Department of Electronics & Communication Engineering

and

Department of Computer Science and Engineering

BoCS approved

Course Structure and Syllabi

For

4 Yrs. B.Tech Programme

Effective from 2020-21

भारतीय सूचना प्रौद्योगिकी संस्थान राँची

INDIAN INSTITUTE OF INFORMATION TECHNOLOGY, RANCHI

(An Institution of National importance under act of Parliament)

(Ranchi - 834010), Jharkhand

I. Highlights of Changes in Proposed B.Tech Course Structure

Existing course structure	Proposed course structure
• B.Tech (Hons.) degree is awarded to every admitted student.	• Bachelor degree is classified into B.Tech and B.Tech (Hon.). Condition for B.Tech (Hons.)= CGPA ≥ 8.0 (at the end of fourth semester)
• There is discrepancy in total credit for CSE and ECE Bachelor course. CSE=190 credit ECE=179 credit	• Total credits for ECE and CSE is equal. B.Tech = 162-170 credits B.Tech (Hons.)=174-182 credits
• Non-uniformity in distribution of subjects in first year.	• Common courses for both ECE and CSE in first year.
• Non-uniformity in distribution of credits of LAB courses for CSE and ECE.	• Two credits is allocated to all laboratory courses of ECE and CSE.

II. Format of Subject codes

1) Course code AA-XYZZ is explained as
AA - Department
X-Academic year
Y-Theory/Lab; 0 ==Theory and 1== Lab
ZZ-odd/even semester; odd number == odd semester and even number == even semester

2) For project/seminar/comprehensive viva:
AA= PR
X= 1

3) For open electives:
AA= OE

Indian Institute of Information Technology, Ranchi
Curriculum for
B. Tech (Hons.) and B.Tech

Breakup of the credits semester wise

Credit required for B Tech – 162-170;
Credit required for B Tech (Hons.) –174-182 (Only for Students with CGPA ≥ 8.0 at the end of 4th Semester)

Semester/ Projects	Credits - B.Tech Hons.	Credits - B.Tech
I	20	20
II	24	24
III	23-25	23-25
IV	21-22	21-22
V	23-24	19-20
VI	20-23	17-19
VII	23-24	18-20
VIII	20	20
Total	174-182	162-170

Semester wise courses

Semester I – Common for B Tech (Hons.) & B Tech.				
S.N.	CSE	ECE	L-T-P	Credits
1.	**MA-1001:** Mathematics-I (Calculus and Differential Equations)		3-1-0	4
2.	**EC-1001:** Electronic Devices & Circuits		3-0-0	3
3.	**EC-1003/ PH-1001:** Electrical Technology/ Engineering Physics		3-0-0	3
4.	**CS-1001:** Computer Programming: Concepts and Practices		3-0-0	3
5.	**HS-1001:** Professional Communication		2-0-0	2
6.	**EC-1101:** Electronic Devices & Circuits lab		0-0-3	2
7.	**CS-1101:** Computer Programming Lab		0-0-3	2
8.	**CA-1101:** Co-Curricular Activity I		0-0-2	1
Total Credits				**20**

Semester II - Common for B Tech (Hons.) & B Tech.			
S.N.	**CSE** / **ECE**	**L-T-P**	**Credits**
1.	**MA-1002:** Mathematics-II (Probability and Statistics)	3-1-0	4
2.	**EC-1002:** Digital Logic & Design	3-0-0	3
3.	**EC-1003/ PH-1001:** Electrical Technology/ Engineering Physics	3-0-0	3
4.	**CS-1002:** Data Structures and Programming Languages	3-0-0	3
5.	**CS-1004:** Discrete Mathematics	3-1-0	4
6.	**HS-1002:** Ethics and Human Values	2-0-0	2
7.	**EC-1102:** Digital Logic & Design Lab	0-0-3	2
8.	**CS-1102:** Data Structures Lab	0-0-3	2
9.	**CA-1102:** Co-Curricular Activity II	0-0-2	1
Total Credits			**24**

