B. Tech. (ECE) – Curriculum (IIITSUGECE16)

Semester-wise Curriculum

I Semester

Sl. No.	Code	Course Name	L	T	P	C
1	HSIR11	English for Communication	3	0	0	3
2	MAIR11	Mathematics I	3	1	0	4
3	PHIR11	Physics – I (Theory & Lab)	2	0	3	3
4	CHIR11	Chemistry – I (Theory & Lab)	2	0	3	3
5	CSIR11	Basics of Programming (Theory and Lab)	2	0	2	3
6	ECIR15	Branch Specific Course	2	0	0	2
7	CEIR11	Basics of Civil Engineering	2	0	0	2
8	MEIR11	Basics of Mechanical Engineering	2	0	0	2
9	MEIR12	Engineering Graphics	1	0	4	3
10	SWIR11	NSS/NCC/NSC	0	0	0	0

Total Credits: 25

II Semester

Sl. No.	Code	Course Name	L	T	P	C
1	HSIR12	Professional Communication	3	0	0	3
2	MAIR12	Mathematics II	3	1	0	4
3	PHIR13	Physics - II (Theory & Lab)	3	0	3	4
4	CHIR13	Chemistry - II (Theory & Lab)	3	0	3	4
5	ENIR11	Energy and Environmental Engineering	2	0	0	2
6	ECPC21	Electrical Circuits and Machines	3	1	0	4
8	PRIR11	Engineering Practice	0	0	4	2
9	SWIR11	NSS/NCC/NSC	0	0	0	0

Total Credits: 23

III Semester

Course Code	Course Type	Course Name	L	T	P	C
MAIR34	GIR	Real Analysis and Partial Differential Equations	3	0	0	3
ECPC31	PC	Signals and Systems	3	1	0	4
ECPC32	PC	Network Analysis and Synthesis	3	0	0	3
ECPC33	PC	Electrodynamics and Electromagnetic Waves	3	1	0	4
ECPC34	PC	Semiconductor Physics and Devices	3	0	0	3
ECPC35	PC	Digital Circuits and Systems	3	0	0	3
ECLR31	ELR	Devices and Networks Laboratory	0	0	3	2
ECLR32	ELR	Digital Electronics Laboratory	0	0	3	2

Total Credits: 24

IV Semester

Course Code	Course Type	Course Name	L	T	P	C
MAIR45	GIR	Probability theory and Random Processes	3	0	0	3
HSIR14	GIR	Professional Ethics	3	0	0	3
ECPC41	PC	Digital Signal Processing	3	1	0	4
ECPC42	PC	Transmission Lines and Waveguides	3	0	0	3
ECPC43	PC	Electronic Circuits	3	0	0	3
ECPC44	PC	Microprocessors and Micro controllers	3	0	0	3
ECLR41	ELR	Electronic Circuits Laboratory	0	0	3	2
ECLR42	ELR	Microprocessor and Microcontroller Laboratory	0	0	3	2

Total Credits: 23

V Semester

Course Code	Course Type	Course Name	L	T	P	C
ECPC51	PC	Statistical Theory of Communication	3	1	0	4
ECPC52	PC	Digital Signal Processors and Applications	3	0	0	3
ECPC53	PC	Analog Communication	3	0	0	3
ECPC54	PC	Analog Integrated Circuits	3	0	0	3
E1	PE – I		3	0	0	3
E2	PE / OE / MI – I		3	0	0	3
ECLR51	ELR	Analog Integrated Circuits Laboratory	0	0	3	2
ECLR52	ELR	Digital Signal Processing and Simulation Laboratory	0	0	3	2

Total Credits: 23

VI Semester

Course Code	Course Type	Course Name	L	T	P	C
ECPC61	PC	Digital Communication	3	0	0	3
ECPC62	PC	Wireless Communication	3	0	0	3
ECPC63	PC	VLSI Systems	3	0	0	3
ECPC64	PC	Antennas and Propagation	3	0	0	3
E3	PE – II		3	0	0	3
E4	PE / OE / MI – II		3	0	0	3
ECLR61	ELR	Communication Engineering Laboratory	0	0	3	2
ECLR62	ELR	VLSI and Embedded System Design Laboratory	0	0	3	2
ECIR16	GIR	Internship/ Industrial Training/ Academic Attachment	0	0	0	2
ECIR19	GIR	Industrial Lecture	0	0	0	1

Total Credits: 25

VII Semester

Course Code	Course Type	Course Name	L	T	P	C
ECPC71	PC	Microwave Components and Circuits	3	0	0	3
HSIR13	GIR	Industrial Economics and Foreign Trade	3	0	0	3
E5	PE –III		3	0	0	3
E6	PE / OE / MI – III		3	0	0	3
E7	PE / OE / MI – IV		3	0	0	3
CSIR18	GIR	Comprehensive Viva-Voce	3	0	0	3

Total Credits: 18

VIII Semester

Course Code	Course Type	Course Name	L	T	P	C
ECPC81	PC	Fiber Optic Communication	3	0	0	3
E8	PE –IV		3	0	0	3
E9	PE / OE / MI – V		3	0	0	3
E10	PE / OE / MI – VI		3	0	0	3
ECIR17	GIR	Project Work	6	0	0	6

Total Credits: 18

Summary

Semester	I	II	III	IV	V	VI	VII	VIII	Total
Credits	25	23	24	23	23	25	18	18	179

List of Electives

V Semester

Programmme Electives – I(1 out of 3)

- Display Systems
- Statistical Signal Processing
- Communication Switching Systems

Programmme/ Open Electives / Minor from other Dept. - I (1 out of 2)

- Computer Architecture and Organization
- Multimedia Communication Technology

VI Semester

Programmme Electives - II (1 out of 3)

- RF MEMS Circuit Design
- Principles of Radar
- Digital Signal Processing for Wireless Communication

Programmme/ Open Electives / Minor from other Dept. – II (1 out of 2)

- Arm System Architecture
- Networks and Protocols

VII Semester

Programmme Electives - III (1 out of 3)

- Cognitive Radio
- Broadband Access Technologies
- Satellite Communication

Programmme/ Open Electives / Minor from other Dept. – III, IV

- Ad hoc Wireless Networks
- Digital Image Processing

VIII Semester

Programmme Electives - IV (1 out of 3)

- Microwave Integrated Circuit Design
- Microwave Electronics
- Electronic Packaging

Programmme/ Open Electives / Minor from other Dept. –V & VI

- Wireless Sensor Networks
- Digital Speech Processing
- Pattern Recognition

Electives for B. Tech. (Honors)*

Course Code	Course Name	L	T	P	C
ECHO11	Advanced Digital Signal Processing	3	0	0	3
ECHO12	Spectral Analysis Of Signals	3	0	0	3
ECHO13	Detection and Estimation	3	0	0	3
ECHO14	Wavelet Signal Processing	3	0	0	3
ECHO15	RF Circuits	3	0	0	3
ECHO16	Numerical Techniques for MIC	3	0	0	3
ECHO17	Applied Photonics	3	0	0	3
ECHO18	Advanced Radiation Systems	3	0	0	3
ECHO19	Bio Mems	3	0	0	3
ECHO20	Analog IC Design	3	0	0	3
ECHO21	VLSI System Testing	3	0	0	3
ECHO22	Electronic Design Automation Tools	3	0	0	3
ECHO23	Design of ASICs	3	0	0	3
ECHO24	Digital System Design	3	0	0	3
ECHO25	Digital Signal Processing Structures for VLSI	3	0	0	3
ECHO26	Low Power VLSI Circuits	3	0	0	3
ECHO27	Vlsi Digital Signal Processing Systems	3	0	0	3
ECHO28	Asynchronous System Design	3	0	0	3
ECHO29	Physical Design Automation	3	0	0	3
ECHO30	Mixed - Signal Circuit Design	3	0	0	3
ECHO31	Digital Signal Processing for Medical Imaging	3	0	0	3

* - *Eligibility Criteria: As per the existing institute norms*

Minors Offered

Course Code	Course Title	L	T	P	C
ECMI11	Signals And Systems	3	0	0	3
ECMI12	Network Analysis and Synthesis	3	0	0	3
ECMI13	Electrodynamics and Electromagnetic Waves	3	0	0	3
ECMI14	Semiconductor Physics and Devices	3	0	0	3
ECMI15	Digital Circuits and Systems	3	0	0	3
ECMI16	Digital Signal Processing	3	0	0	3
ECMI17	Analog Communication	3	0	0	3
ECMI18	Digital Communication	3	0	0	3
ECMI19	Wireless Communication	3	0	0	3

FIRST SEMESTER

Course Code	:	**HSIR11**
Course Title	:	**English for Communication**
Number of Credits	:	**3**
Prerequisites (Course code)	:	**NONE**
Course Type	:	**GIR**

Objective

The primary objective is to develop in the under-graduate students of engineering a level of competence in English required for independent and effective communication for academic and social needs.

Course Material

Instruction will be provided through appropriate material – articles from popular magazines, newspapers, technical journals, samples from industries and also text books. Practice in the four language skills necessary for their specific technical requirements will be provided in an integrated manner.

Course Content

Communication An introduction - Its role and importance in the corporate world–Toolsof communication – Barriers – Levels of communication – English for Specific purposes and English for technical purposes.

Listening Listening process & practice–Exposure to recorded & structured talks, classroom lectures – Problems in comprehension & retention – Note-taking practice – Listening tests-Importance of listening in the corporate world.

Reading Introduction of different kinds of reading materials: technical & non-technical–Different reading strategies: skimming, scanning, inferring, predicting and responding to content – Guessing from context – Note making – Vocabulary extension.

Speaking Barriers to speaking–Building self-confidence & fluency–Conversationpractice-Improving responding capacity - Extempore speech practice – Speech assessment.

Writing Effective writing practice–Vocabulary expansion - Effective sentences: role ofacceptability, appropriateness, brevity & clarity in writing – Cohesion & coherence in writing – Writing of definitions, descriptions & instructions - Paragraph writing - Introduction to report writing.

Outcome

The students will be able to express themselves in a meaningful manner to different levels of people in their academic and social domains.

Text Books

1. Krishna Mohan and Meenakshi Raman ’Effective English Communication’, Tata McGraw Hill, New Delhi, 2000.
2. Meenakshi Raman and Sangeetha Sharma ‘Technical Communication’, Oxford University Press, New Delhi, 2006.

Reference Books

1. M. Ashraf Rizvi ‘Effective Technical Communication’, Tata McGraw-Hill, New Delhi, 2005.
2. Golding S.R. ‘Common Errors in English Language’, Macmillan, 1978.
3. Christopher Turk ‘Effective Speaking’, E & FN Spon, London, 1985.

Course Code	:	**MAIR11**
Course Title	:	**Mathematics I**
Number of Credits	:	**4**
Prerequisites (Course code)	:	**NONE**
Course Type	:	**GIR**

Objective

To acquire fundamental knowledge and apply in engineering disciplines.

Course Content

Characteristic equation of a matrix –Eigen values and Eigen vectors – Properties of Eigen values – Diagonalization of matrix – Cayley-Hamilton Theorem (without proof) verification – Finding Inverse and Power of a matrix using it – Quadratic form – Definite and indefinite forms – Orthogonal reduction of quadratic form to canonical form.

Sequences of real numbers – Limit of a sequence – Convergent and divergent sequences– sub sequence- Cauchy's sequence – monotone convergence theorem (without proof)- Sequence with recurrence relations.

Infinite series-Convergence Tests for positive term series – Comparison, Root, Ratio and Raabe's tests - Alternating series – Leibnitz's rule – Absolute and Conditional Convergence. Riemann rearrangement theorem (without proof).

Functions of several variables – Partial derivatives and Transformation of variables – Jacobian and its Properties- Maxima and Minima of function of two variables.

Double integral – Changing the order of Integration – Change of variables from Cartesian to Polar Coordinates – Area using double integral in Cartesian and Polar Coordinates – Triple integral – Change of Variables from Cartesian to Spherical and Cylindrical Coordinates – Volume using double and triple integrals.

Outcome

After the completion of the course, students would be able to solve curriculum problems.

Text Books

1. Kreyszig, E., 'Advanced Engineering Mathematics', 9th edition, John Wiley Sons, 2006.
1. Grewal, B.S., 'Higher Engineering Mathematics', 42nd edition, Khanna Publications, Delhi, 2012.
2. M K Venkataraman, 'Engineering mathematics', Volume I, 2nd ed., National Publishing Co, 2003.

Reference Books

1. Apostol, T.M. 'Calculus' Volume I & II Second Edition, John Wiley & Sons (Asia) 2005.
2. Greenberg, M.D. 'Advanced Engineering Mathematics', Second Edition, Pearson Education Inc. (First Indian reprint), 2002

3. Strauss. M.J, Bradley, G.L. and Smith, K.J. ‘Calculus’, 3rd Edition, Prentice Hall, 2002.
4. T Veerarajan, ‘Engg Mathematics’ McGraw-Hill Education (India) Pvt Limited, 2007

Course Code	:	**PHIR11**
Course Title	:	**Physics - I**
Number of Credits	:	**3**
Prerequisites (Course code)	:	**NONE**
Course Type	:	**GIR**

Objectives

- To make a bridge between the physics in school and engineering courses.
- To introduce the basic concepts of modern science like Photonics, Engineering applications of acoustics, fundamentals of crystal physics and materials science.

Course Content

Lasers

Introduction to Laser-characteristics of Lasers-Spontaneous and stimulated emissions – Einstein's coefficients – population inversion and lasing action – laser systems: Ruby laser, He-Ne Laser, semiconductor laser-applications:–Holography- CD-drive – industrial and medical applications.

Fiber Optics

Fermat's principle and Snell's law-optical fiber – principle and construction – acceptance cone - numerical aperture - V-Number - types of fibers, Fabrication: Double Crucible Technique, Vapour phase Oxidation Process – fiber optic communication principle – fiber optic sensors-other applications of optical fibers.

Acoustics

Characteristics of musical sound – loudness – Weber-Fechner law – decibel – absorption coefficient – reverberation – reverberation time – Sabine's formula – acoustics of buildings– ultrasonics – production of ultrasonics using piezoelectric method –magnetostriction method-applications.

Crystallography

Crystalline and amorphous solids – lattice and unit cell – seven crystal system and Bravais lattices – symmetry operation – Miller indices – atomic radius – coordination number – packing factor calculation for sc, bcc, fcc – Bragg's law of X-ray diffraction –Laue Method-powder crystal method.

Magnetic materials, conductors and superconductors

Magnetic materials: Definition of terms–classification of magnetic materials and properties – Domain theory of ferromagnetism- hard and soft magnetic materials – applications.
Conductors: classical free electron theory (Lorentz–Drude theory)–electrical conductivity
Superconductors: definition–Meissner effect–type I & II superconductors–BCS theory(qualitative) – high temperature superconductors ¯ Josephson effect – quantum interference (qualitative) – SQUID – applications.

Outcome

The student will be able to understand many modern devices and technologies based on lasers and

optical fibers. Student can also appreciate various material properties which are used in engineering applications and devices.

Text Books

1. 'A text book of Engineering Physics', M.N. Avadhanulu and P.G. Kshirsagar, S. Chand and Company, New Delhi (2009).
2. 'Engineering Physics', R.K. Gaur and S.L. Gupta, Dhanpat Rai Publications (P) Ltd., 8thedn., New Delhi (2001).

Reference Books

1. Laser Fundamentals, William T. Silfvast, 2ndedn, Cambridge University press, New York (2004)
2. Fundamentals of Physics, 6th Edition, D. Halliday, R. Resnick and J. Walker, John Wiley and Sons, New York (2001).
3. Introduction to solid state physics,7thEdn, Charls Kittel, Wiley, Delhi (2007)

Laboratory Experiments

1. Torsional pendulum
2. Numerical aperture of an optical fiber
3. Temperature measurement - Thermocouple
4. Specific rotation of a liquid – Half Shade Polarimeter
5. Thickness of a thin wire – Air Wedge
6. Conversion of galvanometer into ammeter and voltmeter
7. Dispersive power of a prism – Spectrometer
8. Superconductivity- measurement of transition temperature
9. Absorption spectrometer
10. Brewster's Angle measurement
11. Measurement of Young's modulus

Reference Books

1. 'Practical Physics', R.K. Shukla, Anchal Srivastava, New age international (2011) 2. 'B.Sc. Practical Physics', C.L Arora, S. Chand &Co. (2012)

Course Code	:	**CHIR11**
Course Title	:	**Chemistry - I**
Number of Credits	:	**3**
Prerequisites (Course code)	:	**NONE**
Course Type	:	**GIR**

Objectives

To introduce students to water chemistry, bonding concepts, entropy and basic organic chemistry.

Course Content

Water
Sources, hard & soft water, estimation of hardness by EDTA method, softening of water, zeolite process & demineralization by ion exchangers, boiler feed water, internal treatment methods, specifications for drinking water, BIS & WHO standards, treatment of water for domestic use, desalination - Reverse osmosis &Electrodialysis.

Chemical Bonding
Basic concepts, bonding in metals, electron gas theory, physical properties of metals (electrical & thermal conductivity, opaque &lusture, malleability & ductility), Alloy-substitutional alloys, interstitial alloys.

Coordinate bond, EAN rule, 16 & 18 electron rule, crystal field theory, splitting of 'd' orbitals in octahedral, tetrahedral and square planar complexes.

Shape & Intermolecular Interactions
Shape-Lewis dot structures, formal charge, VSEPR method, consequences of shape, dipole moment, valence bond theory; Intermolecular interactions-ion ion interactions, ion-dipole interactions, hydrogen bonding, dipole-dipole interactions, London / dispersion forces, relative strength of intermolecular forces; Consequences-surface tension.

Thermodynamics
Entropy as a thermodynamic quantity, entropy changes in isothermal expansion of an ideal gas, reversible and irreversible processes, physical transformations, work & free energy functions, Helmholtz and Gibbs free energy functions, Gibbs-Helmholtz equation, Gibbs-Duhem equation, Clapeyron-Clausius equation & its applications, Van't Hoff isotherm and applications.

Fuels & Lubricants
Fuels - Classification, examples, relative merits, types of coal, determination of calorific value of solid fuels, Bomb calorimeter, theoretical oxygen requirement for combustion, proximate & ultimate analysis of coal, manufacture of metallurgical coke, flue gas analysis, problems. Lubricants - Definition, theories of lubrication, characteristics of lubricants, viscosity, viscosity index, oiliness, pour point, cloud point, flash point, fire point, additives to lubricants, Solid lubricants.

Outcome
Students will learn about quality of water, bonding theories, entropy change for various processes and basic stereo chemical aspects.

Text Books

1. 'Engineering Chemistry', P.C. Jain, M. Jain, Dhanpat Rai Publishing Company, New Delhi, 2005.
2. 'Physical Chemistry', P. Atkins, J.D. Paula, Oxford University Press, 2002.

Reference Books

1. 'Modern Inorganic Chemistry', R.D. Madan, S. Chand & Company Ltd., New Delhi, 2012.
2. 'Engineering Chemistry', M.J. Shultz, Cengage Learning, New Delhi, 2007.

Laboratory Experiments

1. Estimation of total alkalinity in the given water sample.
2. Estimation of carbonate, non-carbonate and total hardness in the given water sample.
3. Estimation of dissolved oxygen in the given water sample.
4. Determination of the percentage of Fe in the given steel sample.
1. Estimation of Ca in limestone.
2. Estimation of Fe^{3+} by spectrophotometer.

Reference Books

1. Laboratory Manual, Department of Chemistry, NITT
2. Laboratory Manual on Engineering Chemistry, S.K. Bhasin, S. Rani, Dhanpat Rai Publishing Company, New Delhi, 2011.

Course Code	:	**CSIR11**
Course Title	:	**Basics of Programming**
Number of Credits	:	**3**
Prerequisites (Course code)	:	**NONE**
Course Type	:	**GIR**

Objectives

- To learn the fundamentals of computers.
- To learn the problem solving techniques writing algorithms and procedures.
- To learn the syntax and semantics for C programming language
- To develop the C code for simple logic
- To understand the constructs of structured programming including conditionals and iterations

Course Content

Introduction to computers – Computer Organization – Characteristics – Hardware and Software – Modes of operation – Types of programming languages – Developing a program.

Algorithms – Characteristics – Flowcharts - Principles of Structured programming – Sequential, selective structures - Repetitive structures –Bounded , Unbounded and Infinite iterations – Examples for each.

Introduction to C – C character set – Identifiers and Keywords – Datatypes – Constants – Variables – Declarations – Expressions – Statements – Symbolic constants – Operators– Library functions – Data input and output: Single character input and output – Entering input data – Writing output data – gets and puts functions. Control statements – Branching: if-else – Looping: while – do-while – for; Nested control structures – switch statement – break statement – continue statement – comma operator – goto statement.

Modular Programming – Functions and Procedures – Examples – Parameter passing methods.

Arrays – Defining an array – Processing an array – Multidimensional arrays-Pointers – Variable definitions and initialization – Pointer operators – Pointer expressions and arithmetic – Pointers and one-dimensional arrays- Functions – Defining a function – Accessing a function – Function prototypes – Passing arguments to a function –Passing arrays to a function – Passing pointers to a function – Recursion.

Outcome

1. Ability to write algorithms for problems
2. Knowledge of the syntax and semantics of C programming language
3. Ability to code a given logic in C language
4. Knowledge in using C language for solving problems

Text Books

1. Byron Gottfried, ‘Programming with C’, Third Edition, Tata McGraw Hill Education, 2010.
2. R.G.Dromey, ‘How to Solve it By Computers?’, Prentice Hall, 2001

Reference Books

1. J.R. Hanly and E.B. Koffman, 'Problem Solving and Program Design in C', 6th Edition, Pearson Education, 2009.
2. Paul Deital and Harvey Deital, 'C How to Program', Seventh Edition, Prentice Hall, 2012.
3. YashavantKanetkar, 'Let Us C', 12th Edition, BPB Publications, 2012.

Laboratory Experiments

1. Programs using sequence construct
2. Programs using selection construct
3. Programs using Iterative construct
4. Programs using nested for loops
5. Programs using functions with Pass by value
6. Programs using functions with Pass by reference
7. Programs using recursive functions
8. Programs using one dimensional Array
9. Programs using two dimensional Arrays
10. Programs using Pointers and functions
11. Programs using Pointers and Arrays

Course Code	:	**ECIR15**
Course Title	:	**(Branch Specific Course)**
Number of Credits	:	**2**
Prerequisites (Course code)	:	**NONE**
Course Type	:	**GIR**

Curriculum and Assessments will be decided by the respective department

Course Code	:	**CEIR11**
Course Title	:	**Basic Civil Engineering**
Number of Credits	:	**2**
Prerequisites (Course code)	:	**NONE**
Course Type	:	**GIR**

Objectives

- To give an overview of the fundamentals of the Civil Engineering fields to the students of all branches of Engineering
- To realize the importance of the Civil Engineering Profession in fulfilling societal needs

Course Content

Properties and uses of construction materials - stones, bricks, cement, concrete and steel.

Site selection for buildings - Component of building - Foundation- Shallow and deep foundations - Brick and stone masonry - Plastering - Lintels, beams and columns - Roofs.

Roads-Classification of Rural and urban Roads- Pavement Materials-Traffic signs and road marking-Traffic Signals.

Surveying - Classification-Chain Survey-Ranging-Compass Survey-exhibition of different survey equipment.

Sources of Water - Dams- Water Supply-Quality of Water-Wastewater Treatment – Sea Water Intrusion – Recharge of Ground Water.

Outcome

1. The students will gain knowledge on site selection, construction materials, components of buildings, roads and water resources
2. A basic appreciation of multidisciplinary approach when involved in Civil Related Projects.

Reference Books

1. Punmia, B.C, Ashok Kumar Jain, Arun Kumar Jain, 'Basic Civil Engineering', Lakshmi Publishers, 2012.
2. SatheeshGopi, 'Basic Civil Engineering', Pearson Publishers, 2009.
3. Rangwala, S.C, 'Building materials', Charotar Publishing House, Pvt. Limited, Edition 27, 2009.
4. Palanichamy,M.S, 'Basic Civil Engineering', Tata Mc Graw Hill, 2000.
5. Lecture notes prepared by Department of Civil Engineering, NITT.

Course Code	:	**MEIR11**
Course Title	:	**Basic Mechanical Engineering**
Number of Credits	:	**2**
Prerequisites (Course code)	:	**NONE**
Course Type	:	**GIR**

Objectives

- To explain the importance of concepts of mechanical engineering and conservation equations.
- To introduce the techniques for analyzing the forces, momentum and power.
- To introduce the various properties of materials, and the techniques of selection of materials.
- To identify the basic elements of a mechanical system and write their constitutive equations and performance analysis techniques.

Course Content

Fundamentals Introduction to mechanical engineering, concepts of thermal engineering,mechanical machine design, industrial engineering, and manufacturing technology.

Thermal Engineering Laws of thermodynamics, types of systems, concepts and types ofI.C. engine, air compressors, principle of turbomachines, properties of steam and steam generators, automobile engineering, introduction to gas turbines and refrigeration & air-conditioning.

Engineering Materials Types of materials, selection of materials, material properties,introduction to materials structure, machine elements, transmission, fasteners, and support systems.

Manufacturing Technology Manufacturing, classification, lathe, drilling machines, millingmachines, metal joining, metal forming, casting, forging, and introduction to powder metallurgy.

Outcome

The terminal objectives of the course is that, on successful completion of teaching-learning and evaluation activities, a student would be able to identify, appreciate and analyze the problems by applying the fundamentals of mechanical engineering and to proceed for the development of the mechanical systems.

