NATIONAL INSTITUTE OF TECHNOLOGY ANDHRA PRADESH

SYLLABI
FOR B.TECH. PROGRAM

From 2017-18 Batch onwards

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

SCHEME OF INSTRUCTION

B.Tech. (Electronics and Communication Engineering) Course Structure

I - Year

Physics Cycle							
S. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**	**Cat. Code**
1	MA101	Mathematics - I	3	0	0	03	BSC
2	HS101	English for Technical Communication	2	0	2	03	HSC
3	PH101	Physics	3	0	0	03	BSC
4	EC101	Basic Electronic Engineering	3	0	0	03	ESC
5	CE102	Environmental Science and Engineering	2	0	0	02	ESC
6	BT101	Engineering biology	2	0	0	02	ESC
7	CS101	Problem Solving & Comp Programming	3	0	0	03	ESC
8	CS102	Problem Solving & Comp Programming Lab	0	1	2	02	ESC
9	PH102	Physics Laboratory	0	1	2	02	BSC
10	EA101	EAA: Games and Sports	0	0	3	00	MDC
		TOTAL	**18**	**2**	**9**	**23**	

Chemistry Cycle							
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**	**Cat. Code**
1	MA151	Mathematics – II	3	0	0	03	BSC
2	ME102	Engineering Graphics	1	1	4	04	ESC
3	CY101	Chemistry	3	0	0	03	BSC
4	EE101	Basic Electrical Engineering	3	0	0	03	ESC
5	ME101	Basic Mechanical Engineering	3	0	0	03	ESC
6	CE101	Engineering Mechanics	3	0	0	03	ESC
7	ME103	Workshop Practice	0	1	2	02	ESC
8	CY102	Chemistry Laboratory	0	1	2	02	BSC
9	EA151	EAA: Games and Sports	0	0	3	00	MDC
		TOTAL	**16**	**3**	**11**	**23**	

II - Year I –Semester

S.No.	Course No.	Course Title	L	T	P	Credits	
1.	MA213	Complex Variables and Special functions	3	0	0	3	BSC
2.	EE236	Network Analysis	3	0	0	3	ESC
3.	CS235	Data Structures	3	0	0	3	ESC
4.	EC201	Digital System Design - I	3	0	0	3	PCC
5.	EC202	Signals and Systems	3	0	0	3	PCC
6.	EC203	Electronic Devices and Circuits – I	4	0	0	4	PCC
7.	EC204	Electronic Devices and Circuits –I lab	0	1	2	2	PCC
8.	CS236	Data Structures Lab	0	1	2	2	ESC
		Total	**19**	**2**	**4**	**23**	

II – Year, II – Semester

S. No.	Course No.	Course Title	L	T	P	Credits	Cat. code
1.	SM224	Macro Economics and Accountancy	3	0	0	3	HSC
2.	EC251	Digital System Design – II	3	0	0	3	PCC
3.	EC252	Electronic Devices and Circuits – II	4	0	0	4	PCC
4.	EC253	Probability Theory and Stochastic Processes	3	0	0	3	PCC
5.	EC254	Control Systems Engineering	3	0	0	3	PCC
6.	EC255	Transmission lines & Electromagnetic Waves	3	0	0	3	PCC
7.	EC256	Electronic Devices and Circuits – II Lab	0	1	2	2	PCC
8.	EC257	Digital System Design Lab	0	1	2	2	PCC
		Total	**19**	**2**	**4**	**23**	

III - Year I – Semester

S. No.	Course No.	Course Title	L	T	P	Credits	Cat. code
1.	EC301	Linear IC applications	3	0	0	3	PCC
2.	EC302	Analog & Digital Communications	3	0	0	3	PCC
3.	EC303	CMOS VLSI Design	3	0	0	3	PCC
4.	EC304	Antennas & propagation	3	0	0	3	PCC
5.		Department Elective-I	3	0	0	3	DEC
6.	EC306	Microcontrollers	3	0	0	3	PCC
7	EC307	Microcontrollers Lab	0	1	2	2	PCC
8.	EC308	IC Applications Lab	0	1	2	2	PCC
9.	EP349	EPICS	0	0	0	2*	
Total			**18**	**2**	**4**	**22**	

III - Year II – Semester

S.No.	Course No.	Course Title	L	T	P	Credits	Cat. code
1.	EC351	Data Networks	3	0	0	3	PCC
2.	EC352	Digital Signal Processing	3	0	0	3	PCC
3.	EC353	Embedded and Real Time Operating Systems	3	0	0	3	PCC
4.	EC354	Information theory & coding	3	0	0	3	PCC
5.		Open Elective-I	3	0	0	3	OPC
6		Department elective-2	3	0	0	3	DEC
7.	EC357	Communication Systems Lab	0	1	2	2	PCC
8.	EC358	Data Networks Lab	0	1	2	2	PCC
9	EP399	EPICS	0	0	0	2*	
Total			**18**	**2**	**4**	**22**	

*Credits are not considered for computation of SGPA and CGPA in both third year I and II semesters

IV - Year I – Semester

S. No.	Course No.	Course Title	L	T	P	Credits	Cat. code
1.	EC401	Electronic Instrumentation	3	0	0	3	PCC
2.	EC402	Cellular & Mobile Communication	3	0	0	3	PCC
3.	EC403	Advanced Digital Signal Processing	3	0	0	3	PCC
4.		Department Elective -3	3	0	0	3	DEC
5.		Department Elective - 4	3	0	0	3	DEC
6.		Open Elective – 2	3	0	0	3	OPC
7.	EC407	DSP & Instrumentation Lab	0	1	2	2	PCC
8.	EC449	Project work- Part A	0	0	4	2	PRC
		Total	**18**	**1**	**6**	**22**	

IV - Year II – Semester

S. No.	Course No.	Course Title	L	T	P	Credits	Cat. code
1.	SM453	Industrial and Systems Management	3	0	0	3	ESC
2.	EC451	Microwave & Light wave Technologies	3	0	0	3	PCC
3.		Department Elective -5	3	0	0	3	DEC
4.		Department Elective - 6	3	0	0	3	DEC
5.		Department Elective - 7	3	0	0	3	DEC
6.	EC455	Microwave & Light wave Technologies Lab	0	1	2	2	PCC
7.	ME451	Mandatory Audit Course (Self Study) *	0	0	0	0	MDC
8.	EC499	Project Work - Part B	0	0	8	4	PRC
		Total	**15**	**1**	**10**	**21**	

***** *The result of the Mandatory Audit Course (Self Study) completed by the student either in 6th or 7th semester will be reported in this semester*

Mandatory Audit Course (Self Study)

Student is required to complete at least one course offered by the following agencies. The student is required to take prior approval from the Department, before registering for any course. The student can register for such a course either in 6th Semester or 7th semester. Unless the student submits a pass certificate, he/she shall not be eligible for the award of degree.

SWAYAM: www.swayam.gov.in

NPTEL: www.onlinecourse.nptel.ac.in

Course Era: www.coursera.org

Free Online Courses: www.edx.org

MIT Open Course ware: www.ocw.mit.edu

Points to be noted:

1. Definition of Pre-requisite: The student should have studied that subject which is mentioned as Pre-requisite.
2. Course with same name but with different code number indicates that the subject pertains to different departments and also the syllabus is different.
3. EPICS (Engineering Project in Community Service) Project is offered in two parts as Part-A in III Year II Semester and Part-B in IV Year I semester, with Two credits each. The credits earned are not counted for Computation of SGPA and CGPA. The course is not mandatory. It is Optional. Interested students can take it.
4. In first year syllabus, Engineering Biology is included in Physics cycle and Basic Mechanical Engineering is included in Chemistry cycle. This is with effect from 2018-2019 onwards.

Department Electives:

Year	Semester-1	Semester-2
¾ B.Tech.	**Department Elective-I ::** EC3051 : Optimization Techniques EC3052 : Statistical Signal Processing EC3053 : IOT EC3054 : Computer Architectures	**Department Elective-2 ::** EC3561 : Digital Switching & Multiplexing EC3562 : Low Power VLSI EC3563 : Smart Antenna EC3564 : Web Technologies
4/4 B.Tech.	**Department Elective-3 ::** EC4041 : Fuzzy & Neural Networks EC4042 : Satellite Communications EC4043 : SOC Design EC4044 : Digital Image Processing **Department Elective-4 ::** EC4051 : Speech Processing EC4052 : Software Defined Radio EC4053 : Industrial IOT EC4054 : RF IC Design EC4055 : Nano Electronics/ Introduction to MEMs	**Department Elective-5 ::** EC4521 : Computer Vision EC4522 : Bio-Medical Instrumentation EC4523 : Wireless Networks EC4524 : Green Communication **Department Elective-6 ::** EC4531 : Radar Engineering EC4532 : Introduction to MEMs/ Nano Electronics EC4533 : 5G communication **Department Elective-7 ::** EC4541 : Testing and Testability of VLSI circuits EC4542 : Cloud Computing EC4543 : Optical Communications EC4544: Communication Protocols for Instrumentation

B.Tech. (ECE) Scheme for 2017-2018 batches onwards

Semester	I	II	III	IV	V	VI	VII	VIII	Total
Theory Courses	6	6	6	6	6	6	5+1	5+1	48
Lab. Courses	3	3	2	2	2	2	1	1	16
BSC	8	8	3						19
ESC	12	15	8					3	38
HSC	3			3					6
PCC			12	20	19	16	11	5	83
DEC					3	3	6	3+6	15+6
OPC						3	3		6
PRC							2	4	6
MDC	0	0						0	0
Contact Hrs.	26	27	25	25	24	24	25	20+6	196+6
Credits	23	23	23	23	22	22	22	15+6	173+6
Average Contact hours/Semester = 24.5									
Provision is made for interested students to register up to 6 extra credits or 2 extra Elective courses. Mandatory to do one course on self-study. Subject to the approval of Senate.									

DETAILED SYLLABUS

MA101	Mathematics – I	BSC	3-0-0	3 Credits

Pre-requisites: None.

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

CO 1	solve the consistent system of linear equations
CO 2	apply orthogonal and congruent transformations to a quadratic form
CO 3	determine the power series expansion of a given function
CO 4	find the maxima and minima of multivariable functions
CO 5	solve arbitrary order linear differential equations with constant coefficients
CO 6	apply the concepts in solving physical problems arising in engineering

Mapping of course outcomes with program outcomes:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-	-
CO6	3	-	-	-	-	-	-	-	-	-	-	-

Detailed Syllabus:

Matrix Theory: Linear dependence and independence of vectors; Rank of a matrix; Consistency of the system of linear equations; Eigenvalues and eigenvectors of a 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 �′ = ��(�, �); 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 - forced oscillations, electric circuits, etc.

Reading:

1. R.K.Jain and S.R.K.Iyengar, Advanced Engineering Mathematics, 5th edition, Narosa Pub. House, 2016.
2. Erwyn Kreyszig, Advanced Engineering Mathematics, 8th Edition, John Wiley and Sons, 2015.
3. B.S.Grewal, Higher Engineering Mathematics, Khanna Publications, 2015.

****

HS101	English for Technical Communication	HSC	2-0-2	3 Credits

Pre-requisites: None

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

CO1	Understand basic principles of grammar and vocabulary
CO2	Write clear and coherent paragraphs
CO3	Write effective résumé, cover letter and letters for a variety of purposes
CO4	Prepare technical reports and interpret graphs
CO5	Develop reading comprehension skills
CO6	Comprehend English speech sounds, stress and intonation

Mapping of course outcomes with program outcomes:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	1	-	-	-	3	-	1
CO2	-	-	-	-	-	1	-	-	-	3	-	1
CO3	-	-	-	-	-	1	-	-	-	3	-	1
CO4	-	-	-	-	-	1	-	-	-	3	-	1
CO5	-	-	-	-	-	1	-	-	-	3	-	1
CO6	-	-	-	-	-	1	-	-	-	3	-	1

Detailed 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.

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- Intonation in spoken English -definition, patterns of intonation- –falling, rising, etc.-use of intonation in daily life-exercises

3. Introducing oneself in formal and social contexts- Role plays. - Their uses in developing fluency and communication in general.

4. Oral presentation - definition- occasions- structure- qualities of a good presentation with emphasis on body language and use of visual aids.

5. Listening Comprehension -Challenges in listening, good listening traits, some standard listening tests- practice and exercises.

6. Debate/ Group Discussions-concepts, types, Do's and don'ts- intensive practice.

Reading:

1. English for Engineers and Technologists (Combined edition, Vol. 1 and 2) Orient Blackswan 2010.
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

PH101	Physics	BSC	3-0-0	3 Credits

Pre-requisites: None

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

CO1	Solve engineering problems using the concepts of wave and particle nature of Radiant energy.
CO2	Understand the use of lasers as light sources for low and high energy applications
CO3	Understand the nature and characterization of new materials for engineering applications
CO4	Apply the concepts of light propagation in optical fibers, light wave communication systems, holography and for sensing physical parameters
CO5	Apply the knowledge of Solar PV cells for choice of materials in efficient alternate energy generation.

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

Quantum Mechanics:

Concepts and Experiments that led to the discovery of Quantum Nature. Heisenberg uncertainty principle; Schrodinger time independent and time dependent wave equations, The free particle problem - Particle in an infinite and finite potential well, Quantum mechanical tunneling. MB, BE and FD distributions.

Wave and Quantum Optics:

Interference and Diffraction: Concept of interference and working of Fabry-perot Interferometer and its application as wavelength filter. Multiple beam diffraction and Working of diffraction Gratings, Application of Grating as wavelength splitter.

Polarization Devices: Principles, Working and applications of Wave Plates, Half Shade Polarimetr, Polariscope, Isolators and Liquid Crystal Displays.

Lasers: Basic theory of Laser, Concept of population inversion and Construction and working of He-Ne, Nd-YAG, CO_2 Lasers, LED, White light LED, Semiconductor Laser, Holography and NDT.

Optical Fibers: Structure, Types, Features, Light guiding mechanism and applications in Communications and Sensing.

Solar Cells: Solar spectrum, photovoltaic effect, materials, structure and working principle, I-V characteristics, power conversion efficiency, quantum efficiency, emerging PV technologies, applications.

Magnetic and Dielectric Materials:

Magnetic Materials and Superconductors: Introduction - Weiss Theory of Ferromagnetism – Properties – Domains – Curie Transition - Hard and soft magnetic materials – Spinel Ferrites – Structure – Classification – Applications - Meissner effect - Type-I and Type-II Superconductors – Applications.

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.

Functional and Nano Materials:

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

Nanomaterials: Introduction, classification, properties, different methods of preparation and applications.

Reading:

1. Halliday, Resnic and Walker, Fundamentals of Physics, 9th Edition, John Wiley, 2011.
2. Eiser A, Concepts of Modern Physics, 5th Edition, McGraw Hill International, 2003.
3. Ajoy Ghatak, Optics, 5th Edition, Tata McGraw Hill, 2012
4. S.O.Pillai,Solid State Physics,New Age Publishers,2015
5. M.Armugam, Engineering Physics, Anuradha Agencies, 2003

EC101	Basic Electronic Engineering	OEC	3-0-0	3 Credits

Pre-requisites: None

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

CO1	Comprehend the characteristics of semiconductor devices, and operational amplifiers
CO2	Understand the principles of working of amplifiers
CO3	Understand and design of simple combinational and basics of sequential logic circuits
CO4	Understand the principles of electronic measuring instruments and Transducers
CO5	Understand the basic principles of electronic communication

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

Electronics Systems: Introduction to electronics, review of p-n junction operation, diode applications, Zener diode as regulator.

Transistor and applications: Introduction to transistors, BJT Characteristics, biasing and applications, simple RC coupled amplifier and frequency response. FET and MOSFET characteristics and applications.

Feedback in Electronic Systems: open loop and closed loop systems, Negative and positive Feedback, merits and demerits, Principles of LC and RC oscillators.

Integrated Circuits: Operational amplifiers – characteristics and linear applications

Digital Circuits: Number systems and logic gates, Combinational Logic circuits, Flip-Flops, counters and shift registers, data converters, Analog to Digital and Digital to Analog converters (ADC/DAC's), Introduction to microprocessors and microcontrollers.

Laboratory measuring instruments: principles of digital multi-meters, Cathode ray oscilloscopes (CRO's).

Electronics Instrumentation: Measurement, Sensors, principles of LVDT, strain guage and thermocouples. Introduction to data acquisition system.

Principles of Communication: Need for Modulation, Definitions of various Modulation and Demodulation techniques, AM radio transmitter and receiver, brief understanding of FM and mobile communications.

Reading:

1. Bhargava N. N., D C Kulshreshtha and S C Gupta, Basic Electronics & Linear Circuits, 2nd Edition, Tata McGraw Hill, 2013.
2. Malvino and Brown, "Digital Computer electronics" Mcgraw Hill, 3rd Edition.
3. Keneddy and Davis, "Electronic Communication Systems" Mcgraw Hill, 4th Edition.
4. Helfrick and Cooper, " Modern Electronic Instrumentation and Measurement Techniques" PHI, 2011
5. Salivahanan, N Suresh Kumar Electronic Devices and circuits, 3rd Edition, McGraw Hill publications.
6. Neil Storey, Electronics A Systems Approach, 4th Edition, Pearson Education Publishing Company Pvt Ltd.

CE 102	**Environmental Science and Engineering**	**OEC**	**2-0-0**	**2 Credits**

Pre-requisites: None

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

CO1	Identify environmental problems arising due to engineering and technological activities and the science behind those problems.
CO2	Estimate the population - economic growth, energy requirement and demand.
CO3	Analyze material balance for different environmental systems.
CO4	Realize the importance of ecosystem and biodiversity for maintaining ecological balance.
CO5	Identify the major pollutants and abatement devices for environmental management and sustainable development

Mapping of course outcomes with program outcomes:

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

Detailed syllabus:

Introduction to Environmental Science:

Environment and society, major environmental issues: Ozone layer depletion, Acid rains, global climate change etc., sustainable development, Environmental impact assessment, environmental management

Natural Resources Utilization and its Impacts:

Energy, minerals, water and land resources, Resource consumption, population dynamics, urbanization.

Ecology and Biodiversity:

Energy flow in ecosystem, food chain, nutrient cycles, eutrophication, value of biodiversity, biodiversity at global, national and local levels, threats for biodiversity, conservation of biodiversity

Water Pollution:

Sources, types of pollutants and their effects, water quality issues, contaminant transport, self-purification capacity of streams and water bodies, water quality standards, principles of water and wastewater treatment.

Air Pollution:

Sources, classification and their effects, Air quality standards, dispersion of pollutants, control of air pollution, automobile pollution and its control.

Solid Waste Management:

Sources and characteristics of solid waste, effects, Collection and transfer system, disposal methods

Reading:

1. J.G. Henry and G.W. Heinke, Environmental Science and Engineering, Pearson Education, 2004.
2. G.B. Masters, Introduction to Environmental Engineering and Science, Pearson Education., 2013
3. Gerard Kiely, Environmental Engineering, McGraw Hill Education Pvt Ltd, Special Indian Edition, 2007.
4. W P Cunningham, M A Cunningham, Principles of Environmental Science, Inquiry and Applications, Tata McGraw Hill Publishing Company Ltd, New Delhi.
5. M.Chandrasekhar, Environmental science, Hi Tech Publishers, 2009.

CS101	Problem Solving and Computer Programming	OEC	3-0-0	3 Credits

Pre-requisites: None

Course Outcomes: After the completion 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

Mapping of course outcomes with program outcomes:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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	-	-	-

Detailed 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 solving strategies: Top-down approach, Bottom-up approach, Time and space complexities of algorithms.

Number systems and data representation, Basics of C++, Basic data types.

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.

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, function overloading, Problems on Complex numbers, Date, Time, Large Numbers.

Reading:

1. Walter Savitch, Problem Solving with C++, Ninth Edition, Pearson, 2014.
2. Cay Horstmann, Timothy Budd, Big C++, Wiley, 2nd Edition, 2009.
3. R.G. Dromey, How to solve it by Computer, Pearson, 2008.

BT101	ENGINEERING BIOLOGY	EB	2-0-0	2 Credits

Pre-requisites: None

Course Outcomes: After the completion 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 heredity, variation and central dogma of life
CO4	Analyse and understand the concepts of biology for engineering the cell

Mapping of Course Outcomes (COs) and the Program Outcomes (POs) :

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

Detailed Syllabus:

Molecules of life, water and carbon - chemical basis of life, protein structure and function, nucleic acids and the RNA world, carbohydrates, lipids, membranes and first cells.

Cell structure and function, inside the cell, cell–cell Interactions, cellular respiration and fermentation, photosynthesis, cell cycle, biological signal transduction.

Gene structure and expression, Mitosis, Meiosis, Mendel and the gene, DNA and the gene: synthesis and repair, how genes work, transcription, RNA processing, and translation, control of gene expression, analyzing and engineering genes, genomics.

Engineering concepts in biology – genetic engineering, disease biology and biopharmaceuticals, stem cell engineering, metabolic engineering, synthetic biology, neuron transmission, biosafety and bioethics.

Reading:

1. Quillin, Allison Scott Freeman, Kim Quillin and Lizabeth Allison, Biological Science, Pearson Education India, 2016
2. Reinhard Renneberg, Viola Berkling and Vanya Loroch, Biotechnology for Beginners, Academic Press, 2017

PH102	Physics Laboratory	BSC	0-0-3	2 Credits

Pre-requisites: None

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

CO1	Use CRO, Signal generator, spectrometer, polarimeter and GM counter for making measurements
CO2	Test optical components using principles of interference and diffraction of light
CO3	Determine the selectivity parameters in electrical circuits
CO4	Determine the width of narrow slits, spacing between close rulings using lasers and appreciate the accuracy in measurements

Mapping of course outcomes with program outcomes:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	2	-	-	-	-	-	-	1	-	-	-
CO2	2	-	-	-	-	-	-	-	2	-	-	-
CO3	2	-	-	-	-	-	-	-	2	-	-	-
CO4	-	2	-	-	-	-	-	-	2	-	-	-

List of experiments:

1. Determination of Wavelength of Sodium light using Newton’s Rings
2. Determination of Wavelength of He-Ne laser – Metal Scale
3. Measurement of Width of a narrow slit using He- Ne Laser
4. Determination of Specific rotation of Cane sugar by Laurent Half-shade Polarimeter.
5. Determination of capacitance by using R-C circuit
6. Determination of resonating frequency and bandwidth by LCR circuit
7. Measurement of half-life of radioactive source using GM Counter
8. Diffraction grating by normal incidence method

CS102	Problem Solving and Computer Programming Laboratory	OEC	0-1-2	2 Credits

Pre-requisites: None

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

CO1	Design and test programs to solve mathematical and scientific problems
CO2	Develop and test programs using control structures
CO3	Implement modular programs using functions
CO4	Develop programs using classes

Mapping of course outcomes with program outcomes:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	-	-	-	-	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-	-	2	-	-	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-
CO4	-	3	-	-	-	-	-	-	2	-	-	-

Detailed Syllabus:

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.

Reading:

1. Walter Savitch, Problem Solving with C++, Ninth Edition, Pearson, 2014.
2. Cay Horstmann, Timothy Budd, Big C++, Wiley, 2nd Edition, 2009.
3. R.G. Dromey, How to solve it by Computer, Pearson, 2008.

MA151	Mathematics – II	BSC	3-0-0	3 Credits

Pre-requisites: None

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

CO 1	analyze improper integrals
CO 2	evaluate multiple integrals in various coordinate systems
CO 3	apply the concepts of gradient, divergence and curl to formulate engineering problems
CO 4	convert line integrals into surface integrals and surface integrals into volume integrals
CO 5	apply Laplace transforms to solve physical problems arising in engineering

Mapping of course outcomes with program outcomes:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-	-

Detailed 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.

Reading:

1. R. K. Jain and S. R. K. Iyengar, *"Advanced Engineering Mathematics"*, Fifth Edition, Narosa Publishing House, 2016
2. Erwin Kreyszig, *"Advanced Engineering Mathematics"*, 8th Edition, John Wiley & Sons, 2015
3. B. S. Grewal, *"Higher Engineering Mathematics"*, Khanna Publications, 2015

CY101	Chemistry	BSC	3-0-0	3 Credits

Pre-requisites: None

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

CO1	Understand and apply the concepts in electrochemistry and corrosion science
CO2	Understand the concepts in molecular interactions
CO3	Understand the synthesis and analysis of modern materials
CO4	Apply the concepts of organic chemistry for synthesis
CO5	Understand the synthesis and applications of polymer science
CO6	Identify the structure of organic molecules using photo chemistry and chemical Spectroscopy

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

Quantum Chemistry and Chemical Bonding:

Emergence of Quantum Theory; Postulates of Quantum Mechanics, Operators and Observables, Schrodinger Equation, Particle in a One-Dimensional Box and Colour of Conjugate Molecules, Hetero-diatomic Molecule as Harmonic Oscillator and Rigid Rotor, Hydrogen Atom, LCAO-MO Theory (MO Diagram of CO and NO Molecules)

Chemical Thermodynamics:

Enthalpy and Free Energy Changes in Chemical Reactions; Relevance of C_p and C_v in Gas Phase Reactions, Chemical Potential; Heat Capacity of Solids, Absolute Entropy and Third Law of Thermodynamics

Electrochemistry:

Electrodes and Electrochemical Cells; Potentiometric and Amperometric Sensors; Li-Ion and Ni-Cd Rechargeable Batteries; Fuel Cells (Methanol-Oxygen); Electrochemical Theory of Corrosion; Factors Affecting Rate of Corrosion; Sacrificial Anodic and Impressed Current Cathodic Protection.

Coordination Chemistry and Organometallics:

Shapes of Inorganic Compounds; Crystal Field and Molecular Orbital Theories; MO-Diagram for an Octahedral Complex; Metal Ions in Biology; Organometallic Chemistry (Metal Carbonyls).

Basics of Organic Chemistry:

Classification of Organic reaction and their mechanisms. Reaction intermediates: formation, structure and properties. Named Reactions: Skraup's synthesis, Diels- Alder reaction, Click Reactions.

Engineering Materials and Application:

Inorganic and Organic polymers - Zeolites, resins, polymeric membranes, conducting polymers, Applications - optical fibers, OLED, water purification.

Instrumental Methods of Chemical Analysis:

Gas- and Liquid-Chromatographic Separation of Components of Mixtures; UV-Visible, FTIR, NMR and Mass Spectral Methods of Analysis of Structures of Organic Compounds, Radiometry.