Semester III - Common for B Tech (Hons.) & B Tech.				
S. No.	**CSE**	**ECE**	**L-T-P**	**Credits**
1.	**MA-2001:** Mathematics-III (Complex variable, Real analysis & Linear Algebra)		3-1-0	4
2.	**CS-2001:** Python Programming		3-0-0	3
3.	**CS-2003:** Computer Organization and Architecture		3-0-0	3
4.	**CS-2005:** Theory of Computation	**EC-2001:** Analog & Linear Integrated Circuit	3-0-0	3
5.	**CS-2007:** Fundamentals of Algorithms	**EC-2003:** Circuit Analysis & Synthesis	3-0-0	3
6.	**HS-2001:** Management Concepts and Organizational Behaviour		2-0-0	2
7.	**CS-2101:**-Python Programming Lab		0-0-3	2
8.	**CS-2103:** Computer Organization and Architecture Lab		0-0-3	2
9.	**CS-2107:** Algorithms Lab	**EC-2101:** Analog & Linear Integrated Circuit Lab	0-0-3	2
Total Credits				**24**

Semester IV- Common for B Tech (Hons.) & B Tech.				
S. No.	**CSE**	**ECE**	**L-T-P**	**Credits**
1.	**MA-2002:** Mathematics-IV(Combinatorics and Graph Theory)	**EC-2002:** Electromagnetic Theory	3-1-0	4
2.	**EC-2004:** Microprocessors and Microcontrollers		3-0-0	3
3.	**EC-2006:** Signals and Systems		3-0-0	3
4.	**CS-2002:** Compiler Design	**EC-2008:** Analog Communication	3-0-0	3
5.	**CS-2004:** Numerical Methods and Scientific Computing	**EC-2010:** Control System	3-0-0	3
6.	**ES-2002:** Environmental Science & Green Technology		2-0-0	2
7.	**EC-2104:**Microprocessors and Microcontrollers Lab		0-0-3	2
8.	**CS-2102:** Compiler Design Lab	**EC-2108:** Analog Communication Lab	0-0-3	2
Total Credits				**22**

Semester V-B Tech (Hons.) & B Tech.				
S. No.	**CSE**	**ECE**	**L-T-P**	**Credits**
1.	**CS-3001:** Database Management Systems		3-0-0	3
2.	**CS-3003:** Operating System	**EC-3001:** Digital Communication	3-0-0	3
3.	**CS-3005:** Computer Graphics & multimedia	**EC-3003:** Microelectronics Circuits	3-0-0	3
4.	**CS-3007:** Advanced Computer Architecture	**EC-3005:** Microwave Engineering	3-0-0	3
5.	**Hons. Elective-I**		**3-1-0**	**4**
6.	**HS-3001:** Entrepreneurship Development		2-0-0	2
7.	**CS-3101:** Database Management Systems lab		0-0-3	2
8.	**CS-3103:** Operating System Lab	**EC-3101:** Digital Communication Lab	0-0-3	2
9.	**CS-3105:** Computer Graphics & multimedia Lab	**EC-3103:** Microelectronics Circuits Lab	0-0-3	2
Total Credits				**24 (20)**

Semester VI- B Tech (Hons.) & B Tech.				
S. No.	**CSE**	**ECE**	**L-T-P**	**Credits**
1.	**CS-3002:** Artificial Intelligence	**EC-3002:** Measurement & Instrumentation	3-0-0	3
2.	**CS-3004:** Software Engineering	**EC-3004:** VLSI & MEMS Technology	3-0-0	3
3.	**CS-3006:** Computer Network	**EC-3006:** Digital Signal Processing	3-0-0	3
4.	Open Elective-I		3-0-0	3
5.	**Hons. Elective-II**		**3-1-0**	**4**
6.	**CS-3102:** Artificial Intelligence Lab	**EC-3102:** Measurement & Instrumentation Lab	0-0-3	2
7.	**CS-3104:** Software Engineering Lab	**EC-3104:** VLSI & MEMS Lab	0-0-3	2
8.	**CS-3106:** Computer Network Lab	**EC-3106:** Digital Signal Processing Lab	0-0-3	2
Total Credits				**22(18)**