Reference Books

1. Lecture notes prepared by Department of Mechanical Engineering, NITT.
2. K. Venugopal, ‘Basic mechanical Engineering’.

Course Code	:	**MEIR12**
Course Title	:	**Engineering Graphics**
Number of Credits	:	**3**
Prerequisites (Course code)	:	**NONE**
Course Type	:	**GIR**

Objectives

- Irrespective of engineering discipline, it has become mandatory to know the basics of Engineering graphics. The student is expected to possess the efficient drafting skill depending on the operational function in order to perform day to day activity.
- Provide neat structure of industrial drawing
- Enables the knowledge about position of the component and its forms Interpretation of technical graphics assemblies
- Preparation of machine components and related parts

Course Content

Fundamentals Drawing standard - BIS, dimensioning, lettering, type of lines, scaling-conventions.

Geometrical constructions Dividing a given straight line into any number of equal parts,bisecting a given angle, drawing a regular polygon given one side, special methods of constructing a pentagon and hexagon – conic sections – ellipse – parabola – hyperbola - cycloid – trochoid.

Orthographic projection Introduction to orthographic projection, drawing orthographicviews of objects from their isometric views - Orthographic projections of points lying in four quadrants, Orthographic projection of lines parallel and inclined to one or both planes Orthographic projection of planes inclined to one or both planes. Projections of simple solids - axis perpendicular to HP, axis perpendicular to VP and axis inclined to one or both planes.

Sectioning of solids Section planes perpendicular to one plane and parallel or inclined toother plane.

Intersection of surfaces Intersection of cylinder & cylinder, intersection of cylinder &cone, and intersection of prisms.

Development of surfaces Development of prisms, pyramids and cylindrical &conicalsurfaces.

Isometric and perspective projection Isometric projection and isometric views ofdifferent planes and simple solids, introduction to perspective projection.

Computer aided drafting Introduction to computer aided drafting package tomake 2-D drawings.

Self-study only, not to be included in examinations. Demonstration purpose only, not to be included in

Outcome

Towards the end of the course it is expected that the students would be matured to visualize the engineering components. A number of chosen problems will be solved to illustrate the concepts clearly.

Text Books

1. Bhatt, N. D. and Panchal, V.M., 'Engineering Drawing', Pub.: Charotar Publishing House, 2010.
2. Natarajan, K. V., 'A text book of Engineering Graphics', Pub.: Dhanalakshmi Publishers, Chennai, 2006.

Reference Books

1. Venugopal, K. and Prabhu Raja, V., 'Engineering Drawing and Graphics + AutoCAD', Pub.: New Age International, 2009.
2. Jolhe, D. A., 'Engineering drawing', Pub.: Tata McGraw Hill, 2008
3. Shah, M. B. and Rana, B. C., 'Engineering Drawing', Pub.: Pearson Education, 2009.
4. Trymbaka Murthy, S., 'Computer Aided Engineering Drawing', Pub.: I.K. International Publishing House, 2009.

SECOND SEMESTER

Course Code	:	**HSIR12**
Course Title	:	**Professional Communication**
Number of Credits	:	**3**
Prerequisites (Course code)	:	**NONE**
Course Type	:	**GIR**

Objectives

The primary objective is to develop in the under-graduate students of engineering a level of competence in English required for independent and effective communication for their professional needs.

Course Material

Instruction will be provided through appropriate material – articles from popular magazines, newspapers, technical journals, samples from industries and also text books. Practice in the four language skills will be provided in an integrated manner.

Course Content

Listening Barriers to listening: Physical & psychological–Steps to overcome them–Purposive listening practice – Active listening and anticipating the speaker – Use of technology in the professional world.

Speaking Fluency & accuracy in speech–Positive thinking–Kinds of thinking -Improvingself-expression – Tonal variations – Listener oriented speaking -Group discussion practice–Interpersonal Conversation -Developing persuasive speaking skills.

Reading Speed reading practice–Use of extensive readers–Trans-coding: verbal and non-verbal – Eye-reading practice – Analytical and critical reading practice- Introduction to ethics & values through case-study materials.

Writing Professional Correspondence–Formal and informal letters–Argument Writingpractice – Perspectives in writing – Narrative writing -Different registers - Tone in formal writing – Summary writing practice- Introduction to reports.

Study Skills Reference Skills - Use of dictionary, thesaurus etc–Importance of contentspage, cover & back pages – Bibliography.

Outcome

The students will have knowledge of the various uses of English in their professional environment and they will be able to communicate themselves effectively in their chosen profession.

Reference Books

1. Shirley Taylor (1999), 'Communication for Business', Longman, New Delhi.
2. Robert Gannon (2000), 'Best Science Writing: Readings and Insights', University Press, Hyderabad.

3. Richard A. Boning (1990), 'Multiple Reading Skills', McGraw Hill, Singapore.
4. Albert J. Harris, Edward R.Sipay (1990), 'How to Increase Reading Ability', Longman.
5. David Martin (1994), 'Tough Talking', University press, Hyderabad.

Course Code	:	**MAIR12**
Course Title	:	**Mathematics II**
Number of Credits	:	**4**
Prerequisites (Course code)	:	**NONE**
Course Type	:	**GIR**

Objectives To learn mathematical concepts and methods.

Course Content

Vector space – Subspaces – Linear dependence and independence – Spanning of a subspace– Basis and Dimension.Inner product – Inner product spaces – Orthogonal and orthonormal basis – Gram- Schmidt orthogonalization process.

Basic review of first order differential equation - Higher order linear differential equations with constant coefficients –Particular integrals for $x^n e^{ax}$, $e^{ax}\cos(bx)$, $e^{ax}\sin(bx)$ –

Equation reducible to linear equations with constant coefficients using $x\ e^t$ - Simultaneous linear equations with constant coefficients – Method of variation of parameters – Applications – Electric circuit problems.

Gradient, Divergence and Curl – Directional Derivative – Tangent Plane and normal to surfaces – Angle between surfaces –Solenoidal and irrotational fields – Line, surface and volume integrals – Green's Theorem, Stokes' Theorem and Gauss Divergence Theorem (all without proof) – Verification and applications of these theorems.

Analytic functions – Cauchy – Riemann equations (Cartesian and polar) –Properties of analytic functions – Construction of analytic functions given real or imaginary part – Conformal mapping of standard elementary functions (z^2,e^z , sin z, cos z, $z+k^2/z$) and bilinear transformation.

Cauchy's integral theorem, Cauchy's integral formula and for derivatives– Taylor's and Laurent's expansions (without proof) – Singularities – Residues – Cauchy's residue theorem – Contour integration involving unit circle.

Outcome
After the completion of the course, students are able to solve industrially applicable problems.

Text Books

1. Kreyszig, E., Advanced Engineering Mathematics, 9th edition, John Wiley Sons, 2006.
2. Grewal, B.S., 'Higher Engineering Mathematics', 42nd edition, Khanna Publications, Delhi, 2012.
3. Hsiung, C.Y. and Mao, G. Y. 'Linear Algebra', World Scientific Pub Co Inc., 1999.

Reference Books

1. Apostol, T.M. 'Calculus', Volume I & II, 2nd Edition, John Wiley & Sons (Asia), 2005.
2. Greenberg, M.D. 'Advanced Engineering Mathematics', 2nd Edition, Pearson Education Inc. (First Indian reprint), 2002.
3. Strauss. M.J, Bradley, G.L. and Smith, K.J. 'Calculus', 3rd Edition, Prentice Hall, 2002.
4. Venkataraman, M. K.'Linear Algebra', The National Publishing Co, 1999

Course Code	:	**PHIR13**
Course Title	:	**Physics – II**
Number of Credits	:	**4**
Prerequisites (Course code)	:	**NONE**
Course Type	:	**GIR**

Objectives

- To make a bridge between the physics in school and engineering courses.
- To introduce the basic concepts of modern physics like fundamentals of quantum mechanics, nuclear physics and advanced materials.
- To introduce fundamental physics like electrodynamics and semiconductor physics for circuit branch students.

Course Content

Quantum Mechanics

Inadequacy of classical mechanics (black body radiation, photoelectric effect) – wave and particle duality of radiation – de Broglie concept of matter waves – electron diffraction –Heisenberg's uncertainty principle – Schrodinger's wave equation – eigenvalues and eigenfunctions – superposition principle – interpretation of wave function – particle confined in one dimensional infinite square well potential.

Nuclear and Particle Physics

Nuclear properties and forces - Nuclear models - Shell model - Nuclear reaction - Radioactivity - types and half-lives - application in determining the age of rock and fossils-Stellar nucleosynthesis. Fundamental forces - Particle physics - classification of matter - quark model - neutrino properties and their detection.

Advanced Materials

Nanomaterials: Introduction and properties–synthesis–chemical vapour deposition–ball milling – applications. Carbon nanotubes: structure and properties – synthesis– arc method – Pulsed laser deposition- applications.

Liquid Crystals: Types–Nematic, Cholesteric, Smectic–Modes: Dynamic scattering,Twistednematic – Display systems.

Shape memory alloys one way and two way memory effect- pseudoelasticity- applications

Electrodynamics

Electrostatics: Coulomb's law-Gauss's law – proof of Gauss's law- Electrostatic filed inmatter - dielectric polarization, polarizability and susceptibility - types of polarization – internal field and Claussius-Mosotti equation. Magetostatics: Lorentz force -Steady current and equation of continuity - Biot-Savart law – Ampere's law –Magnetostatic field in matter: torques and forces on magnetic dipoles-Magnetization-Faraday's law of induction – Maxwell's equations: generalization of Ampere's law — propagation of EM waves in free space.

Semiconductor Physics

Introduction-Direct and indirect band gap semiconductors - Intrinsic semiconductor at 0 K-Intrinsic semiconductor at room temperature-Intrinsic carriers- Electron and Hole concentrations-doping-n-type – p-type-temperature variation of carrier concentration in extrinsic semiconductor-

Extrinsic conductivity-Law of Mass action-Charge neutrality-Fermi level in extrinsic semiconductors-Electrical conduction in extrinsic semiconductors-Hall effect.

Outcome

The student will be able to understand fundamentals of electrodynamics and semiconductor physics which is base of many modern devices and technologies. Student will also get an exposure to modern physics topics like nuclear physics, nanotechnology and advanced materials.

Text Books

1. 'A text book of Engineering Physics', M.N. Avadhanulu and P.G. Kshirsagar, S. Chand and Company, New Delhi 2009.
2. 'Engineering Physics', R.K. Gaur and S.L. Gupta, Dhanpat Rai Publications (P) Ltd., 8th ed., New Delhi 2001.

Reference Books

1. 'Concepts of Modern Physics'. Arthur Beiser, Tata McGraw-Hill, New Delhi 2010.
2. 'Semiconductor Physics and Devices: Basic principle', Donald A. Neamen 4thed,, McGraw-Hill, New York 2012.
3. 'Introduction to Electrodynamics', David J. Griffiths, 3rded, Printice Hall of India, New Delhi 2012.
4. 'Introduction to Nanotechnology', C.P. Poole and F.J. Owens, Wiley, New Delhi 2007.
5. 'Introduction to Liquid Crystals Chemistry and Physics', 2nded, Peter J. Collings, Princeton University Press, New Jersey, 2002.
6. 'Shape memory alloys-modeling and engineering applications', Ed. D. C. Lagoudas, Springer, New York 2008.

Course Code	:	**CHIR13**
Course Title	:	**Chemistry - II**
Number of Credits	:	**4**
Prerequisites (Course code)	:	**NONE**
Course Type	:	**GIR**

Objectives

To introduce the students to basic principles of electrochemistry, cell construction and evaluation, electrochemical power sources, the importance of corrosion in metal/alloy and polymer.

Course Content

Electrochemistry

Conductivity of electrolytes- Specific, molar and equivalent conductivity, Nernst equation for electrode potential, EMF series, hydrogen electrode, calomel electrode, glass electrode, Electrolytic and galvanic cells, cell EMF, its measurement and applications, Weston standard cell, reversible and irreversible cells, concentration cell, electrode (hydrogen gas electrode) and electrolyte concentration cell, concentration cell with and without transference.

Corrosion

Dry corrosion and wet corrosion, mechanisms, types of corrosion, DMC, DAC, stress, inter granular, atmospheric and soil corrosion, Passivity, Polarization, over potential and its significance, Factors affecting corrosion, protection from corrosion by metallic coatings, electroplating, electroless plating and cathodic protection, Chemical conversion coatings and organic coatings- Paints, enamels.

Batteries

Different types of batteries-Primary, Secondary & Flow battery and Fuel cell. Working principle and uses-Laclanche cell, alkaline battery, nicad battery, lithium battery & Mercury battery. Fuel cell- Theory, working and application.Different types of fuel cells-H2/O2, propane-oxygen, PEFC and SOFC. Lead Acid storage cell-charging & discharging principle, operation and uses. Solar battery- its working principle.

Solid State

Types of solids - close packing of atoms and ions - bcc , fcc structures of rock salt - cesium chloride- spinel - normal and inverse spinels, Stoichiometric Defect, controlled valency&Chalcogen semiconductors, Non-elemental semiconducting Materials, Preparation of Semiconductors-steps followed during the preparation of highly pure materials and further treatments. Semiconductor Devices-p-n junction diode.

Polymer

Nomenclature, functionality, classification, methods of polymerization, mechanism of polymerization, molecular weight determination-Viscometry, light scattering methods. Plastics-Moulding constituents of a plastics and moulding of plastics into articles. Important thermoplastics and thermosetting resins- synthesis & applications of PVA,FLUON, PC, Kevlar, ABS polymer, phenolic & amino resins, epoxy resins and polyurethanes. Conductive polymers.

Outcome

Students would become familiar with the important practical applications of electrochemistry, solids, their properties and applications, and the polymer materials.

Text Books

1. P. C. Jain and M. Jain, 'Engineering Chemistry', Dhanpat Rai Publishing Company, New Delhi, 2005.
2. B.R. Puri, L.R. Sharma, M.S. Pathania, 'Principles of Physical Chemistry', Vishal Publishing Company, 2008.
3. J. D. Lee, 'Concise Inorganic Chemistry', 5th Edn., Chapman and Hall, London, 1996.

Reference Books

1. S. S. Dara, S. S. Umare, 'A Text Book of Engineering Chemistry', S. Chand Publishing, 2011.
2. F.W. Billmayer. 'Textbook of Polymer Science', 3rd Edn, Wiley. N.Y. 1991.
3. A.R. West, 'Basic Solid State Chemistry', 2nd edition, John Wiley and Sons, 1999.

Course Code	:	**ENIR11**
Course Title	:	**Energy and Environmental Engineering**
Number of Credits	:	**2**
Prerequisites (Course code)	:	**NONE**
Course Type	:	**GIR**

Objective

- To teach the principal renewable energy systems.
- To explore the environmental impact of various energy sources and also the effects of different types of pollutants.

Course Content

Present Energy resources in India and its sustainability - Different type of conventional Power Plant--Energy Demand Scenario in India-Advantage and Disadvantage of conventional Power Plants – Conventional vs Non-conventional power generation

Basics of Solar Energy- Solar Thermal Energy- Solar Photovoltaic- Advantages and Disadvantages-Environmental impacts and safety.

Power and energy from wind turbines- India's wind energy potential- Types of wind turbines- Off shore Wind energy- Environmental benefits and impacts.

Biomass resources-Biomass conversion Technologies- Feedstock preprocessing and treatment methods- Bioenergy program in India-Environmental benefits and impacts.Geothermal Energy resources –Ocean Thermal Energy Conversion – Tidal.

Air pollution- Sources, effects, control, air quality standards, air pollution act, air pollution measurement. Water pollution-Sources and impacts, Soil pollution-Sources and impacts, disposal of solid waste.

Greenhouse gases – effect, acid rain. Noise pollution.Pollution aspects of various power plants. Fossil fuels and impacts, Industrial and transport emissions- impacts.

Outcome

Students will be introduced to the Principal renewable energy systems and explore the environmental impact of various energy sources and also the effects of different types of pollutants.

Text Books

1. Boyle, G. 2004.' Renewable energy: Power for a sustainable future'. Oxford University press.
2. B H Khan, 'Non Conventional Energy Resources'-The McGraw –Hill Second edition.
3. G. D. Rai, 'Non conventional energy sources', Khanna Publishers, New Delhi, 2006.
4. Gilbert M. Masters, 'Introduction to Environmental Engineering and Science', 2nd Edition, Prentice Hall, 2003.

References

1. 'Unleashing the Potential of Renewable Energy in India' –World bank report.
2. Godfrey Boyle, Bob Everett and Janet Ramage.2010.'Energy Systems and Sustainability. Power for a sustainable future'. Oxford University press.

Course Code	:	**ECPC21**
Course Title	:	**Electrical Circuits and Machines**
Number of Credits	:	**4**
Prerequisites (Course code)	:	**NONE**
Course Type	:	**GIR**

Syllabus, Curriculum and Assessments will be decided by the respective department

Course Code	:	**PRIR11**
Course Title	:	**Engineering Practice**
Number of Credits	:	**2**
Prerequisites (Course code)	:	**NONE**
Course Type	:	**GIR**

Objectives

Introduction to the use of tools and machinery in Carpentry, Welding, Foundry, Fitting and Sheet Metal Working.

Carpentry
Wood sizing exercise in planning, marking, sawing, chiseling and grooving to make

1. Half lap joint
2. Cross lap joint

Welding
Exercise in arc welding for making

1. Lap joint
2. Butt joint

Foundry
Preparation of sand mould for the following

1. Flange
2. Anvil

Fitting
Preparation of joints, markings, cutting and filling for making

1. V-joint
2. T-joint

Sheet metal
Making of small parts using sheet metal

1. Tray
2. Funnel

THIRD SEMESTER

Course Code	**:**	**MAIR34**
Course Title	**:**	**Real Analysis and Partial Differential Equations**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**NONE**
Course Type	**:**	**GIR**

Course Learning Objective

- To expose the students to the basics of real analysis and partial differential equations required for their subsequent course work.

Course Content

Properties of real numbers, Numerical sequences. Cauchy sequences. Bolzano-Weierstrass and Heine-Borel properties.

Functions of real variables, Limits, continuity and differentiability, Taylor's formula, Extrema of functions.

Riemann integral, mean value theorems, Differentiation under integral sign, Change-of-variables formula, Sequences and series of functions, Point wise and uniform convergence.

Method of separation of variables-Fourier series solution applications to one dimensional wave equation and one-dimensional heat flow equation.

Laplace and Helmholtz equations, Boundary and initial value problems, Solution by separation of variables and Eigen Function Expansion.

Course outcomes

CO1: Develops an understanding for the construction of proofs and an appreciation for deductive logic.

CO2: Explore the already familiar properties of the derivative and the Riemann Integral, set on a more rigorous and formal footing which is central to avoiding inconsistencies in engineering applications.

CO3: Explore new theoretical dimensions of uniform convergence, completeness and important consequences as interchange of limit operations.

CO4: Develop an intuition for analyzing sets of higher dimension (mostly of the R^n type) space.

CO5: Solve the most common PDEs, recurrent in engineering using standard techniques and understanding of an appreciation for the need of numerical techniques.

Text Books

1. Guenther, R.B. &Lee, J.W., "Partial Differential Equations of Mathematical Physics and Integral Equations", Prentice Hall, 1996.
2. W.Rudin, "Introduction to Principles of Mathematical Analysis", McGraw-Hill International Editions, Third Edition, 1976.

Reference Books

1. Kreyszig.E., "Advanced Engineering Mathematics", John Wiley, 1999.
2. S.C. Malik, Savita Arora, "Mathematical Analysis", New Age International Ltd, 4th Edition, 2012.
3. G.B.Gustafson&C.H. Wilcox, "Advanced Engineering Mathematics", Springer Verlag, 1998.

Course Code	**:**	**ECPC31**
Course Title	**:**	**Signals and Systems**
Number of Credits	**:**	**4**
Prerequisites (Course code)	**:**	**NONE**
Course Type	**:**	**PC**

Course Learning Objectives

The aim of the course is for

- Understanding the fundamental characteristics of signals and systems.
- Understanding the concepts of vector space, inner product space and orthogonal series.
- Understanding signals and systems in terms of both the time and transform domains, taking advantage of the complementary insights and tools that these different perspectives provide.
- Development of the mathematical skills to solve problems involving convolution, filtering, modulation and sampling.

Course Content

Vector spaces. Inner Product spaces. Schwartzin equality. Hilbertspaces. Orthogonal expansions. Bessel's inequality and Parseval's relations.

Continuous-time signals, classifications. Periodic signals. Fourier series representation, Hilbert transform and its properties.

Laplace transforms. Continuous - time systems: LTI system analysis using Laplace and Fourier transforms.

Sampling and reconstruction of band limited signals. Low pass and band pass sampling theorems. Aliasing. Anti-aliasing filter. Practical Sampling-aperture effect.

Discrete-time signals and systems. Z-transform and its properties. Analysis of LSI systems using Z – transform.

Course outcomes

CO1: apply the knowledge of linear algebra topics like vector space, basis, dimension, inner product, norm and orthogonal basis to signals.
CO2: analyse the spectral characteristics of continuous-time periodic and a periodic signals using Fourier analysis.
CO3: classify systems based on their properties and determine the response of LSI system using convolution.
CO4: analyze system properties based on impulse response and Fourier analysis.
CO5: apply the Laplace transform and Z- transform for analyze of continuous-time and discrete-time signals and systems.
CO6: understand the process of sampling and the effects of under sampling.

Text Books

1. A.V.Oppenheim, A. Willsky, S. Hamid Nawab, "Signals and Systems (2/e)", Pearson 200.
2. S.Haykin and B.VanVeen "Signals and Systems, Wiley, 1998.
3. M.Mandal and A.Asif, "Continuous and Discrete Time Signals and Systems, Cambridge, 2007.

Reference Books

1. D.C.Lay, “Linear Algebra and its Applications (2/e)”, Pearson, 200.
2. K.Huffman&R.Kunz, “Linear Algebra”, Prentice- Hall, 1971.
3. S.S.Soliman&M.D.Srinath, “Continuous and Discrete Signals and Systems”, Prentice- Hall, 1990.

Course Code	**:**	**ECPC32**
Course Title	**:**	**Network Analysis and Synthesis**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**NONE**
Course Type	**:**	**PC**

Course Learning Objectives

- To make the students capable of analyzing any given electrical network.
- To make the students to learn synthesis of an electrical network for a given impedance/ admittance function.

Course Content

Network concept. Elements and sources. Kirchoff's laws. Tellegen's theorem. Network equilibrium equations. Node and Mesh method. Source superposition. Thevenin's and Norton's theorems. Network graphs.

First and second order networks. State equations. Transient response. Network functions. Determination of the natural frequencies and mode vectors from network functions.

Sinusoidal steady-state analysis. Maximum power-transfer theorem. Resonance. Equivalent and dual networks. Design of equalizers.

Two-port network parameters. Interconnection of two port networks. Barlett's bisection theorem. Image and Iterative parameters. Design of attenuators.

Two-terminal network synthesis. Properties of Hurwitz polynomial and Positive real function. Synthesis of LC, RC and RL Networks, Foster Forms and Cauer Forms.

Course outcomes

CO1: analyze the electric circuit using network theorems
CO2: understand and Obtain Transient & Forced response
CO3: determine Sinusoidal steady state response; understand the real time applications of maximum power transfer theorem and equalizer
CO4: understand the two–port network parameters, are able to find out two-port network parameters & overall response for interconnection of two-port networks.
CO5: synthesize one port network using Foster form, Cauer form.

Text Books

1. Hayt W. H., Kemmerly J. E. and Durbin S. M., "Engineering Circuit Analysis", 6th Ed., Tata
   McGraw-Hill Publishing Company Ltd.,2008.
2. F.F. Kuo, "Network analysis and Synthesis", Wiley International Edition ,2008.

Reference Books

1. Valkenberg V., "Network Analysis", 3rd Ed., Prentice Hall International Edition, 2007.
2. B.S.Nair and S.R.Deepa, "Network analysis and Synthesis", Elsevier,2012.

Course Code	**:**	**ECPC33**
Course Title	**:**	**Electrodynamics and Electromagnetic Waves**
Number of Credits	**:**	**4**
Prerequisites (Course code)	**:**	**NONE**
Course Type	**:**	**PC**

Course Learning Objectives

- To expose the students to the rudiments of Electromagnetic theory and wave propagation essential for subsequent courses on microwave engineering, antennas and wireless communication

Course Content

Electrostatics. Coulomb'slaw. Gauss's law and applications. Electric potential. Poisson's and Laplace equations. Method of images. Multipole Expansion.

Electrostatic fields in matter. Dielectrics and electric polarization. Capacitors with dielectric substrates. Linear dielectrics. Force and energy in dielectric systems.

Magnetostatics. Magnetic fields of steady currents. Biot-Savart's and Ampere's laws. Magnetic vector potential. Magnetic properties of matter.

Electrodynamics. Flux rule for motional emf. Faraday's law. Self and mutual inductances. Maxwell'sEquations. Electromagnetic Boundary conditions. Poynting theorem.

Electromagnetic wave propagation. Uniform plane waves. Wave polarization. Waves in matter. Reflection and transmission at boundaries. Propagation in an ionized medium.

Course outcomes

CO1: recognize and classify the basic Electrostatic theorems and laws and to derive them.
CO2: discuss the behavior of Electric fields in matter and Polarization concepts.
CO3: classify the basic Magneto static theorems and laws and infer the magnetic properties of matter.
CO4: summarize the concepts of electrodynamics &to derive and discuss the Maxwell's equations.
CO5: students are expected to be familiar with Electromagnetic wave propagation and wave polarization.

Text Books

1. D.J.Griffiths, "Introduction to Electrodynamics (3/e)", PHI, 2001
2. E.C. Jordan & G. Balmain, "Electromagnetic Waves and Radiating Systems", PHI, 1995.

Reference Books

1. W.H.Hayt, "Engineering Electromagnetics, (7/e)", McGraw Hill, 2006.
2. D.K.Cheng, "Field and Wave Electromagnetics, (2/e)", Addison Wesley, 1999.
3. M.N.O.Sadiku,"Principles of Electromagnetics, (4/e)", Oxford University Press, 2011.
4. N.NarayanaRao, "Elements of Engineering Electromagnetics, (6/e)", Pearson, 2006.
5. R.E.Collin, "Foundations for Microwave Engineering (2/e)", McGraw –Hill, 2002.
6. R.E.Collin, "Antennas and Radiowave Propagation", McGraw-Hill, 1985.

Course Code	**:**	**ECPC34**
Course Title	**:**	**Semiconductor Physics and Devices**
Number of Credits		**3**
Prerequisites (Course code)	**:**	**NONE**
Course Type	**:**	**PC**

Course Learning Objectives

- To make the students understand the fundamentals of electronic devices.
- To train them to apply these devices in mostly used and important applications.

Course Content

Semiconductor materials: crystal growth, film formation, lithography, etching and doping. Formation of energy bands in solids, Concept of hole, Intrinsic and extrinsic semiconductors, conductivity, Equilibrium Carrier concentration, Density of states and Fermi level, Carrier transport – Drift and Diffusion, continuity equation, Hall effect and its applications.

P-N junction diodes, Energy band diagram, biasing, V-I characteristics, capacitances. Diode models, Break down Mechanisms, Rectifiers, Limiting and Clamping Circuits, types of diodes.

BJT Physics and Characteristics modes of operation, Ebers-Moll Model, BJT as a switch and Amplifier, breakdown mechanisms, Photo devices.

MOSFET: Ideal I-V characteristics, non-ideal I-V effects, MOS Capacitor, MOSFET as switch, CMOS Logic gate Circuits, Bi-CMOS circuits, CCDs.

Power devices, operation and characteristics. Thyristor family. Power diodes. Power transistors. Display devices, Operation of LCDs, Plasma, LED and HDTV

Course outcomes

CO1: Apply the knowledge of basic semiconductor material physics and understand fabrication processes.
CO2: Analyze the characteristics of various electronic devices like diode, transistor etc.,
CO3: Classify and analyze the various circuit configurations of Transistor and MOSFETs.
CO4: Illustrate the qualitative knowledge of Power electronic Devices.
CO5: Become Aware of the latest technological changes in Display Devices.

Text Books

1. S.M.Sze, Semiconductors Devices, Physics and Technology, (2/e), Wiley, 2002
2. A.S.Sedra & K.C.Smith, Microelectronic Circuits (5/e), Oxford, 2004
3. L.Macdonald &A.C.Lowe, Display Systems, Wiley, 2003

Reference Books

1. Robert Pierret, "Semiconductor Device Fundamentals," Pearson Education, 2006
2. J.Millman and C.C.Halkias : Electronic devices and Circuits, McGraw Hill, 1976.
3. B.G.Streetman : Solid state devices, (4/e), PHI, 1995.
4. N.H.E.Weste, D. Harris, "CMOS VLSI Design (3/e)", Pearson, 2005.

Course Code	**:**	**ECPC35**
Course Title	**:**	**Digital Circuits and Systems**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**NONE**
Course Type	**:**	**PC**

Course Learning Objectives

- To introduce the theoretical and circuit aspects of digital electronics, which is the back bone for the basics of the hardware aspect of digital computers?

Course Content

Review of number systems-representation-conversions, error detection and error correction. Review of Boolean algebra- theorems, sum of product and product of sum simplification, canonical forms-minterm and maxterm, Simplification of Boolean expressions-Karnaugh map, completely and incompletely specified functions, Implementation of Boolean expressions using universal gates.

Combinational logic circuits- adders, subtractors, BCD adder, ripple carry look ahead adders, parity generator, decoders, encoders, multiplexers, demultiplexers, Realization of Boolean expressions- using decoders-using multiplexers. Memories – ROM- organization, expansion. PROMs. Types of RAMs – Basic structure, organization, Static and dynamic RAMs, PLDs, PLAs.

Sequential circuits – latches, flip flops, edge triggering, asynchronous inputs. Shift registers, Universal shift register, applications. Binary counters – Synchronous and asynchronous up/down counters, mod-N counter, Counters for random sequence.

Synchronous circuit analysis and design: structure and operation, analysis-transition equations, state tables and state diagrams, Modelling- Moore machine and Mealy machine- serial binary adder, sequence recogniser, state table reduction, state assignment. Hazard; Overview and comparison of logic families.

Introduction to Verilog HDL, Structural, Dataflow and behavioral modelling of combinational and sequential logic circuits.

Course outcomes

CO1: Apply the knowledge of Boolean algebra and simplification of Boolean expressions to deduce optimal digital networks.
CO2: Study and examine the SSI, MSI and Programmable combinational networks.
CO3: Study and investigate the sequential networks suing counters and shift registers; summarize the performance of logic families with respect to their speed, power consumption, number of ICs and cost.
CO4: Work out SSI and MSI digital networks given a state di agram based on Mealy and Moore configurations.
CO5: Code combinational and sequential networks using Virology HDL.

Text Books

1. Wakerly J F, "Digital Design: Principles and Practices, Prentice-Hall", 2nd Ed., 2002.
2. D. D. Givone, "Digital Principles and Design", Tata Mc-Graw Hill, New Delhi, 2003.
3. S.Brown and Z.Vranesic, "Fundamentals of Digital Logic with Verilog Design", Tata Mc-

Graw Hill, 2008.

Reference Books

1. D.P. Leach, A. P. Malvino, GoutamGuha, “Digital Principles and Applications”, Tata Mc-Graw Hill, New Delhi, 2011.
2. M. M. Mano, “Digital Design”, 3rd ed., Pearson Education, Delhi, 2003.
3. R.J.Tocci and N.S.Widner, “Digital Systems - Principles& Applications”, PHI, 10th Ed., 2007 .
4. Roth C.H., “Fundamentals of Logic Design”, Jaico Publishers. V Ed., 2009.
5. T. L. Floyd and Jain ,”Digital Fundamentals”, 8th ed., Pearson Education, 2003.

Course Code	**:**	**ECLR31**
Course Title	**:**	**Devices and Networks Laboratory**
Number of Credits	**:**	**2**
Prerequisites (Course code)	**:**	**ECPC32 & ECPC34**
Course Type	**:**	**ELR**

List of Experiments:

1. Study Experiment
2. PN Junction Diode Characteristics
3. Zener diode characteristics and its application
4. Characteristics study of Bipolar Junction Transistor (BJT)
5. Characteristics study of JFET
6. Response study of Series RLC
7. Constant K High pass Filter
8. Attenuators
9. Equalizers
10. Clippers and Clampers
11. SCR Characteristics
12. LAB view implementation

Course Code	**:**	**ECLR32**
Course Title	**:**	**Digital Electronics Laboratory**
Number of Credits	**:**	**2**
Prerequisites (Course code)	**:**	**ECPC35**
Course Type	**:**	**ELR**

List of Experiments:

1. Study of logic gates and verification of Boolean Laws.
2. Design of adders and subtractors.
3. Design of code converters.
4. Design of Multiplexers.
5. Design of De-multiplexers.
6. Design of Encoder and Decoder.
7. 2-bit and 8-bit magnitude comparators.
8. Study of flip-flops.
9. Design and implementation of counters using flip-flops.
10. Design and implementation of shift registers.

FOURTH SEMESTER

Course Code	**:**	**MAIR45**
Course Title	**:**	**Probability Theory and Random Processes**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**MAIR 34**
Course Type	**:**	**GIR**

Course Learning Objectives

- To expose the students to the basics of probability theory and random processes essential for their subsequent study of analog and digital communication.

Course Content

Axioms of probability theory. Probability spaces. Joint and conditional probabilities. Bayes' Theorem-Independent events.

Random variables and random vectors. Distributions and densities. Independent random variables. Functions of one and two random variables.

Moments and characteristic functions. Inequalities of Chebyshev and Schwartz. Convergence concepts.

Random processes. Stationarity and ergodicity. Strict sense and wide sense stationary processes. Covariance functions and their properties. Spectral representation. Wiener-Khinchine theorem.

Gaussian processes. Processes with independent increments. Poisson processes. Low pass and Band pass noise representations.

Course outcomes

CO1: understand the axiomatic formulation of modern Probability Theory and think of random variables as an intrinsic need for the analysis of random phenomena.
CO2: characterize probability models and function of random variables based on single & multiples random variables.
CO3: evaluate and apply moments & characteristic functions and understand the concept of inequalities and probabilistic limits.
CO4: understand the concept of random processes and determine covariance and spectral density of stationary random processes.
CO5: demonstrate the specific applications to Poisson and Gaussian processes and representation of low pass and band pass noise models.

Text Books

1. Davenport," Probability and Random Processes for Scientist and Engineers", McGraw-Hill, 1970.
2. Papoulis. A.," Probability, Random variables and Stochastic Processes", McGraw Hill, 2002.

Reference Books

1. E.Wong, "Introduction to Random Processes", Springer Verlag,1983.
2. W.A.Gardner, "Introduction to Random Processes", (2/e), McGraw Hill,1990.
3. H.Stark & J.W.Woods, "Probability, Random Processes and Estimations Theory for Engineers", (2/e), Prentice Hall, 1994.

Course Code	**:**	**HSIR14**
Course Title	**:**	**Professional Ethics**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**NONE**
Course Type	**:**	**GIR**

PROFESSIONAL ETHICS: This Course will be provided by the Department of Humanities

Course Code	**:**	**ECPC41**
Course Title	**:**	**Digital Signal Processing**
Number of Credits		**4**
Prerequisites (Course code)	**:**	**ECPC31**
Course Type	**:**	**PC**

Course Learning Objectives

- The subject aims to introduce the mathematical approach to manipulate discrete time signals, which are useful to learn digital tele-communication.

Course Content

Review of VLSI system theory, DTFT, Frequency response of discrete time systems, All pass inverse and minimum phase systems.

DFT, Relationship of DFT to other transforms, FFT, DIT and DIF, FFT algorithm, Linear filtering using DFT and FFT.

Frequency response of FIR filter types, Design of FIR filters, IIR filter design, Mapping formulas, Frequency transformations.

Direct form realization of FIR and IIR systems, Lattice structure for FIR and IIR systems, Finite-word length effects. Limit cycle oscillations.

Sampling rate conversion by an integer and rational factor, Poly phase FIR structures for sampling rate conversion.

Course outcomes

CO1: analyze discrete-time systems in both time & transform domain and also through pole-zero placement.
CO2: analyze discrete-time signals and systems using DFT and FFT.
CO3: design and implement digital finite impulse response (FIR) filters.
CO4: design and implement digital infinite impulse response (IIR) filters.
CO5: understand and develop multirate digital signal processing systems.

Text Books

1. J.G.Proakis, D.G. Manolakis, "Digital Signal Processing", (4/e) Pearson, 2007.
2. A.V.Oppenheim&R.W.Schafer, " Discrete Time Signal processing", (2/e),Pearson Education, 2003.
3. S.K.Mitra, "Digital Signal Processing (3/e)", Tata McGraw Hill, 2006.

Reference Books

1. P.S.R.Diniz, E.A.B.da Silva and S.L.Netto, " Digital Signal Processing", Cambridge,2002.
2. E.C.Ifeachor&B.W.Jervis, "Digital Signal Processing", (2/e), Pearson Education, 2002.
3. J.R.Jhonson, "Introduction to Digital Signal Processing", Prentice-Hall, 1989.

Course Code	**:**	**ECPC42**
Course Title	**:**	**Transmission Lines and Waveguides**
Number of Credits		**3**
Prerequisites (Course code)	**:**	**ECPC33**
Course Type	**:**	**PC**

Course Learning Objectives

- To expose students to the complete fundamentals and essential feature of waveguides, resonators and microwave components and also able to give an introduction to microwave integrated circuit design.

Course Content

Classification of guided wave solutions-TE, TM and TEM waves.Field analysis transmission lines.

Rectangular and circular waveguides. Excitation of waveguides. Rectangular and circular cavity resonators.

Transmission line equations.Voltage and current waves.Solutions for different terminations.Transmission-line loading.

Impedance transformation and matching.Smith Chart, Quarter-wave and half-wave transformers.Binomial and Tchebeyshev transformers. Single, double and triple stub matching .

Microstriplines, stripline, slot lines, coplanar waveguide and fin line. Micro strip MIC design aspects. Computer- aided analysis and synthesis.

Course outcomes

CO1: classify the Guided Wave solutions -TE, TM, and TEM.
CO2: analyze and design rectangular waveguides and understand the propagation of electromagnetic waves.
CO3: evaluate the resonance frequency of cavity Resonators and the associated modal field.
CO4: analyze the transmission lines and their parameters using the Smith Chart.
CO5: apply the knowledge to understand various planar transmission lines.

Text Books

1. D.M.Pozar, “Microwave Engineering (3/e)” Wiley,2004.
2. J.D.Ryder, “Networks, Lines and Fields”, PHI, 2003.

Reference Books

1. R.E.Collin, “Foundations for Microwave Engineering (2/e)”, McGraw-Hill,2002.
2. S.Y.Liao , “ Microwave Devices and Circuits”,(3/e) PHI, 2005.
3. J. A. Seeger, “Microwave Theory, Components, and Devices” Prentice-Hall-A division of Simon & Schuster Inc Englewood Cliffs, New Jersy 07632, 1986.

Course Code	**:**	**ECPC43**
Course Title	**:**	**Electronic Circuits**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC34**
Course Type	**:**	**PC**

Course Learning Objectives

- To make the students understand the fundamentals of electronic circuits.

Course Content

Load line, operating point, biasing methods for BJT and MOSFET. Low frequency and high models of BJT and MOSFET, Small signal Analysis of CE, CS, CD and Cascode amplifier

MOSFET amplifiers: Current mirrors: Basic current mirror, Cascode current mirror, Single-ended amplifiers: CS amplifier – with resistive load, diode connected load, current source load, triode load, source degeneration. CG and CD amplifiers, Cascode amplifier,

Frequency response of amplifiers, Differential Amplifiers, CMRR, Differential amplifiers with active load, Two stage amplifiers

Feedback concept, Properties, Feedback amplifiers, Stability analysis, Condition for oscillation, Sinusoidal oscillators.

Power amplifiers- class A, class B, class AB, Biasing circuits, class C and class D

Course outcomes

CO1: illustrate about rectifiers, transistor and FET amplifiers and its biasing. Also compare the performances of its low frequency models.
CO 2: discuss about the frequency response of MOSFET and BJT amplifiers.
CO 3: illustrate about MOS and BJT differential amplifiers and its characteristics.
CO4: discuss about the feedback concepts and construct feedback amplifiers and oscillators. Also summarizes its performance parameters.
CO 5: explain about power amplifiers and its types and also analyze its characteristics.

Text Books

1. A.S.Sedra &K.C.Smith, “Microelectronic Circuits (5/e)”, Oxford, 2004.
2. D.L.Schilling&C.Belove,”Electronic Circuits: Discrete and Integrated”, (3/e), McGraw Hill, 1989.

Reference Books

1. J.Millman&A., “Microelectronics”, McGraw Hill, 1987.
2. K.V.Ramanan, “Functional Electronics” ,Tata McGraw Hill ,1984.

Course Code	**:**	**ECPC44**
Course Title	**:**	**Microprocessors and Micro Controllers**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC35**
Course Type	**:**	**PC**

Course Learning Objectives

This subject deals about the basics of 16-bit Microprocessor, 8-bit and 16-bit Micro controllers, their architectures, internal organization and their functions, peripherals, and interfacing.

Course Content

Microprocessor based personal computer system. Software model of 8086. Segmented memory operation. Instruction set. Addressing modes. Assembly language programming. Interrupts. Programming with DOS and BIOS function calls.

Hardware detail of 8086. . Bus timing. Minimum vs Maximum mode of operation. Memory interface. Parallel and serial data transfer methods. 8255 PPI chip. 8259 Interrupt controller. 8237 DMA controller.

Microcontroller. Von-Neumann Vs Harvard architecture. Programming model. Instruction set of 8051 Microcontroller. Addressing modes. Programming. Timer operation.

Mixed Signal Microcontroller: MSP430 series. Block diagram. Address space. On-chip peripherals -analog and digital. Register sets. Addressing Modes. Instruction set. Programming. FRAM vs flash for low power and reliability.

Peripheral Interfacing using 8051 and Mixed signal microcontroller. Serial data transfer - UART, SPI and I2C. Interrupts. I/O ports and port expansion. DAC, ADC, PWM, DC motor, Stepper motor and LCD interfacing.

Course outcomes

CO1: recall and apply the basic concept of digital fundamentals to Microprocessor based personal computer system.
CO2: identify the detailed s/w & h/w structure of the Microprocessor.
CO3: illustrate how the different peripherals are interfaced with Microprocessor.
CO4: distinguish and analyze the properties of Microprocessors & Microcontrollers.
CO5: analyze the data transfer information through serial & parallel ports.
CO6: train their practical knowledge through laboratory experiments.

Text Books

1. J.L.Antonakos, "An Introduction to the Intel Family of Microprocessors", Pearson, 1999.
2. M.A.Mazidi&J.C.Mazidi "Microcontroller and Embedded systems using Assembly & C. (2/e)", Pearson Education, 2007.
3. ***John H. Davies,"*** MSP430 Microcontroller Basics", Elsevier Ltd., 2008

Reference Books

1. B.B. Brey, "The Intel Microprocessors, (7/e), Eastern Economy Edition" , 2006.
2. K.J. Ayala, "The 8051 Microcontroller ", (3/e), Thomson Delmar Learning, 2004.
3. S. MacKenzie and R.C.W.Phan., " The 8051 Microcontroller.(4/e)", Pearson education, 2008.

Course Code	**:**	**ECLR41**
Course Title	**:**	**Electronic Circuits Laboratory**
Number of Credits	**:**	**2**
Prerequisites (Course code)	**:**	**ECPC43**
Course Type	**:**	**ELR**

List of Experiments:

Hardware Experiments

1. Stability of Q point
2. Single stage RC coupled CE amplifier
3. Single stage RC coupled Current series CE feedback amplifier
4. Darlington emitter follower
5. Differential Amplifier
6. RC phase shift oscillator
7. Colpitt's Oscillator
8. Power amplifier – Class A & class AB

Simulation Experiments

9. MOS CS amplifier with resistive load, diode connected load, current source load
10. MOS current mirrors

Course Code	**:**	**ECLR42**
Course Title	**:**	**Microprocessor and Microcontroller Laboratory**
Number of Credits	**:**	**2**
Prerequisites (Course code)	**:**	**ECPC44**
Course Type	**:**	**ELR**

List of Experiments

Intel 8086 – 16bit µP- Emulator.

1. Addressing modes of 8086 Microprocessor .
2. Block move and simple arithmetic operations .
3. Identification and displaying the activated key using DOS and BIOS function calls.

Intel 8051 (8-bit Microcontroller) - Proteus VSM Simulator and Trainer Kit

4. Addressing modes of 8051 Microcontroller.
5. Delay generation - i) Nested loop and ii) Timers.
6. Toggling the ports and counting the pulses.
7. LCD Interfacing.
8. Generation of different waveforms using DAC (0808)
9. ADC interfacing.

Mixed-Signal Microcontroller – 16bit – MSP430 series

10. PWM generation and speed control of Motors using MSP430.

FIFTH SEMESTER

Course Code	**:**	**ECPC51**
Course Title	**:**	**Statistical Theory of Communication**
Number of Credits	**:**	**4**
Prerequisites (Course code)	**:**	**MAIR45**
Course Type	**:**	**PC**

Course Learning Objectives

- The subject aims to make the students to understand the statistical theory of telecommunication, which are the basics to learn analog and digital telecommunication.

Course Content

Information measure. Discrete entropy. Joint and conditional entropies. Uniquely decipherable and instantaneous codes. Kraft-Mcmillan inequality. Noiseless coding theorem. Construction of optimal codes.

DMC. Mutual information and channel capacity. Shannon's fundamental theorem. Entropy in the continuous case. Shannon-Hartley law.

Binary hypothesis testing. Baye's, minimax and Neyman-Pearson tests. Random parameter estimation-MMSE,MMAE and MAP estimates. Nonrandom parameters – ML estimation.

Coherent signal detection in the presence of additive white and non-white Gaussian noise.Matched filter.

Discrete optimum linear filtering. Orthogonality principle. Spectral factorization. FIR and IIR Wiener filters.

Course outcomes

CO1: show how the information is measured and able to use it for effective coding.
CO2: summarize how the channel capacity is computed for various channels.
CO3: use various techniques involved in basic detection and estimation theory to solve the problem.
CO4: summarize the applications of detection theory in telecommunication.
CO5: summarize the application of estimation theory in telecommunication.

Text Books

1. R.B.Ash," Information Theory", Wiley,1965.
2. M.D.Srinath, P.K.Rajasekaran&R.Viswanathan, "Statistical Signal Processing with Applications", PHI 1999.

Reference Books

1. H.V.Poor, "An Introduction to Signal Detection and Estimation,(2/e)", Spring Verlag.1994.
2. M.Mansuripur , " Introduction to Information Theory", Prentice Hall.1987.
3. J.G.Proakis, D G Manolakis, "Digital Signal Processing", (4/e), Pearson Education, 2007.

Course Code	**:**	**ECPC52**
Course Title	**:**	**Digital Signal Processors and Applications**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC41**
Course Type	**:**	**PC**

Course Learning Objectives

- To give an exposure to the various fixed point and floating point DSP architectures, to understand the techniques to interface sensors and I/O circuits and to implement applications using these processors.

Course Content

Fixed-point DSP architectures. Basic Signal processing system. Need for DSPs. Difference between DSP and other processor architectures. TMS320C54X, ADSP21XX, DSP56XX architecture details. Addressing modes. Control and repeat operations. Interrupts. Pipeline operation. Memory Map and Buses.

Floating-point DSP architectures. TMS320C3X, DSP96XX architectures. Cache architecture. Floating-point Data formats. On-chip peripherals. Memory Map and Buses.

On-chip peripherals. Hardware details and its programming. Clock generator with PLL. Serial port. McBSP. Parallel port. DMA. EMIF. I^2C. Real-time-clock(RTC). Watchdog timer.

Interfacing. Serial interface- Audio codec. Sensors - Humidity/temperature sensor, flow sensor, accelerometer, pulse sensor and finger print scanner. A/D and D/A interfaces. Parallel interface- Memory interface. RF transceiver interface – Wi-Fi and Zigbee modules.

DSP tools and applications. Implementation of Filters, DFT, QPSK Modem, Speech processing. Video processing, Video Encoding/Decoding. Biometrics. Machine Vision. High performance computing (HPC).

Course outcomes

CO1: learn the architecture details of fixed point DSPs.
CO2: learn the architecture details of floating point DSPs
CO3: infer about the control instructions, interrupts, pipeline operations, memory and buses.
CO4: illustrate the features of on-chip peripheral devices and its interfacing with real time application devices.
CO5: learn to implement the signal processing algorithms and applications in DSPs

Text Books

1. B.Venkataramani&M.Bhaskar, "Digital Signal Processor, Architecture, Programming and Applications",(2/e), McGraw- Hill,2010
2. S.Srinivasan&Avtar Singh, "Digital Signal Processing, Implementations using DSP Microprocessors with Examples from TMS320C54X", Brooks/Cole, 2004.

Reference Books

1. S.M.Kuo&W.S.S.Gan," Digital Signal Processors: Architectures, Implementations, and Applications", Printice Hall, 2004
2. C.Marven&G.Ewers, "A Simple approach to digital signal processing", Wiley Inter science, 1996.
3. R.A.Haddad&T.W.Parson, "Digital Signal Processing: Theory, Applications and Hardware", Computer Science Press NY, 1991.

Course Code	**:**	**ECPC53**
Course Title	**:**	**Analog Communication**
Number of Credits		**3**
Prerequisites (Course code)	**:**	**ECPC31**
Course Type	**:**	**PC**

Course Learning Objectives

- To develop a fundamental understanding on Communication Systems with emphasis on analog modulation techniques and noise performance.

Course Content

Basic blocks of Communication System. Amplitude (Linear) Modulation – AM, DSB-SC, SSB-SC and VSB-SC. Methods of generation and detection. FDM. Super Heterodyne Receivers.

Angle (Non-Linear) Modulation - Frequency and Phase modulation. Transmission Bandwidth of FM signals, Methods of generation and detection. FM Stereo Multiplexing.

Noise - Internal and External Noise, Noise Calculation, Noise Figure. Noise in linear and nonlinear AMreceivers, Threshold effect.

Noise in FM receivers, Threshold effect, Capture effect, FM Threshold reduction, Pre-emphasis and De-emphasis.

Pulse Modulation techniques – Sampling Process, PAM, PWM and PPM concepts, Methods of generation and detection. TDM. Noise performance.

Course outcomes

CO1: Understand the basics of communication system and analog modulation techniques

CO2: Apply the basic knowledge of signals and systems and understand the concept of Frequency modulation.

CO3: Apply the basic knowledge of electronic circuits and understand the effect of Noise in communication system and noise performance of AM system

CO4: Understand the effect of noise performance of FM system.

CO5: Understand TDM and Pulse Modulation techniques.

Text Books

1. S.Haykins, Communication Systems , Wiley, (4/e), Reprint 2009.
2. Kennedy, Davis, Electronic Communication Systems (4/e), McGraw Hill, Reprint 2008.

Reference Books

3. B.Carlson, Introduction to Communication Systems, McGraw-Hill, (4/e), 2009.
4. J.Smith, Modern Communication Circuits (2/e), McGraw Hill, 1997.
5. J.S.Beasley&G.M.Miler, Modern Electronic Communication (9/e), Prentice-Hall, 2008.

Course Code	**:**	**ECPC54**
Course Title	**:**	**Analog Integrated Circuits**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC43**
Course Type	**:**	**PC**

Course Learning Objectives

- To introduce the theoretical & circuit aspects of an Op-amp.

Course Content

Operational Amplifiers, DC and AC characteristics, Typical op-amp parameters: Finite gain, finite bandwidth, Offset voltages and currents, Common-mode rejection ratio, Power supply rejection ratio, Slew rate, Applications of Op-amp: Precision rectifiers. Summing amplifier, Integrators and differentiators, Log and antilog amplifiers. Instrumentation amplifiers, voltage to current converters.

Active filters: Second order filter transfer function (low pass, high pass, band pass and band reject), Butterworth, Chebyshev and Bessel filters. Switched capacitor filter. notch filter, All pass filters, self-tuned filters

Opamp as a comparator, Schmitt trigger, Astable and monostable multivibrators, Triangular wave generator, Multivibrators using 555 timer, Data converters: A/D and D/A converters

PLL- basic block diagram and operation, Four quadrant multipliers. Phase detector, VCO, Applications of PLL:Frequency synthesizers, AM detection, FM detection and FSK demodulation.

CMOS differential amplifiers**:** DC analysis and small signal analysis of differential amplifer with Restive load, current mirror load and current source load, Input common-mode range and Common-mode feedback circuits. OTAs vs Opamps. Slew rate, CMRR, PSRR. Two stage amplifiers, Compensation in amplifiers (Dominant pole compensation).

Course outcomes

CO1: infer the DC and AC characteristics of operational amplifiers and its effect on output and their compensation techniques.

CO2: elucidate and design the linear and non linear applications of an opamp and special application Ics.

CO3: explain and compare the working of multi vibrators using special application IC 555 and general purpose opamp.

CO4: classify and comprehend the working principle of data converters.

CO5: illustrate the function of application specific ICs such as Voltage regulators, PLL and its application in communication.

Text Books

1. S.Franco, Design with Operational Amplifiers and Analog Integrated Circuits (3/e) TMH, 2003.
2. Sedra and Smith, Microelectronics Circuits, Oxford Univ. Press, 2004
3. Coughlin, Driscoll, OP-AMPS and Linear Integrated Circuits, Prentice Hall, 2001.

Course Code	**:**	**ECLR51**
Course Title	**:**	**Analog Integrated Circuits Laboratory**
Number of Credits	**:**	**2**
Prerequisites (Course code)	**:**	**ECPC54**
Course Type	**:**	**ELR**

List of Experiments:

HardwareExperiments

1. Study the characteristics of negative feedback amplifier
2. Design of an instrumentation amplifier
3. Study the characteristics of regenerative feedback system-Schmitt trigger
4. Study the characteristics of integrator circuit
5. Design of a second order butterworth band-pass filter for the given higher and lower cut-off frequencies
6. Design of a high-Q Band pass self-tuned filter for a given center frequency
7. Design of a function generator- Square, Triangular
8. Design of a Voltage Controlled Oscillator
9. Design of a Phase Locked Loop(PLL) (Mini project)

SimulationExperiments

DC and small signal analysis of differential amplifer with Restive load, current mirror load and current source load, Input common-mode range and Common-mode feedback circuits, CMRR, PSRR.

Course Code	**:**	**ECLR52**
Course Title	**:**	**Digital Signal Processing and Simulation Laboratory**
Number of Credits	**:**	**2**
Prerequisites (Course code)	**:**	**ECPC41 & ECPC52**
Course Type	**:**	**ELR**

List of Experiments:

MATLAB Experiments

1. Realization of correlation of two discrete signals
2. Realization of sub band filter using linear convolution
3. Design and implementation of FIR filter
4. Design and implementation of IIR filter
5. Realization of STFT using FFT
6. Demonstration of Bayes technique
7. Demonstration of Min-max technique
8. Realization of FIR Wiener filter

TMS320C54X Processor Experiments

9. Study of various addressing modes
10. Sequence generation and number sorting
11. Convolution using overlap add and overlap save methods
12. Wave pattern generation
13. FIR filter implementation

SIXTH SEMESTER

Course Code	**:**	**ECPC61**
Course Title	**:**	**Digital Communication**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC51**
Course Type	**:**	**PC**

Course Learning Objectives

- To understand the key modules of digital communication systems with emphasis on digital modulation techniques.
- To get introduced to the basics of source and channel coding/decoding and Spread Spectrum Modulation.

Course Content

Base band transmission. Sampling theorem, Pulse code modulation (PCM), DM, Destination SNR in PCM systems with noise. Matched filter. Nyquist criterion for zero ISI. Optimum transmit and receive filters. Correlative Coding, M-ary PAM. Equalization- zero-forcing and basics of adaptive linear equalizers.

BASK, BFSK, and BPSK- Transmitter, Receiver, Signal space diagram, Error probabilities.

M-ary PSK, M-ary FSK, QAM, MSK and GMSK- Optimum detector, Signal constellation, error probability.

Linear block codes-Encoding and decoding. Cyclic codes – Encoder, Syndrome Calculator. Convolutional codes – encoding ,Viterbi decoding. TCM.

Spread Spectrum (SS) Techniques- Direct Sequence Spread Spectrum modulation, Frequency-hop Spread Spectrum modulation - Processing gain and jamming margin.

Course outcomes

CO1: Apply the knowledge of signals and system and explain the conventional digital communication system.
CO2: Apply the knowledge of statistical theory of communication and evaluate the performance of digital communication system in the presence of noise.
CO3: Describe and analyze the performance of advance modulation techniques.
CO4: Apply the knowledge of digital electronics and describe the error control codes like block code, cyclic code.
CO5: Describe and analyze the digital communication system with spread spectrum modulation.

Text Books

1. S.Haykin, “Communication Systems”, Wiley,(4/e),2001.
2. J.G.Proakis, “Digital Communication” , Tata McGraw – Hill,(4/e),2001.

Reference Books

3. B.Sklar, “Digital Communications: Fundamentals & Applications”, Pearson Education, (2/e), 2001.
4. A.B.Carlson, “ Communication Systems”, McGraw Hill, 3/e,2002
5. R.E.Zimer & R.L.Peterson,” Introduction to Digital Communication”, PHI,3/e, 2001

Course Code	**:**	**ECPC62**
Course Title	**:**	**Wireless Communication**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**NONE**
Course Type	**:**	**PC**

Course Learning Objectives

- To get an understanding of mobile radio communication principles, types and to study the recent trends adopted in cellular and wireless systems and standards**.**

Course Content

Introduction to Wireless Communication. Cellular concept. System design fundamentals. Coverage and Capacity improvement in Cellular system. Technical Challenges.

Mobile Radio Propagation; Reflection, Diffraction, Fading. Multipath propagation. Statistical characterization of multipath fading. Diversity Techniques.

Path loss prediction over hilly terrain. Practical link budget design using Path loss models. Design parameters at base station. Antenna location, spacing, heights and configurations.

Multiple access techniques; FDMA, TDMA and CDMA. Spread spectrum. Power control. WCDMA. CDMA network design. OFDM and MC-CDMA.

GSM.3G, 4G(LTE), NFC systems, WLAN technology. WLL. HiperLAN. Ad hoc networks. Bluetooth.

Course outcomes

CO1: Apply the knowledge of basic communication systems and its principles.
CO2: Describe the cellular concept and analyze capacity improvement Techniques.
CO3: Mathematically analyze mobile radio propagation mechanisms.
CO4: Summarize diversity reception techniques.
CO5: Design Base Station (BS) parameters and analyze the antenna configurations.
CO6: Analyze and examine the multiple access techniques and its application.
CO7: Assess the latest wireless technologies.

Text Books:

1. T.S.Rappaport, Wireless Communication Principles (2/e), Pearson, 2002.
2. A.F.Molisch, Wireless Communications, Wiley, 2005.

Reference Books:

1. P.MuthuChidambaraNathan, Wireless Communications, PHI, 2008.
2. W.C.Y.Lee, Mobile Communication Engineering. (2/e), McGraw- Hill,1998.
3. A.Goldsmith, Wireless Communications, Cambridge University Press, 2005.
4. *S.G.Glisic, Adaptive CDMA, Wiley, 2003.*

Course Code	**:**	**ECPC63**
Course Title	**:**	**VLSI Systems**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC35**
Course Type	**:**	**PC**

Course Learning Objectives

- To introduce various aspects of VLSI circuits and their design including testing**.**

Course Content

VLSI design methodology, VLSI technology- NMOS, CMOS and BICMOS circuit fabrication. Layout design rules. Stick diagram. Latch up.

Characteristics of MOS and CMOS switches. Implementation of logic circuits using MOS and CMOS technology, multiplexers and memory, MOS transistors, threshold voltage, MOS device design equations. MOS models, small-signal AC analysis. CMOS inverters, propagation delay of inverters, Pseudo NMOS, Dynamic CMOS logic circuits, power dissipation.

Programmable logic devices- antifuse, EPROM and SRAM techniques. Programmable logic cells.Programmable inversion and expander logic. Computation of interconnect delay, Techniques for driving large off-chip capacitors, long lines, Computation of interconnect delays in FPGAs Implementation of PLD, EPROM, EEPROM, static and dynamic RAM in CMOS.

An overview of the features of advanced FPGAs, IP cores, Softcore processors, Various factors determining the cost of a VLSI, Comparison of ASICs, FPGAs , PDSPs and CBICs . Fault tolerant VLSI architectures

VLSI testing -need for testing , manufacturing test principles, design strategies for test, chip level and system level test techniques.

Course outcomes

CO1: Describe the techniques used for VLSI fabrication, design of CMOS logic circuits, switches and memory

CO2: Describe the techniques used the design of CMOS logic circuits, switches and memory in VLSI

CO3: Generalize the design techniques and analyze the characteristics of VLSI circuits such as area, speed and power dissipation

CO4: Explain and compare the architectures for FPGA, PAL and PLDs and evaluate their characteristics such as area, power dissipation and reliability

CO4: Use the advanced FPGAs to realize Digital signal processing systems

CO5: Describe the techniques for fault tolerant VLSI circuits

CO6: Explain and compare the techniques for chip level and board level testing

Text Books

1. N. H. E. Weste, D.F. Harris, "CMOS VLSI design", (3/e), Pearson , 2005.
2. J. Smith, "Application Specific Integrated Circuits,Pearson", 1997.
3. M.M.Vai, "VLSI design", CRC Press, 2001.

Reference Books

3. Pucknell & Eshraghian, "Basic VLSI Design", PHI, (3/e), 2003.
4. Uyemura, "Introduction to VLSI Circuits and Systems", Wiley, 2002.

Course Code	**:**	**ECPC64**
Course Title	**:**	**Antennas and Propagation**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC33**
Course Type	**:**	**PC**

Course Learning Objectives

- To impart knowledge on basics of antenna theory and to analyze and design a start of art antenna for wireless communications.

Course Content

Radiation fundamentals. Potential theory. Helmholtz integrals. Radiation from a current element. Basic antenna parameters. Radiation field of an arbitrary current distribution. Small loop antennas.

Receiving antenna. Reciprocity relations. Receiving cross section, and its relation to gain. Reception of completely polarized waves. Linear antennas. Current distribution. Radiation field of a thin dipole. Folded dipole. Feeding methods. Baluns.

Antenna arrays. Array factorization. Array parameters. Broad side and end fire arrays. Yagi-Uda arrays Log-periodic arrays.

Aperture antennas. Fields as sources of radiation. Horn antennas. Babinet's principle. Parabolic reflector antenna. Microstrip antennas.

Wave Propagation: Propagation in free space. Propagation around the earth, surface wave propagation, structure of the ionosphere, propagation of plane waves in ionized medium, Determination of critical frequency, MUF. Fading, tropospheric propagation, Super refraction.

Course outcomes

CO1: select the appropriate portion of electromagnetic theory and its application to antennas.

CO2: distinguish the receiving antennas from transmitting antennas, analyze and justify their characteristics.

CO3: assess the need for antenna arrays and mathematically analyze the types of antenna arrays.

CO4: distinguish primary from secondary antennas and analyze their characteristics by applying optics and acoustics principles.

CO5: outline the factors involved in the propagation of radio waves using practical antennas.

Text Books

1. R.E.Collin, "Antennas and Radio Wave Propagation", McGraw – Hill,1985.
2. W.L.Stutzman&G.A.Thiele , "Antenna Theory and Design", Wiley.

Reference Books

3. K.F.Lee, "Principles of Antenna Theory", Wiley,1984.
4. F.E. Terman , "Electronic Radio Engineering (4/e)", McGraw Hill.
5. J.R. James, P. S. Hall, and C. Wood, "Microstrip Antenna Theory and Design", IEE, 1981.
4. C. A.Balanis,"Modern Antenna Handbook", Wiley India Pvt. Limited, 2008.

Course Code	**:**	**ECLR61**
Course Title	**:**	**Communication Engineering Laboratory**
Number of Credits	**:**	**2**
Prerequisites (Course code)	**:**	**ECPC53 & ECPC61**
Course Type	**:**	**ELR**

List of Experiments:

1. AM Modulation and Demodulation
2. DSB-SC Modulation
3. Pulse Amplitude Modulation and Demodulation
4. Pulse Width Modulation and Demodulation
5. Pulse Position Modulation using PLL(IC 565)
6. Amplitude Shift Keying (ASK) Modulation and Demodulation
7. Frequency Shift Keying (FSK) Modulation and Demodulation
8. Frequency Multiplier using PLL
9. Analog and digital modulation using COMMSIM simulation tool
10. Analog and digital modulation using MATLAB
11. Study of wireless communication system using Wi-Comm Kit

Course Code	**:**	**ECLR62**
Course Title	**:**	**VLSI and Embedded System Design Laboratory**
Number of Credits	**:**	**2**
Prerequisites (Course code)	**:**	**ECPC63**
Course Type	**:**	**ELR**

List of Experiments:

USING QUARTUS II

1. Adders and subtractors
2. Mux &Demux
3. Encoders & Decoders
4. Flip-Flops
5. Shift-Registers & Counters

USING XILINX

6. Working with RAM
7. Comparators, parity generators & ALU
8. Counters and Shift Registers
9. Carry look ahead adder
10. MULTIPLIERS

WARP DESIGN

Lab1: Introduction to WARP Design Flows
Lab2: Building a Simple Transmitter
Lab3: Building a Simple and Unidirectional MAC
Lab4: Building a single-carrier streaming PHY.

SEVENTH SEMESTER

Course Code	**:**	**ECPC71**
Course Title	**:**	**Microwave Components and Circuits**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC42**
Course Type	**:**	**PC**

Course Learning Objectives

- The subject introduces the essential Microwave Circuit Theory and the design aspects of Microwave Integrated Circuit components.

Course Content

Scattering matrix formulation.Passive microwave devices; terminations, bends, corners, attenuators, phase changers, directional couplers and hybrid junctions. Basics and design considerations of Microstripline, strip line, coplanar waveguide, Slot line and Finline.

Microwave measurements; frequency, wavelength, VSWR.I mpedance determination.S-parameter measurements. Network analyzer.

Microwave network parameters. Basic circuit elements for microwaves. Transmission line sections and stubs.Richardtransformation.Kuroda identities.

MIC filter design. Low pass to high pass, band pass and band stop transformations. Realization using microstriplines and strip lines.

Design and realization of MIC components.3 dB hybrid design. Ratrace Hybrid Ring, Backward wave directional coupler, power divider; realization using microstrip lines and strip lines.

Course outcomes

CO1: Learn the basics of S parameters and use them in describing the components
CO2: Expose to the Microwave Measurements Principle
CO3: Realize the importance of the theory of Microwave circuit theory.
CO4: Work out the complete design aspects of various M.I.C. Filters
CO5: Confidently design all M.I.C. components to meet the industry standard

Text Books

1. I.J.Bahl&P.Bhartia, “Microwave Solid state Circuit Design”, Wiley, 2003.
2. D.M.Pozar, “Microwave Engineering (2/e)”, Wiley, 2004.

Reference Books

3. A. Das, “Microwave Engineering”, Tata McGraw Hill, 2000
4. B.Bhat, S. K. Koul,,”Stripline like transmission lines for Microwave Integrated Circuits”, New age International Pvt.Ltd. Publishers 2007.
5. G. Matthaei , E.M.T. Jones , L. Young , George Matthaei , Leo Young , George L. Matthaei “Microwave filters, Impedance Matching Network, Coupling Structures (Updated)”,Hardcover, 1,096 Pages, Published 1980 by Artech House Publishers ISBN-13: 978-0-89006-099-5, ISBN: 0-89006-099-1

Course Code	**:**	**HSIR13**
Course Title	**:**	**Industrial Economics and Foreign Trade**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**NONE**
Course Type	**:**	**GIR**

INDUSTRIAL ECONOMICS AND FOREIGN TRADE: This Course will be provided by the Department of Humanities.

EIGHTH SEMESTER

Course Code	**:**	**ECPC81**
Course Title	**:**	**Fiber Optic Communication**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC33 & ECPC53**
Course Type	**:**	**PC**

Course Learning Objectives

- To expose the students to the basics of signal propagation through optical fibers, fiber impairments, components and devices and system design.

Course Content

Optical Fibers: Structure, Wave guiding. Step-index and graded index optical fibers. Modal analysis.Classification of modes.Single Mode Fibers.

Pulse dispersion. Material and waveguide dispersion.Polarization Mode Dispersion.Absorption, scattering and bending losses. Dispersion Shifted Fibers, Dispersion Compensating Fibers.

Optical Power Launching and Coupling. Lensing schemes for coupling improvement.Fiber-to-fiber joints.Splicingtechniques. Optical fiber connectors.

Optical sources and detectors.Laser fundamentals. Semiconductor Laser basics. LEDs.PIN and Avalanche photodiodes, Optical Tx/Rx Circuits.

Design considerations of fiber optic systems: Analog and digital modulation. Noise in detection process. Bit error rate. Optical receiver operation. Power Budget and Rise time Budget. WDM.

Course outcomes

CO1: Recognize and classify the structures of Optical fiber and types.
CO2: Discuss the channel impairments like losses and dispersion.
CO3: Analyze various coupling losses.
CO4: Classify the Optical sources and detectors and to discuss their principle.
CO5: Familiar with Design considerations of fiber optic systems.

Text Books

1. G.Keiser, “Optical Fiber Communications (5/e)”, McGraw Hill ,2013.
2. G.P.Agarwal, “Fiber Optic Communication Systems”, (3/e), Wiley, 2002.

Reference Books

1. M.M.K.Liu, “Principles and Applications of Optical Communications”, Tata McGeaw Hill, 2010.
2. A.Ghatak&K.Thygarajan, “Introduction to Fiber Optics”, Cambridge, 1999.
3. J.Gowar, “Optical Communication Systems”, (2/e), PHI, 2001.
4. A.Selvarajan, S.Kar and T.Srinivas, “Optical Fiber Communication Principles and Systems”, TataMcGraw Hill, 2002.

PROGRAMME ELECTIVES

Course Code	**:**	**ECPE11**
Course Title	**:**	**Display Systems**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC34**
Course Type	**:**	**PE**

Course Learning Objectives

- To expose the students to the basics of the display systems and to illustrate the current design practices of the display systems.

Course Content

Introduction to displays. Requirements of displays. Display technologies, CRT, Flat panel and advanced display technologies. Technical issues in displays.

Head mounted displays. Displays less than and greater than 0.5 m diagonal. Low power and light emitting displays.

Operation of TFTs and MIMS. LCDs, Brightness. Types of LCD displays.

Emissive displays, ACTFEL, Plasma display and Field emission displays, operating principle and performance.

Types of Displays: 3D, HDTV, LED, Touch screen.

Course outcomes

CO1: appreciate the technical requirement of different types of display systems
CO2: analyze the various low power lighting systems
CO3: understand the operation of TFTs and LCD displays.
CO4: analyze the various kinds of emissive displays
CO5: critically evaluate the recent advancements in the displays device technology.

Text Books

1. L.W. Mackonald& A.C. Lowe, Display Systems, Design and Applications, Wiley,2003.
2. E.H. Stupp&M. S. Brennesholtz, Projection Displays, Wiley,1999

ReferenceBooks

1. Peter A. Keller, Electronic Display Measurement: Concepts, Techniques, and Instrumentation, Wiley-Interscience,1997.

Course Code	**:**	**ECPE12**
Course Title	**:**	**Statistical Signal Processing**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC41**
Course Type	**:**	**PE**

Course learning Objectives

- To develop algorithms for optimum filtering (and prediction) and for adaptive filtering for the given observation processes.
- To enable the students understand the frequency analysis and estimation methods

Course Content

Random processes: Stationary 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 modeling: MA, AR, ARMA models.

Optimum Linear Filtering: 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: Exponentially weighted RLS algorithm derivation, Matrix inversion Lemma, Initialization.

Spectrum Estimation: Principle of estimation and applications, Properties of estimates, unbiased and consistent estimators, Estimated autocorrelation function, periodogram, Averaging the periodogram (Bartlett Method), Welch modification, Blackman and Tukey method of smoothing periodogram, Prametric method, AR spectral estimation.

Frequency Estimation, Eigen decomposition of Autocorrelation matrix, Detection of Harmonic signals: Pisarenko's method, MUSIC algorithm, ESPRIT method, Propagator method.

Course outcomes

CO1: apply the knowledge of the discrete-time stochastic processes & its measures and understand various stochastic models.

CO2: develop algorithms for optimum linear filtering and prediction for the given observation processes

CO3: develop steepest descent, Least Mean Square (LMS), and Recursive Least Squares (RLS) adaptive filter algorithms

CO4: derive and analyze the statistical properties of the conventional spectral estimators, namely the periodogram, averaged & modified periodogram and Blackman-Tukey methods

CO5: formulate parametric spectral estimators based upon autoregressive (AR), moving average (MA), and autoregressive moving average (ARMA) models, and detail their statistical properties.

CO6: select an appropriate array processing algorithms for frequency estimation based on the observation models.

Text Books

1. M.H. Hayes, "Statistical Digital Signal Processing and Modelling", John Wiley,1996.
2. P.Stroica & R.Moses," Spectral Analysis of signals",Pearson,2005.

Course Code	**:**	**ECPE13**
Course Title	**:**	**Communication Switching Systems**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC53**
Course Type	**:**	**PE**

Course learning Objectives

- To understand the working principles of switching systems from manual and electro mechanical systems to stored program control systems.

Course Content

Basic elements of communication network. Switching systems. Signaling and signaling functions.

Digital telephone network. TDM Principles. PCM primary multiplex group. Plesiochronous digital hierarchy. Synchronous digital hierarchy. Echo cancellers.

Digital transmission and multiplexing. Synchronous versus Asynchronous transmission. Line coding . Error performance. TDM. Framing, TDM loops and rings.

Space division switching. Multiple-stage switching. Design examples. Switching matrix control. Time division switching. Multiple-stage time and space switching.

Timing recovery. Jitter. Network synchronization. Digital subscriber access-ISDN . ADSL. HFC. Traffic analysis.

Course outcomes

CO1: explain the working principle of switching systems involved in telecommunication switching
CO2: assess the need for voice digitization and T Carrier systems
CO3: compare and analyze Line coding techniques and examine its error performance
CO4: design multi stage switching structures involving time and space switching stages
CO5: analyze basic telecommunication traffic theory

Text Books

1. J.C. Bellamy, "Digital Telephony", Wiley, 3rd edition,2011.
2. J.E. Flood, "Telecommunications Switching, Traffic and Networks" Pearson,1st edition,2012

Reference Books

1. T.Viswanathan, "Telecommunication Switching Systems and Networks", PHI,2006.
2. E.Keiser&E.Strange, "Digital Telephony and Network Integration", Springer, 2nd edition,1995.
3. R. L.Freeman, "Fundamentals of Telecommunications" , John Wiley and Sons, 2ndedition,1999.

Course Code	**:**	**ECPE14**
Course Title	**:**	**RF MEMS Circuit Design**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC42 & ECPC71**
Course Type	**:**	**PE**

Course learning Objectives

- To impart knowledge on basics of MEMS and their applications in RF circuit design.

Course Content

Introduction to Micho machining Processes. RF MEMS relays and switches. Switch parameters. Actuation mechanisms. Bistable relays and micro actuators. Dynamics of switching operation.

MEMS inductors and capacitors. Micro machined inductor. Effect of inductor layout. Modeling and design issues of planar inductor. Gap-tuning and area-tuning capacitors. Dielectric tunable capacitors.

MEMS phase shifters. Types. Limitations. Switched delay lines. Fundamentals of RF MEMS Filters. Micro machined transmission lines. Coplanar lines. Micro machined directional coupler and mixer.
Micro machined antennas. Micros trip antennas–design parameters. Micro machining to improve performance. Reconfigurable antennas.

Course outcomes

CO1: learn the Micro machining Processes
CO2: learn the design and applications of RF MEMS inductors and capacitors.
CO3: learn about RF MEMS Filters and RF MEMS Phase Shifters.
CO4: learn about the suitability of micro machined transmission lines for RF MEMS
CO5: learn about the Micro machined Antennas and Reconfigurable Antennas

Text Book

1. Vijay.K.Varadanetal, “RF MEMS and their Applications”, Wiley-India,2011.

Reference Books

1. H.J.D.Santos, “RF MEMS Circuit Design for Wireless Communications”, Artech House,2002.
2. G.M.Rebeiz, “RF MEMS Theory, Design, and Technology”, Wiley,2003.

Course Code	**:**	**ECPE15**
Course Title	**:**	**Principles of Radar**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC51**
Course Type	**:**	**PE**

Course learning Objectives

- To expose the students to the working principles of a radar from a signal processing perspective.

Course content

Radar equation. Radar cross section. Cross section of small targets. Target scattering matrices. Area and volume targets.

Radar signals. Ambiguity function and its properties. Uncertainty principle. Pulse compression. linear FM pulse. Pulse compression by Costas FM and binary phase coding.

Radar detection. Optimum Bayesian decision rules. Detection criteria for different target models.

Range and Doppler measurements and tracking. Range and Doppler frequency resolutions. Optimum receivers. Optimum filters for Doppler measurements. Coherent and non coherent implementations.

Angle measurement and tracking. Angle measurement and tracking by conical scan and mono pulse. Optimum mono pulse systems.

Course outcomes

CO1: Understand the principle behind radar range equation and different types of targets available.
CO2: Appreciate the different compression techniques of radar pulse signals.
CO3: Distinguish between different detection methods of radar signals.
CO4: Appreciate the building blocks for optimum receiver and Doppler measurements.
CO5: Understand the tracking and scanning methods in the mono pulse systems.

Text books:

1. P.Z.Peebles, Radar Principles, Wiley,1998.
2. Merrill I. Skolink, Introduction to Radar Systems, (3/e), Tata MG Graw Hill,2001

Reference Books:

1. N.Levanon, Radar Signals, Wiley,2005.
2. D.Wehnar : High Resolution Radar, Artech Hous,1987.
3. D.K.Barton : Radar systems Analysis , Prentice Hall,1976.

Course Code	**:**	**ECPE16**
Course Title	**:**	**Digital Signal Processing for Wireless Communication**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC41 & ECPC62**
Course Type	**:**	**PE**

Course learning Objectives

- The subject aims to make the students to understand the signal processing approach for wireless communication

Course Content

Physical model for wireless channel- Input /Output models for wireless channel: System function and impulse response of LTV system-Doppler spread-Coherence time-Delay spread-Coherence frequency-Base band system functions and impulse response.
Statistical channel model-Binary detection in flat Rayleigh fading- Non-cohernent detection in flat Rician fading-Channel measurement-Use of probing signals to estimate the channel-Rake receiver-Jakes model- Jakes spectrum-Ground reflections-Okumura model-Log normal shadowing- Hatamodel.
Cellular communication-Frequency reuse- Practical Link budget design using path loss models-Design parameters at base station-Antennal location, spacing, heights and configurations- Tele traffic theory.
Multiple access techniques: TDMA, FDMA, CDMA: PN sequences-Multipath diversity-Rake receiver- Receiver synchronization-Multicarrier modulation. Orthogonal frequency division Multiplexing (OFDM): Cyclic prefix-Frequency offset-Peak to average power ratio problem.
MIMO-Channel capacity-Spatial Multiplexing-Diversity- Beam forming- MIMO-OFDM-Wireless standards: GSM-WCDMA-LTE-IS 95-Wireless networks-Video over wireless.

Course outcomes

CO1: describe the Coherence time, Coherence frequency, Doppler spread and Delay spread
CO2: model the wireless channel using statistical approach
CO3: prepare the link budget for the wireless communication
CO4: describe various multiple access techniques and diversity techniques
CO5: compare various wireless standards

Textbooks

1. D. Tse and P.Viswanath, "Fundamentals of Wireless Communication", Cambridge university press, 2005
2. A. Goldsmith, "Wireless Communications", Cambridge University Press,2005
3. E.S.Gopi, "Digital signal processing for wireless communication using Matlab'', Springer, 2016

Reference Books

1. T.S.Rappaport, "Wireless Communication Principles (2/e)", Pearson,2002.
2. E. Biglieri, R.Calderbank, A. Constantinides, A. Goldsmith, A.Paulraj, H.Vincent poor, "MIMO Wireless Communications", Cambridge University Press,2007.
3. Robert Gallager, Chapter 9: "Wireless communication", course materials for 6.450 Principles of Digital communication I,Fall 2006.
4. MIT Open courseware http://ocw.mit.edu/.
5. A. K.Jagannatham," Advanced 3G and 4G wireless mobile communications"-,IIT Kanpur, NPTEL Video lectures.http://nptel.iitm.ac.in

Course Code	**:**	**ECPE17**
Course Title	**:**	**Cognitive Radio**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC41**
Course Type	**:**	**PE**

Course learning Objectives

- introduces the fundamentals of multi rate signal processing and cognitive radio.

Course Content

Filter banks-uniform filter bank. direct and DFT approaches. Introduction to ADSL Modem. Discrete multitone modulation and its realization using DFT. QMF. STFT.Computation of DWT using filter banks.
DDFS- ROM LUT approach. Spurious signals, jitter. Computation of special functions using CORDIC. Vector and rotation mode of CORDIC.CORDIC architectures.

Block diagram of a software radio. Digital down converters and demodulators Universal modulator and demodulator using CORDIC. Incoherent demodulation - digital approach for I and Q generation, special sampling schemes. CIC filters. Residue number system and high speed filters using RNS. Down conversion using discrete Hilbert transform. Under sampling receivers, Coherent demodulation schemes.

Concept of Cognitive Radio, Benefits of Using SDR, Problems Faced by SDR, Cognitive Networks, Cognitive Radio Architecture. Cognitive Radio Design, Cognitive Engine Design,

A Basic OFDM System Model, OFDM based cognitive radio, Cognitive OFDM Systems, MIMO channel estimation, Multi-band OFDM, MIMO-OFDM synchronization and frequency offset estimation. Spectrum Sensing to detect Specific Primary System, Spectrum Sensing for Cognitive OFDMASystems.

Course outcomes

CO1: gain knowledge on multirate systems.
CO2: develop the ability to analyze, design, and implement any application using FPGA.
CO3: be aware of how signal processing concepts can be used for efficient FPGA based system design.
CO4: understand the rapid advances in Cognitive radio technologies.
CO5: explore DDFS, CORDIC and its application

Text Books

1. J. H. Reed, “Software Radio”, Pearson,2002.
2. U. Meyer – Baese , “Digital Signal Processing with FPGAs”, Springer,2004.
3. H. Arslan “Cognitive Radio, Software Defined Radio and Adaptive Wireless Systems”, University of South Florida, USA, Springer,2007.

ReferenceBooks

1. S. K. Mitra, “Digital Signal processing”, McGrawHill,1998
2. K.C.Chen, R.Prasad , “Cognitive Radio Networks” , Wiley,2009-06-15.
3. T. W. Rondeau, C.W.Bostian, “Artificial Intelligence in Wireless Communications”, 2009.
4. T. DarcChiueh, P. Yun Tsai,” OFDM baseband receiver design for wireless communications”, Wiley,2007
5. Tusi, “Digital Techniques for Wideband receivers”, Artech House, 2001.

Course Code	**:**	**ECPE18**
Course Title	**:**	**Broadband Access Technologies**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC53 & ECPC61**
Course Type	**:**	**PE**

Course learning Objectives

- To impart fundamentals and latest technologies related to the design of broadband last mile-Access technologies for multimedia communication

Course Content

Wired access technologies using Phone line modem, ISDN modem. Comparison-Cable, DSL, fiber and wireless access technologies.

Last mile copper access, Flavors of Digital subscriber lines, DSL deployment, Common local loop impairments, discrete multitone modulation, VDSL deployment and frequency plans. Standards for XDSL and comparison.

Last mile HFC access, Cable modems. Modulation schemes, DOCSIS. Standards- comparison, physical and MAC layer protocols for HFC networks, ATM and IP-centric modem. Switched digital video.

Fiber access technologies and architectures. ATM passive optical networks, Upstream and downstream transport, Frame format, Ethernet passive optical network, Gigabit passive optical networks.

Survey on emerging broadband wireless access technologies. LMDS,MMDS,WIMAX and WIFI, Satellite technologies serving as last mile solutions, Wireless LAN, Wireless personal area networking, 3G and 4G wireless systems.

Course outcomes

CO1: recall and identify the basics of broadband technology systems and differentiate the differences between the various wired and wireless technology system
CO2: illustrate the aspects of last mile data transport on copper wire networks and flavors of DSL
CO3: summarize the versions of cable network standard and MAC protocols for HFC networks
CO4: distinguish the cost effective broadband services for residential users and ATM based and Ethernet based passive optical networks
CO5: outline the types of broadband wireless access technologies and their characteristics.

Text Books

1. N.Jayant, "Broadband last mile"-Taylor and Francisgroup,2005
2. N.Ransom& A.A. Azzam, "Broadband Access Technologies", McGraw Hill,1999.
3. M.P. Clarke, "Wireless Access Network", Wiley,2000.

Reference Books

1. T.Starr,M.Sorbara,J.M.Cioffi and P.J.Silverman,"DSLadvances",PrenticeHall,2002
2. S. Mervana&C.Le, "Design and Implementation of DSL-based Access Solutions", Cisco Press, 2001.
3. W. Vermillion, "End-to-End DSL Architecture", Cisco Press,2003.
4. DOCSIS 2.0 "Radio frequency interface specification"www.cablemodem.com
5. ITU-T Rec., G.983.1 "Broadband Optical Access systems based on Passive OpticalNetworks",1998.

Course Code	**:**	**ECPE19**
Course Title	**:**	**Satellite Communication**
Number of Credits		**3**
Prerequisites (Course code)	**:**	**ECPC61**
Course Type	**:**	**PE**

Course learning Objectives

- To introduce and to make understand the radio propagation channel for Earth station to satellite & satellite to Earth station.
- To introduce various aspects in the design of communication & multiple access systems for satellite communication.
- To introduce the concept of launchers and design of Earth station and satellite link.

Course Content

Elements of orbital mechanics. Equations of motion. Tracking and orbit determination. Orbital correction/control. Satellite launch systems. Multistage rocket launchers and their performance.

Elements of communication satellite design. Spacecraft subsystems. Reliability considerations. Spacecraft integration.

Multiple access techniques. FDMA,TDMA, CDMA. Random access techniques. Satellite onboard processing.

Satellite Link Design: Performance requirement and standards. VSAT, Mobile satellite services: GSM, GPS, DBS, DTH, MATV, CATV, Satellite based personal communication.
Earth station design. Configurations. Antenna and tracking systems. Satellite broadcasting. satellite navigation-recent advances.

Course outcomes

CO1: understand how analog and digital technologies are used for satellite communication networks.
CO2: To understand the radio frequency channel from earth station to satellite.
CO3: learn the dynamics of the satellite
CO4: learn the keplerian elements
CO5: study the design of Earth station and tracking of the satellites

Text books:

1. D.Roddy,"Satellite Communication (4/e)", McGraw-Hill, 2009.
2. T.Pratt&C.W.Bostain, "Satellite Communication", Wiley 2000.
3. Bruce R. Elbert, 'The Satellite Communication Applications' Hand Book, Artech HouseBostan London, 1997.

Reference Books:

1. B.N.Agrawal, "Design of Geosynchrons Spacecraft", Prentice-Hall,1986.
2. A.K. Maini, V.Agrawal, "Satellite Communications", Wiley India PvtLtd,1999.

Course Code	**:**	**ECPE20**
Course Title	**:**	**Microwave Integrated Circuit Design**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC42 & ECPC71**
Course Type	**:**	**PE**

Course learning Objectives

- To impart knowledge on basics of microwave electron beam devices and their applications in X band frequency**.**

Course Content

Design and realization of power dividers, hybrids, directional couplers etc using strip lines and microstrip lines.

Filter design; Kuroda identities. K and J inverters. Filter transformations. Realization using strip lines and micro strip lines.

Transistor amplifiers; Power gain equations. Stability considerations. Analysis. Design using MICs.

Transistor oscillators. Active devices for microwave oscillators. Three port S parameter characterization of transistors. Oscillation and stability conditions.

Diode mixers. Mixer design. Single ended mixer. Balanced mixer. Image rejection mixer. Phase shifter design. PIN diode. Phase shifter.

Course outcomes

CO1: the topics will make students design of the important and essential M.I.C. components
CO2: Filter is the most needed circuit for many applications and the unit will make the student confident in filter design
CO3: All aspects and different parameters, design factors and properties will me made thorough
CO4: One will be confident to handle any oscillator design
CO5: The student will become familiar and confident in the design of Mixers, the other essential circuits.

Text Books

1. I.J.Bahl&Bhartia, Micrwave Solid State Circuit Design, Wiley,1987.
2. G.D.Vendelin, Design of Amplifiers and Oscillators by the S Parameter Method, Wiley,1982.

Reference Books

1. T.C.Edwards, Foundations for MicrostripCircuir Design (2/e), Wiley,1992.

Course Code	**:**	**ECPC21**
Course Title	**:**	**Microwave Electronics**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC71**
Course Type	**:**	**PC**

Course Learning Objectives

- To impart knowledge on basics of microwave electron beam devices and their applications in X band frequency**.**

Course Content

Limitations of conventional vacuum tubes, Klystrons: Reentrant cavities, Two cavity klystron, Velocity modulation process, Bunching process ,Power output and efficiency; Multi-cavity klystron , Reflex klystron-Velocity modulation process, Mode Characteristics ,Electronic admittance spiral.

Travelling-wave tubes: Slow-wave structures, Helix TWT- Amplification process, Convection current, Wave modes and gain; Coupled cavity TWT, Backward wave oscillator.

Crossed -field devices: Magnetrons- Principle of operation, characteristics, Hull cut-off condition; Carcinotron, Gyrotron.

Microwave transistors and FETs: Microwave bipolar transistors-Physical structures, characteristics, Power-frequency limitations; Microwave tunnel diode, Microwave unipolar transistor – Physical structure, principle of operation, characteristics, High electron-mobility transistors.

Transferred electron and Avalanche transit-time devices: Gunn diode, Gunn diode as an oscillator. IMPATT, TRAPATT and BARITT.

Course outcomes

CO1: Apply the basic knowledge of waveguide and microwave resonator circuits.
CO2: Asses the methods used for generation and amplification of the microwave power.
CO3: Distinguish between the linear and cross field electron beam microwave tubes.
CO4: Critically analyze the operating principles and performances of the microwave semiconductor devices.
CO5: Identify the suitable microwave power sources of given specification for the selected application.
CO6: Aware of current technological changes in the engineering aspects of microwave components.

Text Book

1. S.Y.Liao, “Microwave Devices and Circuits (3/e)”, PHI, 2005.
2. R. F. Soohoo, “Microwave Electronics”, Wesley publication,1971.

Reference Books

1. R.E.Collin, “Foundations for Microwave Engineering (2/e)”,Wiley India, 2007.
2. D.M.Pozar,” Microwave Engineering (3/e)”, Wiley India, 2009.
3. K C Gupta, Indian Institute of Technology, Kanpur,” Microwaves”, Wiley Eastern Limited, 1995.

Course Code	**:**	**ECPE22**
Course Title	**:**	**Electronic Packaging**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**NONE**
Course Type	**:**	**PE**

Course learning Objectives

- To introduce and discuss various issues related to the system packaging.

Course Content

Functions of an Electronic Package, Packaging Hierarchy, IC packaging: MEMS packaging, consumer electronics packaging, medical electronics packaging, Trends, Challenges, Driving Forces on Packaging Technology, Materials for Microelectronic packaging, Packaging Material Properties, Ceramics, Polymers, and Metals in Packaging, Material for high density interconnect substrates.

Electrical Anatomy of Systems Packaging, Signal Distribution, Power Distribution, Electromagnetic Interference, Design Process Electrical Design: Interconnect Capacitance, Resistance and Inductance fundamentals; Transmission Lines , Clock Distribution, Noise Sources, power Distribution, signal distribution, EMI, Digital and RF Issues. Processing Technologies, Thin Film deposition, Patterning, Metal to Metal joining.

IC Assembly – Purpose, Requirements, Technologies, Wire bonding, Tape Automated Bonding, Flip Chip, Wafer Level Packaging , reliability, wafer level burn – in and test. Single chip packaging : functions, types, materials processes, properties, characteristics, trends. Multi chip packaging : types, design, comparison, trends. Passives: discrete, integrated, embedded – encapsulation and sealing : fundamentals, requirements, materials, processes.

Printed Circuit Board: Anatomy, CAD tools for PCB design, Standard fabrication, Micro via Boards. Board Assembly: Surface Mount Technology, Through Hole Technology, Process Control and Design challenges. Thermal Management, Heat transfer fundamentals, Thermal conductivity and resistance, Conduction, convection and radiation – Cooling requirements.

Reliability, Basic concepts, Environmental interactions. Thermal mismatch and fatigue – failures – thermo mechanically induced – electrically induced – chemically induced. Electrical Testing: System level electrical testing, Interconnection tests, Active Circuit Testing, Design for Testability.

Course outcomes

CO1: describe the functions and applications of packages and materials used for packaging.
CO2: explain the procedure used for evaluating the electrical aspects of packaging including delay, cross talk
CO3: apply the design technique and analyse the electrical characteristics of VLSI circuits.
CO4: describe about the single chip and multi chip packages and techniques.
CO5: explain the techniques for bonding the packages todies.
CO6: explain the technique used for fabrication and characteristics of single layer and multi layer PCBs and compare their performances.
CO7: describe about thermal management techniques for packages and reliability of packages.

Text Book

1. Tummala, Rao R., “Fundamentals of Microsystems Packaging”, McGraw Hill,2001.

Reference Books

1. Blackwell (Ed), “The electronic packaging handbook”, CRCPress,2000.
2. Tummala, Rao R, “Microelectronics packaging handbook”, McGraw Hill,1963.
3. Bosshart, “Printed Circuit Boards Design and Technology”,TataMcGrawHill,1983.
4. R.G. Kaduskar and V.B.Baru, “Electronic Product design”, Wiley India,2011.
5. R.S.Khandpur, “Printed Circuit Board”, Tata McGraw Hill,2005.

OPEN ELECTIVES

Course Code	**:**	**ECOE 11**
Course Title	**:**	**Computer Architecture and Organization**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**NONE**
Course Type	**:**	**OE**

Course learning Objectives

- To understand how computers are constructed out of a set of functional units and how the functional units operate, interact, and communicate.
- To make the students to understand the concept of interfacing memory and various I/O devices to a computer system using a suitable bus system.

Course Content

Introduction: Function and structure of a computer, Functional components of a Computer, Interconnection of components, Performance of a computer.

Representation of Instructions: Machine instructions, Memory locations & Addresses, Operands, Addressing modes, Instruction formats, Instruction sets, Instruction set architectures - CISC and RISC architectures, Super scalar Architectures, Fixed point and floating point operations.

Basic Processing Unit: Fundamental concepts, ALU, Control unit, Multiple bus organization, Hardwired control, Micro programmed control, Pipelining, Data hazards, Instruction hazards, Influence on instruction sets, Data path and control considerations, Performance considerations.

Memory organization: Basic concepts, Semiconductor RAM memories, ROM, Speed - Size and cost, Memory Interfacing circuits, Cache memory, Improving cache performance, Memory management unit, Shared/Distributed Memory, Cache coherency in multiprocessor, Segmentation, Paging, Concept of virtual memory, Address translation, Secondary storage devices.

I/O Organization: Accessing I/O devices, Input/output programming, Interrupts, Exception Handling, DMA, Buses, I/O interfaces- Serial port, Parallel port, PCI bus, SCSI bus, USB bus, Firewall and Infini band, I/O peripherals.

Course outcomes

CO1: apply the basic knowledge of digital concept to the functional components of a Computer System.
CO2: analyze the addressing mode concepts and design the instruction set Architecture.
CO3: identify the functions of various processing units within the CPU of a Computer System.
CO4: analyze the function of the memory management unit and create suitable memory interface to the CPU.
CO5: recognize the need for recent Bus standards and I/O devices.

Text Books

1. *C.Hamacher Z. Vranesic and S. Zaky, "Computer Organization", McGraw-Hill,2002.*
2. *W. Stallings, "Computer Organization and Architecture - Designing for Performance", Prentice Hall of India,2002.*
3. *B,Parhami, "Computer Architecture, From Microprocessors to Supercomputers," Oxford University Press, Reprint2014.*

Reference Books

1. *D. A. Patterson and J. L. Hennessy, "Computer Organization and Design,*
2. *Morgan Kaufmann," The Hardware/Software Interface",1998.*
3. *J .P. Hayes, "Computer Architecture and Organization", McGraw-Hill,1998.*

Course Code	**:**	**ECOE12**
Course Title	**:**	**Multimedia Communication Technology**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**NONE**
Course Type	**:**	**OE**

Course learning Objectives

- To made the students to understand various encoding and decoding techniques of audios and videos in multimedia systems.

Course content

Components of multimedia system, Desirable features, Applications of multimedia systems, Introduction to different types, Multimedia storage device.

Digital audio representation and processing-time domain and transform domain representations. Coding standards, transmission and processing of digital audio. Musical instrument synthesizers.

Still image coding-JPEG. Discrete cosine Transform. Sequential and Progressive DCT based encoding algorithms, lossless coding, hierarchical coding. Basic concepts of discrete wavelet transform coding and embedded image coding algorithms. Introduction to JPEG2000.

Feature of MPEG 1, structure of encoding and decoding process, MPEG 2 enhancements, different blocks of MPEG video encoder.

Content based video coding-overview of MPEG 4 video, motion estimation and compensation. Different coding techniques and verification models. Block diagram of MPEG 4 video encoder and decoder. An overview of H261 and H263 video coding techniques.

Course outcomes

CO1: analyze various components of the multimedia systems and its storage devices.
CO2: appreciate the different coding standards for the digital audio and musical synthesizers.
CO3: understand the various types of DCT based image encoding algorithms
CO4: understand the encoding and decoding process of the MPEG standards
CO5: analyse the different content based video processing techniques.

Text Books

1. Y.Q.Shi&H.Sun, Image and Video Compression for Multimedia Engineering, CRC Press,2000.
2. S.V.Raghavan & S,K,Tripathi, Networked Multimedia Systems, Prentice-Hall,1998.

Reference Books

1. J.F.K.Buford, Multimedia Systems, Pearson,2000.

Course Code	**:**	**ECOE13**
Course Title	**:**	**ARM System Architecture**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**NONE**
Course Type	**:**	**OE**

Course learning Objectives

- The objective of this course is to give the students a thorough exposure to ARM architecture and make the students to learn the ARM programming & Thumb programming models.

Course content

RISC machine. ARM programmer's model. ARM Instruction Set. Assembly level language programming. Development tools.

ARM organization.ARM instruction execution.ARM implementation. ARM coprocessor interface. . Interrupt response.

Floating point architecture. Expressions. Conditional statements. Loops. Functions and procedures. Run time environment.

Thumb programmer's model. Thumb Instruction set. Thumb implementation.

Memory hierarchy. Architectural support for operating system. Memory size and speed. Cache memory management. Operating system. ARM processor chips.

Course outcomes

CO1: describe the programmer's model of ARM processor and create and test assembly level programming.
CO2: analyze various types of coprocessors and design suitable co-processor interface to ARM processor.
CO3: analyze floating point processor architecture and its architectural support for higher level language.
CO4: become aware of the Thumb mode of operation of ARM.
CO5: identify the architectural support of ARM for operating system and analyze the function of memory Management unit of ARM.

Text Books

1. S. Furber, "ARM System Architecture",Addison-Wesley,1996.
2. A. Sloss, D.Symes& C.Wright, "ARM system Developer's guide",Elsevier.2005.

Reference Books

1. Technical reference manual for ARM processor cores, including Cortex, ARM 11, ARM 9 & ARM 7 processor families.
2. User guides and reference manuals for ARM software development and modeling tools. David Seal, ARM Architecture Reference Manual, Addison-Wesley.

Course Code	**:**	**ECOE14**
Course Title	**:**	**Networks and Protocols**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**NONE**
Course Type	**:**	**OE**

Course Learning Objectives

- To get an understanding on the fundamentals of networks and issues involved.
- To acquire an understanding on the set of rules and procedures that mediates the exchange of information between communicating devices.

Course Content

Network Components, Topologies, Network hardware and software, Network Models: OSI Model & TCP/IP Protocol stack, HTTP FTP, SMTP, POP, SNMP, DNS, Socket programming with TCP and UDP.

Transport Layer services, UDP, TCP, SCTP, Principles of reliable data transfer, Flow control, Congestion Control, Quality of Service.

Network Layer services, Datagram and Virtual circuit service, DHCP, IPV4, IPV6, ICMP, Unicast routing protocols: DV, LS and Path vector routing, Multicast routing.

Data Link Layer services, Overview of Circuit and Packet switches, ARP, Data link control: HDLC & PPP, Multiple access protocols, Wireless LAN, Comparison wired and wireless LAN.

Network security threats, Cryptography, Security in the Internet: IPSecurity & Firewalls, Multimedia: Streaming stored video/ audio, RTP, Network Troubleshooting.

Course outcomes

CO1: Compare and examine, OSI and TCP/IP protocol stacks
CO2: Categorize services offered by all layers in TCP/IP protocol stack
CO3: Analyze a network under congestion and propose solutions for reliable data transfer
CO4: Examine the protocols operating at different layers of TCP/IP model
CO5: Assess the cryptographic techniques.
CO6: Manage a network and propose solutions under network security threats.

Text Books

1. J.F.Kurose&K.W.Ross, "Computer Networking: A Top-Down Approach featuring the Internet", Pearson, 5th edition, 2010.
2. B.A. Forouzan," Data Communications & Networking", Tata McGraw- Hill, 4th edition, 2006

Reference Books

3. W.Stallings, "Data & Computer Communications", PHI, 9th edition, 2011.
4. W.Stallings, "Cryptography & Network Security", Pearson, 5th edition, 2011.
5. A.S.Tanenbaum & D.J. Wetherall, "Computer Networks", Pearson, 5th edition, 2014.

Course Code	**:**	**ECOE15**
Course Title	**:**	**Ad hoc Wireless Networks**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**NONE**
Course Type	**:**	**OE**

Course learning Objectives

- To analyse the various design issues and challenges in the layered architecture of Ad hoc wireless networks

Course Content

Cellular and ad hoc wireless networks, Applications of ad hoc wireless networks. Issues in ad hoc wireless networks-medium access scheme, routing, transport layer protocols, security and energy management. Ad hoc wireless internet.

Design goals of a MAC protocol, Contention based protocols; Contention based protocols with reservation mechanisms and scheduling mechanisms, MAC protocols using directional antennas.

Table driven routing protocols, On demand routing protocols, hybrid routing protocols, Hierarchical routing protocols, Power aware routing protocols, Tree based and mesh based multicast routingprotocols

Network security requirements-Issues and challenges, network security attacks, key management, secure routingprotocols

Energy management schemes-Battery management,transmission power management, system power management schemes. Quality of service solutions in ad hoc wireless networks.

Course outcomes

CO1: compare the differences between cellular and ad hoc networks and the analyse the challenges at various layers and applications
CO2: summarize the protocols used at the MAC layer and scheduling mechanisms
CO3: compare and analyze types of routing protocols used for unicast and multicast routing
CO4: examine the network security solution and routing mechanism
CO5: evaluate the energy management schemes and Quality of service solution in ad hoc networks

Text books

1. *C.Siva ram murthy,B.S. Manoj, "Ad hoc wireless networks-Architectures and protocols" Pearson Education, 2005*
2. *S.Basagni, M.Conti, "Mobile ad hoc networking", Wielyinterscience2004*
3. *C. E.Perkins ,"Ad hoc networking", AddisonWesley,2001*

Reference books

1. *X.Cheng, X.Huang ,D.Z. DU ,"Ad hoc wireless networking", Kluwer AcademicPublishers,2004*
2. *G. Aggelou,"Mobile ad hoc networks-From wireless LANs to 4G networks", McGraw Hill publishers,2005*

Course Code	**:**	**ECOE16**
Course Title	**:**	**Digital Image Processing**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**NONE**
Course Type	**:**	**OE**

Course learning Objectives

- To treat the 2D systems as an extension of 1D system design and discuss techniques specific to 2D systems.

Course Content

Linearity and space-invariance. PSF, Discrete images and image transforms, 2-D sampling and reconstruction, Image quantization, 2-D transforms and properties.

Image enhancement- Histogram modelling, equalization and modification. Image smoothing, Image crispening. Spatial filtering, Replication and zooming, Generalized cepstrum and homomorphic filtering.

Image restoration- image observation models.Inverse and Wiener filtering. Filtering using image transforms. Constrained least-squares restoration. Generalized inverse, SVD and interactive methods. Recursive filtering. Maximum entropy restoration. Bayesian methods.

Image data compression- sub sampling, Coarse quantization and frame repetition. Pixel coding - PCM, entropy coding, runlength coding Bit-plane coding. Predictive coding. Transform coding of images. Hybrid coding and vector DPCM. Interframe hybrid coding.

Image analysis- applications, Spatial and transform features. Edge detection, boundary extraction, AR models and region representation. Moments as features. Image structure.Morphological operations and transforms.Texture.Scene matching and detection. Segmentation and classification.

Course outcomes

CO1: analyze the need for image transforms, types and their properties.
CO2: become skilled at different techniques employed for the enhancement of images both in spatial and frequency domain.
CO3: explore causes for image degradation and to teach various restoration techniques.
CO4: evaluate the image compression techniques in spatial and frequency domain.
CO5: gain knowledge of feature extraction techniques for image analysis and recognition.

Text Books

1. A.K. Jain, " Fundamentals of Digital Image Processing" , PHI,1995.
2. R.C.Gonzalez& R.E. Woods," Digital Image Processing", (2/e),Pearson,2002.

Reference Books

1. J.C. Russ, "The Image Processing Handbook", (5/e), CRC,2006.
2. E.S.Gopi,"Digital Image processing using Matlab", Scitechpublications,2006.

Course Code	**:**	**ECOE17**
Course Title	**:**	**Wireless Sensor Networks**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**NONE**
Course Type	**:**	**OE**

Course learning Objectives

- To overview the various design issues and challenges in the layered architecture of Wireless sensor networks

Course Content

Motivation for a network of wireless sensor nodes-Definitions and background-challenges and constraints for wireless sensor networks-Applications. Node architecture-sensing subsystems, processing Subsystems, Communication interfaces, Prototypes.

Physical layer- Introduction, wireless channel and communication fundamentals – frequency allocation, modulation and demodulation, wave propagation effects and noise, channels models, spread spectrum communication, packet transmission and synchronization, quality of wireless channels and measures for improvement, physical layer and transceiver design consideration in wireless sensor networks, Energy usage profile, choice of modulation, PowerManagement

Data link layer- Fundamentals of wireless MAC protocols, Characteristics of MAC protocol in wireless sensor networks contention-based protocols, Contention free MAC protocols,HybridMACprotocols

Network layer-routing metrics-Flooding and gossiping, Data centric routing, proactive routing On demand routing, hierarchical routing, Location based routing, QOS based routing. Data Aggregation – Various aggregationtechniques.

Case study-Target detection tracking, Habitat monitoring, Environmental disaster monitoring, Practical implementation issues, IEEE 802.15.4 low rate WPAN, Operating System Design Issues. Simulationtools.

Course outcomes

CO1: analyze the challenges and constraints of wireless sensor network and its subsystems
CO2: examine the physical layer specification, modulation and transceiver design considerations
CO3: analyze the protocols used at the MAC layer and scheduling mechanisms
CO4: compare and analyse the types of routing protocols and data aggregation techniques
CO5: identify the application areas and practical implementation issues.

Text books

1. W. Dargie,C. Poellabauer,"Fundamentals of Wireless sensor networks-Theory and Practice",John Wiley & Sons Publication2010
2. K. Sohraby, D.Minoli and T.Znati, "Wireless Sensor Network Technology- Protocols and Applications", John Wiley & Sons,2007.
3. F.Zhao, L.Guibas, "Wireless Sensor Networks: an information processing approach", Elsevier publication,2004.
4. C.S.Raghavendra Krishna,M.Sivalingam and Taribznati, "Wireless Sensor Networks", Springer publication,2004.

5. H. Karl, A.willig, “Protocol and Architecture for Wireless Sensor Networks”, John Wiley publication, Jan2006.

Reference Books

1. K.Akkaya and M.Younis, “ A Survey of routing protocols in wireless sensor networks”, Elsevier Adhoc Network Journal, Vol.3, no.3,pp. 325-349,2005.
2. Philip Levis, “ TinyOS Programming”, 2006 –www.tinyos.net.
3. I.F. Akyildiz, W. Su, Sankarasubramaniam, E. Cayirci, “Wireless sensor networks: a survey”, computer networks, Elsevier, 2002, 394 -422.
4. Jamal N. Al-karaki, Ahmed E. Kamal, “Routing Techniques in Wireless sensor networks: A survey”, IEEE wireless communication, December 2004, 6 –28.

Course Code	**:**	**ECOE18**
Course Title	**:**	**Digital Speech Processing**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**NONE**
Course Type	**:**	**OE**

Course learning Objectives

- The purpose of this course is to explain how DSP techniques could be used for solving problems in speech communication.

Course Content

Speech production model-1D sound waves-functional block of the Vocal tract model –Linear predictive co- efficients (LPC) -Auto-correlation method-Levinson-durbin algorithm-Auto-co-variance method-Lattice structure-Computation of Lattice co-efficient from LPC-Phonetic Representation of speech-Perception of Loudness - Critical bands – Pitch perception – Auditory masking.

Feature extraction of the speech signal: Endpoint detection-Dynamic time warping- Pitch frequency estimation: Autocorrelation approach- Homomorphic approach-Formant frequency estimation using vocal tract model and Homomorphic approach-Linear predictive co-efficient - Poles of the vocal tract-Reflection co-efficient-Log Arearatio.

Cepstrum- Line spectral frequencies- Functional blocks of the ear- Mel frequency cepstral co-efficients- Spectrogram-Time resolution versus frequency resolution-Discrete wavelet transformation.

Pattern recognition for speech detection: Back-propagation Neural Network-Support Vector Machine- Hidden Markov Model (HMM)-Gaussian Mixture Model(GMM) -Unsupervised Learning system: K-Means and Fuzzy K-means clustering - Kohonen self-organizing map-Dimensionality reduction techniques: Principle component analysis (PCA), Linear discriminant analysis (LDA), Kernel-LDA (KLDA), Independent component analysis(ICA).

Non-uniform quantization for Gaussian distributed data- Adaptive quantization-Differential pulse code modulation- Code Exited Linear prediction (CELP)-Quality assessment of the compressed speech signal Text to Speech (TTS) analysis –Evolution of speech synthesis systems-Unit selection methods - TTS Applications.

Course outcomes

CO1: illustrate how the speech production is modeled
CO2: summarize the various techniques involved in collecting the features from the speech signal in both time and frequency domain
CO3: summarize the functional blocks of the ear
CO4: compare the various pattern recognition techniques involved in speech and speaker detection
CO5: summarize the various speech compression techniques

Text Books

1. L.R.Rabiner and R.W.Schafer," Introduction to Digital speech processing",now publishers USA,2007
2. E.S.Gopi,"Digital speech processing using matlab",Springer,2014.

Reference Books

1. L.R.Rabiner and R.W.Schafer,"Digital processing of speech signals", PrenticeHall,1978
2. T.F.Quatieri,"Discrete-time Speech Signal Processing", Prentice-Hall, PTR,2001
3. L.Hanzaetal, "Voice Compression and Communications", Wiley/ IEEE ,2001.

Course Code	**:**	**ECOE19**
Course Title	**:**	**Pattern Recognition**
Number of Credits		**3**
Prerequisites (Course code)	**:**	**NONE**
Course Type	**:**	**OE**

Course learning Objectives

- The subject aims to make the students to understand the mathematical approach for pattern recognition.

Course Content

Polynomial curve fitting – The curse of dimensionality - Decision theory - Information theory - The beta distribution - Dirichlet distribution-Gaussian distribution-The exponent family: Maximum likelihood and sufficient statistics -Non-parametric method: kernel-density estimators - Nearest neighbor methods.

Linear models for regression and classification: Linear basis function models for regression - Bias variance decomposition-Bayesian linear regression-Discriminant functions - Fisher's linear discriminant analysis (LDA) - Principal Component Analysis (PCA) - Probabilistic generative model - Probabilistic discriminative model.

Kernel methods: Dual representations-Constructing kernels-Radial basis function networks-Gaussian process-Maximum margin classifier (Support Vector Machine) –Relevance Vector Machines-Kernel-PCA, Kernel-LDA.

Mixture models: K-means clustering - Mixtures of Gaussian - Expectation-Maximization algorithm- Sequential models: Markov model, Hidden-Markov Model (HMM) - Linear Dynamical Systems(LDS).

Neural networks: Feed- forward Network functions-Network training - Error Back propagation - The Hessian Matrix - Regularization in Neural Network - Mixture density networks – Bayesian Neural Networks

Course outcomes

CO1: summarize the various techniques involved in pattern recognition
CO2: identify the suitable pattern recognition techniques for the particular applications.
CO3: categorize the various pattern recognition techniques into supervised and unsupervised.
CO4: summarize the mixture models based pattern recognition techniques
CO5: summarize the artificial neural network based pattern recognition techniques

Text Books

1. C.M.Bishop,"Pattern recognition and machinelearning",Springer,2006
2. J.I.Tou&R.C.Gonzalez," Pattern Recognition Priciples", Addition –Wesley,1977.

Reference Books

1. P.A.Devijer&J.Kittler, "Pattern Recognition-A Statistical Approach" , Prentice – Hall,1990.
2. R.Schalkoff, "Pattern Recognition –Statistical, Structural and Neural Approaches", John Wiley, 1992.

Minors Offered

Course Code	**:**	**ECMI11**
Course Title	**:**	**Signals and Systems**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**NONE**
Course Type	**:**	**MI**

Course Learning Objectives

- Understanding the fundamental characteristics of signals and systems.
- Understanding the concepts of vector space, inner product space and orthogonal series.
- Understanding signals and systems in terms of both the time and transform domains, taking advantage of the complementary insights and tools that these different perspectives provide.
- Development of the mathematical skills to solve problems involving convolution, filtering, modulation and sampling.

Course Content

Vector spaces. Inner Product spaces. Schwartz in equality. Hilbert spaces. Orthogonal expansions. Bessel's inequality and Parseval's relations.

Continuous-time signals, classifications. Periodic signals. Fourier series representation, Hilbert transform and its properties.

Laplace transforms. Continuous - time systems: LTI system analysis using Laplace and Fourier transforms.

Sampling and reconstruction of band limited signals. Low pass and band pass sampling theorems. Aliasing. Anti-aliasing filter. Practical Sampling-aperture effect.

Discrete-time signals and systems. Z-transform and its properties. Analysis of LSI systems using Z – transform.

Course outcomes

CO1: apply the knowledge of linear algebra topics like vector space, basis, dimension, inner product, norm and orthogonal basis to signals.

CO2: analyse the spectral characteristics of continuous-time periodic and a periodic signals using Fourier analysis.

CO3: classify systems based on their properties and determine the response of LSI system using convolution.

CO4: analyze system properties based on impulse response and Fourier analysis.

CO5: apply the Laplace transform and Z- transform for analyze of continuous-time and discrete-time signals and systems.

CO6: understand the process of sampling and the effects of under sampling.

Text Books

1. *A.V.Oppenheim, A. Willsky, S. Hamid Nawab, "Signals and Systems (2/e)", Pearson 200.*
2. *S.Haykin and B.VanVeen "Signals and Systems, Wiley, 1998.*
3. *M.Mandal and A.Asif, "Continuous and Discrete Time Signals and Systems, Cambridge, 2007.*

Reference Books

1. *D.C.Lay, "Linear Algebra and its Applications (2/e)", Pearson, 200.*
2. *K.Huffman&R.Kunz, "Linear Algebra", Prentice- Hall, 1971.*
3. *S.S.Soliman&M.D.Srinath, "Continuous and Discrete Signals and Systems", Prentice-Hall, 1990.*

Course Code	**:**	**ECMI12**
Course Title	**:**	**Network Analysis and Synthesis**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**NONE**
Course Type	**:**	**MI**

Course Learning Objectives

- To make the students capable of analyzing any given electrical network.
- To make the students to learn synthesis of an electrical network for a given impedance/ admittance function.

Course Content

Network concept. Elements and sources. Kirchoff's laws. Tellegen's theorem. Network equilibrium equations. Node and Mesh method. Source superposition. Thevenin's and Norton's theorems. Network graphs.

First and second order networks. State equations. Transient response. Network functions. Determination of the natural frequencies and mode vectors from network functions.

Sinusoidal steady-state analysis. Maximum power-transfer theorem. Resonance. Equivalent and dual networks. Design of equalizers.

Two-port network parameters. Interconnection of two port networks. Barlett's bisection theorem. Image and Iterative parameters. Design of attenuators.

Two-terminal network synthesis. Properties of Hurwitz polynomial and Positive real function. Synthesis of LC, RC and RL Networks, Foster Forms and Cauer Forms.

Course outcomes

CO1: analyze the electric circuit using network theorems

CO2: understand and Obtain Transient & Forced response

CO3: determine Sinusoidal steady state response; understand the real time applications of maximum power transfer theorem and equalizer

CO4: understand the two–port network parameters, are able to find out two-port network parameters & overall response for interconnection of two-port networks.

CO5: synthesize one port network using Foster form, Cauer form.

Text Books

1. *Hayt W. H., Kemmerly J. E. and Durbin S. M., "Engineering Circuit Analysis", 6th Ed., Tata McGraw-Hill Publishing Company Ltd., 2008.*
2. *F.F. Kuo, "Network analysis and Synthesis", Wiley International Edition, 2008.*

Reference Books

1. *Valkenberg V., "Network Analysis", 3rd Ed., Prentice Hall International Edition, 2007.*
2. *B.S.Nair and S.R.Deepa, "Network analysis and Synthesis", Elsevier, 2012.*

Course Code	**:**	**ECMI13**
Course Title	**:**	**Electrodynamics and Electromagnetic Waves**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**NONE**
Course Type	**:**	**MI**

Course Learning Objective

- To expose the students to the rudiments of Electromagnetic theory and wave propagation essential for subsequent courses on microwave engineering, antennas and wireless communication

Course Content

Electrostatics. Coulomb's law. Gauss's law and applications. Electric potential. Poisson's and Laplace equations. Method of images. Multipole Expansion.

Electrostatic fields in matter. Dielectrics and electric polarization. Capacitors with dielectric substrates. Linear dielectrics. Force and energy in dielectric systems.

Magneto statics. Magnetic fields of steady currents. Biot-Savart's and Ampere's laws. Magnetic vector potential. Magnetic properties of matter.

Electrodynamics. Flux rule for motional emf. Faraday's law. Self and mutual inductances. Maxwell's Equations. Electromagnetic Boundary conditions. Poynting theorem.

Electromagnetic wave propagation. Uniform plane waves. Wave polarization. Waves in matter. Reflection and transmission at boundaries. Propagation in an ionized medium.

Course outcomes

CO1: recognize and classify the basic Electrostatic theorems and laws and to derive them.
CO2: discuss the behaviour of Electric fields in matter and Polarization concepts.
CO3: classify the basic Magneto static theorems and laws and infer the magnetic properties of matter.
CO4: summarize the concepts of electrodynamics &to derive and discuss the Maxwell's equations.
CO5: students are expected to be familiar with Electromagnetic wave propagation and wave polarization.

Text Books

1. *D.J.Griffiths, "Introduction to Electrodynamics (3/e)", PHI, 2001*
2. *E.C. Jordan & G. Balmain, "Electromagnetic Waves and Radiating Systems", PHI, 1995.*

Reference Books

1. *W.H.Hayt, "Engineering Electromagnetics, (7/e)", McGraw Hill, 2006.*
2. *D.K.Cheng, "Field and Wave Electromagnetics, (2/e)", Addison Wesley, 1999.*
3. *M.N.O.Sadiku,"Principles of Electromagnetics, (4/e)", Oxford University Press, 2011.*
4. *N.NarayanaRao, "Elements of Engineering Electromagnetics, (6/e)", Pearson, 2006.*
5. *R.E.Collin, "Foundations for Microwave Engineering (2/e)", McGraw –Hill, 2002.*
6. *R.E.Collin, "Antennas and Radiowave Propagation", McGraw-Hill, 1985.*

Course Code	**:**	**ECMI14**
Course Title	**:**	**Semiconductor Physics and Devices**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**NONE**
Course Type	**:**	**MI**

Course Learning Objective

- To make the students understand the fundamentals of electronic devices.
- To train them to apply these devices in mostly used and important applications.

Course Content

Semiconductor materials: crystal growth, film formation, lithography, etching and doping. Formation of energy bands in solids, Concept of hole, Intrinsic and extrinsic semiconductors, conductivity, Equilibrium Carrier concentration, Density of states and Fermi level, Carrier transport – Drift and Diffusion, continuity equation, Hall effect and its applications.

P-N junction diodes, Energy band diagram, biasing, V-I characteristics, capacitances. Diode models, Break down Mechanisms, Rectifiers, Limiting and Clamping Circuits, types of diodes.

BJT Physics and Characteristics modes of operation, Ebers-Moll Model, BJT as a switch and Amplifier, breakdown mechanisms, Photo devices.

MOSFET: Ideal I-V characteristics, non-ideal I-V effects, MOS Capacitor, MOSFET as switch, CMOS Logic gate Circuits, Bi-CMOS circuits, CCDs.

Power devices, operation and characteristics. Thyristor family. Power diodes. Power transistors. Display devices, Operation of LCDs, Plasma, LED and HDTV

Course outcomes

CO1: Apply the knowledge of basic semiconductor material physics and understand fabrication processes.
CO2: Analyze the characteristics of various electronic devices like diode, transistor etc.,
CO3: Classify and analyze the various circuit configurations of Transistor and MOSFETs.
CO4: Illustrate the qualitative knowledge of Power electronic Devices.
CO5: Become Aware of the latest technological changes in Display Devices.

Text Books

1. *S.M.Sze, Semiconductors Devices, Physics and Technology, (2/e), Wiley, 2002*
2. *A.S.Sedra&K.C.Smith, Microelectronic Circuits (5/e), Oxford, 2004*
3. *L.Macdonald&A.C.Lowe, Display Systems, Wiley, 2003*

Reference Books

1. *Robert Pierret, "Semiconductor Device Fundamentals," Pearson Education, 2006*
2. *J.Millman and C.C.Halkias: Electronic devices and Circuits, McGraw Hill, 1976.*
3. *B.G.Streetman: Solid state devices, (4/e), PHI, 1995.*
4. *N.H.E.Weste, D. Harris, "CMOS VLSI Design (3/e)", Pearson, 2005.*

Course Code	**:**	**ECMI15**
Course Title	**:**	**Digital Circuits and Systems**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**NONE**
Course Type	**:**	**MI**

Course Learning Objective

- To introduce the theoretical and circuit aspects of digital electronics, which is the back bone for the basics of the hardware aspect of digital computers?

Course Content

Review of number systems-representation-conversions, error detection and error correction. Review of Boolean algebra- theorems, sum of product and product of sum simplification, canonical forms-minterm and maxterm, Simplification of Boolean expressions- Karnaugh map, completely and incompletely specified functions, Implementation of Boolean expressions using universal gates.

Combinational logic circuits- adders, subtractors, BCD adder, ripple carry look ahead adders, parity generator, decoders, encoders, multiplexers, demultiplexers, Realization of Boolean expressions- using decoders-using multiplexers. Memories – ROM- organization, expansion. PROMs. Types of RAMs – Basic structure, organization, Static and dynamic RAMs, PLDs, PLAs.

Sequential circuits – latches, flip flops, edge triggering, asynchronous inputs. Shift registers, Universal shift register, applications. Binary counters – Synchronous and asynchronous up/down counters, mod-N counter, Counters for random sequence.

Synchronous circuit analysis and design: structure and operation, analysis-transition equations, state tables and state diagrams, Modelling- Moore machine and Mealy machine- serial binary adder, sequence recogniser, state table reduction, state assignment. Hazard; Overview and comparison of logic families.

Introduction to Verilog HDL, Structural, Dataflow and behavioral modelling of combinational and sequential logic circuits.

Course outcomes

CO1: Apply the knowledge of Boolean algebra and simplification of Boolean expressions to deduce optimal digital networks.

CO2: Study and examine the SSI, MSI and Programmable combinational networks.

CO3: Study and investigate the sequential networks suing counters and shift registers; summarize the performance of logic families with respect to their speed, power consumption, number of ICs and cost.

CO4: Work out SSI and MSI digital networks given a state diagram based on Mealy and Moore configurations.

CO5: Code combinational and sequential networks using Virology HDL.

Text Books

1. *Wakerly J F, "Digital Design: Principles and Practices, Prentice-Hall", 2nd Ed., 2002.*
2. *D. D. Givone, "Digital Principles and Design", Tata Mc-Graw Hill, New Delhi, 2003.*
3. *S.Brown and Z.Vranesic, "Fundamentals of Digital Logic with Verilog Design", Tata Mc-Graw Hill, 2008.*

Reference Books

1. *D.P. Leach, A. P. Malvino, GoutamGuha, "Digital Principles and Applications", Tata Mc-Graw Hill, New Delhi, 2011.*
2. *M. M. Mano, "Digital Design", 3rd ed., Pearson Education, Delhi, 2003.*
3. *R.J.Tocci and N.S.Widner, "Digital Systems - Principles& Applications", PHI, 10th Ed., 2007.*
4. *Roth C.H., "Fundamentals of Logic Design", Jaico Publishers. V Ed., 2009.*
5. *T. L. Floyd and Jain,"Digital Fundamentals", 8th ed., Pearson Education, 2003.*

Course Code	**:**	**ECMI16**
Course Title	**:**	**Digital Signal Processing**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECMI11**
Course Type	**:**	**MI**

Course Learning Objective

- The subject aims to introduce the mathematical approach to manipulate discrete time signals, which are useful to learn digital tele-communication.

Course Content

Review of VLSI system theory, DTFT, Frequency response of discrete time systems, all pass inverse and minimum phase systems.
DFT, Relationship of DFT to other transforms, FFT, DIT and DIF, FFT algorithm, Linear filtering using DFT and FFT.
Frequency response of FIR filter types, Design of FIR filters, IIR filter design, Mapping formulas, Frequency transformations.
Direct form realization of FIR and IIR systems, Lattice structure for FIR and IIR systems, Finite-word length effects. Limit cycle oscillations.
Sampling rate conversion by an integer and rational factor, Poly phase FIR structures for sampling rate conversion.

Course outcomes

CO1: analyze discrete-time systems in both time & transform domain and also through pole-zero placement.
CO2: analyze discrete-time signals and systems using DFT and FFT.
CO3: design and implement digital finite impulse response (FIR) filters.
CO4: design and implement digital infinite impulse response (IIR) filters.
CO5: understand and develop multirate digital signal processing systems.

Text Books

1. *J.G.Proakis, D.G. Manolakis, "Digital Signal Processing", (4/e) Pearson, 2007.*
2. *A.V.Oppenheim & R.W.Schafer, "Discrete Time Signal processing", (2/e), Pearson Education, 2003.*
3. *S.K.Mitra, "Digital Signal Processing (3/e)", Tata McGraw Hill, 2006.*

Reference Books

1. *P.S.R .Diniz, E.A.B.da Silva and S.L.Netto, "Digital Signal Processing", Cambridge, 2002.*
2. *E.C.Ifeachor & B.W.Jervis, "Digital Signal Processing", (2/e), Pearson Education, 2002.*
3. *J.R.Jhonson, "Introduction to Digital Signal Processing", Prentice-Hall, 1989.*

Course Code	**:**	**ECMI17**
Course Title	**:**	**Analog Communication**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECMI11**
Course Type	**:**	**MI**

Course Learning Objective

- To develop a fundamental understanding on Communication Systems with emphasis on analog modulation techniques and noise performance.

Course Content

Basic blocks of Communication System. Amplitude (Linear) Modulation – AM, DSB-SC, SSB-SC and VSB-SC. Methods of generation and detection. FDM. Super Heterodyne Receivers.
Angle (Non-Linear) Modulation - Frequency and Phase modulation. Transmission Bandwidth of FM signals, Methods of generation and detection. FM Stereo Multiplexing.
Noise - Internal and External Noise, Noise Calculation, Noise Figure. Noise in linear and nonlinear AM receivers, Threshold effect.
Noise in FM receivers, Threshold effect, Capture effect, FM Threshold reduction, Pre-emphasis and De-emphasis.
Pulse Modulation techniques – Sampling Process, PAM, PWM and PPM concepts, Methods of generation and detection. TDM. Noise performance.

Course outcomes

CO1: Understand the basics of communication system and analog modulation techniques
CO2: Apply the basic knowledge of signals and systems and understand the concept of Frequency modulation.
CO3: Apply the basic knowledge of electronic circuits and understand the effect of Noise in communication system and noise performance of AM system
CO4: Understand the effect of noise performance of FM system.
CO5: Understand TDM and Pulse Modulation techniques.

Text Books

1. *S.Haykins, Communication Systems, Wiley, (4/e), Reprint 2009.*
2. *Kennedy, Davis, Electronic Communication Systems (4/e), McGraw Hill, Reprint 2008.*

Reference Books

1. *B.Carlson, Introduction to Communication Systems, McGraw-Hill, (4/e), 2009.*
2. *J.Smith, Modern Communication Circuits (2/e), McGraw Hill, 1997.*
3. *J.S.Beasley&G.M.Miler, Modern Electronic Communication (9/e), Prentice-Hall, 2008.*

Course Code	**:**	**ECMI18**
Course Title	**:**	**Digital Communication**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECMI17**
Course Type	**:**	**MI**

Course Learning Objectives

- To understand the key modules of digital communication systems with emphasis on digital modulation techniques.
- To get introduced to the basics of source and channel coding/decoding and Spread Spectrum Modulation.

Course Content

Base band transmission. Sampling theorem, Pulse code modulation (PCM), DM, Destination SNR in PCM systems with noise. Matched filter. Nyquist criterion for zero ISI. Optimum transmit and receive filters. Correlative Coding, M-ary PAM. Equalization- zero-forcing and basics of adaptive linear equalizers.

BASK, BFSK, and BPSK- Transmitter, Receiver, Signal space diagram, Error probabilities.

M-ary PSK, M-ary FSK, QAM, MSK and GMSK- Optimum detector, Signal constellation, error probability.

Linear block codes-Encoding and decoding. Cyclic codes – Encoder, Syndrome Calculator. Convolutional codes – encoding, Viterbi decoding. TCM.

Spread Spectrum (SS) Techniques- Direct Sequence Spread Spectrum modulation, Frequency-hop Spread Spectrum modulation - Processing gain and jamming margin.

Course outcomes

CO1: Apply the knowledge of signals and system and explain the conventional digital communication system.

CO2: Apply the knowledge of statistical theory of communication and evaluate the performance of digital communication system in the presence of noise.

CO3: Describe and analyze the performance of advance modulation techniques.

CO4: Apply the knowledge of digital electronics and describe the error control codes like block code, cyclic code.

CO5: Describe and analyze the digital communication system with spread spectrum modulation.

Text Books

1. *S.Haykin, "Communication Systems", Wiley, (4/e), 2001.*
2. *J.G.Proakis, "Digital Communication", Tata McGraw – Hill, (4/e), 2001.*

Reference Books

1. *B.Sklar, "Digital Communications: Fundamentals & Applications", Pearson Education, (2/e), 2001.*
2. *A.B.Carlson, " Communication Systems", McGraw Hill, 3/e,2002*
3. *R.E.Zimer & R.L.Peterson," Introduction to Digital Communication", PHI,3/e, 2001*

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Course Code	**:**	**ECMI19**
Course Title	**:**	**Wireless Communication**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECMI18**
Course Type	**:**	**MI**

Course Learning Objective

- To get an understanding of mobile radio communication principles, types and to study the recent trends adopted in cellular and wireless systems and standards**.**

Course Content

Introduction to Wireless Communication. Cellular concept. System design fundamentals. Coverage and Capacity improvement in Cellular system. Technical Challenges.

Mobile Radio Propagation; Reflection, Diffraction, Fading. Multipath propagation. Statistical characterization of multipath fading. Diversity Techniques.

Path loss prediction over hilly terrain. Practical link budget design using Path loss models. Design parameters at base station. Antenna location, spacing, heights and configurations.

Multiple access techniques; FDMA, TDMA and CDMA. Spread spectrum. Power control. WCDMA. CDMA network design. OFDM and MC-CDMA.

GSM.3G, 4G (LTE), NFC systems, WLAN technology. WLL. Hiper LAN. Ad hoc networks. Bluetooth.

Course outcomes
CO1: Apply the knowledge of basic communication systems and its principles.
CO2: Describe the cellular concept and analyze capacity improvement Techniques.
CO3: Mathematically analyze mobile radio propagation mechanisms.
CO4: Summarize diversity reception techniques.
CO5: Design Base Station (BS) parameters and analyze the antenna configurations.
CO6: Analyze and examine the multiple access techniques and its application.
CO7: Assess the latest wireless technologies.

Text Books:

1. *T.S.Rappaport, Wireless Communication Principles (2/e), Pearson, 2002.*
2. *A.F.Molisch, Wireless Communications, Wiley, 2005.*

Reference Books:

1. *P.MuthuChidambaraNathan, Wireless Communications, PHI, 2008.*
2. *W.C.Y.Lee, Mobile Communication Engineering. (2/e), McGraw- Hill, 1998.*
3. *A.Goldsmith, Wireless Communications, Cambridge University Press, 2005.*
4. *S.G.Glisic, Adaptive CDMA, Wiley, 2003.*

HONORS

Course Code	**:**	**ECHO11**
Course Title	**:**	**Advanced Digital Signal Processing**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC41**
Course Type	**:**	**HO**

Course learning Objectives

- To provide rigorous foundations in multirate signal processing, power spectrum estimation and adaptive filters.

Course Content

Review of sampling theory. Sampling rate conversion by integer and rational factors. Efficient realization and applications of sampling rate conversion.

Wiener filtering. Optimum linear prediction. Levinson- Durbin algorithm. Prediction error filters.

Adaptive filters. FIR adaptive LMS algorithm. Convergence of adaptive algorithms. Fast algorithms. Applications: Noise canceller, echo canceller and equalizer.

Recursive least squares algorithms. Matrix inversion lemma. Convergence analysis of the RLS algorithm. Adaptive beam forming. Kalman filtering.

Spectrum estimation. Estimation of autocorrelation. Periodogram method. Nonparametric methods. Parametric methods.

Course outcomes

CO1: summarize multirate DSP and design efficient digital filters.
CO2: construct multi-channel filter banks.
CO3: select linear filtering techniques to engineering problems.
CO4: describe the most important adaptive filter generic problems.
CO5: describe the various adaptive filter algorithms.
CO6: describe the statistical properties of the conventional spectral estimators.

Text books

1. J.G.Proakis, M. Salehi, “Advanced Digital Signal Processing”, McGraw –Hill,1992.
2. S.Haykin, “Adaptive Filter Theory (3/e)”, Prentice- Hall,1996.

Reference Books

1. D.G.Manolakis, V. K. Ingle, and S. M. Kogon ,”Statistical and Adaptive Signal Processing”, McGraw-Hill,2005
2. S.L.Marple,”Digital Spectral Analysis”,1987.
3. M.H.Hays,” Statistical Digital Signal Processing and Modeling”, John-Wiley,2001.

Course Code	**:**	**ECHO12**
Course Title	**:**	**Spectral Analysis of Signals**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC41**
Course Type	**:**	**HO**

Course learning Objectives

- To give an exhaustive survey of methods available for power spectrum estimation.

Course Content

Periodogram and correlogram. Blackman – Tukey, Bartlett, Welch and Daniel methods. Window design considerations.

Parametric methods for rational spectra. Covariance structure of ARMA processes. AR, MA and ARMA signals. Multivariate ARMA signals.

Parametric methods for line spectra. Models of sinusoidal signals in noise. Nonlinear least squares, high order Yule-Walker, min-norm, Pisarenko, MUSIC and ESPRIT methods.

Filter bank methods. Filter-bank interpretation of the periodogram. Refined filter-bank and Capon methods.

Spatial methods. Array model. Nonparametric methods; beam forming and Capon method. Parametric methods; nonlinear least squares, Yule-Walker, min-norm, Pisarenko, MUSIC and ESPRIT methods.

Course outcomes

CO1: derive and analyse the statistical properties of the conventional spectral estimators, namely the periodogram, averaged & modified periodogram and Blackman-Tukey methods.

CO2: formulate modern, parametric, spectral estimators based upon autoregressive (AR), moving average (MA), and autoregresive moving average (ARMA) models, and detail their statistical properties. Describe the consequence of the term resolution as applied to a spectral estimator.

CO3: define techniques for calculating moments in spectral and temporal domains; Analyze filter bank method, capon methods for spectrum estimation.

CO4: demonstrate knowledge and understanding of the principles of parametric and non-parametric array processing algorithms.

CO5: select an appropriate array processing algorithms for frequency estimation and sonar, radar applications.

Text books

1. P.Stoica & R.Moses, “Spectral Analysis of signals”, Pearson,2005.
2. Marple, “Introduction to Spectral Analysis”, Prentice Hall.

Reference Books

1. S.M.Key, “Fundamentals of Statistical Signal Processing”, Prentice Hall PTR, 1998.

Course Code	**:**	**ECHO13**
Course Title	**:**	**Detection and Estimation**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**MAIR45**
Course Type	**:**	**HO**

Course learning Objectives

- The objective of this course is to make the students conversant with those aspects of statistical decision and estimation which are indispensable tools required for the optimal design of digital communication systems.

Course Content

Binary hypothesis testing; Bayes, minimax and Neyman-Pearson tests. Composite hypothesis testing.

Signal detection in discrete time: Models and detector structures. Coherent detection in independent noise. Detection in Gaussian noise. Detection of signals with random parameters. Detection of stochastic signals. Performance evaluation of signal detectionprocedures.

Bayesian parameter estimation; MMSE, MMAE and MAP estimates. Nonrandom parameter estimation. Exponential families. Completeness theorem. ML estimation. Information inequality. Asymptotic properties ofMLEs.

Discrete time Kalman- Bucy filter. Linear estimation. Orthogonality principle. Wiener-Kolmogorov filtering – causal and noncausalfilters.

Signal detection in continous time:Detection of deterministic signals in Gaussian noise. Coherent detection in white Gaussian noise.

Course outcomes

CO1: summarize the fundamental concept on Statistical Decision Theory and Hypothesis Testing
CO2: summarize the various signal estimation techniques with additive noise
CO3: summarizer with Bayesian parameter estimation (minimum mean square error (MMSE), minimum mean absolute error (MMAE), maximum a-posterior probability (MAP) estimation methods).
CO4: compare optimal filtering, linear estimation, and Wiener/Kalman filtering. CO5: construct Wiener and Kalman filters (time discrete) and state space models.

Text Books

1. H.V.Poor, “An Introduction to Signal Detection and Estimation (2/e) Springer”,1994.
2. B.C.Levy, “Priciples of Signal Detection and Parameter Estimatio”n, Springer,2008.

Reference Books

1. H.L.Vantrees, “Detection, Estimation and Modulation theory”, Part I,Wiley,1987.
2. M.D.Srinath & P.K.Rajasekaran, “Statistical Signal Processing with Applications”, Wiley,1979.
3. J.C.Hancock & P.A. Wintz, “Signal Detection Theory”, Mc-Graw Hill,1966.

Course Code	**:**	**ECHO14**
Course Title	**:**	**Wavelet Signal Processing**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC41**
Course Type	**:**	**HO**

Course learning Objectives

- To expose the students to the basics of wavelet theory and to illustrate the use of wavelet processing for data compression and noise suppression.

Course Content

Limitations of standard Fourier analysis. Windowed Fourier transform. Continuous wavelet transform. Time-frequency resolution.

Wavelet bases. Balian-Low theorem. Multiresolution analysis. (MRA). Construction of wavelets from MRA. Fast wavelet algorithm.

Compactly supported wavelets. Cascade algorithm. Franklin and spline wavelets. Wavelet packets.
Hilbert space frames. Frame representation. Representation of signals by frames. Iterative reconstruction. Frame algorithm.

Wavelet methods for signal processing. Noise suppression. Representation of noise-corrupted signals using frames. Algorithm for reconstruction from corrupted frame representation.

Wavelet methods for image processing. Burt- Adelson and Mallat's pyramidal decomposition schemes. 2D-dyadic wavelet transform.

Course outcomes

CO1: understand about windowed Fourier transform and difference between windowed Fourier transform and wavelet transform.
CO2: understand wavelet basis and characterize continuous and discrete wavelet transforms
CO3: understand multi resolution analysis and identify various wavelets and evaluate their time-frequency resolution properties
CO4: implement discrete wavelet transforms with multirate digital filters
CO5: understand about wavelet packets
CO6: design certain classes of wavelets to specification and justify the basis of the application of wavelet transforms to different fields.

Text books

1. E.Hernandez & G.Weiss, A First Course on Wavelets, CRC Press, 1996.
2. L.Prasad & S.S.Iyengar, Wavelet Analysis with Applications to Image Processing, CRC Press, 1997.

Reference Books

1. A.Teolis, Computational Signal Processing with Wavelets, Birkhauser, 1998
2. R.M. Rao & A.S. Bopardikar, Wavelet Transforms, Addition Wesley, 1998.
3. J.C. Goswami & A.K. Chan, Fundamentals of Wavelets, John Wiley,1999.

Course Code	**:**	**ECHO15**
Course Title	**:**	**RF Circuits**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**NONE**
Course Type	**:**	**HO**

Course learning Objectives

- To impart knowledge on basics of IC design at RF frequencies.

Course Content

Characteristics of passive IC components at RF frequencies – interconnects, resistors, capacitors, inductors and transformers – Transmission lines. Noise – classical two-port noise theory, noise models for active and passive components High frequency amplifier design – zeros as bandwidth enhancers, shunt-series amplifier,f doublers, neutralization and unilateralization

Low noise amplifier design – LNA topologies, power constrained noise optimization, linearity and large signal performance

Mixers – multiplier-based mixers, subsampling mixers, diode-ringmixers

RF power amplifiers – Class A, AB, B, C, D, E and F amplifiers, modulation of power amplifiers, linearity considerations

Oscillators & synthesizers – describing functions, resonators, negative resistance oscillators, synthesis with static moduli, synthesis with dithering moduli, combination synthesizers – phase noise considerations.

Course outcomes

CO1: Understand the Noise models for passive components and noise theory
CO2: Analyse the design of a high frequency amplifier
CO3: Appreciate the different LNA topologies & design techniques
CO4: Distinguish between different types of mixers
CO5: Analyse the various types of synthesizers, oscillators and their characteristics.

Text Books

1. T.homas H. Lee, “The Design of CMOS Radio-Frequency Integrated Circuits”, 2nd ed., Cambridge, UK: Cambridge University Press,2004.
2. B.Razavi, “RF Microelectronics”,2nd Ed., Prentice Hall,1998.

Reference Books

1. A.A. Abidi, P.R. Gray, and R.G. Meyer, eds., “Integrated Circuits for Wireless Communications”, New York: IEEE Press,1999.
2. R. Ludwig and P. Bretchko, “RF Circuit Design, Theory and Applications”, Pearson,2000.
3. Mattuck,A., “Introduction to Analysis”,Prentice-Hall,1998.

Course Code	**:**	**ECHO16**
Course Title	**:**	**Numerical Techniques for MIC**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC71**
Course Type	**:**	**HO**

Course learning Objectives

- This subject will prepare the student to face the challenging problem of the most important component of Research namely the numerical analysis.

Course Content

Over view of Numerical Techniques for Microwave I integrated Circuits: Introduction_Quasi Static and Full wave Analysis,Outline if Finite element method, Integral Equation Technique, Planar Circuit Analysis, Spectral Domain Approach, The Method of Lines, The Mode Matching Method, The Transverse Resonance Technique

The Finite Element Method Introduction The Method of Weighted Residuals The Variational Method Using a Variational Expression The Finite Element Method Integral Formulation of Problems Antennas and Scattering from Conductors Waveguides-Hollow,Dielectric and Optical Finite Difference in space and Time Matrix Computations A Finite Element Computer Program forMicrostrips

Planar Circuit Analysis Introduction Planar Circuit Analysis' Function Approach Impedence Green's Functions Contour Integral Approach Analysis of Planar Components of Composite Configurations Planar Circuits with Anisotropic Spacing Media Applications of the Planar Circuits Concept Summary

Spectral Domain Approach Introduction General Approach for Shielded Microstrip Lines The Immittance Approach Formulations for Slot lines, Fin lines, and Coplanar Waveguides Numerical Computation

Transverse Resonance Technique Introduction Inhomogeneous Waveguides Uniform Along a Traverse Coordinate Conventional Traverse Resonance Technique for Transversely Discontinuous Waveguides Generalized Transverse Resonance Technique for Transversely Discontinuous Inhomogeneous Analysis of Discontinuities and Junctions by the Generalized Transverse Resonance Technique Examples of Computer Programs

Course outcomes

CO1: bring awareness of the need for numerical analysis of M.I.C. And prepare to formulate all popular numerical techniques of M.I.C.
CO2: make one formulate and write coding for Finite Element Method
CO3: prepare a person to be strong in the planar circuit Analysis
CO4: bring awareness of the most popular Quasi state analysis Spectral Domain Techniques
CO5: prepare the student formulate and write coding for the Transverse ResonanceTechniques

Text Book

1. T.Itoh, Numerical Techniques for Microwave Integrated Circuits., John Wiley and sons,1989

Course Code	**:**	**ECHO17**
Course Title	**:**	**Applied Photonics**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**NONE**
Course Type	**:**	**HO**

Course learning Objectives

- To prepare the students understand the fundamental principles of light-matter interaction and photonic band gap structures.
- To enable the students appreciate the diverse applications of fiber optic sensors.

Course Content

Introduction to photonics; optical waveguide theory; Interference of light waves -numerical techniques and simulation

Photonic waveguide components Optical Modulators and Switches Electro-optics - Acousto-optics - Magneto-optics

Photonic Band gap Structures: Concept of photonic crystal; bandgap and band structures in 1D, 2D and 3D photonic crystal structures;

Photo-refractive materials, non-linear optics, recent trends in bio andnano-photonics

Optical fiber sensors - Sensing using optical fibers - Types:-Amplitude, Interferometric, Wavelength, Polarimetric – Distributed Sensors

Course outcomes

CO1: understand the interference of light and optical waveguide theory.
CO2: understand the significance of photonic band gap structures and their application
CO3: analyse the different types of optical modulators.
CO4: compare the merits and demerits of different types of fiber optic sensors.
CO5: understand the application of nonlinear optics in bio and nanophotonics.

Text Books

1. A. Ghatak and K. Thyagarajan, “Introduction to Fiber Optics”, Cambridge University Press,2006.
2. Pochi Yeh and Amnon Yariv Photonics,” Optical Electronics in Modern Communications”,2007

Reference Books

1. F. T. S. Yu and S.Yin, “Fiber Optic Sensors”, Marcel Dekker, Inc2002
2. G. W. Hanson, “Fundamentals of Nanoelectronics “,Pearson Education, 1st edition,2008
3. B. Saleh and M. Teich, “Fundamentals of Photonics”, Wiley & Sons(2007)

Course Code	**:**	**ECHO18**
Course Title	**:**	**Advanced Radiation Systems**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC64**
Course Type	**:**	**HO**

Course learning Objectives

- To prepare the students understand the operating principles of various RF radiating systems.
- To enable the students appreciate the diverse applications of radiating systems.
- To design the suitable antenna systems to serve a defined application.

Course Content

Antenna Fundamentals: Antenna fundamental parameters, Radiation integrals, Radiation from surface and line current distributions – dipole, monopole, loop antenna; Broadband antennas and matching techniques, Balance to unbalance transformer, Introduction to numerical techniques.

Apertures Antennas: Field equivalence principle, Radiation from Rectangular and Circular apertures, Uniform aperture distribution on an infinite ground plane; Slot antenna; Horn antenna; Reflector antenna, aperture blockage, and design consideration.

Arrays: General structure of phased array, linear array theory, variation of gain as a function of pointing direction, frequency scanned arrays, digital beam forming, and MEMS technology in phased arrays-Retro directive and self phasedarrays.

Micro Strip Antenna: Radiation Mechanism from patch; Excitation techniques; Microstrip dipole; Rectangular patch, Circular patch, and Ring antenna – radiation analysis from transmission line model, cavity model; input impedance of rectangular and circular patch antenna; Application of microstrip array antenna.

Terahertz Planar Antennas: Electronics band gap materials - Photonic Band-gap Structures-Tera Hertz Patch antennas-Special antenna structures.

Course outcomes

CO1: understand the various antenna parameters and different impedance matching techniques.
CO2: understand the working principle of apertures antennas.
CO3: analyze how the electronic beam formation is done using array of antennas.
CO4: compare the merits and demerits of various microwave patch antenna structures.
CO5: understand the photonic band gap structures and its application in terahertz antennas.

Text Books

1. S. Haykins," Communication Systems", John Wiley, 3rd edition,1995.
2. RR Gulathi, "Monochrome and Colour Television", New Age International Publishers, 2nd edition, 2005.
3. J. G. Proakis& M .Salehi," Communication Systems Engineering", Prentice Hall, 2nd edition,2002.

Reference Books

1. Kennedy & Davis," Electronic Communication systems", Tata McGraw Hill, 4th edition,1999.

Course Code	**:**	**ECHO19**
Course Title	**:**	**Bio MEMS**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC44**
Course Type	**:**	**HO**

Course learning Objectives

- To train the students in the design aspects of Bio MEMS devices and Systems. To make the students aware of applications in various medical specialists especially the Comparison of conventions methods and Bio MEMS usage.

Course Content

Introduction: The driving force behind Biomedical Applications-Biocompatibility-Reliability Considerations-Regularity Considerations-Organizations-Education of Bio MEMS-Silicon Micro fabrication-Soft Fabrication techniques

Micro fluidic Principles: Introduction-Transport Processes- Electro kinetic Phenomena-Micro valves –Micro mixers- Micropumps.

Sensor Principles and Micro Sensors: Introduction-Fabrication-Basic Sensors-Optical fibers-Piezo electricity and SAW devices-Electrochemical detection-Applications in Medicine

Micro Actuators and Drug Delivery: Introduction-Activation Methods-Micro actuators for Micro fluidics-equivalent circuit representation-Drug Delivery

Micro Total Analysis: Lab on Chip-Capillary Electrophoresis Arrays-cell, molecule and Particle Handling-Surface Modification-Microsphere-Cell based Bioassay Systems

Detection and Measurement Methods: Emerging Bio MEMS Technology-Packaging, Power, Data and RF Safety-Biocompatibility, Standards

Course outcomes

CO1: learn and realize the MEMS applications in Bio Medical Engineering
CO2: understand the Micro fluidic Principles and study its applications.
CO3: learn the applications of Sensors in Health Engineering.
CO4: learn the principles of Micro Actuators and Drug Delivery system
CO5: learn the principles and applications of Micro Total Analysis

Text Book

1. S.S. Saliterman," Fundamentals of Bio MEMS and Medical Micro devices", Wiley Interscience, 2006.

Reference Books

1. A. Folch ,"Introduction to Bio MEMS", CRC Press,2012
2. G.A. Urban, "Bio MEMS", Springer,2006
3. W. wang, S.A. Soper," Bio MEMS",2006.
4. M. J. Madou, "Fundametal of Micro fabrication",2002.
5. G.T. A. Kovacs, "Micro machined TransducersSourcebook",1998**.**

Course Code	**:**	**ECHO20**
Course Title	**:**	**Analog IC Design**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC54**
Course Type	**:**	**HO**

Course learning Objectives

- To develop the ability design and analyze MOS based Analog VLSI circuits to draw the equivalent circuits of MOS based Analog VLSI and analyze their performance.
- To develop the skills to design analog VLSI circuits for a given specification.

Course Content

Basic MOS Device Physics – General Considerations, MOS I/V Characteristics, Second Order effects, MOS Device models. Short Channel Effects and Device Models. Single Stage Amplifiers – Basic Concepts, Common Source Stage, Source Follower, Common Gate Stage, Cascode Stage.

Differential Amplifiers – Single Ended and Differential Operation, Basic Differential Pair, Common-Mode Response, Differential Pair with MOS loads, Gilbert Cell. Passive and Active Current Mirrors – Basic Current Mirrors, Cascode Current Mirrors, Active CurrentMirrors.

Frequency Response of Amplifiers – General Considerations, Common Source Stage, Source Followers, Common Gate Stage, Cascode Stage, Differential Pair. Noise – Types of Noise, Representation of Noise in circuits, Noise in single stage amplifiers, Noise in DifferentialPairs.

Feedback Amplifiers – General Considerations, Feedback Topologies, Effect of Loading. Operational Amplifiers – General Considerations, One Stage Op Amps, Two Stage Op Amps, Gain Boosting, Common-Mode Feedback, Input Range limitations, Slew Rate, Power Supply Rejection, Noise in Op Amps. Stability and Frequency Compensation.

Bandgap References, Introduction to Switched Capacitor Circuits, Nonlinearity and Mismatch.

Course outcomes

CO1: draw the equivalent circuits of MOS based Analog VLSI and analyze their performance.
CO2: design analog VLSI circuits for a given specification.
CO3: Analyse the frequency response of the different configurations of a amplifier.
CO4: Understand the feedback topologies involved in the amplifier design.
CO5: Appreciate the design features of the differential amplifiers.

Text Books

1. B.Razavi, “Design of Analog CMOS Integrated Circuits”, McGraw Hill Edition2002.
2. Paul. R.Gray, Robert G. Meyer, “Analysis and Design of Analog Integrated Circuits”, Wiley, (4/e), 2001.

Reference Books

1. D. A. Johns and K. Martin, “Analog Integrated Circuit Design”, Wiley,1997.
2. R. Jacob Baker, “CMOS Circuit Design, Layout, and Simulation”, Wiley, (3/e),2010.
3. P.E.Allen, D.R. Holberg, “CMOS Analog Circuit Design”, Oxford University Press,2002.

Course Code	**:**	**ECHO21**
Course Title	**:**	**VLSI System Testing**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC63**
Course Type	**:**	**HO**

Course learning Objectives

- To expose the students, the basics of testing techniques for VLSI circuits and Test Economics.

Course Content

Basics of Testing: Fault models, Combinational logic and fault simulation, Test generation for Combinational Circuits. Current sensing based testing. Classification of sequential ATPG methods. Fault collapsing and simulation

Universal test sets: Pseudo-exhaustive and iterative logic array testing. Clocking schemes for delay fault testing. Testability classifications for path delay faults. Test generation and fault simulation for path and gate delay faults.

CMOS testing: Testing of static and dynamic circuits. Fault diagnosis: Fault models for diagnosis, Cause- effect diagnosis, Effect-causediagnosis.

Design for testability: Scan design, Partial scan, use of scan chains, boundary scan, DFT for other test objectives, MemoryTesting.

Built-in self-test: Pattern Generators, Estimation of test length, Test points to improve testability, Analysis of aliasing in linear compression, BIST methodologies, BIST for delay faulttesting.

Course outcomes

CO1: apply the concepts in testing which can help them design a better yield in IC design.
CO2: tackle the problems associated with testing of semiconductor circuits at earlier design levels so as to significantly reduce the testing costs.
CO3: analyse the various test generation methods for static & dynamic CMOS circuits
CO4: identify the design for testability methods for combinational & sequential CMOS circuits.
CO5: recognize the BIST techniques for improvingtestability.

Text Books

1. N. Jha & S.D. Gupta, “Testing of Digital Systems”, Cambridge,2003.
2. W. W. Wen, “VLSI Test Principles and Architectures Design for Testability”, Morgan Kaufmann Publishers.2006

Reference Books

1. Michael L. Bushnell &Vishwani D. Agrawal,” Essentials of Electronic Testing for Digital, memory & Mixed signal VLSI Circuits”, Kluwar Academic Publishers.2000.
2. P. K. Lala,” Digital circuit Testing and Testability”, Academic Press.1997.
3. M. Abramovici, M. A. Breuer, and A.D. Friedman, “Digital System Testing and Testable Design”, Computer Science Press,1990.

Course Code	**:**	**ECHO22**
Course Title	**:**	**Electronic Design Automation Tools**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**NONE**
Course Type	**:**	**HO**

Course learning Objectives

- To make the students exposed to Front end and Back end VLSI CAD tools.

Course Content

An overview of OS commands. System settings and configuration. Introduction to UNIX commands. Writing Shell scripts. VLSI design automation tools. An overview of the features of practical CAD tools. Modelsim, Leonardo spectrum, ISE 13.1i, Quartus II, VLSI backendtools.

Synthesis and simulation using HDLs-Logic synthesis using verilog and VHDL. Memory and FSM synthesis. Performance driven synthesis, Simulation- Types of simulation. Static timing analysis. Formal verification.Switchlevelandtransistorlevelsimulation.

Circuit simulation using Spice: Circuit description.AC, DC and transient analysis. Advanced spice commands and analysis. Models for diodes, transistors and opamp. Digital building blocks.A/D, D/A and sample and hold circuits. Design and analysis of mixed signalcircuits.

System Verilog- Introduction, Design hierarchy, Data types, Operators and language constructs. Functional coverage, Assertions, Interfaces and test benchstructures.

Mixed signal circuit modeling and analysis, Concept of System on chip. Introduction to Cypress Programmable System on Chip (PSoC). Structure of PSoC, PSoC Designer, PSoC Modules, Interconnects, Memory Management, Global Resources, and DesignExamples.

Course outcomes

CO1: understand the special features of VLSI back end and front end CAD tools and Unix shell script

CO2: write synthesizable verilog and VHDLcode.

CO3: write Pspice code for any electronics circuit and to perform monte-carlo analysis and sensitivity/worst case analysis.

CO4: understand the difference between verilog and system verilog and are able to write system verilog code.

CO5: understand Cypress PSOC structure, modules and interconnects.

Text Books

1. M.J.S.Smith, “Application Specific Integrated Circuits”,Pearson,2008.
2. M.H.Rashid, “Introduction to PSpice usingOrCAD for circuits and electronics”,Pearson,2004.
3. S. Sutherland,S.Davidmann, P. Flake,”System Verilog For Design”,(2/e), Springer,2006.

Reference Books

1. Z. Dr Mark,”Digital System Design with System Verilog”,Pearson,2010.
2. R. Ashby,”Designer's Guide to the Cypress PSoC,Newnes (An imprint of Elsevier)”,2006.
3. O. H. Bailey,”The Beginner's Guide to PSoC”, Express Timelines IndustriesInc.,2007.

Course Code	**:**	**ECHO23**
Course Title	**:**	**Design Of ASICs**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**NONE**
Course Type	**:**	**HO**

Course learning Objectives

- To prepare the student to be an entry-level industrial standard ASIC or FPGA designer.
- To give the student an understanding of issues and tools related to ASIC/FPGA design and implementation.
- To give the student an understanding of basics of System on Chip and Platform based design.

Course Content

Types of ASICs, VLSI Design flow, Programmable ASICs - Antifuse, SRAM, EPROM, EEPROM based ASICs. Programmable ASIC logic cells and I/O cells. Programmable interconnects. Latest Version - FPGAs and CPLDs and Soft-core processors.

Trade off issues at System Level: Optimization with regard to speed, area and power, asynchronous and low power system design. ASIC physical design issues, System Partitioning, Power Dissipation, Partitioning Methods.

ASIC floor planning, Placement and Routing.

System-On-Chip Design - SoC Design Flow, Platform-based and IP based SoC Designs, Basic Concepts of Bus-Based Communication Architectures, On-Chip Communication Architecture Standards, Low-Power SoCDesign

High performance algorithms for ASICS/ SoCs as case studies – Canonic Signed Digit Arithmetic, KCM, Distributed Arithmetic, High performance digital filters for sigma-delta ADC, USB controllers,OMAP.

Course outcomes

CO1: demonstrate VLSI tool-flow and appreciate FPGA architecture.

CO2: understand the issues involved in ASIC design, including technology choice, design management, tool-flow, verification, debug and test, as well as the impact of technology scaling on ASIC design.

CO3: understand the algorithms used for ASIC construction

CO4: understand the basics of System on Chip, On chip communication architectures like AMBA, AXI and utilizing Platform based design.

CO5: appreciate high performance algorithms available for ASICs

Text Book

1. M.J.S. Smith,"Application Specific Integrated Circuits", Pearson,2003

Reference Books

1. H.Gerez, "Algorithms for VLSI Design Automation", John Wiley,1999
2. J..M.Rabaey, A. Chandrakasan, and B.Nikolic, "Digital Integrated Circuit Design Perspective (2/e)", PHI2003
3. D. A.Hodges, "Analysis and Design of Digital Integrated Circuits (3/e)", MGH2004
4. Hoi-Jun Yoo, Kangmin Leeand Jun Kyong Kim, "Low-Power NoC for High-Performance SoC Design", CRC Press,2008
5. S.Pasricha and N.Dutt," On-Chip Communication Architectures System on Chip Interconnect, Elsveir", 2008

Course Code	**:**	**ECHO24**
Course Title	**:**	**Digital System Design**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC35**
Course Type	**:**	**HO**

Course learning Objectives

- To get an idea about designing complex, high speed digital systems and how to implement such design.

Course Content

Mapping algorithms into Architectures: Data path synthesis, control structures, critical path and worst case timing analysis. FSM and Hazards.

Combinational network delay. Power and energy optimization in combinational logic circuit. Sequential machine design styles. Rules for clocking. Performance analysis.

Sequencing static circuits. Circuit design of latches and flip-flops. Static sequencing element methodology. Sequencing dynamic circuits .Synchronizers.

Data path and array subsystems: Addition / Subtraction, Comparators, counters, coding, multiplication and division. SRAM, DRAM, ROM, serial access memory, context addressable memory.

Reconfigurable Computing- Fine grain and Coarse grain architectures, Configuration architectures-Single context, Multi context, Partially reconfigurable, Pipeline reconfigurable, Block Configurable, Parallel processing.

Course outcomes

CO1: identify mapping algorithms into architectures.

CO2: summarize various delays in combinational circuit and its optimization methods.

CO3: summarize circuit design of latches and flip-flops.

CO4: construct combinational and sequential circuits of medium complexity that is based on VLSIs, and programmable logic devices.

CO5: summarize the advanced topics such as reconfigurable computing, partially reconfigurable, Pipeline reconfigurable architectures and block configurable.

Text Books

1. N.H.E.Weste, D. Harris, CMOS VLSI Design (3/e), Pearson,2005.
2. W.Wolf, FPGA- based System Design, Pearson,2004.
3. S. Hauck, A.DeHon,"Reconfigurable computing: the theory and practice of FPGA-based computation", Elsevier,2008.

Reference Books

1. Franklin P. Prosser, David E. Winkel, Art of Digital Design, . Prentice-Hall,1987.
2. R.F.Tinde," Engineering Digital Design", (2/e), Academic Press,2000.
3. C. Bobda, "Introduction to reconfigurable computing",Springer,2007.
4. M. Gokhale,"Paul S. Graham, Reconfigurable computing: accelerating computation with field- programmable gate arrays", Springer,2005.
5. C.Roth, "Fundamentals of Digital Logic Design", Jaico Publishers, V ed.,2009.

Course Code	**:**	**ECHO25**
Course Title	**:**	**Digital Signal Processing Structures for VLSI**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC52 & ECPC63**
Course Type	**:**	**HO**

Course learning Objectives

- To make an in depth study of DSP structures amenable to VLSI implementation.
- To enable students to design VLSI system with high speed and low power.
- To make the students to implement DSP algorithm in an optimized method.

Course Content

An overview of DSP concepts, Representations of DSP algorithms. Loop bound and iteration bound. Transformation Techniques: Retiming, Folding and Unfolding

Pipelining of FIR filters. Parallel processing of FIR filters. Pipelining and parallel processing for low power, Combining Pipelining and Parallel Processing. Systolic Architecture Design

Pipeline interleaving in digital filters. Pipelining and parallel processing for IIR filters. Low power IIR filter design using pipelining and parallel processing, Pipelined adaptive digital filters.

Synchronous pipelining and clocking styles, clock skew and clock distribution in bit level pipelined VLSI designs. Wave pipelining, constraint space diagram and degree of wave pipelining, Implementation of wave- pipelined systems, Asynchronous pipelining.

Course outcomes

CO1: understand the overview of DSP concepts

CO2: improve the speed of digital system through transformation techniques.

CO3: perform Pipelining and parallel processing in FIR systems to achieve high speed and low power.

CO4: perform Pipelining and parallel processing in IIR systems and adaptive filters

CO5: understand clocking issues and asynchronous system.

Text Book

1. K.K.Parhi, "VLSI Digital Signal Processing Systems", John-Wiley,2007

Reference Book

1. U. Meyer -Baese," Digital Signal Processing with FPGAs", Springer,2004
2. W.Burleson,K. Konstantinides,T.H. Meng," VLSI SignalProcessing"",1996.
3. R.J. Higgins, "Digital signal processing in VLSI",1990.
4. S.Y.Kung,H.J. Whitehouse, "VLSI and modern signal processing",1985

Course Code	**:**	**ECHO26**
Course Title	**:**	**Low Power VLSI Circuits**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC63**
Course Type	**:**	**HO**

Course learning Objectives

- To expose the students to the low voltage device modeling, low voltage, low power VLSI CMOS circuit design.

Course Content

Evolution of CMOS technology.0.25 µm and 0.1 µm technologies. Shallow trench isolation. Lightly-doped drain. Buried channel. BiCMOS and SOI CMOS technologies. Second order effects and capacitance of MOSdevices.

CMOS inverters, static logic circuits of CMOS, pass transistor, BiCMOS, SOI CMOS and low power CMOStechniques.

Basic concepts of dynamic logic circuits. Various problems associated with dynamic logic circuits. Differential, BiCMOS and low voltage dynamic logiccircuits.

Different types of memorycircuits.

Adder circuits, Multipliers and advanced structures – PLA, PLL and Processingunit.

Course outcomes

CO1: acquire the knowledge about various CMOS fabrication process and its modeling.
CO2: infer about the second order effects of MOS transistor characteristics.
CO3: analyze and implement various CMOS static logic circuits.
CO4: learn the design of various CMOS dynamic logic circuits.
CO5: learn the design techniques low voltage and low power CMOS circuits for various applications.
CO6: learn the different types of memory circuits and their design.
CO7: design and implementation of various structures for low power applications.

Text Books

1. Jan Rabaey,"Low Power Design Essentials (Integrated Circuits and Systems)", Springer,2009
2. J.B.Kuo&J.H.Lou,"Low-voltage CMOS VLSI Circuits", Wiley,1999.

Reference Book

1. A.Bellaowar&M.I.Elmasry,"Low power Digital VLSI Design, Circuits and Systems", Kluwer, 1996.

Course Code	**:**	**ECHO27**
Course Title	**:**	**VLSI Digital Signal Processing Systems**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC41 & ECPC63**
Course Type	**:**	**HO**

Course learning Objectives

- To give an in-depth coverage of advanced VLSI Digital Signal Processing Systems.
- To provide knowledge about the effect of finite wordlength.
- To learn regarding the efficient implementation of arithmetic units.

Course Content

Algorithms for fast convolution, Algorithmic strength reduction in filters and transforms: Parallel FIR Filters, DCT and inverse DCT, Parallel Architectures for Rank-OrderFilters.

Scaling and Round off Noise - State variable description of digital filters, Scaling and Round off Noise computation, Round off Noise in Pipelined IIR Filters, Round off Noise Computation using state variable description, Slow-down, Retiming and Pipelining.

Bit level arithmetic Architectures- parallel multipliers, interleaved floor-plan and bit-plane-based digital filters, Bit serial multipliers, Bit serial filter design and implementation, Canonic signed digit arithmetic, Distributed arithmetic.

Redundant arithmetic -Redundant number representations, carry free radix-2 addition and subtraction, Hybrid radix-4 addition, Radix-2 hybrid redundant multiplication architectures, data format conversion, Redundant to Nonredundant converter.

Numerical Strength Reduction - Subexpression Elimination, Multiple Constant Multiplication, Subexpression Sharing in Digital Filters, Additive and Multiplicative NumberSplitting.

Course outcomes

CO1: learn various transforms and its corresponding architectures
CO2: acquire the knowledge of effect of round off noise computation
CO3: design Bit level arithmetic Architectures and optimize the implementation of FIR filters and constant multipliers
CO4: design basic arithmetic units and realize their architecture for higher radices
CO5: learn different numerical strength reduction techniques

Text Book

1. K.K.Parhi, "VLSI Digital Signal Processing Systems", John-Wiley,2007

Reference Book

1. U. Meyer -Baese, Digital Signal Processing with FPGAs, Springer,2004
2. W.Burleson,Konstantinos Konstantinides,Teresa H. Meng, VLSI SignalProcessing,1996.
3. R. J. Higgins,Digital signal processing in VLSI,1990.
4. Sun Yuan Kung,Harper J. Whitehouse, VLSI and modern signal processing,1985
5. M. A. Bayoumi, VLSI Design Methodologies for Digital Signal Processing,2012
6. Earl E. Swartzlander, VLSI signal processing systems,1986.

Course Code	**:**	**ECHO28**
Course Title	**:**	**Asynchronous System Design**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC35**
Course Type	**:**	**HO**

Course learning Objectives

- This subject introduces the fundamentals and performance of Asynchronous system
- To familiarize the dependency graphical analysis of signal transmission graphs
- To learn software languages and its syntax and operations for implementing Asynchronous Designs

Course Content

Fundamentals: Handshake protocols, Muller C-element, Muller pipeline, Circuit implementation styles, theory. Static data-flow structures: Pipelines and rings, Building blocks, examples

Performance: A quantitative view of performance, quantifying performance, Dependency graphic analysis. Handshake circuit implementation: Fork, join, and merge, Functional blocks, mutual exclusion, arbitration and metastability.

Speed-independent control circuits: Signal Transition graphs, Basic Synthesis Procedure, Implementation using state-holding gates, Summary of the synthesis Process, Design examples using Petrify. Advanced 4- phase bundled data protocols and circuits: Channels and protocols, Static type checking, More advanced latch controlcircuits.

High-level languages and tools: Concurrency and message passing in CSP, Tangram program examples, Tangram syntax-directed compilation, Martin's translation process, Using VHDL for Asynchronous Design. An Introduction to Balsa: Basic concepts, Tool set and design flow, Ancillary BalsaTools

The Balsa language: Data types, Control flow and commands, Binary/Unary operators, Program structure. Building library Components: Parameterized descriptions, Recursive definitions. A simple DMA controller: Global Registers, Channel Registers, DMA control structure, The Balsa description.

Course outcomes

CO1: understand the fundamentals of Asynchronous protocols

CO2: analyze the performance of Asynchronous System and implement handshake circuits

CO3: understand the various control circuits and Asynchronous system modules

CO4: gain the experience in using high level languages and tools for Asynchronous Design

CO5: learn commands and control flow of Balsa language for implementing Asynchronous Designs

Text Books

1. Asynchronous Circuit Design- Chris. J. Myers, John Wiley &Sons,2001.
2. Handshake Circuits An Asynchronous architecture for VLSI programming – KeesVanBerkel Cambridge University Press,2004

Reference Book

1. Principles of Asynchronous Circuit Design-Jens Sparso, Steve Furber, Kluver Academic Publishers, 2001.
2. Asynchronous Sequential Machine Design and Analysis, Richard F. Tinder,2009
3. A Designer's Guide to Asynchronous VLSI, Peter A. Beerel, Recep O. Ozdag, Marcos Ferretti,2010

Course Code	**:**	**ECHO29**
Course Title	**:**	**Physical Design Automation**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**NONE**
Course Type	**:**	**HO**

Course learning Objectives

- Understand the concepts of Physical Design Process such as partitioning, Floor planning, Placement and Routing.
- Discuss the concepts of design optimization algorithms and their application to physical design automation.
- Understand the concepts of simulation and synthesis in VLSI Design Automation
- Formulate CAD design problems using algorithmic methods

Course Content

VLSI design automation tools- algorithms and system design. Structural and logic design. Transistor level design. Layout design. Verification methods. Design management tools.

Layout compaction, placement and routing. Design rules, symbolic layout. Applications of compaction. Formulation methods. Algorithms for constrained graph compaction. Circuit representation. Wire length estimation. Placement algorithms. Partitioning algorithms.

Floor planning and routing- floor planning concepts. Shape functions and floor planning sizing. Local routing. Area routing. Channel routing, global routing and its algorithms.

Simulation and logic synthesis- gate level and switch level modeling and simulation. Introduction to combinational logic synthesis. ROBDD principles, implementation, construction and manipulation. Two level logic synthesis.

High-level synthesis- hardware model for high level synthesis. Internal representation of input algorithms. Allocation, assignment and scheduling. Scheduling algorithms. Aspects of assignment. High level transformations.

Course outcomes

CO1: know how to place the blocks and how to partition the blocks while for designing the layout for IC.

CO2: solve the performance issues in circuit layout.

CO3: analyze physical design problems and Employ appropriate automation algorithms for partitioning, floor planning, placement and routing

CO4: decompose large mapping problem into pieces, including logic optimization with partitioning, placement and routing

CO5: analyze circuits using both analytical and CAD tools

TextBooks

1. S.H. Gerez, “A lgorithms for VLSI Design Automation”, John Wiley,1998.
2. N.A.Sherwani , “Algorithms for VLSI Physical Design Automation”, (3/e),Kluwer,1999.

Reference Books

1. S.M. Sait , H. Youssef, “VLSI Physical Design Automation”, World scientific,1999.
2. M.Sarrafzadeh, “Introduction to VLSI Physical Design”, McGraw Hill (IE),1996.

Course Code	**:**	**ECHO30**
Course Title	**:**	**Mixed - Signal Circuit Design**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**NONE**
Course Type	**:**	**HO**

Course learning Objectives

- To make the students to understand the design and performance measures concept of mixed signal circuit.

Course Content

Concepts of Mixed-Signal Design and Performance Measures. Fundamentals of Data Converters.Nyquist Rate Converters and Over sampling Converters.
Design methodology for mixed signal IC design using gm/Id concept.
Design of Current mirrors. References. Comparators and Operational Amplifiers.
CMOS Digital Circuits Design: Design of MOSFET Switches and Switched-Capacitor Circuits, Layout Considerations.
Design of frequency and Q tunable continuous time filters.

Course outcomes

CO1: Appreciate the fundamentals of data converters and also optimized their performances.
CO2: Understand the design methodology for mixed signal IC design using gm/Id concept.
CO3: Analyze the design of current mirrors and operational amplifiers
CO4: Design the CMOS digital circuits and implement its layout.
CO5: design the frequency and Q tunable time domain filters.

Text Books

1. R. Jacob Baker, Harry W. Li, David E. Boyce, CMOS, Circuit Design, Layout, and Simulation, Wiley-IEEE Press,1998
2. David A. Johns and Ken Martin, Analog Integrated Circuit Design, John Wiley and Sons,1997.

Course Code	**:**	**ECHO31**
Course Title	**:**	**Digital Signal Processing For Medical Imaging**
Number of Credits	**:**	**3**
Prerequisites (Course code)	**:**	**ECPC52**
Course Type	**:**	**HO**

Course Content

X-ray projection imaging-X-ray Generation-X-ray attenuation –X-ray Detectors- Factors that determine X-ray image quality - Introduction to Computed Tomography (CT) – Parallel Beam projection- Fan Beam projection- Relationship between Parallel beam and Fan beam projection- Discrete Realization.

Introduction to Magnetic resonance imaging-Bloch equation-Larmor frequency and the tip angle –Trick on MRI- Selecting the human slice and the corresponding external RF pulse- Measurement of the Transverse component using the receiver antenna-Sampling the MRI image in the frequency domain-Practical difficulties and remedies in MRI Proton-Density, MRI image – T_2 MRI image using Spin-Echo and Cartesian scanning -T_2 MRI image using spin-echo and polar scanning - T_1 MRI image.

Nuclear Imaging-Radiopharmaceuticals-Production of short-lived radioactive tracers-Detector systems and the Anger camera-Single photon Emission computed tomography-Positron Emission Tomography-Multi-modality Imaging.

Ultrasound imaging-sound propagation in Biological Tissue-Ultrasound Image formation-Ultra sound Generation and Echo Detection-A-mode scans-B-mode scans-M-mode scans-Volumetric scans and 3D Ultrasound – Doppler ultrasound.

Medical image processing-Image Enhancement- Logarithmic display- Non-linear filtering-Image subtraction-Linear filtering and the Hankel transformation - Histogram equalization - Histogram specification. Medical image compression-Discrete Cosine Transformation-Hoteling transformation-Feature extraction and classification-Dimensionality reduction using Principle component analysis-Linear Discriminant analysis - Kernel-Linear discriminant analysis.

Course outcomes

CO1: Describe the signal processing techniques involved in CT based Imaging techniques
CO2: Describe the signal processing techniques involved in MRI based Imaging techniques
CO3: Describe the signal processing techniques involved in Nuclear Imaging
CO4: Describe the signal processing techniques involved in Ultra sound Imaging
CO5: Describe the signal processing techniques involved in Medical image processing

Text Books

1. Jerry L. Prince, Jonathan M. Links, Medical imaging signals and systems, Pearson education, second edition, 2014
2. Mark. A. Haidekkar, Medical Imaging technology, Springer briefs in physics,2013
3. E.S. Gopi, Digital signal processing for medical imaging using Matlab, Springer, 2013

Reference Books

1. Paul suetens, Fundamentals of medical imaging, second edition, Cambridge university press, 2009.
2. MIT course: http://ocw.mit.edu/courses/nuclear-engineering/22-058-principles-of-medical-imaging-fall-2002/index.htm