<u>Reading:</u>

1. A Textbook of Engineering Chemistry, Shashi Chawla, Dhanpat Rai, 2017.
2. Elements of Physical Chemistry, P. Atkins and Julio de Paula, 7th Ed., Oxford UP, 2017.
3. Engineering Chemistry, Shikha Agarwal, Cambridge UP, 2015.
4. Concise Inorganic Chemistry, J.D. Lee, 5th edition, OUP, 2008.
5. Organic Chemistry, Clayden, Greaves, Warren and Wothers, Oxford University, 2014.
6. Organic Chemistry, Paula Bruce, Pearson, 7th edition, 2013.

EE101	Basic Electrical Engineering	OEC	3-0-0	3 Credits

Pre-requisites: None

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

CO1	Analyze and solve electric and magnetic circuits
CO2	Identify the type of electrical machines for a given application
CO3	Recognize the ratings of different electrical apparatus
CO4	Identify meters for measuring electrical quantities and requirements of illumination

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

DC Circuits: Kirchoff's Voltage and Current Laws, Superposition Theorem, Star-Delta Transformations

AC Circuits: Complex representation of Impedance, Phasor diagrams, Power & Power Factor, Solution of 1-ϕ Series & Parallel Circuits, Solution of 3-ϕ circuits and Measurement of Power in 3-ϕ circuits

Magnetic Circuits: Fundamentals and solution of Magnetic Circuits, Concepts of Self and Mutual Inductances, Coefficient of Coupling

Single Phase Transformers: Principle of Operation of a Single Phase Transformer, EMF Equation, Phasor Diagram, Equivalent Circuit of a 1-ϕ Transformer, Determination of Equivalent circuit parameters, calculation of Regulation & Efficiency of a Transformer

DC Machines: Principle of Operation, Classification, EMF and Torque Equations, Characteristics of Generators and Motors, Speed Control Methods and Applications

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

Measuring Instruments: Moving Coil and Moving Iron Ammeters and Voltmeters

Illumination: Laws of illumination and luminance

Reading:

1. Edward Hughes, Electrical & Electronic Technology – 12th Edition, Pearson, 2016.

2. Vincent Del Toro, Electrical Engineering Fundamentals – 2nd Edition, Pearson, 2015.

3. V N Mittle & Arvind Mittal, Basic Electrical Engineering – 2nd Edition TMH 2005.

4. E. Openshaw Taylor, Utilization of Electrical Energy – Orient Longman, 2010

CE101	Engineering Mechanics	ESC	3-0-0	3 Credits

Pre-requisites: None

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

CO1	Determine the resultant force and moment for a given system of forces.
CO2	Analyze planar and spatial systems to determine the forces in members of trusses, frames and problems related to friction.
CO3	Calculate the motion characteristics of a body subjected to a given force system.
CO4	Determine the deformation of a shaft and understand the relationship between different material constants.
CO5	Determine the centroid and second moment of area.

Mapping of course outcomes with program outcomes:

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

Detailed syllabus:

Introduction - Specification of force vector, Formation of Force Vectors, Moment of Force – Cross product – Problems, Resultant of a general force system in space, Degrees of freedom - Equilibrium Equations, Kinematics – Kinetics – De' Alemberts principle, Degree of Constraints – Free body diagrams.

Spatial Force systems - Concurrent force systems - Equilibrium equations – Problems, Problems (Vector approach) – Tension Coefficient method, Problems (Tension Coefficient method), Parallel force systems - problems, Center of Parallel force system – Problems.

Coplanar Force Systems - Introduction – Equilibrium equations – All systems, Problems on Coplanar Concurrent force system, Coplanar Parallel force system, Coplanar General force system – Point of action, Method of joints, Method of sections, Method of sections, Method of members, Friction – Coulombs laws of dry friction – Limiting friction, Problems on Wedge friction, Belt Friction-problems.

Mechanics of Deformable Bodies - Stress & Strain at a point- Normal and shear stresses, Axial deformations – Problems on prismatic shaft, tapered shaft and deformation due to self-weight, Deformation of Stepped shaft due to axial loading, Poisson's Ratio – Bulk Modulus - Problems, change in dimensions and volume.

Centroid & Moment of Inertia - Centroid and M.I – Arial – Radius of Gyration, Parallel axis– Perpendicular axis theorem – Simple Problems.

Dynamics of Particles - Rectilinear Motion – Kinematics Problems, Kinetics – Problems, Work & Energy – Impulse Moment, Curvilinear Motion – Normal and tangential components

Reading:

1. J.L.Meriam & L.G. Kraige, Engineering Mechanics, 7th Edition, John Wiley & sons, 2012.
2. Timoshenko and Young, Engineering Mechanics, 3rd Edition, Mc Graw Hill Publishers, 2006.
3. Gere and Timoshenko, Mechanics of Materials, 2nd Edition, CBS Publishers, 2011.

ME101	Basic Mechanical Engineering	ESC	3-0-0	3 Credits

Pre-requisites: None

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

CO1	Identify Materials for Engineering Applications
CO2	Describe the functions and operations of Conventional, NC, CNC and 3D Printing methods of manufacturing.
CO3	Select a power transmission system for a given application.
CO4	Understand the concepts of thermodynamics and functions of components of a power plant.
CO5	Understand basics of heat transfer, refrigeration, internal combustion engines and Automobile Engineering.

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

Engineering Materials: Introduction to Engineering Materials, Classification and Properties

Manufacturing Processes: Castings – Patterns & Moulding, Hot Working and Cold Working, Metal Forming processes: Extrusion, Drawing, Rolling, Forging, Welding – Arc Welding & Gas Welding, Soldering, Brazing.

Machine Tools: Lathe – Types – Operations, Problems on Machining Time Calculations, Drilling M/c – Types – Operations, Milling M/c – Types – Operations – Up & Down Milling, Shaping M/c – Operations – Quick Return Mechanism, Planer M/c. – Operations – Shaper Vs Planer, Grinding M/c – Operations. Introduction to NC/CNC Machines, 3D Printing

Power Transmission: Transmission of Power, Belt Drives, Gears and Gear Trains –Simple Problems

Fasteners and Bearings: Fasteners – Types and Applications, Bearings – Types and Selection,

Thermodynamics: Energy Sources – Conventional/Renewable, Thermodynamics – System, State, Properties, Thermodynamic Equilibrium, Process & Cycle, Zeroth law of Thermodynamics, Work & Heat, First law – Cyclic process, Change of State, C_p, C_v, PMM1,Limitations of First law, Thermal Reservoirs, Heat Engine, Heat Pump/Refrigerator, Efficiency/CoP, Second law, PMM2, Carnot Cycle, Entropy – T-s and P-v diagrams.

Thermal Power Plant: Layout of Thermal Power Plant & Four circuits – Rankine cycle, T-s & P-v diagrams, Boilers – Babcock & Wilcox, Cochran Boilers, Comparison of Fire Tube &Water Tube Boilers, Steam Turbines – Impulse Vs. Reaction, Compounding – Pressure & Velocity Compounding, Condensers – Jet Condenser and Surface Condenser; Cooling Towers.

I.C. Engines: 2-Stroke & 4-Stroke Engines, P-v Diagram; S.I. Engine, C.I. Engine, Differences

Refrigeration: Vapor Compression Refrigeration Cycle – Refrigerants, Desirable Properties of Refrigerants

Heat Transfer: Modes of Heat Transfer, Thermal Resistance Concept, Composite Walls & Cylinders, and Overall Heat Transfer Coefficient – problems

Automobile Engineering: Layout of an Automobile, Transmission, Clutch, Differential, Internal Expanding Shoe Brake

Reading:

1. M.L.Mathur, F.S.Mehta and R.P.Tiwari, R.S.Vaishwnar, “Elements of Mechanical Engineering”, Jain Brothers, New Delhi, 2011
2. Praveen Kumar, “Basic Mechanical Engineering”, Pearson Education, India, 2013
3. P.N. Gupta, M.P. Poonia, “Elements of Mechanical Engineering”, Standard Publishers, 2004
4. C.P.Gupta,Rajendra Prakash, “Engineering Heat Transfer”,NemChand Brothers,New Delhi, 1994
5. B.S.Raghuvanshi, “Workshop Technology, Vol. 1&2”, Dhanpath Rai & Sons, New Delhi, 1989

ME102	Engineering Graphics	ESC	2-0-4	4 Credits

Pre-requisites: None

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

CO1	Recall BIS standards and conventions while drawing Lines, printing Letters and showing Dimensions.
CO2	Classify the systems of projection with respect to the observer, object and the reference planes.
CO3	Construct orthographic views of an object when its position with respect to the reference planes is defined.
CO4	Analyse the internal details of an object through sectional views.
CO5	Relate 2D orthographic views to develop 3D Isometric View.
CO6	Construct 2D (orthographic) and 3D (isometric) views in CAD environment.

Mapping of course outcomes with program outcomes:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-
CO4	2	-	-	-	-	-	-	-	-	-	-	-
CO5	2	-	-	-	-	-	-	-	-	-	-	-
CO6	2	-	-	-	-	-	-	-	-	-	-	-

Detailed Syllabus:

Introduction: Overview of the course, Lines Lettering and Dimensioning: Types of lines, Lettering, Dimensioning, Geometrical Constructions, Polygons, Scales

Orthographic Projection: Principles of Orthographic projection, Four Systems of Orthographic Projection.

Projection of Points: Projections of points when they are situated in different quadrants.

Projections of Lines: Projections of a line parallel to one of the reference planes and inclined to the other, line inclined to both the reference planes, Traces.

Projections of Planes: Projections of a plane perpendicular to one of the reference planes and inclined to the other, Oblique planes.

Projections of Solids: Projections of solids whose axis is parallel to one of the reference planes and inclined to the other, axis inclined to both the planes.

Section of Solids: Sectional planes, Sectional views - Prism, pyramid, cylinder and cone, true shape of the section.

Isometric Views: Isometric axis, Isometric Planes, Isometric View, Isometric projection, Isometric views – simple objects.

Auto-CAD Practice: Introduction to Auto-CAD, DRAW tools, MODIFY tools, TEXT, DIMENSION, PROPERTIES

Reading:

1. N.D. Bhat and V.M. Panchal, Engineering Graphics, Charotar Publishers, 2013
2. Sham Tickoo, “AutoCAD 2017 for Engineers & Designers", 23ed, Dreamtech Press, 2016

CY102	Chemistry Laboratory	BSC	0-1-2	2 Credits

Pre-requisites: None

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

CO1	Synthesize polymers
CO2	Analyze ores and bleaching powder
CO3	Estimate the Hardness of water in terms of Calcium and Magnesium ions
CO4	Separate organic compounds using chromatographic techniques
CO5	Standardize solutions using titration, conductivity meter, pH-meter, potentiometer and colorimeter
CO6	Verify the Freundlich adsorption isotherm

Mapping of course outcomes with program outcomes:

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

List of Experiments:

Cycle-I

1. Standardization $KMnO_4$ solution: Understanding the redox process, electron transfer, importance of qualitative and quantitative analysis.
2. Estimation of Hematite: Understanding the importance on purity of an ore, % of metal content (for Fe).

3. Hardness of Water: Understanding of metal complexes, multi dentate ligands, importance of purity of ground water, (EDTA method; complexometry).
4. Analysis of bleaching powder for available chlorine: Understanding the importance and purity of potable water, back titration (Iodometry).
5. Preparation of nanomaterials: Understanding the importance of nanomaterials, their preparation and characterization.

Cycle II

1. pH metry: Concept of pH, Instrumentation, calibration, determination of the concentrations by instrumental methods
2. Conductometry: Concept of conductivity, importance of conductivity
3. Potentiometry: Determination of the redox potential of the reaction
4. Colorimetry: Importance of Beers and Lamberts law,
5. Photochemical experiment: Importance of visible light and its application for a redox process, importance of coloring agent
6. Preparation of bakelite / polypyrrole: Concepts of organic reactions and application for the organic material preparation.
7. Corrosion experiment: Concept of corrosion, importance of corrosion agents
8. Adsorption experiment: Understanding phenomena of adsorption and absorption
9. Analysis of a drug: Importance of the purity, concentrations of a drug molecule.

Reading:

1. Introductory Chemistry laboratory manual: Concepts and Critical Thinking, Charles Corwin, Pearsons edn., 2012.
2. Investigating Chemistry: Laboratory Manual, David Collins, 1st Edn., Freeman & Co., 2006.

ME103	Workshop Practice	ESC	0-0-3	2 Credits

Pre-requisites: None

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

CO1	Study and practice on machine tools and their operations.
CO2	Practice on manufacturing of components using workshop trades including fitting, carpentry, foundry and welding..
CO3	Identify and apply suitable tools for machining processes including turning, facing, thread cutting and tapping.
CO4	Apply basic electrical engineering knowledge for house wiring practice.

Mapping of course outcomes with program outcomes:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	-	-	-
CO2	2	-	-	-	-	-	-	-	-	-	-	-
CO3	2	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	2

DETAILED SYLLABUS:

Fitting Trade: Preparation of T-Shape Work piece as per the given specifications, Preparation of U-Shape Work piece which contains: Filing, Sawing, Drilling, Grinding, and Practice marking operations.

Plumbing: Practice of Internal threading, external threading, pipe bending, and pipe fitting, Pipes with coupling for same diameter and with reducer for different diameters and Practice of T-fitting, Y-fitting, Gate valves fitting.

Machine shop: Study of machine tools in particular Lathe machine (different parts, different operations, study of cutting tools), Demonstration of different operations on Lathe machine, Practice of Facing, Plane Turning, step turning, taper turning, knurling and parting and Study of Quick return mechanism of Shaper. Demonstration of the working of CNC and 3D Printing Machines.

Power Tools: Study of different hand operated power tools, uses and their demonstration and Practice of all available Bosch Power tools.

Carpentry: Study of Carpentry Tools, Equipment and different joints, Practice of Cross Half lap joint, half lap Dovetail joint and Mortise Tenon Joint

Reading:

1. Raghuwanshi B.S., Workshop Technology Vol. I & II, Dhanpath Rai & Sons.
2. Kannaiah P. and Narayana K.L., Workshop Manual, 2nd Edition, Scitech publishers
3. John K.C., Mechanical Workshop Practice, 2nd Edition, PHI, 2010.
4. Jeyapoovan T.and Pranitha S., Engineering Practices Lab Manual, 3rd Edition, Vikas Publishers, 2008.

MA213	Complex variables and Special Functions	BSC	3–0–0	3 Credits

Prerequisites: MA101-Mathematics-I and MA151-Mathematics-II

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

CO1	understand the concept of analytic function
CO2	Convert complicated regions to simpler regions using the conformal mapping.
CO3	Use the power series to solve ordinary differential equations.
CO4	learn and use properties of Bessel and Legendre functions

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

Complex Functions

Complex function: Limit - Derivative - Analytic functions - Cauchy Riemann equations - Laplace's equation. Mappings: Conformal Mapping - Linear fractional transformation. Complex integration: Line integrals in complex plane - Cauchy’s theorem (simple proof only) - Cauchy’s integral formula. Series Expansions: Taylor's and Laurent's series expansions - zeros and singularities - Residue theorem - Evaluation of real integrals using residue theorem. Schwartz- Christoffel transformation.

Series Solutions:

Classification of singularities of an ordinary differential equation - Series solution - Method of Frobenius - Indicial equation - Illustrations.

Bessel Functions:

Bessel equation - Bessel function - Generating function - Recurrence relations - Orthogonality of Bessel functions - Simple Illustrations.

Legendre Functions:

Legendre equation - Legendre functions - Rodrigue's formula - Recurrence relations - Generating function - Orthogonality of Legendre polynomials - Simple Illustrations.

Reading :

1. R.V. Churchill, *Complex variables and its applications*, McGraw Hill, 2009.
2. W.W. Bell, *Special Functions for Scientists and Engineers*, Dover Publications, 2004.
3. Erwin Kreyszig: *Advanced Engineering Mathematics*, John Wiley and Sons, 8^{th} Edition, 2008.
4. B.S. Grewal: Higher Engineering Mathematics, Khanna Publications, 2017.

EE236	Network Analysis	ESC	3–0–0	3 Credits

Prerequisites: None

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

CO1	Solve network problems using mesh current and node voltage equations
CO2	Design resonant circuits for given bandwidth
CO3	Compute responses of first order and second order networks using time domain analysis
CO4	Obtain circuit response using Laplace Transform
CO5	Analyze networks using Thevenin, Norton, Maximum power transfer, Superposition, Miller and Tellegen's theorems

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

Introduction

CIRCUIT ELEMENTS AND RELATIONS: Types of Sources and Source Transformations - Dot convention and formation of loop and node equations, NETWORK GRAPHS AND ANALYSIS: Graph of a network, Incidence matrix, Cutset and tie set matrices - Formation of equilibrium equations - Dual networks. TIME DOMAIN ANALYSIS: Solution of network equations in time domain - classical differential equations approach - Initial conditions and their evaluation - Applications to simple RLC - circuits only.

APPLICATIONS OF LAPLACE TRANSFORMS IN CIRCUIT THEORY: Laplace transforms of Various signals of excitation - Waveform synthesis, Laplace transformed networks - Determination and representation of initial conditions - Response for impulse function only and its relation to network admittance - convolution integral and applications.

STEADY STATE ANALYSIS OF CIRCUITS FOR SINUSOIDAL EXCITATIONS: 1-phase series, parallel, series - parallel circuits - Solution of AC networks using mesh and nodal analysis. RESONANCE AND LOCUS DIAGRAMS: Series and parallel resonance - Selectivity - Bandwidth - Q factors – Times circuits. Locus diagrams for RL and RC circuits with AC excitation for parametric and frequency variations under steady state conditions.

NETWORK THEOREMS AND APPLICATIONS: Superposition theorem; Thevenins and Nortons theorems; substitution and compensation theorems - Reciprocity theorem; Millman's theorem; Maximum power transfer theorem; Tellegen's theorem - Their applications in analysis of networks.

Reading:

1. M.E.Van Valkenberg, Network Analysis, Prentice Hall India, 3rd Edition, 2002.
2. Charles A Desoer, Ernest S Kuh, Basic Circuit Theory, McGraw Hill, 1969.
3. M.L. Soni and J.C. Gupta, A Course in Electrical Circuits Analysis, Dhanpat Rai & Co.(P), 2001.
4. G.K. Mithal and Ravi Mittal, Network Analysis, Khanna Khanna Pub, 1998.

CS235	Data Structures	ESC	3–0–0	3 Credits

Prerequisites: None

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:

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

Detailed 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

Reading:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, *Introduction 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, Sartaj Sahni and Sanguthevar Rajasekaran, *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.

EC201	Digital System Design - I	PCC	3–0–0	3 Credits

Prerequisites: None

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

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:

CO \ PO	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:

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. Jayaram Bhasker, 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.

EC202	Signals and Systems	PCC	3–0–0	3 Credits

Prerequisites: None

Course outcomes: After completion of the course 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	Identify system properties based on impulse response and Fourier analysis.
CO5	Apply transform techniques to analyze continuous-time and discrete-time signals and systems.
CO6	Comprehensive understanding of control systems, order of systems & stability analysis

Mapping of course outcomes with program outcomes:

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

Detailed 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, Impulse sampling, sampling with zero order Hold, Reconstruction of signal from its samples using interpolation, Effect of under sampling

Z-TRANSFORM: Z-transform, Region of convergence and its properties, Inverse Z transform, properties of ZT, Analysis and characterization of LTI systems using ZT, LTI Systems, System function algebra and block diagram representations.

SIGNAL FLOWGRAPHS: Impulse Response and Transfer function of linear Systems, Block diagrams, Signal flow graphs, Basic properties of SFG, SFG Terms, SFG Algebra, Gain formula, Application of gain formula to block diagrams

Reading:

1. Alan V. Oppenheim, Alan S. Willsky, S. Hamid Nawab, Signals and Systems Prentice Hall India, 2nd Edition, 2009.
2. John G. Proakis, Dimitris G. Manolakis, Digital Signal Processing, Principles, Algorithms, and Applications, 4th Edition, PHI, 2007.
3. Robert A. Gable, Richard A. Roberts, Signals & Linear Systems, 3rd Edition, John Wiley, 1995.

EC203	Electronic Devices and Circuits-I	PCC	4–0–0	4 Credits

Prerequisites: EC101-Basic Electronic Engineering

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

CO1	Study and analyze the behavior of PN junction diodes.
CO2	Characterize the current flow of a bipolar transistor in CB,CE and CC configurations
CO3	Bias the transistors and FETs for amplifier applications.
CO4	Realize simple amplifier circuits using BJT and FET**.**
CO5	Analyse RC circuits for low pass and high pass filtering
CO6	Understand the Negative Resistance behavior of semiconductor devices

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

SEMICONDUCTOR DIODES: Band structure of pn junction, current components, Quantitative theory of pn diode, Volt-ampere characteristics and its temperature dependence, Narrow-base diode, Transition and diffusion capacitance of p-n junction diodes, Breakdown of junctions on reverse bias, Zener and Avalanche breakdowns.

JUNCTION TRANSISTOR: PNP and NPN junction 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, Ebers-Moll Model of BJT.

Negative Resistance Switching Circuits: Voltage controlled and Current controlled negative resistance circuits, Negative Resistance Characteristics,Tunnel diode and its V-I characteristics, Applications using Tunnel diode and UJT.

TRANSISTOR BIASING: The operating Point , DC & AC load lines, Fixed Bias and problems, Collector Feedback Bias, Emitter Feed Back Bias, Self-Bias and problems, Stabilization, various stabilization circuits, Thermal runaway and thermal stability.

FIELD EFFECT TRANSISTORS: JFET and its characteristics, Pinch off voltage and drain saturation current, MOSFET: enhancement, depletion modes, Biasing of FETs.

SMALL SIGNAL LOW FREQUENCY TRANSISTOR AMPLIFIER CIRCUITS: Transistor hybrid model, Analysis of transistor amplifier circuits using 'h' parameters, Conversion formulae for the parameters of the three configurations, Analysis of single stage transistor amplifier circuits, RC coupled amplifier. Effect of bypass and coupling capacitors on the low frequency response of the amplifier, FET amplifier configurations, Low frequency response of amplifier circuits, Analysis of single stage FET amplifier circuits.

WAVE SHAPING CIRCUITS: High pass and low pass circuits, Response to sine, step, pulse, square, and ramp inputs with different time constants, High pass as a differentiator, Low pass as an Integrator, Clipping circuits: Diode clippers, transistor clippers and two level clippers, Clamping circuits using diodes.

Reading:

1. Millman and Halkias, *Integrated Electronics*, 2nd Edition, Tata McGraw Hill, 2010.
2. Y.N. Bapat, *Electronic devices and circuits, Discrete and Integrated, 3rd Edition,* Tata McGraw Hill, 2011.
3. Millman and Taub, *Pulse, Digital and Switching Waveforms*, 3rd Edition, Tata McGraw-Hill Education, 2011.
4. David A. Bell, *Solid State Pulse Circuits,* 4th Edition, Prentice Hall India, 2009.
5. Robert L Boylested and Louis Nashelsky, *Electronic Devices and Circuit Theory*, 8th Edition, PHI, 2003.
6. David A Bell, *Electronic Devices and Circuits*, 4th Edition, PHI, 2003.

EC204	Electronic Devices and Circuits - I Laboratory	PCC	0–1–2	2 Credits

Prerequisites: EC101-Basic Electronic Engineering

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:

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

CS236	Data Structures Lab	ESC	0–1–2	2 Credits

Prerequisites: CS101-Problem Solving and Computer Programming

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

CO1	Write structured programs using the concepts of data structures.
CO2	Implement and analyze sorting algorithms.
CO3	Identity the data structure for a given problem.
CO4	Understand and implement the Stack ADT using array based and linked-list based data structures and also implement Stack applications.

Mapping of course outcomes with program outcomes:

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

List of 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 array
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 data structures:
    (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 of stack still take O(1) time.
12. Write a program to implement a queue using a linked list such that the *enqueue* and *dequeue* operations of queue take O(1) time.
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 a node
    (e) Find successor of a node
    (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.
16. Implement the following sorting algorithms:
    (a) Insertion sort
    (b) Merge sort
    (c) Quick sort
    (d) Heap sort
17. Write programs for implementation of graph traversals by applying: (a) BFS (b) DFS
18. Write programs to find out a minimum spanning tree of a simple connected undirected graph by applying: (a) Prim's algorithm (b) Kruskal's algorithm
19. Write a program to implement Dijkstra's algorithm for solving single source shortest path problem using priority queue.
20. Write a program to implement Floydd-Warshall algorithm for solving all pairs shortest path problem.

SM224	Macro Economics and Accountancy	HCS	3-0-0	3 Credits

Pre-requisites: None

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

CO1	**:** Sensitize the student to Macro Economic Environment.
CO2	**:** Understand various methods of Economic Analysis and apply
CO3	**:** Calculate Depreciation using various methods
CO4	**:** Analyze the financial statements with ratio's for investment decisions.
CO5	**:** Analyze costs and their role in pricing
CO6	**:** To develop effective presentation skills

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

MACRO ECONOMICS

1. National Income Accounting, Methods of Estimation, Various Concepts of National Income, Significance of National Income Estimation and its limitations.
2. Inflation, Definition, Process and Theories of Inflation and Measures to Control,
3. Balance of Payments and Exchange Rates
4. New Economic Policy 1991, LPG, Growth of Electronics Industry, startup culture and efforts of the government, NITI Aayog and Make in India.
5. Choosing between alternative investment proposals,methods of economic Analysis.
6. Financial IRR, Equity Vs Debt, Impact of borrowing on investment.
7. Depreciation and methods of calculating depreciation (Straight line, Sum of the years digit method, declining Balance Method, Annuity Method, Sinking Fund method)

ACCOUNTANCY

8. Analysis of financial statements, income statements and balance sheet (simple ratio's).
9. Cost Accounting, Introduction, Classification of costs, Methods of Costing, Techniques of Costing, Cost sheet and preparation cost sheet, Breakeven Analysis, Meaning and its application, Limitations.

Presentations/ Group Discussions on current topics.