Industrial Training: Students to undertake summer internships during summer break (May to July)

Semester VII- B Tech (Hons.) & B Tech.				
S. No.	**CSE**	**ECE**	**L-T-P**	**Credits**
1.	**CS-4001:** Cryptography and Network Security	**EC-4001:** Optical Communication	3-0-0	3
2.	Open Elective II		3-0-0	3
3.	Open Elective III		3-0-0	3
4.	Open Elective IV		3-0-0	3
5.	**Hons. Elective III**		**3-1-0**	**4**
6.	**CS-4101:** Cryptography and Network Security Lab	**EC-4101:**Optical Communication Lab	0-0-3	2
7.	**PR-4101:**Minor Project		----	4
8.	**PR-4103**: Industrial Seminar		----	2
Total Credits				**24(20)**

Semester VIII - Common for B Tech (Hons.) & B Tech.				
S. No.	**CSE**	**ECE**	**L-T-P**	**Credits**
1.	**PR-4102:**Project/Internship		----	16
2.	**PR-4104:** Comprehensive Viva		----	4
Total Credits				**20**

Legend:
L - Number of lecture hours per week
T - Number of tutorial hours per week
P - Number of practical hours per week
C - Number of credits for the course

List of Electives

Hons. Elective I (fifth semester)

Offered by ECE	Offered by CSE
1. EC-3007: Computational Intelligence 2. EC-3009: Optical Sensors 3. EC-3011: Mobile communication 4. EC-3013: Semiconductor Material & Device Characterization	1. CS-3009: Decision making and Expert System 2. CS-3011: Advanced Operating Systems 3. CS-3013: Queueing Theory and Data Networks 4. CS-3015: Game Theory

Open Elective I (in sixth semester) – open to both CSE & ECE

1. OE-3002: Embedded Systems
2. OE-3004: Sensor & Transducer

3. OE-3006: Information Theory & Coding
4. OE-3008: Wireless Communication
5. OE-3010: Parallel and Distributed Systems
6. OE-3012: Quantum Mechanics
7. OE-3014: Advanced Algorithm
8. OE-3016: Advanced Data structure
9. OE-3018: Programming in JAVA
10. OE-3020: Object Oriented System Design

Hons. Elective II (sixth semester)

Offered by ECE	Offered by CSE
1. EC-3008: VLSI testing & testability 2. EC-3010: Optoelectronics & Photonics 3. EC-3012: DSP System Design 4. EC-3014: RF IC Design	1. CS-3008: Multimedia Systems 2. CS-3010: Web System and Technology 3. CS-3012: Evolutionary Computing 4. CS-3014: Introduction to Cognitive Science 5. EC-3006: Digital Signal Processing

Open Elective II/III/IV (in seventh semester) – open to both CSE & ECE

1. OE-4001: Satellite & Radar Communication
2. OE-4003: Digital System Design with VHDL
3. OE-4005: Advanced Semiconductor Devices
4. OE-4007: Optimization techniques
5. OE-4009: Research Methodology and Intellectual Property Rights
6. OE-4011: Antenna Design
7. OE-4013: Data Mining
8. OE-4015: Software Project Process and Quality Management
9. OE-4017: Advanced Computer Networks
10. OE-4019: Cyber Crime
11. OE-4021: Advances in Software Testing
12. OE-4023: Soft Computing
13. OE-4025: Lasers and Ultrafast Optics
14. OE-4027: Pattern Recognition and Classification
15. OE-4029: Machine learning
16. OE-4031: Computer Vision
17. OE-4033: Cloud Computing
18. OE-4035: Statistical Mechanics
19. OE-4037: Data Communication & Networks

Hons. Elective III (seventh semesters)

Offered by ECE	Offered by CSE
1. EC-4003:CAD for VLSI 2. EC-4005:Wireless Sensor Network 3. EC-4007: Adaptive Signal Processing 4. EC-4009: Robotics	1. CS-4003: Natural Language Processing 2. CS-4005: Quantum Computing 3. CS-4007: Big Data Analytics 4. CS-4009: Advanced Database Management Systems 5. EC-4009: Robotics

Note:

1. Others elective courses as decided by committee to be taken from NPTEL/MOOCs/SWAYAM/COURSERA or any other online platform. Course codes will be decided later as per the format.
2. Elective courses may be added or removed later on the recommendation of competent authority.

B.Tech ECE Syllabus

Semester I – Common for ECE and CSE

MA-1001	Mathematics-I (Calculus and Differential Equations)	L-T-P-C:3-1-0-4

Course objective: In this course the students are introduced to some basic tools in Mathematics which are useful in modelling and analyzing physical phenomena involving continuous changes of variables or parameters. The differential and integral calculus of functions of one or more variables and of vector functions taught in this course have applications across all branches of engineering. This course will also help in understanding application of Laplace and Fourier Transformation in Communication theory.

Module I

Infinite series & Mean Value theorem: Sequence and series, convergence, Comparison test, Integral test, D'Alembert ratio test, Rabbe's test, Lograthmic test, Cauchy root test, Leibnitz's rule, Rolle's Theorem, Lagrange and Cauchy Mean Value theorems. Function of Several Variables: Limit, Continuity and Differentiability, Partial Differentiation, Homogeneous function – Euler's theorem, change of variables, Jacobian, Taylor's theorem for function of several variables, Extrema of function of multi-variables, saddle points, Lagrange method for undetermined multipliers.

Module II

Integral Calculus: Multi Integral (Double & Triple Integral) , Change of order of integration, Area of bounded region, Arc length of curve, volume and surface area of solid of revolution, multiple integral by change of variables, Dirichlet integrals, moment of inertia, center of gravity. Beta and Gamma Functions: Improper integrals, Beta function, Gamma functions, Improper integrals involving a parameter

Module III

Vector Calculus: Gradient, Directional derivatives, Divergence and Curl, line integral and Green's theorem, surface and volume integral, Green's, Gauss, Stoke's theorems and their application.

Module IV

Ordinary Differential Equations: Existence and uniqueness of solutions of first order ODE, Exact differential equation, solution of linear differential equation, higher order linear differential equation, Solution of homogeneous and nonhomogeneous ODE, variation of parameters, Undetermined coefficients, power series method, System of simultaneous ODE.

Module V

Partial Differential Equation: First order PDE, Formation of PDE, Classification of solution: Complete, General and Particular solution, Lagrange's linear PDE, Non- linear First Order PDE, Some Standard form- I, II, III, IV. Charpit's Method, Higher Order Homogeneous linear PDE with constant coefficients, C.F. &

P.I., Non- homogeneous P.D.E with constant coefficients, C.F. & P.I. Application of Partial Differential Equation

Module VI

Laplace Transform: Laplace Transform and its properties, Unit-step, Impulse and Periodic functions, Error Function, Inverse Laplace Transform, Convolution Theorem, Evaluation of Integral by Laplace transform, Application of Laplace transform to solution of ODE & PDE. Fourier Series and Fourier Transform: Fourier series, Convergence of Fourier series, Half range series. Fourier Integral, Fourier Sine and Cosine Integral, Complex form of Fourier integral. Fourier Transform, Fourier Sine and Cosine transform, Finite sine and Cosine transform, Convolution Theorem, Application of Fourier Transform to boundary value problems.

Course outcome:

- Learn the relationship between the derivative of a function as a function and the notion of the derivative as the slope of the tangent line to a function at a point
- Compare and contrast the ideas of continuity and differentiability
- To able to evaluate integrals of rational functions by partial fractions.
- To distinguish between linear, nonlinear, partial and ordinary differential equations.
- To solve basic application problems described by second order linear differential equations with constant coefficients.
- Understand the fundamental concepts of functions with several variables, its derivatives in partial forms with other important related concepts, their applications in maxima - minima problems.
- Apply the principles of integral to solve a variety of practical problems in sciences and engineering.
- Apply Laplace and Fourier transform in engineering applications.

Text Book:

1. Simmons, G. F. "Differential Equations, TATA McGraw-Hill Publishing Company LTD. New Delhi, 1995."
2. