.ac.in/courses/108/101/108101092/
3. https://nptel.ac.in/courses/117/107/117107035/

Course Code: EC352	Digital Communications	Credits: 3-0-0: 3

Pre-requisites:

Course Outcomes: After the completion of the course the student will be able to:

CO1	odel a digital communication system.
CO2	mpute probability of error and inter symbol interference from eye diagram in data transmission.
CO3	tain the power spectra of digital modulated signals.
CO4	sign encoder and decoder schemes for error control.

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	-	-	2	-	1	-	-	-	-	-		
CO2	2	3	-	-	1	2	1	-	-	-	-	-		
CO3	2	1	-	-	1	-	1	-	-	-	-	-		
CO4	2	3	-	-	-	1	-	-	-	-	-	-		

Detailed Syllabus:

Introduction: Analog communications versus digital communications, conversion of analog signal to digital form, baseband signal, band pass signal, Block diagram of digital communications, overview, Signal processing operations in digital communications, quantitative analysis of modulation schemes. Communication channels and their characteristics, Model of digital communication system. Geometrical interpretation of signals-numerical examples, Detection of known signals in noise, Union bound on probability of error, Correlation receiver, Matched filter receiver, numerical examples. Detection of signals with unknown phase in noise.

Estimation: concepts and criteria, Maximum likelihood estimation, Wiener filter for waveform estimation. Discrete PAM signals, Intersymbol interference, Nyquist's criterion for distortionless baseband binary transmission. Nyquist's criterion for distortionless baseband binary transmission-numerical examples, Correlative coding, Baseband M-ary PAM systems, Eye pattern, Adaptive equalization for data transmission.

Digital modulation formats-coherent binary modulation techniques, Coherent quadrature modulation techniques Coherent quadrature modulation techniques, Noncoherentbinary modulation techniques, Comparison of binary and quaternary modulation techniques M-ary modulation techniques- M-ary PSK, M-ary QAM, M-ary FSK.

Power spectra, bit versus symbol error probabilities, Error control coding-example, methods of controlling error, types of errors, types of codes. Linear block codes, Binary cyclic codes, Convolutional codes, Trellis.

Reading:

1. S.Haykin, Digital Communications, John Wiley & Sons, 2009.
2. B.Sklar, Digital Communications, 2nd Edition, Pearson Education, New Delhi, 2009.
3. John G.Proakis, Digital Communications, 5th edition, McGraw Hill, 2014.

Course Code: EC353	Data Networks	Credits: 3-0-2: 4

Pre-requisites: None
Course Outcomes: After the completion of the course the student will be able to:

CO1	Identify and explain the fundamental concepts of network architecture, protocols and internetworking principles.
CO2	Design a data communication link considering fundamental concepts of stop & wait, go-back-n and selective repeat link layer concepts, CRC and framing.
CO3	Understand the concepts of Wide Area Networks, such as switching, routing, congestion, and QoS.
CO4	Design and build Local Area Networks considering the shared medium choices for high-speed LANs or Wireless LANs.
CO5	Understand Internet and Transport Protocols and gain knowledge on Internetwork operations.
CO6	Understand the important aspects of internet applications such as network security, Email and network management, DNS, web servers and multimedia.

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	2	-	-	-	-	2	-	-	-	-	-	2	-
CO2	-	2	-	-	-	-	2	-	-	-	-	-	2	2
CO3	-	3	-	-	-	-	2	-	-	-	-	-	2	-
CO4	-	2	-	-	-	1	-	-	-	-	-	-	2	2
CO5	-	-	-	-	-	-	-	-	-	-	-	1	2	-
CO6	-	-	-	1	-	-	-	-	-	-	-	-	2	-

Detailed Syllabus:

Introduction:

Basics of Data Communications for networking; Packet switching, Store-&-Forward operation; Layered network architecture, Overview of TCP/IP operation.

Data Link layer

Framing; error control, error detection, parity checks, Internet Checksum and Cyclic Redundancy Codes for error detection; Flow control, ARQ strategies and their performance analysis using different distributions; HDLC protocol. Media Access Control (MAC): MAC for wired and wireless Local Area Networks (LAN), Pure and Slotted ALOHA, CSMA, CSMA/CD, IEEE802.3; ETHERNET, Fast ETHERNET, Gigabit ETHERNET; IEEE 802.11 WiFi MAC protocol, CSMA/CA; IEEE 802.16 WiMAX.

Network Layer:

Routing algorithms, Link State and Distance Vector routing; Internet routing, RIP, OSPF, BGP; IPv4 protocol, packet format, addressing, subnetting, CIDR, ARP, RARP, fragmentation and reassembly, ICMP; DHCP, NAT and Mobile IP; IPv6summary.

Fundamentals of Queuing Theory:

Simple queuing models, M/M/- Queues, M/G/1/ Queues, queues with blocking, priority queues, vacation systems, discrete time queues.

Transport Layer:

UDP, segment structure and operation; TCP, segment structure and operation. Reliable stream service, congestion control and connection management.

Network Security and Internet Applications:

Security Requirements and Attacks, Confidentiality with Conventional Encryption, Message Authentication and Hash Functions, Public-Key Encryption and Digital Signatures, Secure Socket Layer and Transport Layer Security, IPv4 and IPv6 Security, Wi-Fi Protected Access.

Selected Application layer Protocols:

Web and HTTP, electronic mail (SMTP), file transfer protocol (FTP), Domain Name Service (DNS). Real-Time Traffic, Voice Over IP and Multimedia.

List of Experiments:

1. Understanding the basic networking commands and their operation in Windows and Linux.
2. Understanding the hardware used for networking like routers, switches, LAN cables, connectors, fibre, access points, network interface cards, zigbee cards, bluetooth cards, broadband modems, etc.
3. Study and analyze the design concept and working principle of NITW campus network.
4. Simulation of Computer Networks using Network Simulation software. It makes possible to build, configure networks and verify its availability.
5. Understanding link layer, IP and TCP using Network monitoring software. It supports Ethernet, FDDI, Token Ring, ISDN, PPP, SLIP and WLAN devices, plus several encapsulation formats. Node statistics can be exported.
6. Network Socket programming: TCP/UDP Client-Server program.
7. Analyzing the network traffic using network analyzer software – Wireshark.
8. Simulation of Data Link layer protocols in Matlab. a) Stop and wait (with and without errors) b) Go-back-N (with and without errors) c) Selective repeat (with and without errors) d) Sliding window (with and without errors)
9. Simulation of wired network using Network Simulator NS2.
10. Simulation of Wireless networks (Wifi& Bluetooth) using NS2.

Reading:

1. D. Bertsekas and R. Gallagar, Data Networks, 2/e, PHI,1992.
2. J.F. Kurose and K. W. Ross: Computer Networking, A Top-Down Approach,7/e, Pearson/Addison Wesley,2016.
3. BEHROUZ A. FOROUZAN, Data Communications and Networking, 4th Edition, Tata McGraw-Hill, New Delhi,2006
4. DOUGLAS E COMER, Computer Networks and Internet, Pearson Education Asia,2000.
5. A. Leon-Garcia and I. Widjaja: Communication Networks; 2/e, McGraw Hill,2017.
6. A. S. Tanenbaum, Computer Networks, 5/e, PHI,2013.
7. W. Stallings, Data and Computer Communication, 10/e, Prentice-Hall,2017.

Course Code: EC354	Embedded and Real Time Operating Systems	Credits 3-0-0: 3

Prerequisites:Digital system design and familiar with any one programming language

Course Outcomes:At the end of the course the student will be able to:

CO1	Identify the applications, Design metrics and challenges of Embedded system
CO2	Design, implement and test an embedded system.
CO3	Write the programs for embedded system.
CO4	Describe the various components and operating systems used in real-time Embedded systems.
CO5	Identify Fundamental Issues, Computation models in Hardware-software co- design, and Hardware Software Trade-offs.

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	2	-	-	-	-	-	-	-	-	2	-	2	2
CO2	2	3	-	2	-	-	-	-	-	-	2	-	2	2
CO3	2	3	-	2	-	-	-	-	-	-	2	-	2	2
CO4	-	2	-	2	-	-	-	-	-	-	2	-	2	-
CO5	-	2	-	-	-	-	-	-	-	-	2	-	2	2

Detailed Syllabus:

Introduction to Embedded Systems: Embedded systems Overview, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification, Major Application Areas, Purpose of Embedded Systems, Characteristics of embedded computing applications, Design Challenges, Common Design Metrics

Embedded System Development: Core of the Embedded System: General Purpose and Domain Specific Processors, ASICs, PLDs, Commercial Off The Shelf Components (COTS). Memory: ROM,RAM, Memory according to the type of Interface, Memory Shadowing, Memory selection for Embedded Systems, Sensors and Actuators, Reset Circuit, Brown-out Protection Circuit, Oscillator Unit, Real Time Clock, Watchdog Timer Communication Interface: Onboard and External CommunicationInterfaces

Embedded system Program: Embedded Firmware, ARM processor Architecture, pipeline, registers, instructions, thumb mode, exceptions Embedded Firmware Design Approaches and Development Languages.

Real-Time Operating Systems: Architecture of the kernel, Tasks and Task Scheduler, Scheduling algorithms, Interrupt Service Routines, Semaphores, Mutex, Mailboxes, Message queues, Event Registers, Pipes, Signals, Timers, Memory management, Priority Inversion problem. Overview of off-the shelf operating systems-MicroC/OS II, Vxworks, RT Linux.

Overview of Hardware – Software co design

Fundamental Issues in Hardware-Software co-design, Computation models in Embedded system design, Introduction to Unified Modeling Language (UML), Hardware Software Trade-offs

Reading:

1) Introduction to Embedded Systems -Shibu K.V, McGrawHill
2) Embedded Systems Design –Santanu Chattopadhyay, PHI, 2nd Edition, 2013.
3) Embedded System Design -Frank Vahid, Tony Givargis, JohnWiley
4) Embedded/Real-Time Systems: Concepts Design and Programming, K.V.K.K. Prasad Dreamtech,2005
5) Embedded Systems –Lyla, Pearson,2013
6) An Embedded Software Primer -David E. Simon, Pearson Education.

Course Code: EC355	Communications Systems Lab	Credits 0-1-2: 2

Pre-requisites: None.

Course Outcomes: After the completion of the course the student will be able to:

CO1	Generate AM and FM signals and evaluate their performance
CO2	Perform signal sampling by determining the sampling rates for baseband signals and reconstruct the signals
CO3	Generate digital modulation signals for ASK, PSK and FSK and perform their Detection
CO4	Simulate MSK, DPSK, QPSK and DEPSK schemes and estimate their BER

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	3	3	-	-	-	-	-	-	2	2
CO2	3	-	-	-	3	-	-	-	-	-	-	-	2	2
CO3	1	-	-	-	3	1	-	-	-	-	-	-	2	2
CO4	2	-	-	-	3	2	-	-	1	-	-	-	2	2

List of Experiments:

1. FourierSynthesis
2. AM Transmitter &Receiver
3. FM Transmitter &Receiver
4. AM/FM Radio Receiver
5. Analog signal sampling & Reconstruction
6. Generation & Detection of PAM/PWM/PPM
7. Generation & Detection of PCM
8. Generation & Detection of DM/SIGMA DELTA/ADM
9. Baseband digital data transmission
10. Data conditioning & Reconditioning
11. Generation & Detection of BPSK/DPSK/DEPSK
12. Simulation of digital modulation schemes

Course Code: EC356	Innovation and Start-up activity	Credits 0-1-2: 2

Course Outcomes: At the end of the course, the student will be able to:

CO1	Think creatively and transform ideas into reality.
CO2	Differentiate market transforming strategy
CO3	Create a complete business plan and workout the budget plan
CO4	Understand the startup financing cycle

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	1	2	2	2	2	1	2	1	2	1	1	2
CO2			1	1	1	1	1	1	1		1	1		
CO3	1		1	1	2	1	2	1	1	1	2	1	1	1
CO4				1	1	1	1	1			3	1		

Detailed Syllabus:

Creativity & Discovery
Definition of Creativity, self test creativity, discovery and delivery skills, The imagination threshold, Building creativity ladder, Collection of wild ideas, Bench marking the ideas,
Innovative to borrow or adopt, choosing the best of many ideas, management of tradeoff between discovery and delivery, Sharpening observation skills, reinventing self, Inspire and aspire through success stories

From Idea to Startup
Introduction to think ahead backward, Validation of ideas using cost and strategy, visualizing the business through value profile, activity mapping, Risks as opportunities, building your own road map

Innovation career lessons
Growing & Sharing Knowledge, The Role of Failure In Achieving Success, Creating vision, Strategy, Action & Resistance: Differentiated Market Transforming Strategy; Dare to Take Action; Fighting Resistance; All About the startup Ecosystem; Building a Team; Keeping it Simple and Working Hard.

Action driven business plan
Creating a completed non-business plan (a series of actions each of which moves your idea toward implementation), including a list of the activities to be undertaken, with degrees of importance (scale of 1 to 3, where 1 is ‘most important’). A revision of the original product or service idea, in light of information gathered in the process, beginning to design the business or organization that will successfully implement your creative idea. Preparing an activity map.

Startup financing cycle
Preparing an initial cash flow statement, showing money flowing out (operations; capital) and flowing in. Estimate your capital needs realistically. Prepare a bootstrapping option (self financing). Prepare a risk map. Prepare a business plan comprising five sections: The Need; The

Product; Unique Features; The Market; Future Developments. Include a Gantt chart (project plan – detailed activities and starting and ending dates); and a project budget.

Innovation Activities:

- Introduction and briefing
- Ice-breaker activities
- Review sessions on Design thinking
- Ideate and create real world products
- Build and sell the product exercise
- Find your customer for a product
- Design a product for a customer
- Build a prototype of the product, Revise and re-build with the customer feedback
- Field visits for scouting for problems
- Exposure to gross root innovations and interactive sessions with the innovators

Start-up activities

- Understanding Business canvas
- Develop a business model for the product
- Process of startup registration
- Interaction with founders/CEOs of startups
- Exploring the sources of seed funding
- Exploring other sources of funding: Venture capitalists, Angel Investors
- Conducting Boot camps, hackathons.

Other activities:

- Classroom hacks
- Process skills
- Experience driven approach
- Maximizing the talent

Suggested Readings:

1. Vasant Desai, *"Dynamics of Entrepreneurial Development and Management"*, Himalaya Publishing House, 1997.
2. Prasanna Chandra, *"Project – Planning , Analysis, Selection, Implementation and Review",* Tata McGraw-Hill Publishing Company Ltd., 1995.
3. B. Badhai, "*Entrepreneurship for Engineers*", Dhanpath Rai & Co., Delhi, 2001.
4. Stephen R. Covey and A. Roger Merrill, "*First Things First",* Simon and Schuster, 2002.
5. Robert D. Hisrich and Michael P.Peters, *" Entrepreneurship*", Tata McGRaw Hill Edition, 2002.

Dept. Elective -II

Course Code: EC 365	RFIC DESIGN	Credits 3-0-0: 3

Pre-Requisites: None

Course Outcomes:

At the end of the course, the student will be able to

CO1	Understand the design bottlenecks specific to RF IC design, linearity related issues, ISI.
CO2	Identify noise sources and develop noise models for the devices and systems.
CO3	Specify noise and interference performance metrics like noise figure, IIP3 and different matching criteria.
CO4	Comprehend multiple access techniques, wireless standards and various transceiver architectures.
CO5	Design various constituents' blocks of RF receiver front end.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	3	-	1	-	-	1	-	-	-	3	2	2
CO2	2	-	2	-	1	1	-	-	-	-	-	2	2	2
CO3	1	-	3	-	2	1	-	1	-	-	-	1	2	2
CO4	-	-	1	-	1	-	-	-	-	-	-	3	2	2
CO5	1	-	2	-	3	-	-	-	-	-	-	-	2	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Detailed Syllabus:

INTRODUCTION TO RF AND WIRELESS TECHNOLOGY: Complexity comparison, Design bottle necks, Applications, Analog and digital systems, Choice of Technology.

BASIC CONCEPTS IN RF DESIGN: Nonlinearity and time variance, ISI, Random process and noise, sensitivity and dynamic range, passive impedance transformation.

MULTIPLE ACCESS: Techniques and wireless standards, mobile RF communication, FDMA, TDMA, CDMA, Wireless standards.

TRANSCEIVER ARCHITECTURES: General considerations, receiver architecture, Transmitter Architecture, transceiver performance tests, case studies.

AMPLIFIERS, MIXERS AND OSCILLATORS: LNAs, down conversion mixers, Cascaded Stages, oscillators, Frequency synthesizers.

POWER AMPLIFIERS: General considerations, linear and nonlinear Pas, classification, High Frequency power amplifier, large signal impedance matching, linearization techniques

Text Books:

1. BehzadRazavi, RF Microelectronics Prentice Hall of India,2nd Edition, 2011
2. Thomas H. Lee, The Design of CMOS Radio Integrated Circuits, Cambridge University Press2nd Edition, 2003.

Course Code: EC366	Digital Switching and Multiplexing	Credits 3–0–0:3

Prerequisites: None
Course Outcomes: After completion of the course student will be able to:

CO1	Understand the characteristics of the telephone systems
CO2	Design and test telecom switching systems
CO3	Model and estimate the telecom traffic
CO4	Understand the network synchronization and management
CO5	Evaluate fiber based wide area networks

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	2	-	-	-	-	-	-	2	-
CO2	2	3	-	-	1	-	-	-	-	-	-	-	2	2
CO3	2	2	-	-	-	-	-	-	-	-	-	-	2	2
CO4	1	2	-	-	-	-	-	-	-	-	-	-	2	2
CO5	-	2	-	-	1	2	-	-	-	-	-	1	2	2

Detailed Syllabus:

Introduction – Evolution of Telecommunication, Basics of switching system, step-by-step switching, Design considerations.

Principles of Crossbar switching, electronic space division switching, stored program control, software architecture, switching functions.

Digitaltransmission,FrequencyDivisionmultiplexing,TimeDivisionmultiplexing,StatisticalDivision Multiplexing,switchinghierarchy,Synchronousdigital hierarchy other USAandEuropean standards.

Message switching, circuit switching & packet switching, space division switching, Time division switching. Two dimensional switching, grade of service, non-blocking, digital cross connect, concentrators, expanders and distributors, two stage networks, three stage networks,n-stage networks.

Time Division Switching – Time Division space switching, Time division time switching, and time multiplexed space switching. Time multiplexed time switching, space – time combination switching, three stage combination switching, n-stage combination switching, signaling techniques.

Telecommunication Traffic – Units of Traffic, Network traffic load and parameters, Grade of service andBlockingProbability,trafficmeasurement,Mathematicalmodel,Incomingtrafficandservicetime characteristics, Blocking models and loss estimates, delaysystems.

Digital Subscriber access – ISDN, High data rate digital subscriber loops, Digital Loop carrier systems, fiber in the loop, voice band modems, digital satellite services, Broadband switching systems.

Network synchronization control and management, timing, timing inaccuracies, network synchronization, network control and management.

SONET/SDH – SONET multiplexing overview, frame formats, operation, administration and maintenance,frequencyjustificationandpayloadframing,virtualtributes,DS3payloadmapping,E4 payload mapping, SONET optical standards, SONET rings &networks.

Reading:

1. Digital Telephony, John C Bellamy, 3/e, Wiley-India,2000.
2. Telecommunication Switching Systems and Networks, T Viswanathan, PHI,Second Edition,2015.
3. Telecommunications Switching, Traffic and Networks, J E Flood, Pearson,2004.
4. Introduction to Telecommunications, Gokhale, Second Edition, Cengage Learning,2005
5. Telecommunication Transmission Systems, Robert G Winch, 2/e, Tata McGraw Hill,2004.

Course Code: EC367	Advanced Digital Signal Processing	Credits 3-0-0:3

Prerequisites: EC352- Digital Signal Processing

Course Outcomes: After completion of the course student will be able to:

CO1	Compare the performance of LMS and RLS algorithms in terms of speed of Convergence for a given application.
CO2	Choose an appropriate transform for the given signal
CO3	Choose appropriate decimation and interpolation factors for high performance filters
CO4	Model and design an AR system
CO5	Implement filter algorithms on a given DSP processor platform.

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	-	-	-	-	-	-	-	-	-	-	2	2
CO2	2	2	-	-	-	-	-	-	-	-	-	-	2	2
CO3	2	2	-	-	-	-	-	-	-	-	-	-	2	2
CO4	2	3	2	-	-	-	-	-	-	-	-	2	2	2
CO5	2	1	3	-	-	-	-	-	-	-	-	2	2	2

Detailed Syllabus:

Adaptive Filter theory: Stochastic gradient based algorithms – LMS algorithm, stability analysis, Mean-squared error behavior. Convergence analysis, Normalized

LMS algorithm, Gradient adaptive lattice algorithm. Prediction, filtering and smoothing, adaptive equalization, noise cancellation, blind deconvolution, adaptive IIR filters, RLS algorithms- GRLS, Gauss-Newton and RML.

Transform techniques: Discrete cosine transforms (DCTs), discrete sine transforms (DSTs), KL transforms, Hadamard transforms, Walsh transforms and Wavelet transforms, Applications of DCT sand Wavelets.

Multirate signal processing: Decimation, Interpolation, Applications.

Linear Prediction and Optimum linear filters: Innovations representation of a stationary random process, Gram-Schmidt Orthogonality, signal models – AR,MA and ARMA models; Forward and backward linear prediction, solution of the normal equations, - Levinson – Durbin Algorithm, Schur algorithm, properties of linear- prediction error filters, AR lattice and ARMA Lattice – Ladder filters, Wiener filters for filtering and prediction state-space(Kalman) filters, practical aspects, Kalman filter design methodology, Wiener filter design, Least

Square methods for system modeling & Filter Design.

Digital Signal Processors: Programmable DSP architectures, multiport memory, Special addressingmodes,onchipperipherals,ArchitectureofTMS320C5X/6X,Busstructure,Programme controller, CALU, IDEX, ARCER, ALU, BMAR, on-chip memory,TMS320C5X Assembly language, Instruction pipelining in C5X,Applications programs inC5X.

Signal analysis with higher order spectra.

Reading:

1. Simon Haykin, Adaptive Filter Theory, Prentice Hall, Fifth Edition,2013.
2. JamesV.Candy, Signal Processing, The Model Based Approach, McGraw-Hill Book Company,1987
3. Monson H. Hayes, Statistical Digital Signal Processing and modeling, John Wiley & Sons, 1996
4. Handouts on DSP Processors.
5. S.K.MITRA, Digital Signal Processing – A computer Based Approach, MGH, 4th Edition, 2010.
6. Reference Manuals of Texas TMS 320X and Analog Devices 21XXProcessors.

Course Code: EC368	Software Defined radio	credits 3-0-0:3

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Conceptualize the SDR and implementation details
CO2	Identify the blocks of SDR for a specific application
CO3	Recognize the challenges in the implementation ofSDR
CO4	Analyze the transmitter and receiver architectures in SDR

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	2	-	-	2	-	-	-	-	-	-	-	2	2
CO2	1	2	-	-	2	-	-	-	-	-	-	-	2	2
CO3	-	-	-	-	3	2	1	-	-	-	-	-	2	2
CO4	-	-	-	-	3	2	1	-	-	-	-	2	2	2

Detailed Syllabus:

Introduction – Software Defined Radio – A Traditional Hardware Radio Architecture – Signal Processing Hardware History – Software Defined Radio Project Complexity.

A Basic Software Defined Radio Architecture – Introduction – 2G Radio Architectures- Hybrid Radio Architecture- Basic Software Defined Radio Block Diagram- System Level Functioning Partitioning- Digital Frequency Conversion Partitioning.

RF System Design – Introduction- Noise and Channel Capacity- Link Budget- Receiver Requirements- Multicarrier Power Amplifiers- Signal Processing Capacity Tradeoff.

Analog-to-DigitalandDigital-to-AnalogConversion-Introduction– DigitalConversionFundamentals- Sample Rate- Band pass Sampling- Oversampling- Anti alias Filtering –Quantization

ADCTechniques-SuccessiveApproximation-FigureofMerit-DACs-DACNoiseBudget-DCNoise Budget.

Digital Frequency Up- and Down Converters- Introduction- Frequency Converter Fundamentals- Digital NCO- Digital Mixers- Digital Filters- Half band Filters- CIC Filters- Decimation, Interpolation, and Multi rate Processing-DUCs - Cascading Digital Converters and Digital Frequency Converters.

Signal Processing Hardware Components- Introduction- SDR Requirements for Processing Power- DSPs- DSP Devices- DSP Compilers- Reconfigurable Processors- Adaptive Computing Machine- FPGAs

Software Architecture and Components – Introduction- Major Software Architecture Choices – Hardware–Specific Software Architecture-Software Standards for Software Radio-Software Design Patterns- Component Choices- Real Time Operating Systems- High Level Software Languages- Hardware Languages.

Smart Antennas for Software Radio – Introduction - 3G smart Antenna Requirements- Phased Antenna Array Theory- Applying Software Radio Principles to Antenna Systems- Smart Antenna Architectures- Optimum Combining/ Adaptive Arrays- DOA Arrays- Beam Forming for CDMA- Downlink BeamForming.

Reading:

1. Paul Burns, Software Defined Radio for 3G, Artech House,2002.
2. Tony J Rouphael, RF and DSP for SDR, Elsevier Newnes Press,2008
3. JoukoVanakka, Digital Synthesizers and Transmitter for Software Radio, Springer,2005.
4. P Kenington, RF and Baseband Techniques for Software Defined Radio, Artech House,2005.

IV – Year : I Semester

Course Code: EC401	Microwave and Light Wave Technologies	Credits 3-0-0: 3

Pre-Requisites: NIL

Course Outcomes: After completion of the course student will be able to:

CO1	Study the performance of specialized microwave tubes such as klystron, reflex klystron, magnetron and Travelling wave tube.
CO2	Understand the operation of passive waveguide components.
CO3	Analyze microwave circuits using scattering parameters.
CO4	Identify and characterize different components of an Optical Fiber Communication link
CO5	Analyze optical source, Fiber and Detector operational parameters

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	-	-	-	-	-	-	-	-	-	-	2	-
CO2	1	2	-	-	-	-	-	-	-	-	-	-	2	-
CO3	2	3	-	-	-	-	-	-	-	-	-	-	2	2
CO4	2	-	-	-	1	-	-	-	-	-	-	-	2	2
CO5	1	-	-	-	2	1	-	-	-	-	-	-	2	2

Detailed Syllabus:

Introduction to microwaves: Applications of microwaves, Klystron amplifier, Reflex Klystron oscillator. Travelling Wave tube amplifier Cavity magnetron, Operation and applications of PIN Diode, Gunn diode

S matrix of transmission lines: three port, Scattering matrix of four port microwave junctions. Elementary treatment of attenuators, terminations and twists, Diaphragms and posts, Tee Junctions, directional coupler, Magic tee, Faraday Rotation, Circulators and isolators, Cavity resonators and their applications, Strip line & Micro stripline components, Matrix representation of microwave junctions.

Power measurement: Bolometric and thermocouple methods, Block diagram of VSWR meter, VSWR and impedance measurement, Attenuation measurement, Measurement of S parameters of 3 port and 4 port devices, Reflectometers.

Optical fiber: Types, Step index fiber, Graded index fiber, Fiber materials, Mode theory for circular waveguides, wave equations in step index fibers, Modes in step index fiber and Graded index fiber.
Attenuation mechanisms: Absorption, Scattering losses, Bending losses, Core cladding losses, Signal distortion in single mode fibers, Polarization mode dispersion, Intermodal dispersion, Design optimization of single mode fibers

Optical sources and Photo detectors: LED, LASER DIODES, Modes and Threshold conditions, PIN Photo detector, Avalanche photo diode, Comparison of Photo detectors, Transmission Link Analysis, Point to point links, Link Power budget.

Learning Resources:

Text Books:

1. R.E.Collin, Foundations for Microwave Engineering, Mc Graw Hill, 2nd Edition, 2011.
2. S.Y.Liao, Microwave Devices and Circuits, Prentice Hall of India, 4th Edition, 2002.
3. G.KEISER, Optical Fiber Communications, MGH, 4th Edition, 2010.
4. G.P. Srivastava and V.L. Gupta, Microwave Devices and Circuit Design, PHI, 1st Edition
5. J. GOWAR, Optical Communication Systems, PHI, 2nd Ed. 1993.
6. G.P. Agrawal, Fiber-optic communication systems, 4th Edition, 2012

Course Code: EC402	Microwave and Light Wave Technologies Lab	Credits 0-1-2: 2

Prerequisites: None

Course Outcomes: After completion of the course student will be able to:

CO1	Measure performance of simple microwave circuits and devices.
CO2	Perform microwave measurements with sophisticated instruments such as vector network analyzer and spectrum analyzer
CO3	Assess the performance of optical devices: light sources, fibers and detectors.
CO4	Plot the loss characteristics of optical fibers.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	2	-	-	-	-	-	-	-	-	-	-	2	2
CO2	1	2	-	-	-	-	-	-	-	-	-	-	2	2
CO3	-	2	-	-	1	-	-	-	-	-	-	-	2	2
CO4	1	2	-	-	-	-	-	-	-	-	-	-	2	2

List of Experiments:

1. Antenna Demonstration
2. Mode characteristics of Reflex Klystron
3. Gunn oscillator characteristics and power measurement
4. Measurement of VSWR & impedance
5. Measurement of radiation pattern and gain of an antenna
6. Properties of circulators & Directional coupler
7. Properties of the Magic Tee Junction
8. Vector Network Analyzer Demonstration
9. Measurement of Numerical Aperture
10. Integrated Voice and Data Optical Communication System
11. Study of Optical Sources, Detectors and Fiber Characteristics

Course Code: EC 415	ELECTRONIC PACKAGING	Credits 3-0-0: 3

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the role of packaging in the computer, telecommunication, automotive, medical and consumer electronics industry
CO2	Learn the fundamentals of electrical packaging design, design for reliability, thermal management
CO3	Analyze the performance of various TSVs for 3-D ICs
CO4	Identify the packaging materials with their appropriate properties

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	3			2	2				1	2	2	
CO2	3	3	3	2		2	1				1	2	2	
CO3	3	3	3	3	3						1	2	2	1
CO4	3	3	3	3		2	1				1	2	2	1

Detailed Syllabus:

Overview of electronic systems packaging: Definition of a system and history of semiconductors, Products and levels of packaging, Packaging aspects of handheld products.

Overview of Semiconductor Packaging: Basics of Semiconductor and Process flowchart, Wafer fabrication, inspection and testing, Wafer packaging; Packaging evolution; Different integration approaches in SIP: TSV and Non-TSV. System-on-Package Technology, Chip connection choices, Wire bonding, TAB and flipchip.

Semiconductor Packages: Single chip packages or modules (SCM); Commonly used packages, advanced packages; Materials in packages; Thermal mismatch in packages; Current trends in packaging. Multichip modules (MCM)-types; System-in-package (SIP); Packaging roadmaps; Hybrid circuits.

Electrical Design considerations in systems packaging: Electrical Issues: Resistive, Capacitive and Inductive Parasitic, Layout guidelines and the Reflection problem; Interconnection. CAD for Printed Wiring Boards (PWB), PWB Technologies, Surface Mount Technology, Thermal design consideration in systems packaging, Embedded Passives Technology

3-D technology and Packaging Techniques: Silicon interposer technology, Through Silicon Vias (TSVs). Hybrid packaging technique, Silicon-Less Interconnect technology. 3D Integrated Architectures. Electrical Modeling of Through Silicon Via: Materials, Electrical Performance and Signal Integrity. Power distribution, Return path discontinuities and thermal management. Modeling and performance analysis of Copper-based, CNT-based, GNR-based TSVs. Liners in TSVs. Physical Design and Thermal Management Techniques for 3-D ICs
Case study: Clock distribution networks for 3-D ICs.

Learning Resources:

Text Books:

1. Fundamentals of Microsystem Packaging, Rao R. Tummala, McGraw Hill, 2001.
2. Introduction to System-on-Package (SOP): Miniaturization of the Entire System, Rao R. Tummala, McGraw Hill, 2008.
3. Design and modeling for 3D ICs and Interposers, MadhavanSwaminathan and Ki Jin Han, World Scientific, 2014.
4. Three-Dimensional Integrated Circuit Design, Vasilis F Pavlidis, E G Friedman, Morgan Kaufmann Publishers, Elsevier, 2009.
5. Related research papers.

Reference Books:

6. William D. Brown, Advanced Electronic Packaging, IEEE Press, 2nd Edition, 2006..

Online Resources:

1. https://nptel.ac.in/courses/108/108/108108031/
2. https://nptel.ac.in/courses/112/105/112105267/

Course Code: EC416	Satellite Communications	Credits 3–0–0: 3

Pre-Requisites: None

Course Outcomes: After completion of the course student will be able to:

CO1	Understand the orbital and functional principles of satellite communication systems
CO2	Architect, interpret, and select appropriate technologies for implementation of specified satellite communication systems
CO3	Analyze and evaluate a satellite link and suggest enhancements to improve the link performance.
CO4	Select an appropriate modulation, multiplexing, coding and multiple access schemes for a given satellite communication link.
CO5	Specify, design, prototype and test analog and digital satellite communication systems as per given specifications.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	2	1	2	1	-	-	-	-	-	2	2
CO2	1	-	-	1	2	2	2	-	-	-	-	-	2	2
CO3	-	-	-	-	2	2	1	-	-	-	-	-	2	2
CO4	1	-	-	-	3	2	1	-	-	-	-	1	2	2
CO5	1	1	-	-	3	2	1	-	-	-	-	1	2	2

Detailed Syllabus:

Introduction: Overview of Satellite Communications, GEO, MEO and LEO satellite systems, frequency bands

Orbital Mechanics: Orbit Equations, Locating the satellite w.r.t. the earth, Orbital elements, look Angles, Orbital perturbation, Effects of earth's oblate ness ,moon and sun , Satellite eclipse, sun transit outage, Coverage angle, slant range, satellite launching

Satellite subsystems: Attitude and Orbit Control System (AOCS), Telemetry, Tracking and Command System (TT&C), Power System, Satellite antennas, Communications subsystem, transponders

Satellite Link Design: Basic transmission theory, System noise temperature and G/T ratio, CNR, CIR, ACI, IMI, down link design, up link design, System design examples

Modulation and Multiplexing: FM with multiplexed telephone signals, Analog FM SCPC, PSK, QPSK

Multiple Access Schemes: FDM/FM/FDMA, TDMA, Frame structure, frame acquisition, synchronization, TDMA in VSAT network, On-board processing, CDMA, Spread spectrum transmission and reception, DS-SS CDMA capacity,

Error Control for Digital Satellite Links: Error control coding, Block codes, Convolution codes, - Implementation of error detection on satellite links.
VSAT Systems: Overview of VSAT systems, Network architectures, Access control, multiple access selection

LEO Satellite systems: Orbits, Coverage and frequency bands, off axis scanning, delay and throughput, NGSO constellation design, Problems

Learning Resources:

Text Books:

1. TIMOTHY PRATT, CHARLES BOSTIAN JERMEY ALLNUTT, Satellite Communications, John Wiley, Singapore, Second Edition, reprint 2013.
2. M. RICHHARAIA, Satellite Communication Systems, BS Publishers, Second Edition, 2008.
3. TRI.T. HA, Digital Satellite Communications, McGraw-Hill, 2000.

Course Code: EC417	Computer Vision	credits 3-0-0:3

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Development of algorithms and techniques to analyze and interpret the visible world.
CO2	Apply feature extraction methods for computer processing.
CO3	Implement pattern recognition algorithms for real world problems
CO4	Design of face detection and recognition algorithms

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	-	3	2	-	-	1	-	-	-	-	2	2
CO2	3	3	3	2	2	2	-	2	-	-	-	-	2	2
CO3	3	3	3	3	3	-	-	-	2	-	-	-	2	2
CO4	2	3	2	2	2	2	-	2	2	-	-	-	2	2

Detailed Syllabus:

Digital Image Formation and Low-level processing: Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing.

Digital Image Formation: Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing

Feature Extraction : Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative , Gabor Filters and DWT.

Image Segmentation: Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection.

sPattern Analysis: Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN.

Motion Analysis: Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation.

Use Cases on Finger print recognition, Face detection and recognition, Object tracking, medical Diagnosis etc

Learning Resources:

Text Books:

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.
2. D. A. Forsyth, J. Ponce, Computer Vision: A Modern Approach, PHI Learning 2009.
3. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Pearson Educatio, 4th Edition,2017.

References:

Milan Soanka, Vaclav Hlavac and Roger Boyle, Digital Image Processing and Computer Vision, Cengage Learning, 2014

Online Resources:

1. https://nptel.ac.in/courses/108/103/108103174/
2. https://nptel.ac.in/courses/106/106/106106224/
3. https://nptel.ac.in/courses/106/105/106105216/

Course Code: EC418	Biomedical instrumentation and Signal Processing	Credits 3 –0–0: 3

Pre-requisites: Signals and Systems, Digital Signal Processing, Electronic Instrumentation, Machine Learning for Signal processing, Familiarity with MATLAB

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand and analyse the dynamic characteristics of biomedical systems and modelling.
CO2	Apply the methods of measuring biomedical signals in the design and development of medical equipment.
CO3	specific mathematical techniques and solve problems in ECG signals Implement various signal processing techniques to model EEG signals
CO4	Design and Develop machine leaning techniques for biomedical signals.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1								3		3		
CO2														
CO3			3							3	3	3		
CO4											3	3		

Detailed syllabus:

UNIT-1: Biomedical signal origin, dynamics and modeling

The nature of biomedical signals : Cell resting potential and action potentials – Origin of bio potentials – characteristics – Frequency and amplitude ranges Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG) etc., Biomedical signal origin & dynamics of ECG, ECG; ECG lead system, ECG signal characteristics; Non-Stationarities in ECG signal, Cardiac Arrhythmias, EEG data acquisition, EEG lead system, EEG signal characteristics. Linear prediction and Spectral estimation, modeling: Auto-regressive and moving average.

UNIT-2

Diagnostic and Therapeutic Equipment: Blood pressure monitors – Electro-cardio scope – Pulse Oximeter – pH meter – Auto analyzer – Pacemakers – Defibrillator – Heart lung machine – Nerve and muscle stimulators – Dialysis machines – Surgical diathermy equipment – Nebulizer; inhalator – Aspirator – Humidifier – Ventilator and spirometry.

UNIT-3: Cardiological signal processing

Time domain analysis of ECG: Cardiac Arrhythmia Detection, Preprocessing of ECG -Filtering for removal of artifacts: signal averaging, limitations, ECG signal processing in time domain: Real time QRS detection algorithm, Frequency domain analysis of ECG: FFT Algorithm, Higher order spectral analysis of ECG. Multi resolution analysis of ECG signal. Estimation of heart rate in ECG- Harmonic analysis - Heart rate monitoring, Pitch detection,Filtering for Removal of artifacts in ECG :adaptive filtering , LMS adaptive algorithm- steepest descent algorithm, Weiner filters ,50-Hz adaptive noise cancelling, Cancellation of maternal ECG in fetal electrocardiography, ECG data reduction techniques.

UNIT-4: Neurological signal processing

Analysis of EEG, EEG rhythms, Detection of neurological disorders, Template matching for EEG, spike and wave detection. Estimation of the spectrum in EEG, Modeling EEG- linear, stochastic models - Nonlinear modeling of EEG - artifacts in EEG & their characteristics and processing – Nonparametric spectral analysis, Model based spectral analysis -EEG segmentation - Joint Time-Frequency analysis - correlation analysis of EEG channels - coherence analysis of EEG channels. Evoked potentials- noise characteristics, Noise reduction by linear filtering, Blind source separation: Use of principal component analysis (PCA) and independent component analysis (ICA) for filtering, Multi resolution analysis of EEG signals

UNIT-5: Machine Learning for Biomedical Signal Processing

Introduction to Machine learning and algorithms for bio-medical signals: SVM, K-Means, Naive-Bayes, Decision Tree, Random Forest, Neural Networks (Multi-Layer Perceptron and Random Basis Function) and Deep Neural Networks for classification of cardiac disorders and brain disorders. Implement above biomedical signal processing techniques in MATLAB as Assignments

TEXTBOOKS:

1. John G Webster, “Medical Instrumentation – Application and Design”, 4th ed., John Wiley and Sons, 2009.
2. Leslie Cromwell, Fred. J. Weibell, Erich. A. Pfeiffer, “Biomedical Instrumentation & Measurements, 2nd ed., Pearson Education., 2001.
3. Biomedical Signal Processing -Vol. I Time & Frequency Analysis - Cohen.A, 1986, CRC Press
4. Biomedical Signal Analysis, Rangaraj M. Rangayyan, 2015 Wiley-IEEEPress, 2nd Edition.

REFERRENCE TEXTBOOKS:

1 .Biomedical Digital Signal Processing, Willis J Tompkins, Prentice Hall India Private Limited, First Edition, 2006.

2. Eugene N. Bruce, Biomedical Signal Processing and Signal Modeling, John Wiley & Sons, 2000

3. ECG Signal Processing, Classification and Interpretation _A Comprehensive Framework of Computational Intelligence”, Adam Gacek ,WitoldPedrycz Editors, Springer

4. https://nptel.ac.in/courses/108/105/108105101/

Course Code: EC419	FPGA Design (Elective)	Credits 3–0–0:3

Prerequisites: Nil

Course Outcomes: After completion of the course student will be able to:

CO1	Distinguish between DSP and FPGA based filter architectures
CO2	Compare the architectures of general purpose processors and DSP processors
CO3	Design simple IP cores for FPGA applications
CO4	Use the CAD tools to model an FPGA design
CO5	Model and design a heterogeneous FPGA based embedded system

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	-	-	-	-	-	-	-	-	-		
CO2	-	2	-	-	-	-	-	-	-	-	-	-		
CO3	-	3	2	-	-	-	-	-	-	-	-	-		
CO4	-	2	3	-	-	-	-	-	-	-	-	1		
CO5	-	3	3	-	-	-	-	-	-	-	-	2		

Detailed Syllabus:

Introduction to Field-programmable Gate Arrays: Programmability and DSP. A Short History of the Microchip, Challenges of FPGAs, DSP System Basics, DSP System Definitions, DSP Transforms, Filter Structures, Adaptive Filtering , Basics of Adaptive Filtering
Arithmetic Basics: Number Systems, Fixed-point and Floating-point, Arithmetic Operations, Fixed-point versus Floating-point, Technology Review: Introduction, Architecture and Programmability, DSP Functionality Characteristics .Processor Classification, Microprocessors, DSP processors
Current FPGA Technologies: Introduction, Toward FPGA, Altera FPGA Technologies, Xilinx FPGA Technologies , Detailed FPGA Implementation Issues: Introduction, Various Forms of the LUT ,Memory Availability , Fixed Coefficient Design Techniques, Distributed Arithmetic, Reduced Coefficient Multiplier, Rapid DSP System Design Tools and Processes for FPGA: Introduction, Design Methodology Requirements for FPGA DSP, IP Core Generation Tools for FPGA, System-level Design Tools for FPGA,
The IRIS Behavioural Synthesis: Introduction of Behavioural Synthesis Tools, Hierarchical Design Methodology, Hardware Sharing Implementation (Scheduling Algorithm) for IRIS.DECISION ANALYSIS AND SUPPORT: Decision Making. Modeling throughout System Development, Modeling for Decision

Complex DSP Core Design for FPGA: Motivation for Design for Reuse, Intellectual Property (IP) Cores, Evolution of IP Cores. Model-based Design for Heterogeneous FPGA: Dataflow Modelling and Rapid Implementation for FPGA DSP Systems, Rapid Synthesis and Optimization of Embedded Software from DFGs, System-level Modelling for Heterogeneous Embedded DSP Systems, System-level Design and Exploration of Dedicated Hardware Network, Adaptive Beamformer Example, Low Power FPGA Implementation.

Learning Resources:

Text Books:

1. Roger Woods, John McAllister, Gaye Light body, Ying Yi, FPGA-based Implementation of Signal Processing Systems, Wiley, 2e, 2017

Course Code: EC420	Cellular and Mobile Communications	Credits 3–0–0:3

Prerequisites: None

Course Outcomes: After completion of the course student will be able to:

CO1	Understand the evolution of cellular communication systems upto and beyond 3G
CO2	Design a cellular link and estimate the power budget.
CO3	Choose proper multiple accessing methods depending on channel model
CO4	Identify traffic channels for call processing
CO5	Calculate key performance metrics of a cellular communication system.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	1	2	2	-	-	-	-	-	2	-
CO2	2	-	-	-	2	2	1	-	-	-	-	2	2	2
CO3	2	-	-	-	2	2	1	-	-	-	-	-	2	2
CO4	1	-	-	-	2	-	2	-	-	-	-	-	2	2
CO5	2	-	-	-	3	2	2	-	-	-	-	2	2	2

Detailed Syllabus:

An Overview of Wireless Systems - Introduction - Everything moves - Mobility versus portability - Mobile devices – Wireless communication and the layer model - First- and Second- Generation Cellular Systems - Cellular Communications from 1G to 3G - Road Map for Higher Data Rate Capability in 3G - Wireless 4G Systems - Future Wireless Networks – Standardization Activities for Cellular Systems.

Cellular System design concepts and fundamentals - Frequency Reuse – Channel Assignment - Handoff Strategies – Interference and System Capacity – Trunking and Grade of service – Improving Coverage and Capacity in cellular systems. Mobile Radio Wave propagation - I - Large scale path loss and propagation models – Reflection – Diffraction – Scattering – Practical link budget design – Outdoor propagation models – Indoor propagation models.

Mobile Radio Wave propagation – II -- Small- Scale fading and multipath propagation, Rayleigh and Ricean Distributions. Multiple Access Techniques for Wireless Communications - I – FDMA – TDMA –Spread Spectrum multiple access – FHMA, CDMA – SDMA;

Multiple Access Techniques for Wireless Communications – II -- Packet radio – Pure ALOHA, Slotted ALOHA, CSMA, Reservation ALOHA, PRMA - Capacity of Cellular Systems. Wireless systems and standards – I – AMPS and ETACS – IS 54 and IS 136 – GSM features – Architecture – Radio subsystems – Traffic channels – call processing.

Wireless systems and standards – II -– CDMA features – Architecture – IS 95 – Forward and reverse channels – power control - system capacity. Wireless Networking– WLAN – PAN – Mobile network layer – Mobile Transport layer – Wireless data services, Common channel signaling; Introduction to OFDM

Wireless Networking – Satellite data communication - cellular data communications, third generation UMTS system features – Wi MAX - RFID.

Learning Resources:

Text Books:

1. William C Y Lee, “Mobile Cellular Telecommunications, McGraw Hill.(Main Book)

2. Stallings, *Wireless Communications and Networks*, Prentice Hall, 2e, 2004.

3. Schwartz, *Mobile Wireless Communications*, Cambridge University Press.(Main Book)

4. Theodore S Rappaport, “Wireless Communications Principles and Practice”, Prentice Hall, 2e, 2001.

Course Code: EC421	OPTIMIZATION TECHNIQUES	Credits 3–0–0:3

Pre-requisites: Nil

Course Outcomes: At the end of the course, the student will be able to:

CO1	Able to formulate mathematical models of real world problems
CO2	Understand the major limitations and capabilities of deterministic operations
CO3	Handle, Solve and analyze problems using linear programming and other mathematical programming algorithms
CO4	Solve various multivariable optimization problem

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	2	2	2
CO2	3	-	-	-	-	-	-	-	-	-	-	-	2	2
CO3	3	-	-	-	-	-	-	-	-	-	-	-	2	2
CO4	3	-	-	-	-	-	-	-	-	-	-	-	2	2

Detailed Syllabus:

Introduction: Statement of an optimization problem, Classification of optimization problems, Overview of various optimization Techniques, The simplex optimization technique, Applications of Simplex, Test Functions, Examples

Unconstrained optimization: Definitions and existence conditions, General properties of minimization algorithms, Line search, The Steepest-Descent Optimization Technique, Newton's method, The Least-pth Optimization Technique- Least square Algorithm.
Constrained optimization: Active Constraints versus Inactive constraints, Transformations, penalty functions

Advanced Techniques for Optimization:
Genetic algorithm (GA): Fundamentals of Genetic algorithm, History, Basic concepts, working principle, Applications of GA for standard Bench mark test functions.
Swarm intelligence: Main inspiration source, early variants of PSO, Basic particle swarm optimization, Initialization techniques, Theoretical investigations and parameter selection, Design of PSO algorithm using computational statistics, Termination conditions. Application of PSO, Standard test function optimization.

Differential Evaluation: Classical differential evaluation- An outline, Mutation, cross over, selection

Teaching Learning Based Optimization (TLBO), Applications of TLBO for standard Bench mark test functions, Case studies

Learning Resources:

Text Books:

1. Richard W Daniels, An Introduction to Numerical Methods and Optimization Techniques, Elsevier North Holland Inc,

2. Milani Mitchel, An introduction to Genetic algorithms, MIT Press, 1998

3. AE Eiben and J.E Smith, Introduction to Evolutionary Computing, Springer 2010

4. S Rajasekharan, G.A Vijaya Lakshmi Pai, Neural Networks, Fuzzy logic, and Genetic algorithms, Synthesis and Applications, Prentice hall of India, 2007

5. Weifan Wang, Xuding Zhu, Ding-Zhu Du, Combinatorial Optimization and Applications:5th International Conference, Springer Publications, 2011

Course Code: EC422	Radar Engineering	credits 3-0-0:3

Prerequisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the basic operation of pulse and CW radar systems.
CO2	Evaluate the radar performance based on pulse width, peak power and beam width.
CO3	Choose suitable tracking radar for a given problem.
CO4	Select appropriate criterion for detecting a target.
CO5	Understand the working of phased array radars and navigational a

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	2	2
CO3	2	2	-	-	-	1	-	-	-	-	-	-	2	2
CO4	2	-	-	-	1	-	-	-	-	-	-	-	2	2
CO5	2	2	-	-	-	-	-	-	-	-	-	2	2	2

Detailed Syllabus:

Radar and Radar Equation: Introduction, Radar block diagram and operation, frequencies, applications, types of displays, derivation of radar equation, minimum detectable signal, probability of false alarm and threshold detection, radar cross-section, system losses.

CW Radar – Doppler Effect, CW Radar, applications, FM – CW radar, altimeter, Multiple Frequency Radar. Pulse Radar – MTI, Delay Line Canceller, Multiple Frequencies, Range-gated Doppler Filters, Non-coherent MTI, Pulse Doppler Radar.

Tracking Radar- Sequential lobing, conical scanning, mono pulse, phase comparison mono pulse, tracking in range, comparison of trackers.

Detection – Introduction, Matched Filter, Detection Criteria, Detector characteristics.

Phased Arrays – Basic concepts, feeds, phase shifters, frequency scan arrays, multiple beams, applications, advantages and limitations. Navigational Aids: Direction Finder, VOR, ILS and Loran

Learning Resources:

Text Books:

1. M.I. Skolnik, Introduction Radar Systems, Second Edition, Mc Graw Hill Book Co., 3e, 2002.
2. F.E. Terman, Radio Engineering, Mc Graw Hill Book Co. (for Chapter 7 only), Fourth Edition 1955
3. Simon Kingsley & Shaun Quegan, Understanding RADAR Systems, McGraw Hill Book Co., 1993.

Online Resources:

1. https://nptel.ac.in/courses/108/105/108105154/

2. Robert O'Donnell. *RES.LL-001 Introduction to Radar Systems.* Spring 2007. Massachusetts Institute of Technology: MIT Open Course Ware, https://ocw.mit.edu. License: Creative Commons BY-NC-SA.

Course Code: EC423	Image and Video Processing	Credits 3-0-0:3

Course Outcomes: At the end of the course, the student will be able to

CO1:- Interpret, Analyze, model and process the Image data using appropriate methods, algorithms

CO2:- Interpret and apply edge detection, image segmentation and representation for image recognition.

CO3:- Specify and design optimal image and video processing techniques for the given Imaging problem to efficiently use the available hardware and software tools.

CO4:- Demonstrate the use of image and video processing algorithms for different applications.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3												
CO2	3	2												
CO3	2	1	3											
CO4	2	2		2			2							

1 - Slightly; 2 - Moderately; 3 – Substantially

Detailed Syllabus:

Image Processing Overview: Basic image fundamentals, Image Sensing and Acquisition, Digital Image Representation, Relationships between Pixels, Image Transforms, Image Enhancement in spatial domain and frequency domain, Histogram Processing and Image restoration.

Image Segmentation: Segmentation concepts, Point, Line and Edge Detection, First order derivative, Prewitt and Sobel operators, second order derivatives, canny edge detector, Edge linking, Hough Transform, Thresholding and its types, Otsu's Method, Region based segmentation.

Image Representation and Description: Chain codes, Signatures, Boundary Descriptors, Shape numbers, Fourier Descriptors, Statistical moments, Regional Descriptors–Topological, Texture, Principal Component Analysis.

Object Recognition and Applications: Feature extraction, Histogram based features, intensity features, colour features, Patterns and Pattern Classes and representation of pattern classes, Types of classification algorithms, Minimum distance classifier, Correlation based classifier, Bayes classifier, template matching Image Processing Applications - Biometric Authentication, Character Recognition etc.

Video Sampling: Analog video, Digital Video, Time varying Image formation models, 3D-Motion models, Geometric image formation, Photometric image formation, Sampling of video signals, Filtering operations.

Motion Detection and Estimation: Hypothesis Testing, Markov Random Fields, MAP Estimation, Motion Detection, Motion Estimation: Optical flow, General Methodologies, Pixel Based Motion Estimation, Block Matching Algorithm, Region Based Motion Estimation, Motion Estimation, Waveform Based Coding, Block Based Transform coding, Predictive Coding, Application of Motion estimation in Video Coding.MPEG-1 Video Coding Standard, MPEG-1 Video Coding vs. H.261 MPEG-1 Video Structure, Summary of the Major Differences between MPEG-1 Video and H.261 Coders.

Case Study: Object Recognition/Tracking, Medical Imaging, Face and Facial Expression Recognition, Video Compression and Biometric Recognition.

Text Books:

1. Rafael C. Gonzalez and Richard E. Woods, “Digital Image Processing”, 4th Edition, -Pearson Education, 2015.
2. Yao wang, JoemOstarmann and Ya – quin Zhang, ”Video processing and communication “,1st edition , PHI.
3. ALAN C BOVIK, “Hand Book of Image and Video Processing”, 2nd Edition, Elsevier Academic Press, 2005.
4. Jayaraman, S., Esakkirajan, S., &Veerakumar, T. (2009). Digital image processing tmh publication. Year of Publication, 444-542.

Reference Books:

1. Rafael C. Gonzalez, Richard E. Woods, and Steven L. Eddins, “Digital Image Processing Using MATLAB”, 2nd Edition, Tata McGraw Hill Publication, 2010.
2. Oge Marques, “Practical Image And Video Processing Using Matlab”, John Wiley & Sons, Inc., 2011.

Course Code: EC424	IPR & CYBER LAWS	Credits 3-0-0: 3

Course Outcomes: At the end of the course, the student will be able to:

CO1	Explain origin and development of IPRs
CO2	Understand the economic importance of IPRs
CO3	Understand the international development of cyber laws
CO4	Understand the relation between IPR and Cyber laws

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						2		1				1		
CO2						2		2	1	2	1	1	1	2
CO3						1	1	1			1	1		
CO4						1		2	1	1		1		2

Detailed Syllabus:

IPR

Introduction: Nature and Concept; Meaning; Types of Intellectual Property Rights; Nature of Intellectual Property Rights; Historical Background; Technological Development of IPR; Sustainable Development; Challenges for IPR system; Role of Government in fostering the IPR

IP Jurisprudence: Justification and Rationale for Protecting Intellectual Property; Basic elements of Property and Constitutional Aspects of Property and its Protection ; Economic importance of Intellectual Property; Commercialization aspects of IPR; Development and IP; Overview of Intellectual Property Law – to cover the various categories and its interplay in innovation and technology delivery mechanisms.

International & National Regime: Introduction to the leading international instruments concerning intellectual property rights: the Berne Convention, Universal Copyright Convention, the Paris Convention, the Rome Convention, Trade Related Aspects of Intellectual Property Rights (TRIPS), the World Intellectual Property Rights Organization (WIPO) and the UNESCO; Background to the national regime; Evolution and development of IPR in India.

Cyber Laws

Conceptual and theoretical perspective of Cyber Law - Computer and Web Technology - Development of Cyber Law – National and International Perspective Cyber Law - Legal Issues and Challenges in India, Web Content Accessibility Guidelines (WCAG). Information Technology Act, 2000 - Overview of the Act – Jurisdiction -Electronic Governance – Electronic Evidence - Digital Signature Certificates - Digital signatures - Internet Service Providers and their Liability – Powers of Police - Impact of the Act on other Laws - Social Networking Sites Vis-àvis Human Rights.

Cyber Law and IPRs - Understanding Copy Right in Information Technology - Software -

Copyrights Vs Patents debate- Authorship and Assignment Issues - Copyright in Internet - Multimedia and Copyright issues - Software Piracy –Patents - Understanding Patents - Indian

Position on Computer related Patents –Trademarks - Trademarks in Internet - Domain name registration - Domain Name Disputes & WIPO - Databases in Information Technology - Protection of databases

Learning Resources:

References:

IPR :

1. AnanthPadmanabhan, Intellectual Property Rights: Infringement and Remedies, LexisNexis, Nagpur, 2012.
2. N.S. Gopalakrishnan, Principles of Intellectual Property, EBC, Lucknow, 2014.
3. Bently and Sherman, Intellectual Property Law, Oxford University Press, U.K., 5e, 2018.
4. Paul Torremans, Holyoak&Torremans Intellectual Property Law, Oxford Univ.Press, 2010

Cyber Laws :

1. Justice Yatindra Singh, Cyber Laws, Universal Law Publishing, UP, 2016.
2. Farouq Ahmed, Cyber Law in India, Allahabad Law Agency, 2015
3. Karnika Seth, Computers, Internet and New Technology Laws-A Comprehensive Reference Work With Special Focus On Developments In India, LexisNexis, Nagpur, 2016.
4. Kamath Nandan: Law relating to Computer, Internet and E-Commerce, Universal Law Publishing, UP, 2007.

Course Code: EC 425	CRYPTOGRAPHY AND NETWORK SECURITY	Credits 3-0-0: 3

Course Outcomes: At the end of the course, the student will be able to:

CO1	To understand basics of Cryptography and Network Security.
CO2	To construct and cryptanalysis of block ciphers, stream ciphers & hash functions.
CO3	To understand the modern trends in asymmetric key cryptography.
CO4	To understand cybersecurity, i.e., network, data, mobile, cloud & endpoint security.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	3			1			1			2		
CO2	2	2	3			1			1			2		
CO3	2	2	3			1			1			2		
CO4	2	2	3			1			1			2		

Syllabus:

Unit-1: Introduction, Security Trends, The OSI Security Architecture, Security Attacks, Security Services, Security Mechanisms, A Model for Network Security, Symmetric Ciphers - Classical Encryption Techniques, Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Rotor Machines, Steganography.

Unit-2: Block Ciphers and the Data Encryption Standard - Block Cipher Principles, The Data Encryption Standard, The Strength of DES, Differential and Linear Cryptanalysis, Block Cipher Design Principles. Advanced Encryption Standard - Evaluation Criteria For AES, The AES Cipher.

Unit-3: Public-Key Cryptography and RSA, Principles of Public-Key Cryptosystems, The RSA Algorithm, Key Management - Other Public-Key Cryptosystems, Key Management, Diffie-Hellman Key Exchange, Elliptic Curve Arithmetic, Elliptic Curve Cryptography.

Unit-4: Message Authentication and Hash Functions, Authentication Requirements, Authentication Functions, Message Authentication Codes, Hash Functions, Security of Hash Functions and Macs. Digital Signatures and Authentication Protocols, Digital Signatures, Authentication Protocols, Digital Signature Standard.

Unit-5: Web Security - Web Security Considerations, Secure Socket Layer and Transport Layer Security, Secure Electronic Transaction, System Security - Intruders, Intrusion Detection, Password Management, Malicious Software, Viruses and Related Threats, Virus Countermeasures, Distributed Denial of Service Attacks, Firewalls, Firewall Design Principles, Trusted Systems.

Unit-6:Wireless LAN Security, the Hacking Threat WLAN Security, WEP – Wired Equivalent Privacy Encryption, Wi-Fi Protected Access, WPA IEEE 802.11i and WPA2, WLAN Security Measures, Wireless Hotspot Security.

Learning Resources:

Text Books:

1. Cryptography and Network Security Principles and Practices, Fourth Edition, William Stallings, Prentice Hall, 7e, 2018
2. Fundamentals of Computer Security, Pieprzyk, J.; Hardjono, T.; and Seberry, J, New York: Springer-Verlag, 2003.

Reference Books:

1. Introduction to Computer Security, Bishop, M, Boston: Addison-Wesley, 2005.
2. Secrets and Lies: Digital Security in a Networked World, Schneier, B, New York: Wiley 2000.
3. Breaking Codes: An Introduction to Cryptology. Upper Saddle River, Garrett, P, New Jersey: Prentice Hall, 2001.

Online Resources:

1. https://nptel.ac.in/courses/106/106/106106178/
2. https://nptel.ac.in/courses/106/106/106106221/
3. https://onlinecourses.nptel.ac.in/noc20_cs21/preview

Course Code: EC426	Optical Switching and Networks	Credits 3-0-0: 3

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the optical switching concept
CO2	Design and analyze the different switches used in optical networks
CO3	Identify the building blocks of an optical network for the given application
CO4	Recognize the tradeoff issues in the design of optical networks

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1											
CO2	2	3	3	1										
CO3		2	2	3	2									
CO4				2	3	3								

Syllabus:

Introduction: The Evolution of Optical Networks, View of the Current Network, optical Networking, Switching in Optical Networks, Optical Switching, Opaque Switching, Challenges for Optical Switching.

Optical Switches: Parameters Used for Switch Performance Evaluation, Applications of Optical Switches, Optical Cross connects, Protection and Restoration, Optical Add/Drop Multiplexing, Optical Signal Monitoring, Network Provisioning, Opto-mechanical Switches. Electro-Optic Switches, Liquid-Crystal Switches, Bubble Switches, Acousto-Optic Switches, All-Optical Switches.

Optical Switching Paradigms: Circuit switching and packet switching, Generalized Multiprotocol Label Switching, Overview of GMPLS, Fundamental GMPLS Features, The GMPLS Protocol Suite, Routing Protocols, Signaling Protocols, Link Management Protocol, Optical Burst Switching, Burst Assembly, signaling and routing.

Optical networking building blocks: Optical fibers, Optical transmitter, receiver and filters, multiplexers, switching elements, wavelength converter, and optical amplifiers, WDM network elements.

Industrial Optical Networks: Dense Wavelength Division Multiplied (DWDM) networks, Elastic Optical Networks (EON), Spatial Division Multiplied (SDM) networks, Passive Optical Networks (PON)-Fiber Ethernet.

Optical Access Network: Access networks, Photonic packet switching. Deployment

considerations. Overview of PON technologies, Ethernet access network, WDM-PON. Control and management, network survivability, protection schemes

Learning Resources:

Text Books:

1. Optical Switching, G.I Papadimitriou, C. Papazoglon and A.S Pomportsis, (Wiley series in microwave & optical Engg), 2008
2. Optical Networks: A Practical Perspective, R RAMASWAMY, KN SIVARAJAN, Elsevier, 3e, 2009.
3. Optical WDM Networks, BiswanathMukharjee, Springer, 2006.

Reference Books:

1. Optical Switching, Tarek S. El-Bawab, Springer, 2006
2. Optical fiber communication, John M. senior, PHI, 3e, 2010.
3. Optical fiber communication, Gerd Keiser, McGraw Hill, 5th Edition, 2017.
4. Optical WDM Networks - Principles and Practice, Krishna M. Sivalingam, Suresh Subramaniam, Springer, 2010.
5. WDM Optical Networks, C. Sivaramamurthy& M. Gurusamy, PHI.

Course Code: EC449	SUMMER INTERNSHIP / EPICS	Credits 0-1-2: 2

Course Outcomes: At the end of the course, the student will be able to:

CO1	Design/develop a small and simple product in hardware or software
CO2	Realize a pre-specified target, with limited scope
CO3	Learn to find alternate viable solutions for a given problem and evaluate these alternatives with reference to pre-specified criteria
CO4	Identify and formulate solution for a society based issue and document the same

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	3	1	2	1	1	1	2	2	1	2	3	2
CO2	1	1	2	1	2	1	1	1	1	1	1	2	1	1
CO3	1	1	2	1	2	1	2	1	2	2	2	2	1	3
CO4	1	3	3	1	2	3	3	1	3	3	2	2	3	3

Summer Internship/EPICS (Engineering Projects In Community Service) is introduced as part of the curricula for encouraging students to work on problems of interest to industries or society. A batch of two or three students will be attached to a person from an Electronics Industry / R & D Organization / National Laboratory or a faculty under EPICS program approved by the department for a period of 8 weeks. This will be during the summer vacation following the completion of the IV or VI semester. One faculty member will act as an internal guide for each batch to monitor the progress and interacts with the Industry guide.

After the completion of the project, students will submit a brief technical report on the project executed and present the work through a seminar talk to be organized by the department. Award of sessional are to be based on the performance of the student at the work place to be judged by industry guide and internal guide (25 Marks) followed by presentation before the committee constituted by the department (25 Marks). One faculty member will coordinate the overall activity of Summer Internship.

***The credits will be awarded after evaluation in VII semester.**

Course Code: EC 465	ORGANIC ELECTRONICS	Credits 3-0-0: 3

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand “what is organic electronics good for?”
CO2	Learn about structure and properties of organic materials and devices
CO3	Explain energy bands, charge transport, and doping in organic electronic materials
CO4	Exemplify the architecture, characterization, and utilization of electronic components based on organic electronic materials (such as transistors)

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	3				2				2	3	3	2
CO2	2	2	3	2							2	2	2	2
CO3	3	2	3	2	3						1	2	2	2
CO4	3	2	3		3					1	2	2	3	2

Syllabus:

Introduction to Organic electronics: Overview, history, crystal structure & binding

Optical & Electronic properties of organic semiconductors: Born-Oppenheimer approximation & Franck-Condon principle; Transitions between states: Fermi’s golden rule; Excitons, Spin, Energy transfer; Exciton diffusion and recombination; Electronic properties: Energy bands, electron transport, conduction, mobility, doping, HJs

Materials growth & purification, device patterning, packaging

Light Emitters, Detectors & Organic Transistors:
Basics, efficiency, fluorescence, phosphorescence, TADF, Rolloff, White OLEDs, outcoupling, reliability; Light Detectors: Basics, efficiency, architect, materials, transparency, Multijunction OPV, reliability, modules; Transistors: Basics, architectures, morphology, reliability, organic transistor circuit applications

Learning Resources:

Text Books:

1. Organic Electronics: Foundations to Applications, Stephen R. Forrest, Oxford University Press, 2020, 1st edition.

Reference Books:

1. Organic Flexible Electronics: Fundamentals, Devices and Applications, PieroCosseddu and Mario Caironi, Elsevier, 2021, 1st edition.

Online Resources:

1. https://nptel.ac.in/courses/113/104/113104012/

Course Code: EC 466	5G Communications and MIMO	Credits 3-0-0: 3

Course Outcomes: At the end of the course, the student will be able to:

CO1	Learn 5G Technology advances and their benefits
CO2	Learn the key RF, PHY, MAC and air interface changes required to support 5G
CO3	Learn Device to device communication and millimeter wave communication
CO4	Understand the Implementation options for 5G

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1				1							1	1
CO2	1	1	1										1	
CO3	1		1	1									1	
CO4	1												1	1

Detailed Syllabus:

Overview of 5G Broadband Wireless Communications: Evaluation of mobile technologies 1G to 4G (LTE, LTEA, LTEA Pro) , An Overview of 5G requirements, Regulations for 5G,Spectrum Analysis and Sharing for 5G.

RF FRONT END FOR 5G: Millimeter Wave Communications: Hardware technologies for mmW systems – Architecture and Mobility – Massive MIMO: Resource allocation and transceiver algorithms for massive MIMO - Fundamentals of baseband and RF implementations in massive MIMO - Beamforming.

Transmission and Design Techniques for 5G: Basic requirements of transmission over 5G, Modulation Techniques – Orthogonal frequency division multiplexing (OFDM), generalized frequency division multiplexing (GFDM), filter bank multi-carriers (FBMC) and universal filtered multi-carrier (UFMC), Multiple Accesses Techniques – orthogonal frequency division multiple accesses (OFDMA), generalized frequency division multiple accesses (GFDMA), non-orthogonal multiple accesses (NOMA).

NETWORKING IN 5G: Coordinated multi-point transmission in 5G: Joint Transmission CoMP enablers - Distributed cooperative transmission - JT CoMP with advanced

receivers - Relaying and network coding in 5G: Multi-flow wireless backhauling - Buffer-aided relaying.

Device-to-device (D2D) and machine-to-machine (M2M) type communications – Extension of 4G D2D standardization to 5G, radio resource management for mobile broadband D2D, multi-hop and multi-operator D2D communications.

Millimeter-wave Communications – spectrum regulations, deployment scenarios, physical layer techniques, interference and mobility management, Massive MIMO propagation channel models, Channel Estimation in Massive MIMO, Massive MIMO with Imperfect CSI, Multi-Cell Massive MIMO, Pilot Contamination, Spatial Modulation (SM),

Text Books:

1. Martin Sauter“From GSM From GSM to LTE–Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband”, Wiley-Blackwell.

2. AfifOsseiran, Jose.F.Monserrat, Patrick Marsch, “Fundamentals of 5G Mobile Networks” , Cambridge University Press.

3. Athanasios G.Kanatos, Konstantina S.Nikita, Panagiotis Mathiopoulos, “New Directions in Wireless Communication Systems from Mobile to 5G”, CRC Press.

4. Wei Xiang, Kan Zheng, Xuemin(Sherman) Shen, - 5G Mobile Communications, Springer, 2017.

5. Theodore S.Rappaport, Robert W.Heath, Robert C.Danials, James N.Murdock “Millimeter Wave Wireless Communications”, Prentice Hall Communications.

References :

1. Jonathan Rodriguez, “Fundamentals of 5G Mobile Networks”, John Wiley & Sons.

2. Amitabha Ghosh and RapeepatRatasuk“Essentials of LTE and LTE-A”, Cambridge University Press.

Course Code: EC467	Speech Processing	Credits 3–0–0:3

Prerequisites: None

Course Outcomes: After the completion of the course student will be able to:

CO1	Model speech production system and describe the fundamentals of speech.
CO2	Extract and compare different speech parameters.
CO3	Choose an appropriate statistical speech model for a given application.
CO4	Design a speech recognition system.
CO5	Use different speech synthesis techniques

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	2	-	-	-	-	-	-	2	-
CO2	2	3	-	-	-	-	-	-	-	-	-	-	2	2
CO3	2	3	-	-	-	-	-	-	-	-	-	-	2	2
CO4	-	3	-	-	-	-	-	-	-	-	-	-	2	2
CO5	-	3	-	-	-	-	-	-	-	-	-	2	2	2

Detailed Syllabus:

BASIC CONCEPTS: Speech Fundamentals: Articulatory Phonetics – Production and Classification of Speech Sounds; Acoustic Phonetics – Acoustics of speech production; Review of Digital Signal Processing concepts; Short-Time Fourier Transform, Filter-Bank and LPC Methods.

SPEECH ANALYSIS: Features, Feature Extraction and Pattern Comparison Techniques: Speech distortion measures– mathematical and perceptual – Log–Spectral Distance, Cepstral Distances, Weighted Cepstral Distances and Filtering, Likelihood Distortions, Spectral Distortion using a Warped Frequency Scale, LPC, PLP and MFCC Coefficients, Time Alignment and Normalization – Dynamic Time Warping, Multiple Time – Alignment Paths

SPEECH MODELING: Hidden Markov Models: Markov Processes, HMMs – Evaluation, Optimal State Sequence – Viterbi Search, Baum-Welch Parameter Re-estimation, Implementation issues.

SPEECH RECOGNITION: Large Vocabulary Continuous Speech Recognition: Architecture of a large vocabulary continuous speech recognition system – acoustics and language models – n-grams, context dependent sub-word units; Applications and present status.

SPEECH SYNTHESIS: Text-to-Speech Synthesis: Concatenative and waveform synthesis methods, sub-word units for TTS, intelligibility and naturalness – role of prosody, Applications and present status.

Learning Resources:

Text Books:

1. Lawrence Rabiner and Biing-Hwang Juang, “Fundamentals of Speech Recognition”, Pearson Education, 2003.
2. Daniel Jurafsky and James H Martin, “Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition”, Pearson Education, 2002.
3. Frederick Jelinek, “Statistical Methods of Speech Recognition”, MIT Press, 1997.
4. Steven W. Smith, “The Scientist and Engineer”s Guide to Digital Signal Processing”, California Technical Publishing, 1997.
5. Thomas F Quatieri, “Discrete-Time Speech Signal Processing – Principles and Practice”, Pearson Education, 2004.
6. Claudio Becchetti and Lucio PrinaRicotti, “Speech Recognition”, John Wiley and Sons, 1999.
7. Ben Gold and Nelson Morgan, “Speech and Audio Signal Processing, Processing and Perception of Speech and Music”, Wiley- India Edition, 2006.

Online Resources:
https://nptel.ac.in/courses/117/105/117105145/

Course Code: EC468	Hardware-Software Co-Design	Credits 3-0-0:3

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to

CO1	Understand Hardware/Software Co-design
CO2	Model the data flow and implement the same through software and hardware.
CO3	Design the Control Flow on Transistor Structures
CO4	Understand the design principles in SoC Architecture
CO5	Design CORDIC and Crypto coprocessor.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1					2		2			1		1	2	
CO2					2	1	2					2	2	
CO3					2		3			1		1	2	
CO4					2	1	2					2	2	
CO5					2		1			1		2	2	

Detailed Syllabus:

The Nature of Hardware and Software: Introducing Hardware/ Software Co-design, The Quest for Energy Efficiency, The Driving Factors in Hardware/ Software Co-design, The Dualism of Hardware Design and Software Design.

Data Flow Modeling and Transformation: Introducing Data Flow Graphs, Analyzing Synchronous Data Flow Graphs, Control Flow Modeling and the Limitations of Data Flow, Transformations.

Data Flow Implementation in Software and Hardware: Software Implementation of Data Flow, Hardware Implementation of Data Flow, Hardware/ Software Implementation of Data Flow.

Analysis of Control Flow and Data Flow: Data and Control Edges of a C Program, Implementing Data and Control Edges, Construction of the Control Flow Graph and Data Flow Graph.

FiniteState Machine with Datapath: Cycle-Based Bit-Parallel Hardware, Hardware Modules, Finite State Machines with Datapath, FSMD Design Example: A Median Processor.

System on Chip: The System-on-Chip Concept, Four Design Principles in SoC Architecture, SoC Modeling in GEZEL. Applications: Trivium Crypto-Coprocessor, CORDIC Co-Processor.

Learning Resources:

TextBooks:

1. Patrick Schaumont, A Practical Introduction to Hardware/ Software Co-design, Springer, 2010.
2. Ralf Niemann, Hardware/Software Co-Design for Data flow Dominated Embedded Systems, Springer, 1998.

Reference Books:

1. Handbook of Hardware/Software Codesign (Springer Reference) by Soonhoi Ha, Jürgen Teich, 2017, ISBN: 978-94-017-7267-9
2. Hardware/Software Co-Design: Principles and Practice, by JørgenStaunstrup, Wayne Wolf, 1997

Online Resources:

1. https://nptel.ac.in/courses/106/103/106103182/

Course Code: EC469	INTELLIGENT CAD	Credits 3-0-0: 3

Course Outcomes: At the end of the course, the student will be able to:

CO1	Specify routing techniques in IC design.
CO2	Incorporate timing analysis and floor planning.
CO3	Design the IC with programmable structures.
CO4	Implement EDA/CAD with machine intelligence.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	3		2						1	2	2	
CO2	2	2	3	2	2						1	2	2	
CO3	2	2	3	2	3						1	2	2	
CO4	2	2	3		3						1	2	2	

Syllabus:

Introduction to Design Methodologies: The VLSI Design Problem, Design Methods and Technologies, Layout Methodologies, Top-Down Approach; Routing: Fundamentals, Global Routing, Detailed Routing; Performance Issues in Circuit Layout: Delay Models, Timing Driven Placement, Timing Driven Routing, Power Minimization.

Single-Layer Routing and Applications: Planar Subset Problem, Single-Layer Global Routing, Over-the-cell Routing, Multichip Modules, Wire-Length and Bend Minimization Techniques.

Cell Generation and Programmable Structures: Programmable Logic Arrays, Transistor chaining, Weinberger Arrays and Gate Matrix Layout, CMOS Cell Layout Styles Considering Performance Issues, Compaction: 1D Compaction, 2D Compaction.

Machine Intelligence in EDA/CAD: Intro to Machine Learning in EDA/CAD, Develop EDA and CAD applications like resistance estimation, Error Analysis, capacitance estimation, cell classification etc.

Learning Resources:

Text Books:

4. S.H. Gerez, Algorithms for VLSI Design Automation, Wiley, 2006.

Reference Books:

1. M. Sarrafzadeh and C. K. Wong, An Introduction to VLSI Physical Design, McGraw Hill, 1996.

Online Resources:

4. https://nptel.ac.in/courses/106/105/106105161/
5. https://nptel.ac.in/courses/106/106/106106088/
6. https://nptel.ac.in/courses/106/106/106106089/

Course Code: EC470	Secured Communications	Credits 3-0-0: 3

Course Outcomes: At the end of the course, the student will be able to:

CO1	ve a fundamental understanding of the objectives of cryptography and network urity.
CO2	Become familiar with the cryptographic techniques that provide information and network security
CO3	Be able to evaluate the security of communication systems

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	-	2	-	-	-	-	-	-	-	1	
CO2	-	-	-	-	2	-	-	-	-	-	-	-	1	
CO3	-	1	-	-	3	-	-	-	-	-	-	-		

Detailed Syllabus**:**

Introduction on security, security goals and types of attacks: Passive attack, active attack, attacks on confidentiality, attacks on integrity and availability, Security services and mechanisms.

Modular arithmetic: Groups, Ring, Fields. The Euclidean algorithm, Finite fields of the form GF(p) ; Polynomial arithmetic: Finite fields of the form GF (2n).

Classical encryption technique, Symmetric Ciphers, Symmetric Cipher Model, Substitution Techniques, transposition techniques, Caesar Cipher, Mono alphabetic Cipher,Play fair cipher, Hill cipher, Poly alphabetic Cipher, one time pad

Stream ciphers -Pseudo random sequence generators – linear complexity - Non-linear combination of LFSRs- Boolean functions –Cryptanalysis of LFSR based stream ciphers

Transposition techniques ,Block Ciphers, Data encryption Standards, DES Encryption, DES decryption ; Differential and Linear Crypt analysis Advanced Encryption standard; The AES Cipher, substitute bytes transformation, Shift row transformation, Mix Column transformation; multiple encryption and triple DES, Block cipher modes of operation, stream ciphers and RC4 algorithm

Intruders: Intrusion techniques, Intrusion detection, Statistical anomaly detection, Rule based intrusion detection, Distributed intrusion detection, Honey pot, Intrusion detection exchange format.

Password management: Password protection, password selection strategies.

Private key and Public key cryptosystems – One way functions - Discrete log problem – Factorization problem - Fermat and Euler's theorem, Chinese remainder theorem, discrete algorithms, RSA encryption - Diffie Hellmann key exchange – Message authentication and hash

functions ; Application for Public key cryptosystem requirements; RSA algorithm, Key management, Distribution of public key, public key certificates, Distribution of secret keys.

Digital signatures - Secret sharing - features of visual cryptography - other applications of cryptography, Elliptic curves - Basic theory - Weirstrass equation - Group law - Point at Infinity

Reading:

1. Behrouz A. Forouzan , Cryptography and Network security Tata McGraw-Hill, 2008
2. William Stallings, Cryptography and Network Security, Pearson, 2011.
3. David S. Dummit, Richard M. Foote, Abstract Algebra, John Wiley & Sons
4. Douglas A. Stinson, Cryptography, Theory and Practice, 2nd edition, Chapman &Hall, CRC Press Company,Washington
5. Wade Trappe, Lawrence C. Washington, Introduction to Cryptography with CodingTheory, Second edition Pearson Education, 2006
6. Lawrence C. Washington, Elliptic Curves, Chapman & Hall, CRC Press Company,Washington.
7. EvangelosKranakis, Primality and Cryptography, John Wiley & Sons
8. Rainer A. Ruppel, Analysis and Design of Stream Ciphers, Springer Verlag
9. Bruce Schneier, Applied Cryptography, 2nd Edition, Wiley India Pvt. Ltd. 2009.

NPTEL links:https://nptel.ac.in/courses/106/105/106105162/
https://nptel.ac.in/content/storage2/courses/106105080/pdf/M8L2.pdf
https://onlinecourses.nptel.ac.in/noc21_cs91/preview

Course Code: EC471	Wireless Sensor Networks	Credits 3-0-0: 3

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify the components of Wireless Sensor Networks
CO2	Understand the challenges in network coverage and routing for energy efficiency
CO3	Define node Architecture for specific applications
CO4	Program sensor network platforms using specialized operating system
CO5	Recognize upcoming challenges in Sensor Networks.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	3	-	-	-	-	-	-	-	-	-	-		
CO2	-	1	-	-	2								1	
CO3	-	2	-	-	1	-	-	-	2	-	3	-	1	
CO4	-	2	-	-	1	-								
CO5	-	2	-	-	-	-	-	-	-	-	-	3		

Detailed Syllabus:

Introduction: Constraints and Challenges, Opportunities and Challenges in Wireless Sensor Networks, Advantages of Sensor Networks (Energy Advantage and Detection Advantage), Sensor Network Applications, Smart Transportation, Collaborative Processing

Sensor Network Architecture and Applications: Introduction, Functional Architecture for Sensor Networks, Sample Implementation Architectures, Classification of WSNs, Characteristics, Technical Challenges, and Design Directions, Technical Approaches, Coverage in Wireless Sensor Networks, Location in Wireless Sensor Networks, Data Gathering and Processing

Infrastructure Establishment: Topology Control, Clustering, Time Synchronization, Localization and Localization Services

Sensor Network Platforms and Tools: Individual Components of SN Nodes, Sensor Network Node, WSNs as Embedded Systems, Sensor Node Hardware, Sensor Network Programming Challenges.

Taxonomy of Routing Techniques: Routing Protocols, Applications/Application Layer Protocols, Localization Protocols, Time Synchronization Protocols, Transport Layer Protocols, Network Layer Protocols, Data Link Layer Protocols

Reading:

1. F. ZHAO, C GUIBAS, Wireless Sensor Networks, Elsevier, Morgan Kaufmann, 2004.

2. MOHAMMAD ILYAS, IMAD MAHGOUB, Hand book of Sensor Networks, CRC Press, 2005.

NPTEL links: https://nptel.ac.in/courses/106/105/106105160/
http://cse.iitkgp.ac.in/~smisra/course/wasn.html
http://www.nitttrc.edu.in/nptel/courses/video/106105160/L16.html

Course Code: EC472	Cloud Computing	credits 3-0-0: 3

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Identify the appropriate cloud services for a given application
CO2	Analyze Cloud infrastructure including Google Cloud and Amazon Cloud.
CO3	Analyze authentication, confidentiality and privacy issues in Cloud computing environment.
CO4	Determine financial and technological implications for selecting cloud computing platforms

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	2	1	2	2	2	1	-	-	-	2	2
CO2	2	3	2	2	3	2	1	2	1	-	-	-	2	2
CO3	2	3	2	2	1	2	3	2	1	-	-	-	2	2
CO4	2	2	3	3	3	3	2	2	1	-	-	-	2	2

Detailed Syllabus:

Introduction - Cloud Computing Architecture, Cloud Delivery Models, The SPI Framework, SPI Evolution, The SPI Framework vs. the Traditional IT Model, Cloud Software as a Service (SaaS), Cloud Platform as a Service (PaaS), Cloud Infrastructure as a Service (IaaS) Google Cloud Infrastructure - Google File System – Search engine – Map Reduce - Amazon Web Services - REST APIs - SOAP API - Defining Service Oriented Architecture, Combining the cloud and SOA, Characterizing SOA, Loosening Up on Coupling, Making SOA Happen, Catching the Enterprise Service Bus, Telling your registry from your repository, Cataloging services, Understanding Services in the Cloud.

Serving the Business with SOA and Cloud Computing, Query API - User Authentication- Connecting to the Cloud – OpenSSH Keys - Tunneling / Port Forwarding - Simple Storage Service - S3, EC2 - EC2 Compute Units, Platforms and storage, EC2 pricing, EC2 customers Amazon Elastic Block Storage - EBS - Ubuntu in the Cloud - Apache Instances in EC2 – Amazon Cloud Services- Amazon Elastic Compute Cloud (Amazon EC2), Amazon Simple DB, Amazon Simple Storage Service (Amazon S3), Amazon Cloud Front, Amazon Simple Queue Service (Amazon SQS), Amazon Elastic Map Reduce, Amazon Relational Database Service (Amazon RDS) , EC2 Applications - Web application design - AWS EC2 Capacity Planning – Apache Servers - Mysql Servers - Amazon Cloud Watch - Monitoring Tools.

Learning Resources:

Text Books:

1. Anothony T Velte, Toby J Velte, Robert Elsenpeter, Cloud Computing: A Practical Approach, MGH, 2010.
2. Gautam Shroff, Enterprise Cloud Computing, Cambridge, 2010.
3. Ronald Krutz and Russell Dean Vines, Cloud Security, First Edition, Wiley, 2010.

References:

1. ArshdeepBahga, Vijay Madisetti, "Cloud Computing: A Hands-on Approach", Universities Press (India) Private Limited, 2014
2. RajkumarBuyya, James Broberg, Andrzej Goscinski, "Cloud Computing Principles and Paradigms", Wiley, 2011

Online Resources:

https://nptel.ac.in/courses/106/105/106105223/