Reading:

1. D N Dwivedi "Managerial Economics", Vikas Publishing House Private Limited
2. Agrawal AN, "Indian Economy" Wiley Eastern Ltd, New Delhi
3. R.K Sharma and Sashi K Gupta," Financial Management",Kalyani Publications
4. Arora, M.N." Cost Accounting", Vikas Publication

Source- Internet

- Latest trends in Indian Economy.
- Capitaline Plus Database – http://www.capitaline.com/
- Ministry of Finance – http:/finmin.nic.in/
- Database of Indian Economy - http://dbie.rbi.org.in
- Statistics of India – http://statistics ofindia.com/ or
  www.indiastat.com/ or http://mospi.nic.in/
- The Economist Magazine.

EC251	Digital System Design II	PCC	3–0–0	3 Credits

Prerequisites: EC201-Digital System Design- I

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

CO1	Design digital systems using Top-down design style and develop Verilog models
CO2	Realize ASM chart using the available synthesizing techniques or Verilog and CAD tools
CO3	Implementation of 32-bit MIPS processor on FPGA/CPLD prototype board
CO4	Understanding the concepts of memory hierarchies, cache memory and virtual memory

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

Elements of Design style, Top–down design, separation of controller and architecture, Refining architecture and control algorithm, Algorithmic state Machines (ASM), ASM chart notations.

Design of Digital systems using top-down approach: Serial to parallel data conversion, Traffic light controller, Vending machine controller and Serial adder, 32-bit MIPS processor.

Traditional synthesis for ASM charts and Multiplexer controller method, One -hot method and ROM based method.

Shift and add multiplier, Booth's multiplier, Modified booth's multiplier, Vedic Multiplier, Array multiplier, Non-restoring divider, Single precision Floating point adder/multiplier/divider, ALU, MAC unit, Barrel shifter

Programmable logic devices: CPLD/ FPGA devices, Design flow using FPGA/CPLD, Implementation of 32-bit MIPS processor

Memory management: memory hierarchies- cache memory organization, replacement policies; Virtual memory-Paging

Reading:

1. William J. Dally and John W. Poulton, *Digital Systems Engineering,* Cambridge University Press, 2008.
2. Franklin P. Processor, David E. Winkel, The Art of Digital Design: An Introduction to Top-Down Design, 2nd Edition, PTR Prentice Hall, 1987
3. John L. Hennessy David A. Patterson, Computer Organization and Design : The Hardware/Software Interface 4th Edition, Morgan Kaufmann, 2011
4. Sameer Palnitkar, Verilog HDL: A guide to digital Design and Synthesis, 2nd edition, Pearson, 2003

EC252	Electronic Devices and Circuits- II	PCC	4–0–0	4 Credits

Prerequisites: EC203- Electronic Devices and Circuits- I

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

CO1	Design and analyze multistage amplifiers.
CO2	Apply compensation techniques for stabilizing analog circuits against parameter variations
CO3	Design negative feedback amplifier circuits and oscillators
CO4	Analyze and design solid state power amplifier circuits.
CO5	Analyze and design tuned amplifier circuits.

Mapping of Course outcomes with Program outcomes:

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

Detailed Syllabus:

MULTISTAGE AMPLIFIERS: Classification of amplifiers, Distortion in amplifiers, Frequency response of an Amplifier, Bode plots, Step response of an amplifier, CE short circuit current gain, High frequency response of a CE stage. Gain bandwidth product, Emitter follower at high frequencies, Analysis of Multistage amplifier, Design of two stage amplifier, Common Source and Common Drain amplifier at high frequencies. Frequency response of cascaded stages, Cascode amplifiers (CE-CB), the effect of coupling and bypass capacitors, Differential amplifiers, Analysis of Differential amplifiers.

FEEDBACK AMPLIFIERS: Classification and representation of amplifiers, Feedback concept, the 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.

STABILITY AND RESPONSE OF FEEDBACK AMPLIFIER: Effect of feedback on bandwidth, Stability, Test of stability, Compensation, General method of compensation, Frequency response of feedback amplifier double pole transfer function. Phase Margin and gain Margin, Three pole transfer function with feedback amplifier response, approximate analysis of a multi pole feedback amplifier.
OSCILLATORS: 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.

POWER AMPLIFER: Class A, B, AB, and C power amplifiers, push – pull and complementary symmetry push-pull amplifier. Design of heat sinks, power output, efficiency, crossover distortion and harmonic distortion.

TUNED AMPLIFIER: Design and analysis of single tuned amplifier circuit with a capacitor coupled load, double tuned inter stage design. Stability consideration, Class B and class C tuned power amplifiers.

Reading:

1. Integrated Electronics J.Millman & Halkias, TMH
2. Micro Electronics 2nd Edition J.Millman & Arian Grabel, TMH.
3. Electronic circuits, 1st Ed., Md.Gausi, John Wiley
4. Micro Electronic Circuits, A.S.Sedra & K.C.Smith , 4th edition, Oxford press.

* * * *

EC253	Probability Theory and Stochastic Processes	PCC	3–0–0	3 Credits

Prerequisites: None

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

CO1	Distinguish between random and stochastic processes.
CO2	Model communication system as a stochastic process
CO3	Characterize LTI systems driven by a stationary random process using auto correlation and power spectral density functions.
CO4	Understand the probability distribution functions of noise in a communication link.

Mapping of course outcomes with program outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	1	-
CO2	2	2	-	-	-	-	-	-	-	-	-	2	1	-
CO3	2	3	-	-	-	-	-	-	-	-	-	-	1	1
CO4	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 distributions ,etc. 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, Nth 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, 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.

Reading:

1. P.Z. Peebles.Jr., PROBABILITY, RANDOM VARIABLES AND RANDOM SIGNAL PRINCIPLES, Tata McGraw Hill Education, 3rd edition, 2002.
2. A.Papoulis, Probability, Random variables and Stochastic Processes, McGraw Hill, 3rd edition, 1991.

EC254	Control System Engineering	DEC	3–0–0	3 Credits

Pre-requisites: None

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

CO1	Analyze electromechanical systems using mathematical modelling
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:

PO / CO	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.

Mathematical models – Differential equations, Impulse Response and transfer functions.

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- State Transition Matrix and it's Properties – Concepts of Controllability and Observability.

Reading:

1. Control Systems Theory and Applications - S. K. Bhattacharya, Pearson.
2. B.C. Kuo, Automatic Control Systems, 7th Edition, Prentice Hall of India, 2009.
3. I.J. Nagarath and M. Gopal: Control Systems Engineering, 2nd Edition, New Age Pub. Co. 2008.
5. Control Systems - N. C. Jagan, BS Publications.
6. Control Systems - A. Ananad Kumar, PHI.
7. Control Systems Engineering - S. Palani, TMH.
8. Control Systems - Dhanesh N. Manik, Cengage Learning.
9. Control Systems - N. K. Sinha, New Age International (P) Limited Publishers.

EC255	Transmission Lines & EM waves	PCC	3-0-0	3 Credits

Prerequisites: None

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

CO1	Introduce various types of transmission lines and analyze the lumped circuit model of a transmission line and their characteristics.
CO2	Use the smith chart as a graphical tool to solve impedance matching issues
CO3	Solve Maxwell's equations using vector calculus in three standard coordinate systems
CO4	Understand the power flow mechanism of plane wave
CO5	Deduce EM wave propagation in free space and in dielectric medium

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

Networks and Transmission line:

Image and iterative impedance, characteristic impedance

Types of Transmission lines, Applications of Transmission lines, Equivalent circuit of a pair of Transmission lines, Primary constants, transmission line equations, Secondary constants, Distortion less Transmission lines, Phase & Group velocities, Input impedance of Transmission line, Loading of Lines

RF lines:

RF lines, Lossless transmission lines, Relation between reflection coefficient, load and characteristic impedance, Relation between reflection coefficient and voltage standing wave ratio, Line of different lengths λ/8, λ/4, λ/2 , Losses in Transmission lines, Smith chart and applications, Impedance matching with single and double stubs.

Static Electric and steady Magnetic field:

Coordinate systems, Coloumb's law, Electric Field Intensity, Electric flux density, Gauss's law, Application of Gauss's law, point form of Gauss's law, potential, Potential gradient, Electric Dipole, Current and Current density, Continuity of current, Boundary conditions Poisson's and Laplace's equation. Ampere's law, curl, Vector magnetic potentials, Magnetic Boundary conditions.

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 materials, skin effect, Poynting vector and the flow of power: Poynting theorem, Polarization of plane waves. Power flow for a plane wave and Power loss in a plane conductor.

Reflection and Transmission of Plane Waves: Refelction and Transmission at a general dielectric interface, Normal Incidence, Refection and Transmission at conductor on oblique incidence, Oblique Incidence on dielectric Interfaces.

Reading:

1. John D. Ryder, “Network lines and Fields”, PHI, Second Edition (Reprint), 2008
2. Engineering Electromagnetics W H Hayt, J A Buck, Seventh Edition, Mc Graw Hill Companies, 2006
3. Elements of Electromagnetics, Matthew N O Sadiku, Fourth Edition, Oxford University Press, 2007
4. David K. Cheng, “Field and Wave Electromagnetics”, Pearson, 2e, 2014.
5. Electromagnetics, Krauss, Mc Graw Hill Companies.
6. Engineering Electromagnetics, Nathan Ida, Second Edition, Springer, 2005
7. Transmission Lines and Networks, JOHNSON, Mc-Graw Hill, 1950.
8. Electromagnetic Waves and Radiating Systems, EC Jordan & K. G. Balmain, Prentice Hall of India.

EC256	Electronic Devices and Circuits II Laboratory	PCC	0–1–2	2 Credits

Prerequisites: None.

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

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

Mapping of Course outcomes with Program outcomes:

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

LIST OF EXPERIMENTS:

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
12. Power amplifier
13. Tuned amplifier

EC257	Digital System Design Lab	PCC	0–1–2	2 Credits

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:

CO \ PO	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 models for
   a) 2-to-4 decoder
   b) 8-to-3 encoder
   c) 4:1 mux
   d) full adder/subtractor
   e) 8-bit parity generator/checker
   f) 8-bit Kogge-stone adder
2. Develop structural Verilog models for
   a) 16:1 mux realization using 4:1 mux
   b) 4-bit ripple carry adder using full adder
   c) 8-bit adder using 4-bit ripple carry adder
   d) 8-bit carry select adder using 4-bit ripple carry adder
   e) 16-bit adder by cascading an 8-bit Kogge-stone adder/Ripple carry adder
   f) 4-bit asynchronous up/down counter

3. Develop behavior Verilog models for
    a) 4-bit carry look-ahead adder
    b) 4-bit ripple carry adder
    c) Edge triggered T-FF/D-FF
    d) 16-bit synchronous up/down counter with asynchronous/synchronous load and clear
    e) 16-bit Universal shift register
4. Develop Verilog models for implementation of the following modules using top-down design style
    a) Serial Adder b) 16-bit Modified Booth's multiplier c) 16-bit Vedic multiplier d) 32-bit MIPS Processor.

EC301	Linear IC Applications	PCC	3-0-0	3 Credits

Pre-requisites: None

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:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	-	-	-	-	-	-	-	-	-	2	2
CO2	2	3	2	-	-	-	-	-	-	-	-	-	2	2
CO3	1	2	2	-	-	-	-	-	-	-	-	-	2	2
CO4	1	2	-	-	2	-	-	-	-	-	-	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. Practical op amps, Basic building blocks: Current sources and active loads

LINEAR AND NON-LINEAR APPLICATIONS OF OP-AMPS: 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 Monostable multi vibrator, Triangular wave- generators, RC-phase shift 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.

TIMERS & PHASE LOCKED LOOPS: 555 Timer functional diagram, monostable and astable operation, applications. 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.

IC VOLTAGE REGULATORS: Series op amp regulator, three terminal IC voltage regulator exercise problems. IC 723 general purpose regulator, Switching Regulator.

DIGITAL TO ANALOG AND ANALOG TO DIGITAL CONVERTERS: Weighted resistor DAC, R-2R and inverted R-2R DAC. IC DAC-08. Counter type ADC, successive approximation ADC, Flash ADC, dual slope ADC, 1-bit converters, sigma-Delta ADC. DAC and ADC Specifications, Specifications of AD 574 (12 bit 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, 2011.
3. Roy Choudary D. and Shail B. Jain, Linear Integrated circuits, 4th Edition, New Age International Publishers, 2010
4. Ramakant A.Gayakward, Op-Amps and Linear Integrated Circuits, 4th Edition, PHI, 2010.

EC302	Analog and Digital Communications	PCC	3-0-0	3 Credits

Pre-requisites: EC202-Signals and Systems

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

CO1	Compare the performance of AM, FM schemes
CO2	Model a Digital Communication System
CO3	Convert Analog signal to Digital Signal
CO4	Compare different digital modulation schemes.

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

INTRODUCTION: Introduction to communication system, Communication Channels, Need for modulation, Analog vs Digital, Review of Signals and Systems.

AMPLITUDE MODULATION: Definition, Time domain and frequency domain description - AM, DSB-SC, single tone modulation, power relations in AM waves, Generation of AM waves (square law, Switching), Envelop detector, Generation of DSBSC Waves (Balanced, Ring), Coherent detection of DSB-SC Modulated waves, COSTAS Loop.

SSB MODULATION: Time domain, Frequency domain description, Frequency discrimination, Demodulation of SSB Waves, Frequency Division Multiplexing, Vestigial side band modulation- Time domain, Frequency description, Envelope detection of a VSB Wave pulse Carrier, Comparison of AM Techniques, Applications of different AM Systems.

ANGLE MODULATION: Basic concepts, Frequency Modulation: Single tone frequency modulation, Spectrum Analysis of Sinusoidal FM Wave, Narrow band FM, Wide band FM, Constant Average Power, Transmission bandwidth of FM Wave – Generation and Demodulation of FM Waves; Comparison of FM and AM, Super heterodyne Receiver.

PULSE MODULATION TECHNIQUES: Pulse Analog and Pulse Digital Modulation Schemes–Pulse Amplitude Modulation, Pulse width modulation, PPM, TDM, Pulse Code Modulation, Differential PCM systems (DPCM), Delta modulation, adaptive Delta modulation, comparison of PCM and DM systems, noise in PCM and DM systems.

DETECTION AND ESTIMATION: Model of Digital Communication Systems, Gram-Schmidt Orthogonalization, Geometric interpretation of signals, detection of known signals in noise, probability of error, matched filter receiver, correlation receiver

BASE BAND SHAPING FOR DATA TRANSMISSION: Requirements of a line encoding format, various line encoding formats- Unipolar, Polar, Bipolar, Discrete PAM signals, Inter symbol interference, Nyquist's criterion, Raised cosine filter, Eye pattern.

DIGITAL MODULATION TECHNIQUES: Digital Modulation formats, Coherent binary modulation techniques (BPSK, BFSK), Coherent quadrature modulation techniques (QPSK), Non-Coherent binary modulation techniques (DPSK), QAM, M-ary modulation techniques (PSK, FSK, QAM), Comparison of M-ary digital modulation techniques, power spectra, bandwidth efficiency; BER for BPSK

Reading:

1. S. Haykin,"Communication Systems", John Wiley and Sons, 2001
2. B.P. Lathi, "Modern Digital & Analog Communications Systems", Oxford University Press
3. J. G. Proakis, M. Salehi, "Communication Systems Engineering", Pearson Education, 2002
4. H. Taub, D.L. Schilling, "Principles of Communication Systems", Tata McGraw Hill, 2001
5. Behrouz A. Forouzan, "Data communication and Networking", Tata McGraw Hill, 2007
6. Leon W.Couch II., Digital and Analog Communication Systems, 6th Edition, Pearson Education Inc., New Delhi, 2001.
7. A Bruce Carlson, PB Crilly, JC Rutledge, Communication Systems, 4th Edition, McGraw Hill New York, 2002.

EC303	CMOS VLSI Design	PCC	3-0-0	3 Credits

Pre-requisites: None

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

CO1	Explain the fabrication, operation and characteristics MOSFET
CO2	Analyze the performance of CMOS inverter
CO3	Design digital circuits using CMOS gates
CO4	Design analog circuits using CMOS gates
CO5	Outline the latest trends in CMOS technology

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

INTRODUCTION to MOSFETs: Unit process steps of CMOS technology, Fabrication process flow: NMOS, PMOS, Twin well CMOS; Structure and operation of the MOS transistor, I-V and C-V characteristics, MOSFET capacitances, layout, design rules, Scaling and Short channel effects.

MOS INVERTERS: Inverters with resistive, MOSFET load; CMOS inverter: Voltage transfer characteristics, Noise margins, switching characteristics, calculation of delay times; effect of load on switching characteristics and driving large loads, logical effort of paths

Digital circuits using CMOS: Pseudo NMOS, Pass transistor, transmission gates, Dynamic logic, Domino logic, Differential cascode voltage switch logic, design of combinational circuits, design of sequential circuits, timing requirements.

Analog circuits: Second order effects in MOSFETs. Single stage Amplifiers: Common-source stage, Source follower, Common-gate, Cascode stage, Differential Amplifiers, Passive and Active current mirrors, CMOS operational amplifier, gain boosting techniques.

Trends in CMOS technology: SOI, FinFET and multi-gate FET, 2D materials based FETs, On-chip interconnects.

Reading:

1. Sung-Mo Kang, Yusuf Leblebici Chulwoo kim, Digital Integrated Circuits: Analysis and Design, 4th Edition, McGraw Hill Education, 2016.
2. Behzad Razavi, Design of Analog CMOS Integrated Circuits, 2nd Edition, McGraw Hill Education, 2016.
3. Jan M RABAEY, Digital Integrated Circuits, 2nd Edition, Pearson Education, 2003.
4. Neil H.E. Weste and David Harris, CMOS VLSI Design: A circuits and systems perspective, 4th Edition, Pearson Education, 2015.

EC304	Antennas and Propagation	PCC	3-0-0	3 Credits

Pre-requisites: None

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

CO1	Analyze the electromagnetic wave propagation in guiding structures under various matching conditions.
CO2	Provide an understanding of antenna radiating principle and discuss the fundamental characteristics and parameters of antennas.
CO3	Develop the performance characteristics of antennas arrays, its operating principles, methods and concepts to design
CO4	Measure the antenna parameters
CO5	Understand the behavior of nature on EM wave propagation

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:
Review of electromagnetic fields

Guided waves: Waves between parallel planes, TE and TM waves, characteristics of TE and TM waves, TEM waves, Velocities of propagation, Wave Impedance.

Wave guides: Rectangular wave-guides, TE & TM modes in wave-guides, Wave Impedance in rectangular waveguides**.**

Antenna Fundamentals: Introduction to antennas & its significance, Scalar electric potential, vector magnetic potential, radiation from an alternating current element, Induction field, radiation field, power radiated by a current element, Definition of electric dipole, radiation by a half wave dipole. Power by a half wave dipole & its radiation resistance, Radiation from a quarter wave monopole Power radiation and radiation resistance of dipole & monopole (approximate analysis), Radiation resistance of aerials and loop, problems Isotropic radiator, network theorem, application of network theorem to antennas.

Antenna Parameters: Radiation pattern, power pattern, field pattern Radiation intensity, Antenna impedance, mutual impedance, gain and directivity, bandwidth, Polarization, efficiency, effective length, area or aperture, scattering loss, Collecting aperture, physical aperture---relation between large aperture and gain Effective aperture of a small elementary dipole, half wave antenna, effective length, front to back ratio, Antenna beam width and side lobes. Friss Transmission formula, Radar range equation**.**

Design of Arrays: N-element linear array- broadside array, End fire array, multiplication of patterns Effect of earth on vertical pattern mutual impedance effects, Binomial arrays, problem solving.

Practical antennas: VLF, LF, MF transmitting antennas, resonant & non resonant antennas, V antenna, travelling wave antenna, Rhombic antenna, VHF &UHF antennas, horn antenna Folded dipole & Yagi-Uda antenna, Parabolic reflector antenna,, Corner reflector, Parabolic reflector antenna, Micro strip Antennas**.**

Antenna impedance measurements: Radiation pattern measurements Measurement of antenna beam width and gain, Polarization measurements. Measurement of radiation resistance.

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

Reading:

1. E.C. Jordan & K.G. Balmain, Electromagnetic waves & Radiating Systems, PHI, 2007
2. Antenna Theory: Analysis and Design – Constantine A. Balanis, John Wiley & Sons, 3 rd Ed., 2009.
3. David K. Cheng, “Field and Wave Electromagnetics”, Pearson, 2e, 2014.
4. John D. Kraus, Antennas, 2nd Edition, McGraw Hill, 1988.
5. R.E. Collins, Antennas and Radio Propagation, Singapore: McGraw Hill, 1985.
6. David M. Pozar, “Microwave Engineering”, Wiley, 4e, 2012.

EC3051	OPTIMIZATION TECHNIQUES	DEC	3–0–0	3 Credits

Pre-requisites: None

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

Mapping of course outcomes with program outcomes:

CO \ PO	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-p^{th} 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

Reading:

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

EC3052	Statistical Signal Processing	DEC	3–0–0	3 Credits

Pre-requisites: EC253-Probability and Random Processes, and EC352-Digital Signal Processing

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

CO1	Acquire knowledge about Random Signal Processing,
CO2	Gain knowledge about estimating techniques
CO3	Evaluate adaptive filtering methods
CO4	Analyze spectrum with more accuracy

Mapping of course outcomes with program outcomes:

PO / CO	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

Detailed Syllabus:

Review of random variables:

Distribution and density functions, moments, independent, uncorrelated and orthogonal random variables; Vector-space representation of Random variables, Schwarz Inequality Orthogonality principle in estimation, Central Limit theorem, Random processes, wide-sense stationary processes, autocorrelation and auto-covariance functions, Spectral representation of random signals, Wiener Khinchin theorem Properties of power spectral density, Gaussian Process and White noise process, Linear System with random input, Spectral factorization theorem and its importance, innovation process and whitening filter, .Random signal modelling: MA(q), AR(p) , ARMA(p,q) models.

Parameter Estimation Theory:

Principle of estimation and applications, Properties of estimates, unbiased and consistent estimators, Minimum Variance Unbiased Estimates (MVUE), Cramer Rao bound, Efficient estimators; Criteria of estimation: the methods of maximum likelihood and its properties ; Bayesian estimation : Mean square error and MMSE, Mean Absolute error, Hit and Miss cost function and MAP estimation.

Estimation of signal in presence of white Gaussian Noise:

Linear Minimum Mean-Square Error (LMMSE) Filtering: Wiener Hoff Equation, FIR Wiener filter, Causal IIR Wiener filter, Non-causal IIR Wiener filter, Linear Prediction of Signals, Forward and Backward Predictions, Levinson Durbin Algorithm, Lattice filter realization of prediction error filters.

Adaptive Filtering:

Principle and Application, Steepest Descent Algorithm Convergence characteristics; LMS algorithm, convergence, excess mean square error, Leaky LMS algorithm; Application of Adaptive filters; RLS algorithm, derivation, Matrix inversion Lemma, Initialization, tracking of nonstationarity.

Kalman filtering:

State-space model and the optimal state estimation problem, discrete Kalman filter, continuous-time Kalman filter, extended Kalman filter.

Spectral analysis:

Estimated autocorrelation function, periodogram, Averaging the periodogram (Bartlett Method), Welch modification, Blackman and Tukey method of smoothing periodogram, Parametric method, AR(p) spectral estimation and detection of Harmonic signals, MUSIC algorithm.

Reading:

1. M. Hays: Statistical Digital Signal Processing and Modelling, John Willey and Sons, 1996.
2. M.D. Srinath, P.K. Rajasekaran and R. Viswanathan: Statistical Signal Processing with Applications, PHI, 1996.
3. Simon Haykin: Adaptive Filter Theory, Prentice Hall, 1996.
4. D.G. Manolakis, V.K. Ingle and S.M. Kogon: Statistical and Adaptive Signal Processing, McGraw Hill, 2000.
5. S. M. Kay: Modern Spectral Estimation, Prentice Hall, 1987.

EC3053	IOT	PCC	3–0–0	3 Credits

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

CO \ PO	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-attacks in centralized and distributed systems

Reading:

1. Designing the Internet of Things, by Adrian McEwen, Hakim Cassimally Wiley 2013

2. Enterprise IoT Naveen Balani Create Space Independent Publishing Platform 2016

EC3054	Computer Architectures	DEC	3-0-0	3 Credits

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:

CO \ PO	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

Detailed Syllabus:

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 addressing modes.

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.Carl Hamacher, Zvonko G. Varanesic and Safat G. Zaky, "Computer Organisation", VI edition, Mc Graw-Hill Inc, 2012.
3. William Stallings "Computer Organization and Architecture", Seventh Edition, Pearson Education, 2006.
4. Vincent P. Heuring, Harry F. Jordan, "Computer System Architecture", Second Edition, Pearson Education, 2005.
5. John P. Hayes, "Computer Architecture and Organization", Third Edition, Tata Mc Graw Hill,1998

EC306	Micro Controllers	PCC	3-0-0	3 Credits

Pre-requisites: EC201-Digital system design-I

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:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	-	3	-	-	-	-	-	-	-	-	2	-
CO2	-	3	-	3	-	-	-	-	1	-	-	-	2	-
CO3	-	3	-	-	-	-	-	-	1	-	-	-	2	-
CO4	-	2	-	3	-	-	-	-	1	-	-	-	2	-
CO5	-	2	-	3	-	-	-	-	1	-	-	-	2	-
CO6	2	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.
4. D. V. Hall. Microprocessors and Interfacing, TMGH. Second Edition 2006.
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.

EC307	Micro controllers Laboratory	PCC	0-1-2	2 Credits

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:

CO \ PO	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

EC308	Integrated Circuit Applications Lab	PCC	0-1-2	2 Credits

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

CO1	Measure the parameters of IC 741 Op-amp.
CO2	Realize analog filters using Op-amp.
CO3	Plot the characteristics of TTL NAND Gate.
CO4	Design monostable and astable multivibrators using 555 IC.
CO5	Design modulo-N counters using TTL ICs. .

Mapping of course outcomes with program outcomes:

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

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.amp monostable and astable multivibrators.

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 astable multivibrators.

12: Mod-N counter using 7492 and 74192.

13: Shift register IC 7495.

14: Low voltage regulator IC 723.

EC351	Data Networks	PCC	3-0-0	3 Credits

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:

CO \ PO	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, IEEE 802.3; 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; IPv6 summary.

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.

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, 4/e, Pearson/Addison Wesley, 2008.
3. BEHROUZ A. FOROUZAN, Data Communications and Networking, 2nd Edition, Tata McGraw-Hill, New Delhi, 2003
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, 2004.
6. A. S. Tanenbaum, Computer Networks, 4/e, PHI, 2000.
7. W. Stallings, Data and Computer Communication, 7/e, Prentice-Hall, 2004.

EC352	Digital Signal Processing	PCC	3-0-0	3 Credits

Pre-requisites: None

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

CO1	Find DFT of a given signal through Fast Fourier Transform Techniques
CO2	Design FIR and IIR type 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	Compare the key architectural features of DSP Processors.

Mapping of course outcomes with program outcomes:

CO \ PO	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:

DISCRETE FOURIER TRANSFORM (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 - Radix 2 (DIT & DIF), Radix 4, 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.

DIGITAL FILTERS: Linear phase FIR filter, characteristic response, location of zeros, Design of FIR filter - Windowing, Frequency sampling, Design of IIR filters from Analog filters - Impulse invariance, Bilinear transformation, Matched z-transform. Quantization of filter coefficients - Sensitivity to Quantization of filter coefficients, Quantization of coefficients in FIR filters, Round off 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 & Implementation for sampling rate conversion, Applications: Phase Shifters, Digital Filter Banks, Sub band Coding of Speech Signals, Quadrature Mirror Filters, Trans multiplexers, Over Sampling A/D and D/A Conversion.

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

ACTIVE LEARNING ASSIGNMENTS:

Suggested List: Simulate the following

1 Direct form – I, II form realization of the given IIR system function.

2 plot pole-zero of a given FIR filter.

3 (i) Create Blackman, Hanning, Hamming and Gaussian window and plot them in the same filter design tool. (ii) Design an FIR filter with side lobe attenuation of 40 dB using Kaiser Window of 200 points.

4 (i) Design low pass butter worth digital filter with given specification using impulse invariance method. (ii) Design a high pass elliptical filter with given specification using impulse invariance method. (iii) Design a band pass chebychev-2 filter with given specification using impulse invariance method.

5 Design a second-order digital bandpass Butterworth filter with the following specifications: f_u= 2.6 kHz,f_L = 2.4 kHz , f_s = 8000 Hz. Plot the magnitude and phase response.

6 The time shifting and frequency shifting property of DTFT.

7 The Linear and circular convolution, correlation of two sequences using DFT.

8 To up sample the sinusoidal sequence by an integer factor.

9 To down sample the sinusoidal sequence by an integer factor.

10 To convert the sampling by non-integer factor of a sinusoidal sequence.

Note:

Design based Problems (DP)/Open Ended Problem: Apply Digital Signal Processing technique to any one specific area like Speech processing, Image processing, Audio processing, Bio-Medical Instrumentation, Encoding of signals, Signal Compression etc. Develop a program for the same using MATLAB/SciLab of equivalent software.

Reading:

1. J.G.PROAKIS & D.G.MANOLAKIS, Digital Signal Processing - Principles, algorithms & Applications, PHI, 2000.
2. .B.Venkataramani, M.Bhaskar, "Digital Signal Processors, Architecture, Programming and Application", Tata McGraw Hill, New Delhi, 2003
3. A.V. Oppenheim and Ronald W. Schafer, Discrete Time Signal Processing, 2nd Edition, PHI, 2000.
4. S.K.MITRA, Digital Signal Processing – A computer Based Approach, 2nd Edition, MGH, 2001.
5. Multi Rate Systems and Filter Banks – P.P.Vaidyanathan – Pearson Education.
6. Fundamentals of Digital Signal Processing using Matlab – Robert J. Schilling, Sandra L. Harris, Thomson, 2007

EC353	Embedded and Real Time operating Systems	PCC	3-0-0	3 Credits

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-soft ware co-design, and Hardware Software Trade-offs.

Mapping of COs and POs:

CO \ PO	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 Communication Interfaces

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, McGraw Hill
2) Embedded Systems Design –Santanu Chattopadhyay, PHI, 2013.
3) Embedded System Design -Frank Vahid, Tony Givargis, John Wiley
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.

EC354	Information Theory & Coding	PCC	3-0-0	3 Credits

Pre-requisites: EC302-Analog and Digital communication

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

CO1	Acquire knowledge about information and entropy.
CO2	Analyze source-coding and channel-coding techniques
CO3	Specify specific error detecting and error correcting codes in a precise mathematical manner.
CO4	Develop and execute encoding and decoding algorithms associated with the major classes of error detecting and error correcting codes.

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

INFORMATION THEORY: Uncertainty, Information & Entropy, Source coding theorem, The kraft inequality, Huffman coding, Shannon-Fano coding, variable-length coding, Discrete memory-less channels, Channel representation, channel matrix, Types of channels- lossless, deterministic, noise less, binary symmetric channel.

CHANNEL CAPACITY: Mutual information, Channel capacity, Shannon Hartley law, channel coding theorem, differential entropy, mutual information for continuous ensembles, channel capacity theorem.

LINEAR BLOCK CODES: Introduction to error correcting codes, basic definitions, A Prelude, Galois Field- addition and multiplication tables, Matrix Description of Linear block Codes , Equivalent codes, The Parity Check Matrix , Decoding of linear block codes, syndrome decoding, The Standard Array, Error probability after coding, Perfect codes, Hamming codes, Low density parity check codes (LDPC), LDPC encoder , LDPC decoder (Tanner graphs).

CYCLIC CODES: Introduction to Cyclic codes, Polynomials, Algebraic description of Cyclic codes, The Division algorithm for polynomials, a method for generating cyclic codes, Matrix description of cyclic codes, Systematic and non-systematic encoding and parity check matrix, Circuit implementation of cyclic codes- Systematic Encoding using generator polynomial and parity check polynomial, Syndrome Decoding- Meggit decoder, Binary CRC codes.

CONVOLUTIONAL CODES: Introduction to Convolutional codes, Tree codes and Trellis codes, Polynomial description of Convolutional codes (analytical representation), Distance notions for Convolutional codes, Matrix description of Convolutional codes, Viterbi decoding, Trellis coded modulation(TCM), Turbo codes- Interleaving, puncturing and Encoding Parallel Concatenated Codes, Turbo decoding Algorithms.

Reading:

1. S. Haykin, Digital Communications, John Wiley & Sons, 2009.
2. Shulin/ Daniel J.Costello Jr., Error Control Coding, Prentice Hall series in computer applications in electrical engineering series (2/e) 2005.
3. R Bose, “Information Theory, Coding and Cryptography”, TMH 2007
4. B.P. Lathi, “Modern Digital & Analog Communications Systems”, Oxford University Press
5. Todd K. Moon, Error Correction coding, John Wiley, 2005.
6. John G.Proakis, Digital Communications, 3rd edition, McGraw Hill, 1995.
7. S Gravano, “Introduction to Error Control Codes”, Oxford University Press 2007
8. Amitabha Bhattacharya, “Digital Communication”, TMH 2006
9. Fred Halsall, “Multidedia Communications: Applications, Networks, Protocols and Standards”, Perason Education Asia, 2002

EC3561	Digital Switching and Multiplexing	DEC	3–0–0	3 Credits

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:

CO \ PO	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.

Digital transmission, Frequency Division multiplexing, Time Division multiplexing, Statistical Division Multiplexing, switching hierarchy, Synchronous digital hierarchy both USA and European 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 and Blocking Probability, traffic measurement, Mathematical model, Incoming traffic and service time characteristics, Blocking models and loss estimates, delay systems.

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, frequency justification and payload framing, virtual tributes, DS3 payload mapping, E4 payload mapping, SONET optical standards, SONET rings & networks.

Reading:

1. Digital Telephony, John C Bellamy, 3/e, Wiley-India, 1999.
2. Telecommunication Switching Systems and Networks, T Viswanathan, PHI, 1997.
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.

EC3562	Low Power VLSI Design	DEC	3-0-0	3 Credits

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 COs with POs

PO / CO	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 Graw Hill
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.

EC3563	Smart Antenna	DEC	3-0-0	3 Credits

Pre-requisites: None

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

CO1	To Familiarize with smart and adaptive antennas.
CO2	To study about the different adaptive algorithms for the antenna.
CO3	Understanding the concept of direction of arrival and angle of arrival
CO4	To analyze the effect of mutual coupling and to study the space time.

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

Introduction

Introduction to Smart Antennas, Architecture of a Smart Antenna System: Transmitter and Receiver, Smart Antenna Configurations: Switched and Fixed Beam Antennas, Adaptive Antenna Approach, Types of Smart Antennas, Benefits and Drawbacks of Smart Antennas, Applications of Smart Antennas.

Fixed Beam Smart Antenna Systems

Introduction, Conventional Sectorization, Antenna Arrays Fundamentals: Linear Arrays, Array Weighting, Circular Arrays, Rectangular Planar Arrays, Fixed Side lobe Canceling, Retro directive Arrays, Beamforming, Adaptive Arrays, Butler Matrix, Spatial Filtering with Beam formers, Switched Beam Systems, Multiple Fixed Beam System.

Adaptive Array Systems

Uplink Processing: Diversity Techniques, Angle Diversity, Maximum Ratio Combining, Adaptive Beamforming, Fixed Multiple Beams versus Adaptive Beamforming.

Downlink Processing: Transmit Diversity Concepts, Downlink Beamforming, Spatial Signature-Based Beamforming, and DOA-Based Beamforming.

Angle-of-Arrival Estimation

Fundamentals of Matrix Algebra, Array Correlation Matrix, AOA Estimation Methods: Bartlett AOA Estimate, Capon AOA Estimate, Linear Prediction AOA Estimate, Maximum Entropy AOA Estimate, Pisarenko Harmonic Decomposition AOA Estimate, Min-Norm AOA Estimate, MUSIC AOA Estimate, ESPRIT AOA Estimate.

Mobile Stations' Smart Antennas

Introduction, Multiple-Antenna MS Design, RAKE Receiver Size, Mutual Coupling Effects, Dual-Antenna Performance Improvements, Downlink Capacity Gains, Principles of MIMO systems: SISO, SIMO, MISO,MIMO.

Reading:

1. Ahmed El Zooghby, 'Smart Antenna Engineering', ARTECH HOUSE, INC, 2005.
2. Frank B. Gross, 'Smart antenna with MATLAB', Second Edition, McGraw-Hill, 2015.

EC3564	WEB TECHNOLOGIES	DEC	3-0-0	3 Credits

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 COs with POs:

CO \ PO	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:

Creating home pages, Introduction to XHTML- Editing XHTML, First XHTML Example, W3C XHTML Validation Service, Headers, Linking, Images, Special Characters and More Line Breaks, Unordered Lists, Nested and Ordered Lists, Internet and World Wide Web Resources.

Dynamic HTML: Object Model and Collections- Introduction, Object Referencing, Collections all and children, Dynamic Styles, Dynamic Positioning, Using the frames Collection, navigator Object, Summary of the DHTML Object Model, Dynamic HTML: Event Model- Introduction- Event onclick, Event on load, Error Handling with one error, Tracking the Mouse with Event onmousemove, Rollovers with onmouseover and onmouseout, Form Processing with onfocus and onblur, More Form Processing with onsubmit and onreset, Event Bubbling, More DHTML Events. Dynamic HTML Filters and transitions, Dynamic HTML Data binding with tabular data control, structured graphics and active X control.

JavaScript: Functions- Introduction, Program Modules in JavaScript, 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, JavaScript objects.

Extensible Markup Language (XML)- Introduction, Structuring Data, XML Namespaces, Document Type Definitions (DTDs) and Schemas, Document Type Definitions, W3C XML Schema Documents, XML Vocabularies, Chemical Markup Language (CML), Other Markup Languages, Document Object 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.

EC357	Communication Systems Laboratory	PCC	0-1-2	2 Credits

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:

CO \ PO	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. Fourier Synthesis

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

EC358	Data Networks Laboratory	PCC	0-1-2	2 Credits

Objectives: The laboratory provides practical exposure and handson training to students with data networks and data transmission. They will learn the socket programming to build network application, visualize the protocols of data link, network and transport layer. Wireshark, NS-2 simulator are used to train the students in monitoring traffic on the network and simulate wired and wireless networks.

Pre-requisites: EC351-Data Networks

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

CO1	The students on completion of the lab possess a solid foundation in networking concepts and practices
CO2	On completion of the lab students get trained in working knowledge of IP addressing, TCP/IP operation, LAN solutions, OSI Models, Network Topology, modern hardware and various networking devices.
CO3	On completion of the lab students get trained to use of network protocol analyzer and network simulator to understand, administrate and maintain the operations of wired and wireless networks.

Mapping of course outcomes with program outcomes:

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

List of Experiments:

Week 1: Understanding the basic networking commands and their operation in Windows and Linux.

Week 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.

Week 3: Study and analyze the design concept and working principle of NITW campus network.

Week 4: Simulation of Computer Networks using Network Simulation software. It makes possible to build, configure networks and verify its availability.

Week 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.

Week 6: Network Socket programming: TCP/UDP Client-Server program.

Week 7: Analyzing the network traffic using network analyzer software – Wireshark.

Week 8: Internal Exam

Week 9 & 10: 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)

Week 11 & 12: Simulation of wired network using Network Simulator NS2.

a) Monitoring traffic for the given topology b) Analysis of CSMA and Ethernet protocols c) Network Routing: Shortest path routing, DVR, LSR. d) Analysis of congestion control (TCP and UDP).

Week 13 & 14: Simulation of Wireless networks (Wifi & Bluetooth) using NS2.

a) Monitoring wireless traffic for the given topology b) Analysis of CSMA and Ethernet protocols c) Network Routing: AODV, DSR. d) Analysis of congestion control (TCP and UDP).

Week 15: Skill test

Week 16: End exam

EC401	Electronic Instrumentation	PCC	3–0–0	3 Credits

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 and Harmonic Distortion Analyzer.
CO6	Identify data acquisition system for a specific application

Mapping of course outcomes with program outcomes:

CO \ PO	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.

Impedance Measurement: Kelvin Bridge; Megger; Maxwell, Hay and Shering Bridges. 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 Storage Oscilloscopes.

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, McGraw Hill.
2. Electronic Instrumentation & Measurement techniques, by W.D.Cooper & Felbrick, PHI.
3. Electronic Instrumentation and Measurements, by D.A. Bell, Reston.
4. H S Kalsi, Electronic Instrumentation, McGraw Hill, 3rd Edition, 2011.

EC402	Cellular and Mobile Communications	PCC	3–0–0	3 Credits

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.

Mapping of course outcomes with program outcomes:

CO \ PO	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.

Reading:

1. William C Y Lee, "Mobile Cellular Telecommunications, McGraw Hill.(Main Book)
2. Stallings, *Wireless Communications and Networks*, Prentice Hall.
3. Schwartz, *Mobile Wireless Communications*, Cambridge University Press.(Main Book)
4. Theodore S Rappaport, "Wireless Communications Principles and Practice", Prentice Hall.

EC403	Advanced Digital Signal Processing	PCC	3-0-0	3 Credits

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:

CO \ PO	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 DCTs and 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 addressing modes, on chip peripherals, Architecture of TMS 320 C5X/6X,Bus structure, Programme controller, CALU, IDEX, ARCER, ALU, BMAR, on-chip memory,TMS320C5X Assembly language, Instruction pipelining in C5X,Applications programs in C5X.

Signal analysis with higher order spectra.

Reading:

1. Simon Haykin, Adaptive Filter Theory, Prentice Hall, Second Edition, 2001.
2. Janes V.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, 2nd Edition, 2001.
6. Reference Manuals of Texas TMS 320X and Analog Devices 21XX Processors.

EC4041	FUZZY LOGIC & NEURAL NETWORKS (Elective)	DEC	3-0-0	3 credits

Prerequisites: None

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

CO1	Understand the fundamentals and types of neural networks
CO2	Explain the learning and adaptation capability of neural networks
CO3	Design, Analyze and train the neural network models
CO4	Describe the principles of knowledge based neural networks.
CO5	Understand engineering applications that can learn using neural networks
CO6	Understand the fuzzy sets, and apply the knowledge for representation using fuzzy rules

Mapping of course outcomes with program outcomes

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	-	2	2
CO2	-	-	3	-	-	-	-	-	-	-	-	-	2	2
C03	-	-	-	-	-	-	2	-	-	-	-	-	2	2
C04	-	-	-	-	-	-	2	-	-	-	-	-	2	2
C05	-	-	-	-	-	-	-	-	3	-	-	-	2	2
C06	-	-	-	-	-	-	-	-	-	2	-	-	2	2

Detailed Syllabus:

INTRODUCTION: Background and History; Knowledge-based Information processing; Neural Information Processing; Hybrid Intelligence.

BASIC NEURAL COMPUTATIONAL MODELS: Basic concepts of Neural Nets (such as node properties, Network properties and Dynamics); Inference and learning (Data representation and functional classification); Classification models (single layer Perceptrons, multi-layer perceptrons); Association models (Hop field Nets, Bi- directional associative memories); Self organizing models (Kohonen Networks, Competitive learning, Hebbian learning).

LEARNING: Supervised and Unsupervised learning; Statistical learning; Neural Network learning (Back propagation, Radial basis Function Networks, ART Networks); Genetic Algorithms.

KNOWLEDGE BASED NEURAL NETWORKS & INCREMENTAL LEARNING: Rule-based Neural networks; Network Training; Decision Tree Based NN's; Principles; Symbolic methods; Neural Network Approaches (Probabilistic NN's); Incremental RBCN.

NN APPLICATIONS: Signal Processing; Computer Vision; Medical Applications; Automated Inspection and Monitoring; Business and Finance.

FUZZINESS Vs PROBABILITY: Fuzzy Sets & Systems; The Geometry of Fuzzy sets; The Fuzzy Entropy theorem; The subset hood Theorem; The Entropy Subset hood theorem.

FUZZY ASSOCIATIVE MEMORIES: Fuzzy & Neural Function Estimators; Fuzzy Hebbian FAMs; Adaptive FAMs.

COMPARISON OF FUZZY & NEURAL SYSTEMS: Case studies.

Reading:

1. Neural Networks in Computer Intelligence by Limin Fu, McGraw Hill Co., 1994.
2. Neural Networks & Fuzzy systems by B.Kosko, Prentice Hall (India) Ltd., 1992.
   Chapters: 7, 8, 9, 10, 11
3. Neural Networks – A Comprehensive Foundation by S.Haykin, Maxell Macmillan International, 1991.

EC4042	Satellite Communication	DEC	3–0–0	3 Credits

Prerequisites: 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.

Mapping of course outcomes with program outcomes:

CO \ PO	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:

Reading:

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.

EC4043	SoC Design	DEC	3–0–0	3 Credits

Prerequisites: None

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

CO1	To understand the basic concepts of SOC design.
CO2	To summarize and explain the performance evaluation methods
CO3	To classify and understand the power management process and modeling design tools
CO4	To understand and study the micro-architecture design and modeling, software and hardware design verifications

Mapping of course outcomes with program outcomes:

CO \ PO	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

Detailed Syllabus:

System Level Design: System level design-Tools & methodologies for system level design, System level space & modelling languages, SOC block based design & IP assembly, Performance evaluation methods for multiprocessor SOC design

Power Management And Synthesizing : System level power management, Processor modelling & design tools, Embedded software modelling & design Using performance metrics to select microprocessor for IC design, Parallelizing High-Level Synthesize, A code transformational approach to High Level Synthesize.

Micro-Architecture Design and Power Optimization: Micro-architecture design, Cycle accurate system – level modelling, Performance evaluation, Micro architectural power estimation optimization, Design planning.

Software Design Verification: logical verification, Design & Verification languages, Digital simulation, using transactional, level models in an SOC design, Assertion based verification.

Hardware Design Verification: Hardware acceleration & emulation, Formal property verification, TEST, DFT, ATPG, Analog & mixed signal test

Reading:

1. Louis Scheffer Luciano Lavagno and Grant Martin, “EDA for IC System verification and Testing”, CRC, 2006.
2. Wayone Wolf, “Modern VLSI Design: SOC Design”
3. Prakash Rashnikar, Peter Paterson, Lenna Singh “System-On-A-Chip Verification methodology & Techniques”, Kluwer Academic Publishers.
4. Alberto Sangiovanni Vincentelli,” Surviving the SOC Revolution: A Guide to Platform based Design”, Kluwer Academic Publishers.

EC4044	Digital Image Processing	DEC	3–0–0	3 Credits

Prerequisites: None

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

CO1	Understand the need for image transforms and their properties.
CO2	Choose appropriate technique for image enhancement both in spatial and frequency domains.
CO3	Identify causes for image degradation and apply restoration techniques.
CO4	Compare the image compression techniques in spatial and frequency domains.
CO5	Select feature extraction techniques for image analysis and recognition.

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

INTRODUCTION: Digital Image Representation, Fundamental Steps in Image Processing, Elements of Digital Image Processing Systems.

DIGITAL IMAGE FUNDAMENTALS: Elements of Visual Perception, A Simple image model, Sampling and Quantization, Neighborhood of Pixels, Pixel Connectivity, Labeling of Connected Components, Distance Measures, Arithmetic and Logic Operations, Image Transformations, Perspective Transformations, Stereo Imaging.

IMAGE ENHANCEMENT: Spatial Domain Methods, Frequency Domain Methods, Point processing, Intensity Transformations, Histogram Processing, Spatial filtering, Smoothing Filters, Sharpening Filters, Enhancement in the Frequency Domain, Low Pass Filtering, High Pass Filtering, Homomorphic filtering,

WAVELETS and MULTIRESOLUTION PROCESSING: Sub band Coding, Haar Transform, Multiresolution Series Expansions, Wavelet Transforms in One Dimension, Discrete Wavelet Transform, Fast Wavelet Transform, Wavelet Transforms in Two Dimensions, Wavelet Packets

IMAGE COMPRESSION: Fundamentals of Compression, Image Compression Model, Error free Compression, Lossy Predictive Coding, and Transform Coding.

IMAGE SEGMENTATION: Detection of Discontinuities, Line Detection, Edge Detection, Edge Linking and Boundary Detection, Thresholding, Threshold Selection on Boundary Characteristics, Region Growing, Region Splitting and Merging, Use of motion in Segmentation.

IMAGE REPRESENTATION AND DESCRIPTION: Chain Codes, Polygonal Approximations, Signatures, Skeleton, Boundary Descriptions, Shape Numbers, Fourier descriptors, Moments, Topological Descriptors.

IMAGE RECOGNITION AND INTERPRETATION: Elements of Image Analysis, Pattern and Pattern Classes, Minimum Distance Classifier, Matching by Correlation, Baye's Classifier, Neural Network Training Algorithm, Structural methods.

Reading:

1. Rafael C Gonzalez and Richard E Woods, Digital Image Processing, Pearson Education Asia, New Delhi, 2000.
2. B. Chanda, D. Dutta Majumder, Digital Image Processing and Analysis, PHI, New Delhi, 2000.
3. A.K. Jain, Fundamentals of Digital Image Processing, PHI, New Delhi, 2001.

EC4051	Speech Processing	DEC	3–0–0	3 Credits

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.

Mapping of course outcomes with program outcomes:

CO \ PO	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.

Reading:

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 Prina Ricotti, "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.

EC4052	Software Defined radio	DEC	3-0-0	3 credits

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 of SDR
CO4	Analyze the transmitter and receiver architectures in SDR

Mapping of course outcomes with program outcomes:

CO \ PO	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-Digital and Digital-to-Analog Conversion- Introduction – Digital Conversion Fundamentals-Sample Rate- Bandpass Sampling- Oversampling- Anti alias Filtering – Quantization

ADC Techniques-Successive Approximation- Figure of Merit-DACs- DAC Noise Budget- ADC Noise 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 Beam Forming.

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. Jouko Vanakka, Digital Synthesizers and Transmitter for Software Radio, Springer, 2005.
4. P Kenington, RF and Baseband Techniques for Software Defined Radio, Artech House, 2005.

EC 4053	Industrial IOT	DEC	3-0-0	3 credits

Prerequisites: None

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

CO1	Use of Devices, Gateways and Data Management in IoT.
CO2	Applications of IoT in Industrial Automation and Real World.
CO3	Security in IOT

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

Overview and Introduction: Internet of Things (IoT) and Web of Things (WoT): What's WoT?, The Internet of Things Today, Time for Convergence, Towards the IoT Universe, Internet, of Things Vision, IoT Strategic Research and Innovation Directions, IoT Applications, Future Internet Technologies, Infrastructure, Networks and Communication, Processes, Data Management, Security, Privacy & Trust, Device Level Energy Issues, IoT Related Standardization, Recommendations on Research Topics.

M2M to IoT A Basic Perspective: Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven, global value chain and global information monopolies.

M2M to IoT-An Architectural Overview: Building architecture, Main design, principles and needed capabilities, An IoT architecture outline, standards considerations.

IoT Architecture -State of the Art: Introduction, State of the art, Architecture Reference Model-Introduction, Reference Model and architecture, IoT reference Model, IoT Reference Architecture-Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

IoT Applications for Value Creations: Introduction, IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Four Aspects in your Business to Master IoT, Value, Creation from Big Data and Serialization, IoT for Retailing Industry, IoT For Oil and Gas, Industry, Opinions on IoT Application and Value for Industry, Home Management, eHealth.

Internet of Things Privacy, Security and Governance: Introduction, Overview of Governance, Privacy and Security Issues, Contribution from FP7 Projects, Security, Privacy and Trust in IoT Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach.

Reading:

1. From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence: By Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, 1st Edition, Academic Press, 2014.
2. Internet of Things (A Hands-on-Approach), by Vijay Madisetti and Arshdeep Bahga, 1st Edition, VPT, 2014.

EC 4054	RF IC Design	DEC	3-0-0	3 credits

Prerequisites: 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.

Mapping of COs with POs

CO \ PO	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

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

Reading:

1) Behzad Razavi, RF Microelectronics Prentice Hall of India, 2001
2) Thomas H. Lee, The Design of CMOS Radio Integrated Circuits**,** Cambridge University Press.

EC 4055	Nano Electronics	DEC	3-0-0	3 credits

Prerequisites: None

CO1	be able to problematize the limitations of traditional technologies
CO2	be able to describe the function of a number of nano devices
CO3	be able to explain where nano devices can be used
CO4	know how nano devices can be used in communication technology.

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

Introduction: Recent past, the present and its challenges, Future, Overview of basic Nano electronics.

Nano electronics & Nano computer architectures: Introduction to Nano computers, Nano computer Architecture, Quantum DOT cellular Automata (QCA), QCA circuits, Single electron circuits, molecular circuits, Logic switches – Interface engineering – Properties (Self-organization, Size-dependent) – Limitations.

Nanoelectronic Architectures: Nanofabrication – Nanopatterning of Metallic/Semiconducting nanostructures (e-beam/X-ray, Optical lithography, STM/AFM- SEM & Soft-lithography) – Nano phase materials – Self assembled Inorganic/Organic layers.

Spintronics: Introduction, Overview, History & Background, Generation of Spin Polarization Theories of spin Injection, spin relaxation and spin dephasing, Spintronic devices and applications, spin filters, spin diodes, spin transistors.

Memory Devices And Sensors: Memory devices and sensors – Nano ferroelectrics – Ferroelectric random access memory –Fe-RAM circuit design –ferroelectric thin film properties and integration – calorimetric -sensors – electrochemical cells – surface and bulk acoustic devices – gas sensitive FETs – resistive semiconductor gas sensors –electronic noses – identification of hazardous solvents and gases –semiconductor sensor array

Reading:

1. Nanoelectronics & Nanosystems: From Transistor to Molecular & Quantum Devices: Karl Goser, JanDienstuhl and others.
2. Nano Electronics and Information Technology: Rainer Waser
3. Concepts in Spintronics – Sadamichi Maekawa
4. Spin Electronics – David Awschalom

EC407	DSP & Instrumentation laboratory	PCC	0-1-2	2 Credits

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:

PO / CO	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 and recording.
6. Development of signal condition circuit and interfacing to read.

PART – B

1. To perform basic arithmetic operations on DSP processor (TMS320C6748) using CCS
2. To perform linear and circular convolution on DSP processor
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

SM703	Industrial Management	ESC	3–0–0	3 Credits

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.
CO5	Understand and use appropriate methods/tools of inventory classification and control in industry.
CO6	Recognize activities with their interdependency so as to optimize time vs costs utilizing the Techniques of project management/CPM.

Mapping of COs with POs:

CO \ PO	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.2001.
- Jones, G. R., & Jones, G. R. (2013). *Organizational theory, design, and change*. Upper Saddle River, NJ: Pearson
- 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. (1980). *Industrial engineering and management*. Dhanpat Rai.
- Meridith, J. R. (2006). Project Management. A Management Approach.
- 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. (2011). Marketing Management 14e 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.

EC451	Microwave & Light Wave Technologies	PCC	3–0–0	3 Credits

Prerequisites:

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

Mapping of course outcomes with program outcomes:

CO \ PO	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.

<u>Reading:</u>

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
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

EC 4521	Computer Vision	DEC	3-0-0	3 credits

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

Mapping of course outcomes with program outcomes:

CO \ PO	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

Reading:

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 Education.

EC 4522	Bio-Medical Instrumentation	DEC	3-0-0	3 Credits

Prerequisites: None

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

CO1	Model biological systems.
CO2	Comprehend the principles of transducers in bio-instrumentation.
CO3	Analyze the ECG, EEG and EMG.
CO4	Measure bio medical signal parameters.
CO5	Study pace makers, defibrillators, surgical instruments etc.

Mapping of COs and POs :

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	3	-	-	-	-	-	-	3	-	-	2	2
CO2	-	-	3	-	-	-	-	-	-	3	-	2	2	2
C03	-	-	-	-	-	-	-	-	-	3	-	2	2	2
C04	-	-	-	-	-	-	-	-	-	3	-	-	2	2
CO5	-	-	-	-	-	-	-	-	-	3	-	-	2	2

Detailed Syllabus:

BASICS OF BIOMEDICAL INSTRUMENTATION: Terminology, Medical Measurements constraints, Classification of Biomedical Instruments, Introduction to biological system modelling; Electrical and ionic properties of cellular membranes, Sources and theories of bioelectric potentials.

BIOMEDICAL TRANSDUCERS: Types of transducers used in Bio-instrumentation. Recording electrodes, Electrodes theory, Biopotential electrodes, Biochemical electrodes

BIOMEDICAL SIGNAL MEASUREMET BASICS: Bioamplifiers, Measurement of PH, oxygen and carbondioxide

THERAPEUTIC AND PROSTHETIC DEVICES: Cardiac Pacemakers, defribillators, Hemodynamics & Hemodialysis,Ventilators, InfantIncubators, Surgical Instruments, Therapeutic Applications of the Laser.

CARDIOVASCULAR MEASUREMENTS: Blood flow, pressure; Cardiac output and impedance measurements; Pleathysmography, Measurement of Heart sounds, An Introduction to Electrocardiography (ECG), Elements of Intensive care monitoring heart-rate monitors; Arrhythmia monitors.

EEG & EMG: Anatomy and Functions of Brain, Bioelectric Potentials from Brain, Resting Rhythms, Clinical EEG, Instrumentation techniques of electroencephalography, Electromyography

MEDICAL IMAGING SYSTEMS: Radiography, MRI, Computed Tomography, Ultrasonography

NONINVASIVE INSTRUMENTATION: Temperature Measurements, Principles of Ultrasonic Measurements, Ultrasonic and its applications in medicine.

BIOTELEMETRY: Introduction to Biotelemetry, Physiological parameters adaptable to biotelemetry, Biotelemetry System Components, Implantable units and Applications of Telemetry in Patient Care.

Reading:

1. L.A.Geddes and Wiley, Principles of Biomedical Instrumentation L.E.Baker (2nd Ed.)
2. L.Cromwell, Biomedical Instrumentation and Measurements, Prentice Hall.
3. John G.Webster (Ed.), Medical Instrumentation – Application and Design, 3rd Edition, John Wiley & Sons Inc.

EC 4523	Wireless Networks	DEC	3-0-0	3 credits

Prerequisites: None

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

CO1	Identify and explain the fundamental concepts of wireless network architecture, layer technologies and Wireless LAN, PAN and MAN devices.
CO2	Represent the RF and IR communication spectrum details and propagation principles.
CO3	Understand the concepts of wireless LAN standards and their implementation details
CO4	Identify and explain the Wireless LAN security methodologies
CO5	Understand wireless PAN and MAN standards and their implementation details
CO6	Identify the important aspects of the future wireless networking technologies.

Mapping of course outcomes with program outcomes:

CO \ PO	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
CO5	2	-	-	-	-	-	-	-	-	-	-	-	2	2
CO6	2	-	-	-	-	-	-	-	2	-	-	-	2	2

Detailed Syllabus:

Introduction: Introducing Wireless Networking, Wireless Network Logical Architecture, the OSI Network Model, Network Layer Technologies, Data Link Layer Technologies, Physical Layer Technologies, Wireless Network Physical Architecture, Wired Network Topologies, Wireless LAN Devices, Wireless PAN Devices, Wireless MAN Devices

Wireless Communication: Radio Communication Basics, RF Spectrum, Spread Spectrum Transmission , Wireless Multiplexing and Multiple Access Techniques, Digital Modulation Technique , RF Signal Propagation and Reception, Ultra-Wideband Radio, MIMO Radio, Near Field Communications , Infrared Communication Basics , Ir Spectrum , Infrared Propagation and Reception

Wireless LAN Implementation: The 802.11 WLAN Standards, The 802.11 MAC Layer, 802.11 PHY Layer, Implementing Wireless LANs, Planning and Designing the Wireless LAN, Pilot Testing, Installation and Configuration , Operation and Support , A Case Study: Voice over WLAN,

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

Wireless PAN: Implementation, Wireless PAN Standards, Bluetooth (IEEE 802.15.1), Wireless USB, ZigBee (IEEE 802.15.4), IrDA, Near Field Communications**,** Implementing Wireless PANs,
Wireless PAN Technology Choices, Pilot Testing, Wireless PAN Security

Wireless MAN: Implementation, Wireless MAN Standards, 802.16 Wireless MAN Standards, Metropolitan Area Mesh Networks, Implementing Wireless MANs, technical Planning, Business Planning, Start-up Phase, Operating Phase, Future of Wireless Networking Technology, Leading Edge Wireless Networking Technologies, Wireless Mesh Network Routing, Network Independent Roaming, Gigabit Wireless LANs, Cognitive Radio.

Reading:

1. Steve Rackley, Wireless Networking Technology, Elsevier, 2007.
2. Ivan Marsic: Wireless Networks- Local and Ad Hoc Networks, Rutgers University, 2008.
3. Wireless Communications and Networks, Williant Stallings, Second Edition, Pearson, 2005
4. A. S. Tanenbaum, Computer Networks, Third Edition, PHI, 2003.
5. Koushik Sinha, Sasthi C. Ghosh, Bhabani Wireless Networks and Mobile Computing, Chapman and Hall/CRC, 2015.

EC 4524	Green Communication	DEC	3-0-0	3 Credits

Prerequisites: EC402-Cellular communication principles

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

CO1	Recognize the challenges in energy efficiency and spectral efficiency for digital data transmission
CO2	Suggest the methods to manage the dynamic loads of mobile communications for energy saving
CO3	Indicate the design practices for power minimization at cellular base station
CO4	Practice cell deployment strategies for efficient network management

Mapping of course outcomes with program outcomes

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

Detailed Syllabus:

Green Wireless Communications : Introduction - Preliminaries - Effective Capacity and Energy Per Information Bit - Variable-Rate/Variable-Power and Variable-Rate/Fixed-Power Transmissions - Fixed-Rate/Fixed-Power Transmissions - Transmissions over Imperfectly-Known Wireless Channels - Energy Efficiency in the Low-Power Regime - Energy Efficiency in the Wideband Regime

Energy Efficiency-Spectral Efficiency Trade-off in Cellular Systems: Spectral Efficiency; Energy Efficiency; Energy Efficiency-Spectral Efficiency Trade-Off; Idealistic vs. Realistic Power Consumption Model; MIMO vs. SISO: An Energy Efficiency Analysis; Power Model Implications

Energy Savings for Mobile Communication Networks through Dynamic Spectrum and Traffic Load Management : Dynamic Spectrum and Traffic Load Management ; Power Saving by Dynamically Powering Down Radio Network Equipment ; Power Saving by Propagation Improvement ; Power Saving by Channel Bandwidth Increase or Better Balancing Performance Assessment ; Power Saving by Propagation Improvement.

Minimizing Power Consumption to Achieve More Efficient Green Cellular Radio Base Station Designs: Explosive Traffic Growth - Cellular Scenarios - Energy Metrics; Energy Reduction Techniques for High Traffic Load Scenarios; Energy Reduction Techniques for Low Traffic Load Scenarios, Other Energy Reduction Techniques.

Green Wireless Access Networks: Energy Efficiency and Network Technologies; Cell Deployment Strategies; Relaying Techniques; Base Station Coordination and Cooperation; Adaptive Network Reconfiguration; Radio Resource Management; Future Architectures;

Green Ad Hoc and Sensor Networks: Energy Harvesting Techniques.

Reading:

1. Green Communications: Theoretical Fundamentals, Algorithms, and Applications, Jinsong Wu, Sundeep Rangan, Honggang Zhang

2. Green Communications and Networking; F. Richard Yu, Xi Zhang, Victor C.M. Leung

EC 4531	Radar Engineering	DEC	3-0-0	3 credits

Prerequisites: None

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 aids

Mapping of course outcomes with program outcomes:

CO \ PO	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

Reading:

1. M.I. Skolnik, Introduction Radar Systems, Second Edition, Mc Graw Hill Book Co., 1981
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.

EC 4532	Introduction to MEMs	DEC	3-0-0	3 credits

Prerequisites: EC203-Electronic Circuits

CO1	To gain basic knowledge on overview of MEMS (Micro electro Mechanical System)
CO2	To gain basic knowledge on overview of various fabrication techniques
CO3	To design, analysis, fabrication and testing the MEMS based components.
CO4	To introduce the students various opportunities in the emerging field of MEMS.

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

INTRODUCTION TO MEMS AND MICROFABRICATION

History of MEMS Development, Characteristics of MEMS-miniaturization – microelectronics integration - Mass fabrication with precision. Micro fabrication - microelectronics fabrication process-silicon based MEMS processes- new material and fabrication processing- points of consideration for processing.

ELECTRICAL AND MECHANICAL PROPERTIES OF MEMS MATERIALS

Conductivity of semiconductors, crystal plane and orientation, stress and stain – definition – relationship between tensile stress and stain- mechanical properties of silicon and thin films, Flexural beam bending analysis under single loading condition- Types of beam- deflection of beam-longitudinal stain under pure bending spring constant, torsional deflection, intrinsic stress, resonance and quality factor.

SENSING AND ACTUATION

Electrostatic sensing and actuation-parallel plate capacitor – Application-Inertial, pressure and tactile sensor parallel plate actuator- comb drive. Thermal sensing and Actuations-thermal sensors-Actuators- Applications- Inertial, Flow and Infrared sensors. Piezo resistive sensors- piezo resistive sensor material- stress in flexural cantilever and membrane-Application-Inertial, pressure, flow and tactile sensor.

Piezoelectric sensing and actuation- piezoelectric material properties-quartz-PZT-PVDF –ZnO Application-Inertial, Acoustic, tactile, flow-surface elastic waves. Magnetic actuation- Micro magnetic actuation principle- deposition of magnetic materials-Design and fabrication of magnetic coil.

BULK AND SURFACE MICROMACHINING

Anisotropic wet etching, Dry etching of silicon, deep reactive ion etching (DRIE), and Isotropic wet etching, Basic surface micromachining process- structural and sacrificial material, stiction and antistiction methods, Foundry process.

POLYMER AND OPTICAL MEMS

Polymers in MEMS- polymide-SU-8 liquid; crystal polymer (LCP)-PDMS-PMMA-Parylene-Flurocorbon, Application-Acceleration, pressure, flow and tactile sensors. Optical MEMS-passive MEMS, optical components-lenses-mirrors-Actuation for active optical MEMS.

Reading:

[1].Chang Liu, "Foundations of MEMS", Pearson International Edition, 2006.

[2].Gaberiel M.Rebiz, "RF MEMS Theory,Design and Technology", John Wiley & Sons,2003

[3].Charles P.Poole, Frank J.Owens, "Introduction to nanotechnology" John Wiley & sons, 2003.

[4].Julian W.Gardner, Vijay K Varadhan, "Microsensors, MEMS and Smart devices", John Wiley & sons, 2001.

EC 4533	5G communication	DEC	3-0-0	3 credits

Prerequisites: EC402-Communication

CO1	Learn 5G technology & its features
CO2	Learn the Key RF, PHY, MAC, and air interface changes required to support 5G
CO3	Understand the Radio technology that enables devices to communicate directly with each other without any additional network infrastructure.
CO4	Evaluate implementation options for 5G

Mapping of course outcomes with program outcomes:

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

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

5G wireless Propagation Channels: Channel modeling requirements, propagation scenarios and challenges in the 5G modeling

5G Wireless System Architecture : Basic Radio Accesses Network (RAN) architecture, High level requirements for the 5G Technology, Functional Architecture and flexibility – integration of LTE, LTEA and new air-interface to fulfill 5G requirements, Enhanced multi RAT coordination towards 5G; Physical Architecture and Deployment – Deployment enablers, flexible function placement in 5G deployments

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); 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, beam-forming, physical layer techniques, interference and mobility management ; Massive MIMO

MAC Layer for 5G: Overview of Wireless MAC Protocols and its Characteristics; Case Study; Implementation and Analysis of MAC Protocols in Lab View/MATLAB

Reading:

1. Martin Sauter “From GSM From GSM to LTE–Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband”, Wiley-Blackwell
2. Afif Osseiran, 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. Theodore S.Rappaport, Robert W.Heath, Robert C.Danials, James N.Murdock “Millimeter Wave Wireless Communications”, Prentice Hall Communications
5. Jonathan Rodriguez, “Fundamentals of 5G Mobile Networks”, John Wiley & Sons

EC 4541	Testing and Testability of VLSI circuits	DEC	3-0-0	3 credits

Prerequisites: None

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

CO1	Identify the significance of testable design
CO2	Understand the concept of yield and identify the parameters influencing the same.
CO3	Specify fabrication defects, errors and faults
CO4	Implement combinational and sequential circuit test generation algorithms
CO5	Identify techniques to improve fault coverage

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

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. Modelling basic concepts, Functional modelling at logic level and register level, structure models, logic simulation, delay models. Various types of faults, Fault equivalence and Fault dominance in combinational sequential circuits.

Fault simulation applications, General fault simulation algorithms- Serial, and parallel, Deductive fault simulation algorithms.

Combinational circuit test generation, Structural Vs Functional test, ATPG, Path sensitization methods. Difference between combinational and sequential circuit testing, five and eight valued algebra, and Scan chain based testing method.

D-algorithm procedure, Problems, PODEM Algorithm. Problems on PODEM Algorithm. FAN Algorithm. Problems on FAN algorithm, Comparison of D, FAN and PODEM Algorithms. Design for Testability, Ad-hoc design, Generic scan based design.

Classical scan based design, System level DFT approaches Test pattern generation for BIST, Circular BIST. BIST Architectures. Testable memory design-Test algorithms-Test generation for Embedded RAMs.

Reading:

1. M. Abramovici, M. Breuer, and A. Friedman, "Digital Systems Testing and Testable Design, IEEE Press, 1990.
2. Stroud, "A Designer's Guide to Built-in Self-Test", Kluwer Academic Publishers, 2002
3. M. Bushnell and V. Agrawal, "Essentials of Electronic Testing for Digital, Memory & Mixed-Signal VLSI Circuits", Kluwer Academic Publishers, 2000.
4. V. Agrawal and S.C. Seth, Test Generation for VLSI Chips, Computer Society Press.1989

EC 4542	Cloud Computing	DEC	3-0-0	3 credits

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

Mapping of course outcomes with program outcomes:

PO / CO	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.

Reading:

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.

EC4543	Optical Communication	DEC	3–0–0	3 Credits

Prerequisites: None

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

CO1	Identify and characterize different components of an Optical Fiber Communication link.
CO2	Analyze optical source, Fiber and Detector operational parameters
CO3	Compute optical fiber link design parameters
CO4	Understand WDM, Optical Amplifiers, Optical Switching and networking technology concepts.

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

Motivation for optical communications, advantages of optical fibers, optical bands, telecom signal multiplexing, optical multiplexing standard, key elements of optical fiber communication link.

Optical windows, standards, few exercise problems. Linear polarization, optical laws, polarizer, fiber types, rays and modes, ray optics, Numerical aperture, optical fiber modes, evanescent tails, mode cutoff condition, wave equation in SI fibers, modes in SI fibers, LP modes, Single mode fibers, graded index fibers.

Fiber materials, fiber fabrication, Fiber optic cables, exercise problems. Attenuation in fibers, absorption and scattering losses, bending losses, chromatic dispersion, modal delay, group delay, material dispersion, signal distortion in SM fibers, cutoff wavelength, mode field diameter, specialty fibers, exercise problems.

Energy bands, pn junction, LED structures, light source materials, quantum efficiency and LED power, modulation of LED, exercise problems.

Laser diode, structure, modes and threshold conditions, single mode lasers, modulation of laser diodes, external modulation, linearity, exercise problems.

Source to fiber power launching, lensing schemes, fiber to fiber joints, fiber splicing, fiber connectors, exercise problems. Photo diode principles, Avalanche photodiode, photo detector noise, detector response time, structures for APD, exercise problems.

Optical receiver operation, error sources, digital receiver performance, receiver sensitivity, eye pattern features, coherent detection, heterodyne detection, BER comparisons, analog receivers, exercise problems.

Digital links, point to point links, link power budget, error control, Analog links, CNR, photo detector and preamplifier noise, multichannel AM, multichannel FM, RF over fiber, exercise problems,

WDM overviews, operational principles, WDM standards, optical coupler, star coupler, optical isolator, fiber Bragg grating, tunable optical filters, optical add/drop multiplexers, exercise problems. Optical amplifiers, basic operation, amplifier gain, Erbium doped fiber amplifiers, amplification mechanism, EDFA architecture, optical network concepts, topologies, SONET/SDH transmission formats and speeds, optical cross connect switches,

Reading:

1. GERD KEISER, Optical Fiber Communications, TMH India, Fourth Edition, 2010.
2. SENIOR JOHN M., Optical Fiber Communications, Pearson Education India, Third Edition, 2009.

EC4544	COMMUNICATION PROTOCOLS FOR INSTRUMENTATION	DEC	3-0-0	3 Credits

Prerequisites: None

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

CO1	Quantitative analysis of individual components of industrial data communications.
CO2	Analysis and specification of serial communication protocol standards.
CO3	Understanding the error detection, cable shielding techniques to avoid stray pickups, noise.
CO4	Systematic understanding and development of industrial communication protocols.

Mapping of course outcomes with program outcomes

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

Detailed Syllabus:

Overview: Standards, OSI model, Protocols, Physical standards, Modern instrumentation and control systems, PLCs, Smart instrumentation systems, Communication principles and modes, error detection, Transmission, UART.

Serial communication standards: Standards, serial data communication interface standards, EIA-RS232 interface standard, RS-449, RS-422, RS-423 and RS-485 standards, Troubleshooting and testing with RS-485, GPIB standard, USB interface.

Error Detection, Cabling and Electrical Noise: Errors, Types of error detection, control and correction, copper and fiber cables, sources of electrical noise, shielding, cable ducting and earthling.

Modems and Multiplexers: Synchronous and Asynchronous modes, flow control, modulation techniques, types of a modem, modem standards, terminal and statistical multiplexers.

Communication Protocols: Flow control protocols, XON/XOFF, BSC, HDLC and File transfer protocols, OSI model and layers, ASCII protocols, Modbus protocol.

Industrial Protocols: Introduction to HART protocol, Smart instrumentation, HART physical layer, HART data link layer, HART application layer, ASD_i interface, Seriplex, CANbus, Devicenet, Profibus, FIP bus, Fieldbus.

Local Area Networks: Circuit and packet switching, Network topologies, Media access control mechanisms, LAN standards, Ethernet protocol, Token ring protocol

Reading:

1. Practical data communications for instrumentation and control: John Park, Steve Mackay, Edwin Wright, Elsevier Newnes Publisher, 2008.

EC455	Microwave and Light wave technologies Lab	PCC	0–1–2	2 Credits

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.

Mapping of COs with POs:

CO \ PO	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:

Antenna Demonstration

Mode characteristics of Reflex Klystron

Gunn oscillator characteristics and power measurement

Measurement of VSWR & impedance

Measurement of radiation pattern and gain of an antenna

Properties of circulators & Directional coupler

Properties of the Magic Tee Junction

Vector Network Analyzer Demonstration

Measurement of Numerical Aperture

Integrated Voice and Data Optical Communication System

Study of Optical Sources, Detectors and Fiber Characteristics

CE390	Environmental Impact Analysis	OPC	3–0–0	3 Credits

Pre-requisites: None

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

CO1	Identify the environmental attributes to be considered for the EIA study.
CO2	Formulate objectives of the EIA studies.
CO3	Identify the suitable methodology and prepare Rapid EIA.
CO4	Prepare EIA reports and environmental management plans.
CO5	Plan the methodology to monitor and review the relief and rehabilitation works.

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

Introduction: The Need for EIA, Indian Policies Requiring EIA , The EIA Cycle and Procedures, Screening, Scoping, Baseline Data, Impact Prediction, Assessment of Alternatives, Delineation of Mitigation Measure and EIA Report, Public Hearing, Decision Making, Monitoring the Clearance Conditions, Components of EIA, Roles in the EIA Process. Government of India Ministry of Environment and Forest Notification (2000), List of projects requiring Environmental clearance, Application form, Composition of Expert Committee, Ecological sensitive places, International agreements.

Identifying the Key Issues: Key Elements of an Initial Project Description and Scoping, Project Location(s), Land Use Impacts, Consideration of Alternatives, Process selection: Construction Phase, Input Requirements, Wastes and Emissions, Air Emissions, Liquid Effluents, Solid Wastes, Risks to Environment and Human, Health, Socio-Economic Impacts, Ecological Impacts, Global Environmental Issues.

EIA Methodologies**:** Criteria for the selection of EIA methodology, impact identification, impact measurement, impact interpretation & Evaluation, impact communication, Methods-Adhoc methods, Checklists methods, Matrices methods, Networks methods, Overlays methods, Environmental index using factor analysis, Cost/benefit analysis, Predictive or Simulation methods. Rapid assessment of Pollution sources method, predictive models for impact assessment, Applications for RS and GIS.

Reviewing the EIA Report: Scope, Baseline Conditions, Site and Process alternatives, Public hearing. Construction Stage Impacts, Project Resource Requirements and Related Impacts, Prediction of Environmental Media Quality, Socio-economic Impacts, Ecological Impacts,

Occupational Health Impact, Major Hazard/ Risk Assessment, Impact on Transport System, Integrated Impact Assessment.

Review of EMP and Monitoring: Environmental Management Plan, Identification of Significant or Unacceptable Impacts Requiring Mitigation, Mitigation Plans and Relief & Rehabilitation, Stipulating the Conditions, What should be monitored? Monitoring Methods, Who should monitor? Pre-Appraisal and Appraisal.

Case Studies: Preparation of EIA for developmental projects- Factors to be considered in making assessment decisions, Water Resources Project, Pharmaceutical industry, thermal plant, Nuclear fuel complex, Highway project, Sewage treatment plant, Municipal Solid waste processing plant, Tannery industry.

Reading:

1. Jain, R.K., Urban, L.V., Stracy, G.S., *Environmental Impact Analysis*, Van Nostrand Reinhold Co., New York, 1991.
2. Barthwal, R. R., *Environmental Impact Assessment*, New Age International Publishers, 2002
3. Rau, J.G. and Wooten, D.C., *Environmental Impact Assessment,* McGraw Hill Pub. Co., 1996.
4. Anjaneyulu.Y., and Manickam. V., Environmental Imapact Assessment Methodologies, B.S. Publications, Hyderabad, 2007.
5. Wathern.P., Environmental Impact Assessment- Theory and Practice, Routledge Publishers, London, 2004.

EE390	LINEAR CONTROL SYSTEMS	OPC	3–0–0	3 Credits

Pre-requisites: None.

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

CO1	Analyze electromechanical systems using mathematical modelling
CO2	Determine Transient and Steady State behavior of systems using standard test signals
CO3	Analyze 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:

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

Detailed syllabus:

Introduction

Control system, types, feedback and its effects-linearization

Mathematical Modeling of Physical Systems:

Block diagram Concept and use of Transfer function. Signal Flow Graphs, Mason's gain formula.

Time Domain Analysis of Control Systems - BIBO stability, absolute stability, Routh-Hurwitz Criterion.

P, PI and PID controllers. Root Locus Techniques - Root loci theory, Application to system stability studies.

Introduction to state variables technique, Analysis of R-L, R-L-C networks.

Frequency Domain Analysis of Control Systems - polar plots, Nyquist stability criterion, Bode plots, application of Bode plots.

Reading:

1. B.C.Kuo, Automatic Control Systems, 7th Edition, Prentice Hall of India, 2009.
2. I.J. Nagarath and M. Gopal: Control Systems Engineering, Second Edition, New Age Pub. Co.2008.

EE391	Soft Computing Techniques	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes:

CO1	Understand the concepts of population based optimization techniques
CO2	Examine the importance of exploration and exploitation in heuristic optimization techniques to attain near-global optimal solution
CO3	Evaluate the importance of parameters in heuristic optimization techniques
CO4	Apply for the solution of multi-objective optimization

Mapping of course outcomes with program outcomes

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

Detailed Syllabus:

FUNDAMENTALS OF SOFT COMPUTING TECHNIQUES

Definition-Classification of optimization problems- Unconstrained and Constrained optimization Optimality conditions- Introduction to intelligent systems- Soft computing techniques- Classification of meta-heuristic techniques - Single solution based and population based algorithms – Exploitation and exploration in population based algorithms - Properties of Swarm intelligent Systems - Application domain - Discrete and continuous problems - Single objective and multi-objective problems.

GENETIC ALGORITHM AND PARTICLE SWARM OPTIMIZATION

Genetic algorithms- Genetic Algorithm versus Conventional Optimization Techniques - Genetic representations and selection mechanisms; Genetic operators- different types of crossover and mutation operators -Bird flocking and Fish Schooling – anatomy of a particle- equations based on velocity and positions -PSO topologies - control parameters. Application to SINX maximization problem.

ANT COLONY OPTIMIZATION AND ARTIFICIAL BEE COLONY ALGORITHMS

Biological ant colony system - Artificial ants and assumptions - Stigmergic communications - Pheromone updating- local-global - Pheromone evaporation - ant colony system- ACO models- Touring ant colony system-max min ant system - Concept of elistic ants-Task partitioning in honey bees - Balancing foragers and receivers - Artificial bee colony (ABC) algorithms-binary ABC algorithms.

SHUFFLED FROG-LEAPING ALGORITHM AND BAT OPTIMIZATION ALGORITHM

Bat Algorithm- Echolocation of bats- Behavior of microbats- Acoustics of Echolocation- Movement of Virtual Bats- Loudness and Pulse Emission- Shuffled frog algorithm-virtual population of frogs-comparison of memes and genes -memeplex formation- memeplex updation.

Application to multi-modal function optimization

Introduction to Multi- Objective optimization-Concept of Pareto optimality.

Reading:

1. Xin-She Yang, "Recent Advances in Swarm Intelligence and Evolutionary Computation", Springer International Publishing, Switzerland, 2015.
2. Kalyanmoy Deb "Multi-Objective Optimization using Evolutionary Algorithms", John Wiley & Sons, 2001.
3. James Kennedy and Russel E Eberheart, "Swarm Intelligence", The Morgan Kaufmann Series in Evolutionary Computation, 2001.
4. Eric Bonabeau, Marco Dorigo and Guy Theraulaz, "Swarm Intelligence-From natural to Artificial Systems", Oxford university Press, 1999.
5. David Goldberg, "Genetic Algorithms in Search, Optimization and Machine Learning", Pearson Education, 2007.
6. Konstantinos E. Parsopoulos and Michael N. Vrahatis, "Particle Swarm Optimization and Intelligence: Advances and Applications", InformatIon science reference, IGI Global, 2010.
7. N P Padhy, "Artificial Intelligence and Intelligent Systems", Oxford University Press, 2005.

ME390	AUTOMOTIVE MECHANICS	OPC	3–0–0	3 Credits

Pre-requisites: None

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

CO1	Analyze operation and performance indicators of transmission systems, internal combustion engines and after treatment devices.
CO2	Understand operation of engine cooling system, lubrication system, electrical system and ignition system.
CO3	Understand fuel supply systems in an diesel and petrol vehicles
CO4	Analyze current and projected future environmental legislation and its impact on design, operation and performance of automotive power train systems.
CO5	Understand operation and performance of suspension, steering and braking system.
CO6	Understand layout of automotive electrical system

Mapping of course outcomes with program outcomes:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	-	2	-	-	3
CO2	-	-	-	-	-	-	-	-	2	-	-	3
CO3	-	-	-	-	-	-	-	-	-	-	-	3
CO4	-	-	-	-	-	-	-	-	2	-	2	3
CO5	-	2	-	-	-	-	-	-	-	-	-	3
CO6	-	3	-	-	-	-	-	-	-	-	-	-

Detailed syllabus:

Introduction: Layout of an automotive chassis, engine classification.

Cooling Systems: Air cooling, air cleaners, Water cooling: Thermosyphon and pump circulation systems, Components of water cooling systems- Radiator, thermostat etc.

Engine Lubrication: Petroils system, Splash system, Pressure lubrication and dry sump system

Ignition System: Battery, Magneto and Electronic, Engine Starting drives Fuel supply system: Components in fuel supply system, types of feed pumps, air cleaners, fuel and oil filters, pressure and dry sump systems.

Engine testing and Performance: Performance parameters, constant and variable speed test, heat balance test, performance characteristics. Engine Emissions: SI and CI engine emissions, emission control methods

Automotive electrical and electronics: Electrical layout of an automobile, ECU, sensors, windscreen wiper, Electric horn.

Transmission: Clutch**-** Single and multiplate clutch, semi & centrifugal clutch and fluid flywheel, Gear box: Sliding mesh, constant mesh and synchromesh gear box, selector mechanism, over drive, Propeller shaft and Differential.

Suspension System: Front and rear suspension, shock absorbers, Rear Axles mountings, Front Axle. Steering Mechanism: Manual and power steering systems, Braking System: Mechanical, Hydraulic and Air braking systems.

Engine service: Engine service procedure.

Reading:

1. S. Srinivasan, Automotive Mechanics, Tata McGraw-Hill, 2004.
2. K.M.Gupta, Automobile Engineering, Vol.1 and Vol.2, Umesh Publications, 2002
3. Kirpal Singh, Automobile Engineering, Vol.1 and Vol.2, Standard Publishers, 2003.
4. William H.Crouse and Donald L. Anglin, Automotive Mechanics, Tata McGraw-Hill, 2004
5. Joseph Heitner, Automotive Mechanics, East-West Press, 2000.

ME391	ROBUST DESIGN	OPC	3–0–0	3 Credits

Pre-requisites: None

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

CO1	Understand stages in engineering design and concept of robust design.
CO2	Develop quality loss functions and S/N ratios for S, N and L type objective functions.
CO3	Identify control and noise factors for a given product or process.
CO4	Conduct experiments using DOE concepts to decide the optimal setting of parameters
CO5	Apply quality loss function approach for fixing the component tolerances.

Mapping of course outcomes with program outcomes:

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

Detailed syllabus:

Introduction: Taguchi's quality philosophy, causes of performance variation, concept of robust design, stages in product/process design, need for experimentation, QFD, process flow analysis, cause and effect diagram.

Design of Experiments**:** Principles of experimentation, Basic concepts of probability and statistics, Comparison of two means and two variances, Comparison of multiple (more than two) means & Anova, Factorial designs, fractional factorial designs, orthogonal arrays, standard orthogonal arrays & Interaction tables, modifying the orthogonal arrays, selection of suitable orthogonal array design, analysis of experimental data.

Parameter Design**:** Loss function, average quality loss, S/N ratios, objective functions, selection of control & noise factors and their levels, strategy for systematic sampling of noise, classification of control factors, inner-array and outer-array design, data analysis, selection of optimum levels/values for parameters.

Tolerance Design: Experiments, selection of tolerances to be tightened, fixing the final tolerances.

Reading:

1. Taguchi G, Chowdhury S and Taguchi S, Robust Engineering, TMH, 2000.
2. Ross PJ, Taguchi Techniques for Quality Engineering, TMH, 2005.

ME392	ENTREPRENEURSHIP DEVELOPMENT	OPC	3–0–0	3 Credits

Pre-requisites: None

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

CO1	Understand entrepreneurship and entrepreneurial process and its significance in economic development.
CO2	Develop an idea of the support structure and promotional agencies assisting ethical entrepreneurship.
CO3	Identify entrepreneurial opportunities, support and resource requirements to launch a new venture within legal and formal frame work.
CO4	Develop a framework for technical, economic and financial feasibility.
CO5	Evaluate an opportunity and prepare a written business plan to communicate business ideas effectively.
CO6	Understand the stages of establishment, growth, barriers, and causes of sickness in industry to initiate appropriate strategies for operation, stabilization and growth.

Mapping of course outcomes with program outcomes:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	-	3	-	2	-
CO2	-	-	-	-	-	-	-	-	2	-	3	-
CO3	-	-	-	-	-	-	-	-	-	2	3	-
CO4	-	-	-	-	-	-	-	-	-	-	3	-
CO5	-	-	-	-	-	-	-	-	-	3	3	-
CO6	-	-	-	-	-	-	-	-	-	-	3	2

Detailed syllabus:

Entrepreneur and Entrepreneurship: Introduction; Entrepreneur and Entrepreneurship; Role of entrepreneurship in economic development; Entrepreneurial competencies and motivation; Institutional Interface for Small Scale Industry/Enterprises.

Establishing Small Scale Enterprise: Opportunity Scanning and Identification; Creativity and product development process; Market survey and assessment; choice of technology and selection of site.

Planning a Small Scale Enterprises**:** Financing new/small enterprises; Techno Economic Feasibility Assessment; Preparation of Business Plan; Forms of business organization/ownership.

Operational Issues in SSE**:** Financial management issues; Operational/project management issues in SSE; Marketing management issues in SSE; Relevant business and industrial Laws.

Performance appraisal and growth strategies**:** Management performance assessment and control; Causes of Sickness in SSI, Strategies for Stabilization and Growth.

Reading:

1. G.G. Meredith, R.E.Nelson and P.A. Neek, The Practice of Entrepreneurship, ILO, 1982.
2. Dr. Vasant Desai, Management of Small Scale Enterprises, Himalaya Publishing House, 2004.
3. A Handbook for New Entrepreneurs, Entrepreneurship Development Institute of India, Ahmedabad, 1988.
4. Bruce R Barringer and R Duane Ireland, Entrepreneurship: Successfully Launching New Ventures, Third Edition, Pearson Edu., 2013.

EC390	COMMUNICATION SYSTEMS	OPC	3–0–0	3 Credits

Pre-requisites: None

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

CO1	Understand different modulation and demodulation schemes for analog communications.
CO2	Design analog communication systems to meet desired application requirements
CO3	Evaluate fundamental communication system parameters, such as bandwidth, power, signal to quantization noise ratio etc.
CO4	Elucidate design tradeoffs and performance of communications systems.

Mapping of course outcomes with program outcomes:

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

Detailed syllabus:

Signal Analysis**:** Communication Process, Sources of Information, Communication Channels, Modulation Process, Types of Communication, Random Process, Gaussian Process, Correlation Function, Power Spectral Density, Transmission of Random Process through an LTI Filter.

Noise Analysis: External Noise, Internal Noise, White Noise, Narrow Band Noise, Representation of Narrow Band noise in phase and Quadrature Components, Noise Figure, Noise Bandwidth, Noise Temperature.

Amplitude (Linear) Modulation: Linear Modulation Schemes, Generation of AM, Envelope Detector, DSB-SC Product Modulator, Switching Modulator, Ring Modulator, Coherent Detection, Costas receiver, SSB Signal Representation, Filtering Method, Phase Shift Method, Coherent Demodulation, VSB Modulator and Demodulator, Carrier Acquisition using Squaring Loop and Costas Loop, Receiver Model, SNR, Noise in SSB and DSB receivers using coherent detection, Noise in AM Receiver using Envelope detection, Threshold Effect.

Angle (Exponential) Modulation: Types of Angle Modulation, Relation between FM and PM, Narrow Band FM, Wideband FM, Transmission Bandwidth of FM Signals, Generation of FM using Direct and Indirect methods, FM Demodulation using Slope Circuit, Frequency Discriminator, Interference in Angle Modulation, Noise in FM Receiver, FM Threshold Effect, Pre-emphasis and De-emphasis in FM, Model of PLL for FM Demodulation.

Pulse Modulation: Sampling Process, PAM, PWM, PPM, Quantization, PCM, TDM, Digital Multiplexer Hierarchy, DM, DSM, Linear Prediction, DPCM, ADPCM, Noise in PCM System, Companding, Comparison of the Noise Performance of AM,FM,PCM and DM.

Information Theory: Uncertainty, Information, Entropy, Source Coding Theorem, Data Compaction, Mutual information, Channel Capacity, BSC Channel, Information Capacity Theorem, Bandwidth - Power Tradeoff, Huffman Coding.

Reading:

1. S. Haykin, Communication Systems, Fourth Edition, John Wiley & Sons, Singapore, 2001.
2. B.P. Lathi, Modern Digital & Analog Communication Systems, 3rd Edn, Oxford University Press, Chennai, 1998.
3. Leon W.Couch II., Digital and Analog Communication Systems, Sixth Edition, Pearson Education inc., New Delhi, 2001.
4. A Bruce Carlson, PB Crilly, JC Rutledge, Communication Systems, Fourth Edition, MGH, New York, 2002.

EC391	MICROPROCESSOR SYSTEMS	OPC	3–0–0	3 Credits

Pre-requisites: None

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

CO1	Develop basic understanding of microprocessor architecture.
CO2	Design Microprocessor and Microcontroller based systems.
CO3	Understand C, C++ and assembly language programming
CO4	Understand concept of interfacing of peripheral devices and their applications

Mapping of course outcomes with program outcomes:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	2	-	-	-	-	-	-	-	-	-
CO2	-	-	3	-	-	-	-	-	2	-	-	-
CO3	-	-	3	-	-	-	-	-	2	-	-	-
CO4	-	-	3	-	-	-	-	-	-	-	-	-

Detailed syllabus:

Microcomputer Organization: CPU, Memory, I/O, Operating System, Multiprogramming, Multithreading, MS Windows

80386 Micro Processors : Review of 8086,salient features of 80386,Architecture and Signal Description of 80386,Register Organization of 80386,Addressing Modes,80386 Memory management, Protected mode, Segmentation, Paging, Virtual 8086 Mode, Enhanced Instruction set of 80386, the Co- Processor 80387

Pentium & Pentium-pro Microprocessor: Salient features of Pentium microprocessor, Pentium architecture, Special Pentium registers, Instruction Translation look aside buffer and branch Prediction, Rapid Execution module, Memory management, hyper-threading technology, Extended Instruction set in advanced Pentium Processors

Microcontrollers: Overview of micro controllers-8051 family microcontrollers, 80196 microcontrollers family architecture, instruction set, pin out, memory interfacing.

ARM Processor Fundamentals: Registers, current Program Status Registers, Pipeline Exceptions, Interrupts and Vector Table, Architecture Revisions, ARM Processor families, ARM instruction set, Thumb Instruction set-Exceptions Handing, Interrupts, Interrupt Handling schemes, firmware, Embedded operating systems, Caches-cache architecture, Cache policy, Introduction to DSP on the ARM, DSP on the ARM7TDMI,ARM9TDMI.

Case study-Industry Application of Microcontrollers

Reading:

1. Barry B.Brey: Intel Microprocessor Architecture, Programming and Interfacing-8086/8088, 80186, 80286, 80386 and 80486, PHI, 1995.
2. Muhammad Ali Mazidi and Mazidi: The 8051 Microcontrollers and Embedded systems, PHI, 2008
3. Intel and ARM Data Books on Microcontrollers.

CH390	Nanotechnology and Applications	OPC	3–0–0	3 Credits

Prerequisites: None

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

CO1	Understand the properties of Nano-materials and applications
CO2	Apply chemical engineering principles to Nano-particle production
CO3	Solve the quantum confinement equations.
CO4	Characterize Nano-materials.
CO5	Scale up the production Nanoparticles for Electronics and Chemical industries.

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

Introduction to Nanotechnology: Introduction to nanotechnology and materials, Nanomaterials, Introduction to nano-sizes and properties comparison with the bulk materials, Different shapes and sizes and morphology.

Fabrication of Nanomaterials: Top Down Approach Grinding, Planetory milling and Comparison of particles, Bottom Up Approach, Wet Chemical Synthesis Methods, Microemulsion Approach, Colloidal Nanoparticles Production, Sol Gel Methods, Sonochemical Approach, Microwave and Atomization, Gas phase Production Methods : Chemical Vapour Depositions.

Kinetics at Nanoscale: Nucleation and growth of particles, Issues of Aggregation of Particles, Oswald Ripening, Stearic hindrance, Layers of surface charges, Zeta Potential and pH.

Carbon Nanomaterials: Synthesis of carbon bucky-balls, List of stable carbon allotropes extended, fullerenes, metallofullerenes, solid C60, bucky onions, nanotubes, nanocones.

Quantum mechanics: Quantum dots and its Importance, Pauli exclusion principle, Schrödinger's equation, Application of quantum Dots: quantum well, wire, dot, characteristics of quantum dots, Synthesis of quantum dots Semi-conductor quantum dots

Nanomaterials characterization: Fractionation principles of Particle size measurements, Particle size and its distribution, XRD, Zeta potential, Electronic band structure Electron statistics Application:

Optical transitions in solids, photonic crystals, Microscopies SEM, TEM, Atomic Forced Microscopy, Scanning and Tunneling Microscopy.
Applications: Self-assembly and molecular manufacturing, Surfactant based system Colloidal system applications, Functional materials Applications, commercial processes of synthesis of nanomaterials, Nano inroganic materials of $CaCO_3$ synthesis, Hybrid Waste Water Treatments systems, Electronic Nanodevices.

Nanobiology: Biological synthesis of nanoparticles and applications in drug delivery, Nanocontainers and Responsive Release of active agents, Layer by Layer assembly for nanospheres, Safety and health Issues of nano materials, Environmental Impacts, Case Study for Environmental and Societal Impacts.

Reading:

1. Kulkarni Sulabha K, Nanotechnology: Principles and Practices, Capital Publishing Company, 2007
2. Stuart M. Lindsay, Introduction to Nanoscience, Oxford University Press, 2009.
3. Robert Kelsall, Ian Hamley, Mark Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, 2005.
4. Gabor L. Hornyak , H.F. Tibbals , Joydeep Dutta , John J. Moore Introduction to Nanoscience and Nanotechnology CRC Press
5. Davies, J.H. 'The Physics of Low Dimensional Semiconductors: An Introduction', Cambridge University Press, 1998.

CH391	Industrial Safety and Hazards	OPC	3–0–0	3 Credits

Prerequisites: None

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

CO1	Analyze the effects of release of toxic substances.
CO2	Select the methods of prevention of fires and explosions.
CO3	Understand the methods of hazard identification and preventive measures.
CO4	Assess the risks using fault tree diagram.

Mapping of course outcomes with program outcomes:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	-	-	-	-	3
CO2	3	-	-	-	-	-	-	-	-	-	-	2
CO3	2	-	-	-	-	-	-	-	-	-	-	3
CO4	-	-	-	-	-	-	-	-	-	-	-	3

Detailed syllabus:

Introduction-Safety Programs, Engineering Ethics, Accident and Loss Statistics, Acceptable Risk, Public Perceptions, the Nature of the Accident Process, Inherent Safety.

Industrial Hygiene- Anticipation and Identification, Hygiene Evaluation, Hygiene Control.

Toxic Release and Dispersion Models- Parameters Affecting Dispersion, Neutrally Buoyant Dispersion Models, Dense Gas Dispersion, Toxic Effect Criteria, Effect of Release Momentum and Buoyancy, Release Mitigation.

Fires and Explosions- The Fire Triangle, Distinction between Fires and Explosions, Flammability Characteristics of Liquids and Vapors, Limiting Oxygen Concentration and Inerting, Flammability Diagram

Hazards Identification- Process Hazards Checklists, Hazards Surveys, Hazards and Operability Studies, Safety Reviews.

Risk Assessment- Review of Probability Theory, Event Trees, and Fault Trees.

Safety Procedures: Process Safety Hierarchy, Managing Safety, Best Practices, Procedures—Operating, Procedures—Permits, Procedures—Safety Reviews and Accident Investigations.

Reading:

1. D. A. Crowl and J.F. Louvar, Chemical Process Safety (Fundamentals with Applications), Prentice Hall, 2011.
2. R.K. Sinnott, Coulson & Richardson's Chemical Engineering, Vol. 6, Elsevier India, 2006.

CS390	OBJECT ORIENTED PROGRAMMING	OPC	3–0–0	3 Credits

Pre-requisites: None

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

CO1	Understand fundamental concepts in object oriented approach.
CO2	Analyze design issues in developing OOP applications.
CO3	Write computer programs to solve real world problems in Java.
CO4	Analyze source code API documentations.
CO5	Create GUI based applications.

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

Object- oriented thinking, History of object-oriented programming, overview of java, Object-oriented design, Structure of java program. Types and modifiers, Classes, declaring objects in classes, Methods, constructors, garbage collection, Method overloading, passing objects as parameters, Inheritance, various forms and types of inheritance, Multilevel hierarchy, use of super, method overriding, Applications of method overriding, abstract classes, Packages with examples

Interfaces and implementation, Exception handling, types, throwing, creating own exceptions, Multithreading and concepts, its usage and examples, Input/output streams, String operations and examples, Collection classes-array, stack collection, bit set collection, Utility classes-string tokenize, bit set, date, Applets- methods, creation, designing and examples, Event handling- event classes, Event listener interfaces, AWT classes, working with frames, AWT controls-layout manager, user interface components, Graphics programming

Reading:

1. Timothy Budd, "Understanding object-oriented programming with Java", Pearson,
2. Herbert Schildt, " The complete reference Java 2", TMH,

BT390	GREEN TECHNOLOGY	OPC	3–0–0	3 Credits

Pre-requisites: None

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

CO1	Address smart energy and green infrastructure
CO2	Build models that simulate sustainable and renewable green technology systems
CO3	Understand the history, global, environmental and economical impacts of green technology
CO4	Address non-renewable energy challenges

Mapping of course outcomes with program outcomes:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	-	-	3
CO2	-	-	-	-	-	-	-	-	2	-	-	3
CO3	2	-	-	-	-	-	-	-	-	-	2	3
CO4	2	-	-	-	-	-	-	-	-	-	-	3

Detailed Syllabus:

Biomass Energy, basic concepts, sources of biomass energy, uses of biomass energy, science and engineering aspects of biomass energy, production of biomass electricity, transmission of biomass electricity, storage of biomass electricity.

Energy transformation from source to services; Energy sources, sun as the source of energy; biological processes; photosynthesis; food chains, classification of energy sources, quality and concentration of energy sources; fossil fuel reserves - estimates, duration; theory of renewability, renewable resources; overview of global/ India's energy scenario.

Environmental effects of energy extraction, conversion and use; sources of pollution from energy technologies, Criteria for choosing appropriate green energy technologies, life cycle cost; the emerging trends – process/product innovation-, technological/ environmental leap-frogging; Eco/green technologies for addressing the problems of Water, Energy, Health, Agriculture and Biodiversity.

First and second laws of thermodynamics and their applications – Thermodynamic processes - Irreversibility of energy – Entropy. Properties of steam and classification of steam engines. Carnot cycle - Rankine cycle, Current energy requirements, growth in future energy requirements, Review of conventional energy resources- Coal, gas and oil reserves and resources, Tar sands and Oil, Shale, Nuclear energy Option.

Biomass fuels, market barriers of biomass fuels, biomass fuel standardization, biomass fuel life cycle, Sustainability of biomass fuels, economics of biomass fuels, Fuel stoichiometry and analysis: Fuel stoichiometry relations; Estimation of air required for complete combustion; Estimation of minimum amount of air required for a fuel of known composition; Estimation of dry flue gases for known fuel composition; Calculation of the composition of fuel & excess air supplied, from exhaust gas analysis; Dew point of products; Flue gas analysis (O2, CO2, CO, NOx, SOx).

Biomass as a major source of energy in India: Fuel-wood use in rural households. Consequences for ecosystems. Future energy scenario in rural areas. Utilization of biomass in industrial and semi-Industrial settings. Future utilization of biomass in India. Future of landscape management: optimal management.

Reading:

1. Ayhan Demirbas, Green Energy and Technology, Biofuels, Securing the Planet's Future Energy Needs, First Edition, Springer, 2009.
2. Jay Cheng, Biomass to Renewable Energy Processes, First Edition, CRC press, 2009.
3. Samir K. Khanal, Rao Y. Surampally, First Edition, American Society of Civil Engineers, 2010.

SM390	MARKETING MANAGEMENT	OPC	3–0–0	3 Credits

Pre-requisites: None

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

CO1	Understand concepts and scope of marketing and market oriented strategic planning
CO2	Analyze macro level environment
CO3	Identify factors influencing consumer behavior in competitive global business environment
CO4	Identify tools and techniques for marketing management through integrated marketing communication systems.

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

Importance of Marketing, Scope of Marketing, Core Marketing concepts company orientation towards market place-production concept, Product concept, selling concept and Marketing concept.

Market oriented Strategic planning – Defining corporate Mission and Vision Statement at Corporate level and at Business unit level. Assigning resources to Strategic Business units through B.C.G Matrix and G.E Model.

Analyzing Macro environment-Demographic environment. Economic Environment, Technical Environment, Social-Cultural Environment and political – Legal Environment.

Components of Marketing information systems- Internal Records, Marketing intelligence, Marketing research and Marketing Decision support system.

Consumer Behavior- Buying Decision process and the factors influencing consumer Behavior-Psychological factors, social factors, cultural factors and personal factors.

Importance of Market segmentation, Target market selection and positioning.

Importance of new product development process and the various stages involved.

The concept of product lifecycle and the various strategies used by the marketer in each stage.

Product characteristics and classification, Product mix and product line decisions Branding Decisions, Building Brand Equity.

Importance of Pricing, Factors influencing pricing decisions. Various pricing methods-cost based and demand based methods.

Role of Marketing channels-Channel functions and channel levels channel Design and channel Management Decisions, Managing Retailing. Wholesaling and logistics. Importance of Electronic channels.

Importance of integrated Marketing communication. Advantages and Disadvantages of Various promotional tools- Advertising, Sales promotion, personal selling, publicity and public Relations and Direct marketing.

Reading:

1. Philip Kotler, Marketing Management, PHI, Fourteenth Edition, 2013.
2. William Stonton & Etzel, Marketing Management, TMH, Thirteenth Edition, 2013.
3. Rama Swamy & Namakumari, Marketing Management, McMillan, 2013.

MA390	NUMERICAL SOLUTION OF DIFFERENTIAL EQUATIONS	OPC	3–0–0	3 Credits

Pre-requisites: None

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

CO1	Solve nonlinear differential equations by numerical methods.
CO2	Determine the convergence region for a finite difference method.
CO3	Solve elliptic PDE by finite difference method
CO4	Solve a parabolic PDE by finite difference method
CO5	Solve a hyperbolic PDE by finite difference method

Mapping of course outcomes with program outcomes:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-	-

Detailed Syllabus:

Ordinary Differential Equations: Multistep (explicit and implicit) methods for initial value problems, Stability and Convergence analysis, Linear and nonlinear boundary value problems, Quasi-linearization, Shooting methods

Finite difference methods: Finite difference approximations for derivatives, boundary value problems with explicit boundary conditions, implicit boundary conditions, error analysis, stability analysis, convergence analysis.

Partial Differential Equations: Classification of partial differential equations, finite difference approximations for partial derivatives and finite difference schemes for Parabolic equations, Schmidt's two level, multilevel explicit methods, Crank-Nicolson's two level, multilevel implicit methods, Dirichlet's problem, Neumann problem, mixed boundary value problem, stability analysis.

Hyperbolic Equations: Explicit methods, implicit methods, one space dimension, two space dimensions, ADI methods.

Elliptic equations: Laplace equation, Poisson equation, iterative schemes, Dirichlet's problem, Neumann problem, mixed boundary value problem, ADI methods.

Reading:

1. M.K. Jain, Numerical Solution of Differential Equations, Wiley Eastern, 1984.
2. G.D. Smith, Numerical Solution of Partial Differential Equations, Oxford Univ. Press, 2004.
3. M.K.Jain, S.R.K. Iyengar and R.K. Jain, Computational Methods for Partial Differential Equations, Wiley Eastern, 2005.

MA391	FUZZY MATHEMATICS AND APPLICATIONS	OPC	3–0–0	3 Credits

Pre-requisites: None

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

CO1	Apply operations on Fuzzy sets
CO2	Solve problems related to Propositional Logic.
CO3	Apply Fuzzy relations to cylindrical extensions.
CO4	Apply logic of Boolean Algebra to switching circuits.
CO5	Develop Fuzzy logic controllers

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

Crisp set theory (CST): Introduction, Relations between sets, Operations on sets, Characteristic functions, Cartesian products of crisp sets, crisp relations on sets.

Fuzzy set theory (FST): Introduction, concept of fuzzy set (FS), Relation between FS, operations on FS, properties of standard operations, certain numbers associated with a FS, certain crisp sets associated with FS, Certain FS associated with given FS, Extension principle.

Propositional Logic (PL1): Introduction, Syntax of PL1, Semantics of PL1, certain properties satisfied by connectives, inference rules, Derivation, Resolution.

Predicate Logic (PL2): Introduction, Syntax of PL2, Semantics of PL2, certain properties satisfied by connectives and quantifiers, inference rules, Derivation, Resolution

Fuzzy Relations (FR): Introduction, Operations on FR, □ -cuts of FR, Composition of FR, Projections of FR, Cylindric extensions, Cylindric closure, FRA domain.

Fuzzy Logic (FL): Introduction, Three-valued logics, N-valued logics and infinite valued logics, Fuzzy logics, Fuzzy propositions and their interpretations in terms of fuzzy sets, Fuzzy rules and their interpretations in terms of FR, fuzzy inference, More on fuzzy inference, Generalizations of FL.

Switching functions (SF) and Switching circuits (SC): Introduction, SF, Disjunctive normal form, SC, Relation between SF and SC, Equivalence and simplification of circuits, Introduction of Boolean Algebra BA, Identification, Complete Disjunctive normal form.

Applications: Introduction to fuzzy logic controller (FLC), Fuzzy expert systems, classical control theory versus fuzzy control, examples, working of FLC through examples, Details of FLC, Mathematical formulation of FLC, Introduction of fuzzy methods in decision making.

Reading:

1. M. Ganesh, Introduction to Fuzzy Sets and Fuzzy Logic, PHI, 2001.
2. G.J. Klir and B.Yuan, Fuzzy sets and Fuzzy Logic–Theory and Applications, PHI, 1997.
3. T. J. Ross, Fuzzy Logic with Engineering Applications, McGraw-Hill, 1995.

PH390	MEDICAL INSTRUMENTATION	OPC	3–0–0	3 Credits

Pre-requisites: None

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

CO1	Understand the origin of bio-potentials and their physical significance.
CO2	Understand anatomy and functioning of human heart and its common problems.
CO3	Analyze ECG, ENG and EMG signals and instrumentation.
CO4	Compare different techniques of measuring blood pressure, blood flow and volume.
CO5	Interpret the principle and operation of therapeutic and prosthetic devices.
CO6	Differentiate between the various techniques for measurement of parameters.

Mapping of course outcomes with program outcomes:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	2	-	-	-
CO4	3	-	2	-	-	-	-	-	2	-	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-	2
CO6	3	-	-	-	-	-	-	-	-	-	-	-

Detailed Syllabus:

General Introduction: The cell, body fluids, Musculoskeletal system, respiratory system, gastrointestinal system, Nervous system, endocrine system and circulatory system.

Origin of Bio potentials: electrical activity of Excitable cells: the resting state, The active state, Volume conductor fields, Functional organization of the peripheral nervous system: Reflex are & Junctional transmission.

The Electroneurogram (ENG): The H-Reflex, The Electromyogram (EMG), The Electrocardiogram (ECG), heart and the circulatory system, Electro conduction system of the heart and heart problems, ECG waveform and Physical significance of its wave features, Electrical behavior of cardiac cells, the standard lead system, The ECG preamplifier, DC ECG Amplier, Defibrillator protection circuit, Electro surgery Unit filtering, Functional blocks of ECG system, Multichannel physiological monitoring system, Common problems encountered and remedial techniques.

Blood Pressure: indirect measurement of blood pressure, korotkoff sounds, auscultatory method using sphygmo manometer, Oscillometric and ultrasonic non invasive pressure measurement, Direct measurement of blood pressure H2O manometers, electronic manometry, Pressure transducers,. Pressure amplifier designs, Systolic, diastolic mean detector circuits

Blood flow and Volume Measurement: indicator dilution methods, Transit time flow meter, DC flow meter, Electromagnetic flow meter AC electromagnetic flow meter, Quadrature suppression flow meter, Ultrasonic flow meter, Continuous-wave Doppler flow meter, Electric impedance plethysmography, chamber plethysmography, Photo plethysmography.

Pulse Oximetr: Principles of Operation, Absorption Spectrum, Sensor design, Pulse oximeter, Therapeutic and Prosthetic Devices.

Cardiac Pacemakers: Lead wires and electrodes, Synchronous Pacemakers, rate responsive pacemaking, Defibrillators, cardioverters, Electrosurgical unit, Therapeutic applications of laser, Lithotripsy Haemodialysis.

Reading:

1. John G Webster, Medical Instrumentation: Application and Design, John Wiley, Third Edition, 2012.
2. Joseph J. Carr & John M. Brown , Introduction to biomedical Equipment Technology, Fourth Edition, Prentice Hall India, 2001

MM390	METALLURGY FOR NON-METALLURGISTS	OPC	3–0–0	3 Credits

Pre-requisites: None

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

CO1	Understand the characteristics and usefulness of metals and alloys.
CO2	Differentiate metals and alloys and their fabrication techniques.
CO3	Correlate the microstructure, properties, processing and performance of materials.
CO4	Select metal/alloy for engineering applications.

Mapping of course outcomes with program outcomes:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	2
CO2	3	-	-	-	-	-	-	-	-	-	-	2
CO3	2	-	-	-	-	-	-	-	-	-	-	3
CO4	-	-	-	-	-	-	-	-	2	-	-	3

Detailed Syllabus:

Introduction to Metallurgy:

Structure of Metals and Alloys: Nature of Metallic Bonding, Crystal Structures of Metals, Structure of Alloys, Imperfections in Crystals

Mechanical Properties: Plastic Deformation Mechanisms, Tensile, Creep, Fatigue, Fracture

Strengthening Mechanisms: Strain Hardening, Grain Size Refinement, Solid Solution Strengthening, Precipitation Hardening

Discovering Metals: Overview of Metals, Modern Alloy Production

Fabrication and Finishing of metal products: Metal Working and Machining

Testing of Metals: Both Destructive and Non-Destructive, Inspection and Quality Control of Metals

Engineering Alloys: Steel Products and Properties, Cast Irons, Tool Steels and High Speed Steels, Stainless Steels, Nonferrous Metals

Heat Treatment: Annealing, Normalizing, Hardening, Tempering

Corrosion and its Prevention: Electro chemical considerations, Corrosion Rates, Passivity, Environmental Effects, Forms of Corrosion, Corrosion Environments, Oxidation; Durability of Metals and Alloys

The material selection processes: Case studies

Reading:

1. M. F. Ashby: Engineering Metals, Fourth Edition, Elsevier, 2005.
2. R. Balasubramaniam (Adapted): Calister's Materials Science and Engineering, seventh Edition, , Wiley India (P) Ltd, 2007.
3. Reza Abbaschian, Lara Abbaschian, R E Reed-Hill: Physical Metallurgy Principles, Affiliated East-West Press, 2009.
4. V Raghavan: Elements of Materials Science and Engineering- A First Course, Fifth Edition, PHI, 2006

PH391	ADVANCED MATERIALS	OPC	3–0–0	3 Credits

Pre-requisites: None

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

CO1	Understand the synthesis and properties of nanomaterials
CO2	Evaluate the usefulness of nanomaterials in medicine, biology and sensing
CO3	Understand modeling of composite materials by finite element analysis
CO4	Differentiate superconducting materials
CO5	Understand the characteristics and uses of functional materials

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

Nano Materials: Origin of nano technology, Classification of nano materials, Physical, chemical, electrical, mechanical properties of nano materials. Preparation of nano materials by plasma arcing, physical vapour deposition, chemical vapour deposition (CVD), Sol-Gel, electro deposition, ball milling, carbon nano tubes(CNT).Synthesis, preparation of nanotubes, nano sensors, Quantum dots, nano wires,nano biology, nano medidcines.

Biomaterials: Overview of biomaterials. Biomaterials, bioceramics, biopolymers, tissue grafts, soft tissue applications, cardiovascular implants, biomaterials in ophthalmology, orthopeadiac implants, dental materials.

Composites: General characteristics of composites , composites classes, PMCs, MMCs, CMCs, CCCs, IMCs, hybrid composites, fibers and matrices, different types of fibers, whiskers, different matrices materials, polymers, metal, ceramic matrices, toughening mechanism, interfaces, blending and adhesion, composite modeling, finite element analysis and design.

Optical materials: Mechanisms of optical absorption in metals, semiconductors and insulators. Nonlinear optical materials, optical modulators, optical fibers. Display devices and materials photo-emissive, photovoltaic cells, charge coupled devices (CCD), laser materials.

Super conducting materials: Types of super conductors, an account of mechanism of superconductors, effects of magnetic field currents, thermal energy, energy gap, acoustic attenuation, penetration depth, BCS theory, DC and AC Josephson effects, high Tc superconductors, potential applications of superconductivity, electrical switching element, superconductor power transmission and transformers, magnetic mirror, bearings, superconductor motors, generators, SQUIDS etc.

Smart materials: An introduction, principles of smart materials, input – output decision ability, devices based on conductivity changes, devices based on changes in optical response, biological systems smart materials. Devices based on magnetization, artificial structures, surfaces, hetero structures, polycrystalline, amorphous, liquid crystalline materials.

Surface Acoustic Wave (SAW) Materials and Electrets: Delay lines, frequency filters, resonators, pressure and temperature sensors, Sonar transducers. Comparison of electrets with permanent magnets, Preparation of electrets, Application of electrets.

Reading:

1. T.Pradeep, Nano: The Essentials; TaTa McGraw-Hill, 2008.
2. B.S. Murthy et al., Textbook of Nano science and Nanotechnology, University press
3. Krishan K Chawla, Composite Materials; Second Edition, Springer 2006.

CY390	INSTRUMENTAL METHODS IN CHEMICAL ANALYSIS	OPC	3–0–0	3 Credits

Pre-requisites: None

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

CO1	Characterize materials using ultraviolet and visible absorption and fluorescence techniques
CO2	Analyze materials, minerals and trace samples using atomic absorption, emission and X-ray fluorescence techniques
CO3	Analyze environmental, industrial, production-line materials by liquid, gas and size-exclusion chromatographic techniques.
CO4	Characterize interfaces and traces of surface adsorbed materials using electro-analytical techniques
CO5	Understand principles of thermo gravimetry and differential thermal analyses.
CO6	Characterize chemical, inorganic and engineering materials using analytical techniques

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

UV-Visible Spectrophotometry and Fluorescence Beer-Lambert's law, limitations, Molecular fluorescence, influencing factors, basic instruments, standardization, quantitative methods, applications.

Atomic spectrometry, atomic absorption, X-ray fluorescence methods Flame atomic emission and absorption, flame emission photometer, flame absorption spectrometer, spectral interferences, quantitative aspects, X-ray fluorescence principle, Instrumentation, quantitative analysis.

Separation techniques Solvent extraction, Principle, Extraction of solutes, Soxhlet extraction Chromatography methods Gas chromatography, High performance liquid chromatography, Size exclusion chromatography, Principle, Basic instrumentation, Capillary Electrophoresis: Principle and application.

Thermoanalytical methods Thermogravimetry, Differential thermal analysis, differential scanning calorimetry, Principle, Block diagram, Applications, Quantitative determinations.

Electroanalytical methods Coulometric methods, Polarography, Pulse voltammetric methods, Amperometry, Principles, Applications, Electrochemical sensors, Ion selective, Potentiometric and amperometric sensors, Applications.

Spectroscopic methods Molecular absorption, Woodward rules, applications, Infra-red absorption, functional group analysis, qualitative analysis, 1H- and 13C-NMR spectroscopy, Principle, Basic instrumentation, terminology, Interpretation of data, Quantitative applications.

Mass spectrometry Principles, Instrumentation, Ionization techniques, Characterization and applications.

Reading:

1. Mendham, Denny, Barnesand Thomas, Vogel: Text book of Quantitative Chemical Analysis, Pearson Education, Sixth Edition, 2007.
2. Skoog, Holler and Kouch, Thomson, Instrumental methods of chemical analysis, 2007.
3. Willard, Meritt and Dean, Instrumental methods of chemical analysis, PHI, 2005.

CY391	CHEMICAL ASPECTS OF ENERGY SYSTEMS	OPC	3–0–0	3 Credits

Pre-requisites: None

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

CO1	Understand traditional and alternative forms of energy
CO2	Understand energy production, storage, distribution and utilization.
CO3	Model environmental impacts of energy generation and conservation
CO4	Apply concepts of engineering design to energy challenges

Mapping of course outcomes with program outcomes:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	2
CO2	3	-	-	-	-	-	-	-	-	-	-	2
CO3	-	-	-	-	-	-	-	-	-	-	-	3
CO4	-	3	-	-	-	-	-	-	-	-	-	-

Detailed Syllabus:

Energy as the Key of Civilisation; Thermochemistry of Energy Sources and Kinetics of Energy Tapping; Conventional and Finite Energy Sources; Coal Based Energy Sources and Coal Carbonisation; Petroleum and Natural Gas; Biomass and Gobar Gas; Primary and Secondary Batteries, Reserve Batteries, Solid State and Molten Solvent Batteries, Lithium Ion Batteries;, Solar Energy Harnessing, Photogalvanic and Photovoltaic Energy Storage; Fuel Cells; Hydrogen as Future Fuel; Photochemical Water Cleavage; Green Energies.

Reading:

1. Tokio Ohta, Energy Systems, Elsevier Science, 2000.
2. R. Narayan and B. Viswanathan, Chemical and Electrochemical Energy Systems, Universities Press, 1998

HS390	SOFT SKILLS	OPC	3–0–0	3 Credits

Pre-requisites: None

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

CO1	Understand corporate communication culture
CO2	Prepare business reports and proposals expected of a corporate professional
CO3	Employ appropriate speech in formal business situations
CO4	Exhibit corporate social responsibility and ethics
CO5	Acquire corporate email, mobile and telephone etiquette

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

English Language Enhancement: Verbs and tenses, Phrasal verbs, Synonyms, Antonyms, Homonyms - Descriptive Words, Combining Sentences, Business Idioms, Indianisms in English.

Art of Communication, Communication process- Non-verbal Communication- Effective Listening.

Interpersonal and Intra Personal Communication Skills- Self-Awareness- Self-Esteem and Confidence- Assertiveness and Confidence- Dealing with Emotions-Team Concept- Elements of Teamwork- Stages of Team Formation- Effective Team-Team Player Styles-Leadership.

Campus to Company- Dressing and Grooming- The Corporate Fit- Business Etiquette-Communication; media etiquette- Group Discussions, Interviews, and Presentation Skills.

Interview handling skills- Effective Resume-- Common Interview Mistakes- Body-language- Content Aid, Visual Aids- Entrepreneurial Skills Development.

Reading:

1. Robert M. Sherfield, Developing Soft Skills, Montgomery and Moody Fourth Edition, Pearson, 2009.
2. K.Alex, Soft Skills: Know Yourself & Know The world, S. Chand; 2009.
3. Robert Bramson, Coping with Difficult People, Dell, 2009

CE440	BUILDING TECHNOLOGY	OPC	3–0–0	3 Credits

Pre-requisites: None

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

CO1	Apply basic principles to develop stable, sustainable and cost-effective building plans.
CO2	Identify effective measures for fire proofing, damp proofing, and thermal insulation.
CO3	Adopt standard building provisions for natural ventilation and lighting.
CO4	Identify different materials, quality and methods of fabrication & construction.

Mapping of course outcomes with program outcomes:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	-	3	-	2	-
CO2	-	-	-	-	-	-	-	-	3	-	-	-
CO3	-	-	-	-	-	-	-	-	2	-	-	3
CO4	-	-	-	-	-	-	-	-	-	-	3	-

Detailed Syllabus:

Overview of the course, basic definitions, Buildings – Types, components, economy and design, Principles of planning of buildings and their importance.

Definitions and importance of Grouping and circulation; Lighting and ventilation; How to consider these aspects during planning of building

Termite proofing: Inspection, control measures and precautions, Lighting protection of buildings: General principles of design of openings, various types of fire protection measures to be considered while planning a building.

General requirements and extra requirements for safety against fire, special precautions, Vertical transportation in building – types of vertical transportation, Stairs, different forms of stairs, planning of stair cases, Other modes of vertical transportation – lifts, ramps, escalators.

Prefabrication systems in residential buildings – walls, openings, cupboards, shelves etc., planning and modules and sizes of components in prefabrication.

Planning and designing of residential buildings against the earthquake forces, Principles, Seismic forces and their effect on buildings.

Air conditioning – process and classification of air conditioning, Dehumidification. Systems of air-conditioning, ventilation, functional requirements of ventilation.

Acoustics, effect of noise, properties of noise and its measurements, Principles of acoustics of building. Sound insulation – importance and measures.

Plumbing services – water supply system, maintenance of building pipe line, sanitary fittings, principles governing design of building drainage.

Reading:

1. Building Construction - Varghese, PHI Learning Private Limited, 2008
2. Building Construction - Punmia, B C, Jain, A J and Jain A J, Laxmi Publications, 2005.
3. Building Construction by S.P. Arora and S.P. Bindra – Dhanpatrai and Sons, New Delhi, 1996.
4. Building Construction – Technical Teachers Training Institute, Madras, Tata McGraw Hill, 1992.
5. National Building code of India, Bureau of Indian Standards, 2005.

EE440	NEW VENTURE CREATION	OPC	3–0– 0	3 Credits

Pre-requisites: None

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

CO1	Understand the process and practice of entrepreneurship and new venture creation
CO2	Identify entrepreneurial opportunities, preparation of a business plan for launching a new venture
CO3	Explore the opportunities in the domain of respective engineering disciplines for launching a new venture
CO4	Expose the students with the functional management issues of running a new venture

Mapping of course outcomes with program outcomes:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	1	2	1	1	1	2	2	2
CO2	2	2	2	2	1	1	3	2	1	2	2	2
CO3	2	2	2	2	1	1	1	1	2	3	2	3
CO4	2	2	2	2	1	3	1	1	1	2	3	3

Detailed Syllabus:

ENTREPRENEUR AND ENTREPRENEURSHIP

Entrepreneurship and Small Scale Enterprises (SSE), Role in Economic Development, Entrepreneurial Competencies, and Institutional Interface for SSE

ESTABLISHING THE SMALL SCALE ENTERPRISE

Opportunity Scanning and Identification, Market Assessment for SSE, Choice of Technology and Selection of Site, Financing the New/Small Enterprises, Preparation of the Business Plan, Ownership Structures and Organizational Framework

OPERATING THE SMALL SCALE ENTERPRISES

Financial Management Issues in SSE, Operational Management Issues in SSE, Marketing Management Issues in SSE, and Organizational Relations in SSE

Reading:

1. Holt: Entrepreneurship: New Venture Creation, PHI (P), Ltd., 2001.
2. Madhulika Kaushik: Management of New & Small Enterprises, IGNOU course material, 1995
3. B S Rathore S Saini: Entrepreneurship Development Training Material, TTTI, Chandigarh, 1988.
4. P.C.Jain: A Hand Book for New Entrepreneurs, EDI-Faculty & External Experts, EDII, Ahmedabad, 1986.
5. J.B. Patel, D.G Allampalli: A Manual on How to Prepare a Project Report, EDII, Ahmedabad, 1991.
6. J B Patel, S S Modi : A Manual on Business Opportunity Identification and Selection , EDII, Ahmedabad, 1995.

ME440	ALTERNATIVE SOURCES OF ENERGY	OPC	3–0–0	3 Credits

Pre-requisites: None

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

CO1	Identify renewable energy sources and their utilization.
CO2	Understand basic concepts of solar radiation and analyze solar thermal systems for its utilization.
CO3	Understand working of solar cells and its modern manufacturing technologies.
CO4	Understand concepts of Fuel cells and their applications
CO5	Identify methods of energy storage.
CO6	Compare energy utilization from wind energy, geothermal energy, biomass, biogas and hydrogen.

Mapping of course outcomes with program outcomes:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	2
CO2	2	-	-	-	-	-	-	-	-		-	3
CO3	-	-	-	-	-	-	-	-	-	-	2	3
CO4	-	-	-	-	-	-	-	-	2	-	-	3
CO5	2	-	-	-	-	-	-	-	-	-	-	3
CO6	-	-	-	-	-	-	-	-	2	-	-	3

Detailed Syllabus:

Introduction: Overview of the course; Examination and Evaluation patterns; Global warming; Introduction to Renewable Energy Technologies

Energy Storage: Introduction; Necessity of Energy Storage; Energy Storage Methods

Solar Energy: Fundamentals; Solar Radiation; Estimation of solar radiation on horizontal and inclined surfaces; Measurement of solar radiation data

Solar Thermal systems: Introduction; Basics of thermodynamics and heat transfer; Flat plate collector; Evacuated Tubular Collector; Solar air collector; Solar concentrator; Solar distillation; Solar cooker; Solar refrigeration and air conditioning; Thermal energy storage systems

Solar Photovoltaic systems: Introduction; Solar cell Fundamentals; Characteristics and classification; Solar cell: Module, panel and Array construction; Photovoltaic thermal systems.

Wind Energy: Introduction; Origin and nature of winds; Wind turbine siting; Basics of fluid mechanics; Wind turbine aerodynamics; wind turbine types and their construction; Wind energy conversion systems

Fuel cells: Overview; Classification of fuel cells; operating principles; Fuel cell thermodynamics

Biomass Energy: Introduction; Photosynthesis Process; Biofuels; Biomass Resources; Biomass conversion technologies; Urban waste to energy conversion; Biomass gasification.

Other forms of Energy: Introduction: Nuclear, ocean and geothermal energy applications; Origin and their types; Working principles

Reading:

1. Sukhatme S.P. and J.K.Nayak, Solar Energy - Principles of Thermal Collection and Storage, Tata McGraw Hill, New Delhi, 2008.
2. Khan B.H., Non-Conventional Energy Resources,Tata McGraw Hill, New Delhi, 2006.
3. J.A. Duffie and W.A. Beckman, Solar Energy - Thermal Pro

EC44(	ELECTRONIC MEASUREMENTS AND INSTRUMENTAION	OPC	3–0–0	3 Credits

Pre-requisites: None

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

CO1	Apply knowledge of instruments for effective use
CO2	Select suitable instruments for typical measurements.
CO3	Identify various transducers to measure strain, temperature and displacement.
CO4	Understand data acquisition system and general purpose interfacing bus.

Mapping of course outcomes with program outcomes:

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

Detailed syllabus:

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

Instruments: D'Arsonval movement and basic principles of Measurement of Voltage, Current and Resistance in instruments. Analog and Digital Multimeters, Measurement of time and Frequency – Digital Frequency Meter and applications.

Impedance Measurement: Kelvin Bridge; Megger; Maxwell, Hay and Shering Bridges. Q-meter; Noise and Interference reduction techniques in Measurement Systems.

Oscilloscopes: Block diagram, probes, Deflection amplifier and delay line, Trigger Generator, Coupling, Automatic Time Base and Dual Trace Oscilloscopes, Pulse Measurements, Delayed Time Base, Analog Storage, Sampling and Digital Storage Oscilloscopes.

Special instruments: Wave Analyzer, Harmonic Distortion Analyzer, Spectrum Analyzer, FFT Analyzer.

Transducers (Qualitative Treatment Only): Classification and selection of Transducers, Introduction to strain, Load, force, Displacement, Velocity, Acceleration, Pressure and Temperature Measurements.

Introduction to Data Acquisition Systems (DAS): Block Diagram, Specifications and various components of DAS.

General purpose Instrumentation Bus (GP-IB): Protocol, SCPI Commands and Applications to DSO and DMM.

Reading:

1. Oliver and Cage, Electronic Measurements and Instrumentation, McGraw Hill, 2009
2. Helfrick Albert D. and Cooper William D., Electronic Instrumentation & Measurement Techniques, PHI, 2008.
3. D.A. Bell, Electronic Instrumentation and Measurements, Third Edition, Oxford, 2013.

MM440	MATERIALS FOR ENGINEERING APPLICATIONS	OPC	3–0–0	3 Credits

Pre-requisites: None

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

CO1	Correlate processing, microstructure and properties of materials.
CO2	Understand behaviour of materials under various conditions.
CO3	Characterize modes of failure of engineering materials and design new materials with better properties and cost effective processes.
CO4	Identify suitable materials for engineering applications.

Mapping of course outcomes with program outcomes:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	2
CO2	3	-	-	-	-	-	-	-	-	-	-	2
CO3	-	-	-	-	-	-	-	-	2	-	-	2
CO4	2	-	-	-	-	-	-	-	-	-	-	2

Detailed Syllabus:

Materials Science and Engineering Materials, Classification of Materials and Properties: Mechanical, Dielectric, Magnetic and Thermal

Metallurgical Aspects of Materials: Structure of Metals and Alloys, Nature of Metallic Bonding, Crystal Structures of Metals, Structure of Alloys, Imperfections in Crystals, Significance of microstructural features

Heat Treatment: effect of cooling and heating rates and ageing materials for mechanical load bearing applications

Corrosion Resistant Materials: Some important Metals, Alloys, Ceramics and Polymers

Materials for Electrical Applications: Conductors, Dielectrics, insulators

Materials for Civil Engineering Applications

Materials for Biomedical applications: Steels, Ti and its alloys, Ni-Ti alloys, bio ceramics, porous ceramics, bioactive glasses, calcium phosphates, collagen, thin films, grafts and coatings, biological functional materials Latex products.

Reading:

1. M.F. Ashby: Engineering Materials, 4th Edition, Elsevier, 2005.
2. M.F. Ashby: Materials Selection in Mechanical Design, B H, 2005.
3. ASM Publication Vol. 20, Materials Selection and Design, ASM, 1997
4. Pat L. Mangonon: The Principles of Materials Selection and Design, PHI, 1999.

CH440	INDUSTRIAL POLLUTION CONTROL	OPC	3–0–0	3 Credits

Pre-requisites: None

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

CO1	Analyze the effects of pollutants on the environment.
CO2	Understand meteorological aspects of air pollution
CO3	Understand air pollution control methods
CO4	Select treatment technologies for water/wastewater/solid waste.
CO5	Design unit operations for pollution control.

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

Introduction: Biosphere, hydrological cycle, nutrient cycle, consequences of population growth, pollution of air, water and soil.

Air pollution sources & effects: Classification and properties of air pollutants, emission sources, behavior and fate of air pollutants, effect of air pollution.

Meteorological aspects of air pollutant dispersion: Temperature lapse rates and stability, wind velocity and turbulence, plume behavior, dispersion of air pollutants, estimation of plume rise.

Air pollution sampling and measurement: Types of pollutant sampling and measurement, ambient air sampling, stack sampling, analysis of air pollutants.

Air pollution control methods & equipment: Control methods, source correction methods, cleaning of gaseous effluents, particulate emission control, selection of a particulate collector, control of gaseous emissions, design methods for control equipment.

Water pollution: Water resources, origin of wastewater, types of water pollutants and there effects.

Waste water sampling, Analysis and Treatment: Sampling, methods of analysis, determination of organic matter, determination of inorganic substances, physical characteristics, bacteriological measurement, basic processes of water treatment, primary treatment, secondary treatment, advanced wastewater treatment, recovery of materials from process effluents.

Solid Waste Management: Sources and classification, public health aspects, methods of collection, disposal Methods, potential methods of disposal.

Hazardous Waste Management: Definition and sources, hazardous waste classification, treatment methods, disposal methods.

Reading:

1. Rao C.S. – Environmental Pollution Control Engineering- Wiley Eastern Limited, India, 1993.
2. Noel de Nevers- Air Pollution and Control Engineering- McGraw Hill, 2000.
3. Glynn Henry J. and Gary W. Heinke - Environmental Science and Engineering, Second Edition, Prentice Hall of India, 2004.
4. Rao M.N. and Rao H.V.N - Air Pollution, Tata – McGraw Hill Publishing Ltd., 1993.
5. De A.K - Environmental Chemistry, Tata – McGraw Hill Publishing Ltd., 1999.

CS440	Management Information Systems	OPC	3–0–0	3 Credits

Pre-requisites: None

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

CO1	Determine key terminologies and concepts including IT, marketing, management, economics, accounting, finance in the major areas of business.
CO2	Design, develop and implement Information Technology solutions for business problems.
CO3	Analysis of computing systems and telecommunication networks for business information systems.
CO4	Understand ethical issues that occur in business, evaluate alternative courses of actions and evaluate the implications of those actions.
CO5	Plan projects, work in team settings and deliver project outcomes in time.

Mapping of course outcomes with program outcomes:

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

Detailed syllabus:

Organization and Information Systems, Foundation Concepts, Information Systems in Business, the Components of Information Systems, Competing with Information Technology, Fundamentals of Strategic Advantage, Using Information Technology for Strategic Advantage.

Changing Environment and its impact on Business, Kinds of Information Systems.

Computer Fundamentals, Computer Hardware, and Computer Systems: End User and Enterprise Computing, Computer Peripherals: Input, Output, and Storage Technologies, Computer Software, Application Software, System Software, Computer System Management, Data Resource Management, Technical Foundations of Database Management, Managing Data Resources

Telecommunication and Networks, Telecommunications and Networks, the Networked Enterprise, Telecommunications Network Alternatives

System Analysis and Development and Models, Developing Business/IT Strategies, Planning Fundamentals, Implementation Challenges, Developing Business/IT Solutions, Developing Business Systems, Implementing Business Systems

Manufacturing and Service Systems Information systems for Accounting, Finance, Production and Manufacturing, Marketing and HRM functions, Enterprise Resources Planning (ERP), Choice of IT, Nature of IT decision, Managing Information Technology, Managing Global IT,

Security and Ethical Challenges, Security and Ethical Challenges, Security and Ethical, and Societal Challenges of IT, Security Management of Information Technology, Enterprise and Global Management of Information Technology

Reading:

1. Kenneth J Laudon, Jane P. Laudon, *Management Information Systems*, tenth Edition, Pearson/PHI, 2007.
2. W. S. Jawadekar, *Management Information Systems*, Third Edition, TMH, 2004.

BT440	BIOSENSORS	OPC	3–0–0	3 Credits

Pre-requisites: None

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

CO1	Understand bio sensing and transducing techniques
CO2	Understand principles of linking cell components and biological pathways with energy transduction, sensing and detection
CO3	Demonstrate appreciation for the technical limits of performance of biosensor
CO4	Apply principles of engineering to develop bio analytical devices and design of biosensors

Mapping of course outcomes with program outcomes:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	2
CO2	3	-	-	-	-	-	-	-	-	-	-	2
CO3	-	-	-	-	-	-	-	-	-	-	-	2
CO4	3	2	-	-	-	-	-	-	-	-	-	-

Detailed Syllabus:

General principles: A historical perspective; Signal transduction; Physico-chemical and biological transducers; Sensor types and technologies, Definitions and Concepts Terminology and working vocabulary; Main technical definitions: calibration, selectivity, sensitivity, reproducibility, detection limits, response time.

Physico-chemical transducers: Electrochemical transducers (amperometric, potentiometric, conductimetric); optical transducers (absorption, fluorescence, SPR); Thermal transducers; piezoelectric transducers.

Bio recognition systems: Enzymes; Oligonucleotides and Nucleic Acids; Lipids (Langmuir-Blodgett bilayers, Phospholipids, Liposomes); Membrane receptors and transporters; Tissue and organelles (animal and plant tissue); Cell culture; Immuno receptors; Chemoreceptors; Limitations & problems. Immobilization of biomolecules.

Biosensor Engineering: Methods for biosensors fabrication: self-assembled monolayers, screen printing, photolithography, micro-contact printing, MEMS. Engineering concepts for mass production.

Application of modern sensor technologies: Clinical chemistry; Test-strips for glucose monitoring; Urea determination; Implantable sensors for long-term monitoring; Environmental monitoring; Technological process control; Food quality control; Forensic science benefits; Problems & limitations.

Reading:

1. Donald G. Buerk, Biosensors: Theory and Applications, First Edition, CRC Press, 2009.
2. Alice Cunningham, Introduction to Bioanalytical Sensors, John Wiley& Sons, 1998.
3. Brian R. Eggins, Chemical Sensors and Biosensors, John Wiley& Sons, 2003.

SM440	HUMAN RESOURCE MANAGEMENT	OPC	3–0–0	3 Credits

Pre-requisites: None

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

CO1	Understand principles, processes and practices of human resource management.
CO2	Apply HR concepts and techniques in strategic planning to improve organizational performance.
CO3	Understand tools to manage HR systems and procedures.

Mapping of course outcomes with program outcomes:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	3	-	2	3	-
CO2	-	-	-	-	-	-	-	-	-	2	3	-
CO3	-	-	-	-	-	-	-	-	-	2	3	-

Detailed Syllabus:

Introduction to Human Resource Management, Objectives, Scope and Significance of HRM, Functions of HRM, Problems and Prospects in HRM, Environmental scanning.

Human Resource Planning, Demand Forecasting Techniques, Supply Forecasting Techniques, Analyzing work and designing jobs, Recruitment and Selection, Interviewing Candidates.

Human Resource Development, Orientation, Training and Development, Management Development, Performance Appraisal and Employee Compensation, Factors Influencing Employee Remuneration and Challenges of Remuneration.

Industrial Relations, Industrial Disputes and Discipline, Managing Ethical Issues in Human Resource Management, Workers Participation in Management, Employee safety and health, Managing Global Human Resources and Trade Unions

International HRM, Future of HRM and Human Resource Information Systems

Reading:

1. Aswathappa, Human Resource Management — TMH., 2010.
2. Garry Dessler and Biju Varkkey ,Human Resource Management, PEA., 2011.
3. Noe & Raymond ,HRM: Gaining a Competitive Advantage, TMH, 2008.
4. Bohlander George W, Snell Scott A, Human Resource Management, Cengage Learning, 2009.

PH440	NANOMATERIALS AND TECHNOLOGY	OPC	3–0–0	3 Credits

Prerequisites: None

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

CO1	Understand synthesis and properties of nanostructured materials.
CO2	Analyze magnetic and electronic properties of quantum dots
CO3	Understand structure, properties and applications of Fullerenes and Carbon nanotubes.
CO4	Understand applications of nanoparticles in Nano biology and Nano medicine

Mapping of course outcomes with program outcomes:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	2	-	-	-	-	-	-	-	3	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-
CO4	2	-	-	-	-	-	-	-	-	-	-	3

Detailed Syllabus:

General properties of Nano materials: Origin of nanotechnology. Classification of nanomaterials. Fullerene,carbon, Nanotubes (CNT's), Nanoparticles. Physical, Chemical, Electrical, Optical, Magnetic and mechanical properties of nanomaterials.

Fullerenes and Carbon Nanotubes (CNT's): Introduction: Synthesis and purification. Preparation of fullerenes in the condensed phase, Transport, mechanical, physical properties of CNT's.

Investigation and manipulating materials in the Nanoscale: Electron microscope, scanning probe microscopes, optical microscopes for Nanoscience and Technology, X-Ray Diffraction.

SAMs and clusters: Growth process. Patterning monolayers. Types of clusters. Bonding and properties of clusters.

Semi conducting Quantum Dots: Introduction: Synthesis of Quantum Dots. Electronic structure of Nanocrystals, properties.

Nanobiology: Interaction between Biomolecules and Nanoparticle surgaces. Different types of Inorganic materials used for the synthesis of Hybrid Nano-bio assemblies. Nanoprobes for Analytical Applications.

Nanosensors: Nanosensors based on optical properties. Nanosensors based on quantum size effects. Nanobiosensors.

Nanomedicines: Developments of nanomedicines. Nanotechnology in Diagnostic Applications, materials for use in Diagnostic and therapeutic Applications.

Reading:

1. T. Pradeep, Nano: The Essentials; Tata McGraw-Hill, 2008.
2. W.R. Fahrner, Nanotechnology and Nanoelectronics; Springer, 2006.
3. Rechard Booker and Earl Boysen, Nanotechnology, Willey, 2006.

CY440	CORROSION SCIENCE	OPC	3–0–0	3 Credits

Pre-requisites: None

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

CO1	Understand the electrochemical Principles of Corrosion.
CO2	Apply eight forms of corrosion to industrial problems.
CO3	Evaluate corrosion rates for industrial problems
CO4	Evaluate the corrosion rates of steel in RCC under corrosive environments.
CO5	Perform case studies using microbially induced corrosion of metals.
CO6	Perform case studies using appropriate methods of corrosion control of metals and alloys

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

Understanding Corrosion:

Types of corrosion: uniform corrosion, Galvanic corrosion, pitting corrosion, stress corrosion cracking, corrosion fatigue, stray current corrosion, selective leaching, microbial corrosion Pourbaix potential-pH diagrams for iron, for aluminium, limitations of Pourbaix diagram Passivity-characteristics of passivation and the Flade potential, Theories of passivity, passive-active cells, critical pitting potential, Anodic protection and transpassivity.

Methods of corrosion monitoring:

Polarisation and corrosion rates, polarisation diagrams of corroding metals, calculation of corrosion rates from polarization data. Electrochemical impedance spectroscopy: Nyquist plots, Bode plots, simple equivalent circuits for fitting the impedance data, calculation of corrosion parameters from impedance measurements. Electrochemical cell assembly for polarization and impedance studies. Gravimetric method of determination of corrosion rates.

Measurement of corrosion rates of carbon steel in reinforced cement concrete, Corrosion rates of metals due to micriobially induced corrosion.

Methods of corrosion prevention and control:

Cathodic protection; By impressed current, By the use of sacrificial anodes, combined use with coatings, Advances in cathodic protection.

Metallic coatings: Methods of application, Electroplating, Electroless plating, specific metal platings like Cu, Ni and Cr.

Inhibitors and passivators: Picking inhibitors, vapour phase inhibitors, Inhibitors for cooling water systems, understanding of action of inhibitors through polarization and impedance.

Corrosion prevention and control strategies in different industries – case studies

Reading:

1. R. Winston Revie, Herbert H. Uhlig, Corrosion and Corrosion control, Fourth Edition, Wiley-Interscience, 2007
2. Mc Cafferty and Edward, Introduction to Corrosion Science, First Edition, Springer, 2010.
3. Mars G. Fontana, Corrosion Engineering, Third Edition, Tata McGraw- Hill, New Delhi, 2008.

EE441	PRINCIPLES OF ELECTRIC POWER CONVERSION	OPC	3-0-0	3 Credits

Pre-requisites: EE101-Basic Electrical Engineering and EC101-Basic Electronic Engineering

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

CO 1	Understands the basics in the electric power conversion using power switching devices
CO 2	Evaluate the conversion for range of renewable energy sources with the help of available electrical machines drives
CO 3	Analyzes the different energy storage systems
CO 4	Identify the various Industrial and domestic applications

Mapping of COs with POs:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	1	2	2	2	2	2	1	2
CO2	3	2	3	2	2	2	2	2	2	2	1	2
CO3	3	3	3	2	1	2	2	2	2	2	1	2
CO4	3	2	3	2	2	2	2	2	2	2	1	2

Detailed syllabus:

POWER ELECTRONIC DEVICES AND CONVERTERS:
V-I characteristics of SCR, MOSFET and IGBT. Phase controlled rectifiers, DC-DC converters and Inverters.

APPLICATIONS TO ELECTRIC DRIVES:
Speed control of DC motor, Induction motors, PMSM and BLDC drives

APPLICATIONS TO RENEWABLE ENERGY:
Introduction to solar cell, solar panels, MPPT, wind and other renewable energy sources, Integration of renewable energy sources to the grid.

ENERGY STORAGE SYSTEMS:
Study of automotive batteries, SMF, pumped storage systems, super-capacitors, fly wheels - applications, Li-ion batteries and applications to electric vehicles.

DOMESTIC AND INDUSTRIAL APPLICATIONS:
Induction heating, melting, hardening, lighting applications and their control, UPS, battery chargers

Reading:

1. M.H.Rashid: Power Electronics-circuits, Devices and applications, Prentice Hall India, New Delhi,2009
2. P.S.Bhimbra: Power Electronics, Khanna publishers, New Delhi, 2012
3. Ned Mohan, Undeland and Robbin: Power electronics converters, applications and design, John Willey & Sons,Inc.NewYork, 2006.

CH441	FUEL CELL TECHNOLOGY	OPC	3–0–0	3 Credits

Pre-requisites: None

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

CO1	Understand fuel cell fundamentals.
CO2	Analyze the performance of fuel cell systems.
CO3	Understand construction and operation of fuel cell stack and fuel cell system.
CO4	Apply the modeling techniques for fuel cell systems

Mapping of course outcomes with program outcomes:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	2
CO2	-	-	-	-	-	-	-	-	3	-	-	2
CO3	3	-	-	-	-	-	-	-	-	-	-	2
CO4	-	2	-	-	-	-	-	-	-	-	-	3

Detailed syllabus:

Overview of Fuel Cells: What is a fuel cell, brief history, classification, how does it work, why do we need fuel cells, Fuel cell basic chemistry and thermodynamics, heat of reaction, theoretical electrical work and potential, theoretical fuel cell efficiency.

Fuels for Fuel Cells: Hydrogen, Hydrocarbon fuels, effect of impurities such as CO, S and others.

Fuel cell electrochemistry: electrode kinetics, types of voltage losses, polarization curve, fuel cell efficiency, Tafel equation, exchange currents.

Fuel cell process design: Main PEM fuel cell components, materials, properties and processes: membrane, electrode, gas diffusion layer, bi-polar plates, Fuel cell operating conditions: pressure, temperature, flow rates, humidity.

Main components of solid-oxide fuel cells, Cell stack and designs, Electrode polarization, testing of electrodes, cells and short stacks, Cell, stack and system modeling

Fuel processing: Direct and in-direct internal reforming, Reformation of hydrocarbons by steam, CO2 and partial oxidation, Direct electro-catalytic oxidation of hydrocarbons, carbon decomposition, Sulphur tolerance and removal , Using renewable fuels for SOFCs

Reading:

1. Gregor Hoogers, Fuel Cell Technology Hand Book, CRC Press, 2003.
2. Karl Kordesch& Gunter Simader, Fuel Cells and Their Applications, VCH Publishers, NY, 2001.
3. F. Barbir, PEM Fuel Cells: Theory and Practice, Second Edition, Elsevier/Academic Press, 2013.
4. Subhash C. Singal and Kevin Kendall, High Temperature Fuel Cells: Fundamentals, Design and Applications

MA441	OPERATIONS RESEARCH	OPC	3–0–0	3 Credits

Prerequisites: None

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

CO1	Formulate and solve linear programming problems
CO2	Determine optimum solution to transportation problem
CO3	Determine average queue length and waiting times of queuing models.
CO4	Determine optimum inventory and cost in inventory models.

Mapping of course outcomes with program outcomes:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	2
CO2	3	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-

Detailed Syllabus:

Linear Programming: Formulation and graphical solution of LPP's. The general LPP, slack, surplus and artificial variables. Reduction of a LPP to the standard form. Simplex computational procedure, Big-M method, Two-phase method. Solution in case of unrestricted variables. Dual linear programming problem. Solution of the primal problem from the solution of the dual problems.

Transportation Problems: Balanced and unbalanced Transportation problems. Initial basic feasible solution using N-W corner rule, row minimum method, column minimum, least cost entry method and Vogel's approximation method. Optimal solutions. Degeneracy in Transportation problems.

Queuing Theory: Poisson process and exponential distribution. Poisson queues - Model (M/M/1) (FIFO) and its characteristics.

Elements of Inventory Control: Economic lot size problems - Fundamental problems of EOQ. The problem of EOQ with finite rate of replenishment. Problems of EOQ with shortages - production instantaneous, replenishment of the inventory with finite rate. Stochastic problems with uniform demand (discrete case only).

Reading:

1. Kanti Swarup, Man Mohan and P.K.Gupta, Introduction to Operations Research, S. Chand & Co., 2006
2. J.C. Pant, Introduction to Operations Research, Jain Brothers, New Delhi, 2008.
   N.S.Kambo : Mathematical Programming Tec

PH441	BIOMATERIALS AND TECHNOLOGY	OPC	3–0–0	3 Credits

Prerequisites: None

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

CO1	Understand the structure and properties of biomaterials
CO2	Classify implant biomaterials
CO3	Evaluate biocompatibility of implants
CO4	Identify appropriate biomaterials for specific medical applications

Mapping of course outcomes with program outcomes:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	2
CO2	2	-	-	-	-	-	-	-	-	-	-	-
CO3	2	-	-	-	-	-	-	-	2	-	-	-
CO4	2	-	-	-	-	-	-	-	-	-	-	3

Detailed Syllabus:

Overview of biomaterials: Historical developments, impact of biomaterials, interfacial phenomena, tissue responses to implants.

Structure and properties of biomaterials: Crystal structure of solids, phase changes, imperfections in solids, non-crystalline solids, surface properties of solids, mechanical properties, surface improvements.

Types of biomaterials: Metallic implant materials, ceramic implant materials, polymeric implant materials composites as biomaterials.

Characterization of materials: Electric properties, optical properties, X-ray absorption, acoustic and ultrasonic properties.

Bio implantation materials: Materials in ophthalmology, orthopedic implants, dental materials and cardiovascular implant materials.

Tissue response to implants: Normal wound healing processes, body response to implants, blood compatibility, structure – property relationship of tissues.

Reading:

1. Joon Park, R.S. Lakes , Biomaterials an introduction; Third Edition, Springer, 2007
2. Sujatha V Bhat, Biomaterials; Second Edition, Narosa Publishing House, 2006.

CY441	CHEMISTRY OF NANOMATERIALS	OPC	3–0–0	3 Credits

Pre-requisites: None

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

CO1	Understand the state of art synthesis of nano materials
CO2	Characterize nano materials using ion beam, scanning probe methodologies, position sensitive atom probe and spectroscopic ellipsometry.
CO3	Analyze nanoscale structure in metals, polymers and ceramics
CO4	Analyze structure-property relationship in coarser scale structures
CO5	Understand structures of carbon nano tubes.

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

Introduction: Scope of Nano science and nanotechnology, Nano science in nature, classification of nanostructured materials, importance of nano materials.

Synthetic Methods: Chemical Routes (Bottom-Up approach):- Sol-gel synthesis, micro emulsions or reverse micelles, solvothermal synthesis, microwave heating synthesis and sonochemical synthesis. Physical methods (Top-Down approach):- Inert gas condensation, plasma arc technique, ion sputtering, Laser ablation, laser pyrolysis, and chemical vapour deposition method.

Techniques for characterization:

Diffraction Technique: - Powder X-ray diffraction for particle size analysis.

Spectroscopy Techniques: - Operational principle and applications of spectroscopy techniques for the analysis of nanomaterials, UV-VIS spectrophotometers and its application for band gap measurement.

Electron Microscopy Techniques: Scanning electron microscopy (SEM) and EDAX analysis, transmission electron microscopy (TEM), scanning probe microscopy (SPM).

BET method for surface area determination.

Dynamic light scattering technique for particle size analysis.

Reading:

1. T. Pradeep, NANO: The Essentials: McGraw-Hill, 2007.
2. B. S. Murty, P. Shankar, Baldev Rai, BB Rath and James Murday, Textbook of Nanoscience and nanotechnology: Univ. Press, 2012.
3. Guozhong Cao, Nanostructures & Nanomaterials; Synthesis, Properties & Applications: Imperial College Press, 2007.
4. M.A. Shah and Tokeer Ahmad, Principles of Nanoscience and Nanotechnology: Narosa Pub., 2010.
5. Manasi Karkare, Nanotechnology: Fundamentals and Applications: IK International, 2008.
6. C. N. R. Rao, Achim Muller, K.Cheetham, Nanomaterials Chemistry, Wiley-VCH, 2007

HS440	CORPORATE COMMUNICATION	OPC	3–0–0	3 Credits

Pre-requisites: None

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

CO1	Understand corporate communication culture
CO2	Prepare business letters, memos and reports
CO3	Communicate effectively in formal business situations
CO4	Exhibit corporate social responsibility and ethics
CO5	Practice corporate email, mobile and telephone etiquette
CO6	Develop good listening skills and leadership qualities

Mapping of course outcomes with program outcomes:

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

Detailed Syllabus:

Importance of Corporate communication - Introduction to and definition of corporates – Communication, process, patterns and channels of communication- Barriers to communication and strategies to overcome them- Evolution of corporate culture- Role and contribution of individual group and organization - Role of psychology in communication.

Oral Communication- Techniques for improving oral fluency-Speech mechanics-Group Dynamics and Group Discussion – Debate and oral presentations.

Written Communication- Types and purposes- Writing business reports, and business proposals- Memos, minutes of meetings- Circulars, persuasive letters- Letters of complaint- ; language and formats used for drafting different forms of communication. Internal and external communication.

Corporate responsibility- Circulating to employees vision and mission statements- ethical practices- Human rights -Labour rights-Environment- governance- Moral and ethical debates surrounding - Public Relations - Building trust with stakeholders.

Corporate Ethics and Business Etiquette- Integrity in communication-Harmful practices and communication breakdown- Teaching how to deal with tough clients through soft skills. Body language- Grooming- Introducing oneself- Use of polite language- Avoiding grapevine and card pushing – Etiquette in e-mail, mobile and telephone.

Listening Skills - Listening- for information and content- Kinds of listening- Factors affecting listening and techniques to overcome them- retention of facts, data and figures- Role of speaker in listening.

Leadership Communication Styles - Business leadership -Aspects of leadership-qualities of leader- training for leadership-delegation of powers and ways to do it-humour-commitment.

Reading:

1. Raymond V. Lesikar, John D. Pettit, Marie E. Flatley Lesikar's Basic Business Communication – Seventh Edition: Irwin, 1993
2. Krishna Mohanand Meera Banerji, Developing Communication Skills: Macmillan Publishers India, 2000
3. R.C. Sharma & Krishna Mohan Business Correspondence and Report Writing: – Third Edition
4. Tata McGraw-Hill, 2008
5. Antony Jay & Ross Jay, Effective Presentation, University Press, 1999.
6. Shirley Taylor, Communication for Business, Longman, 1999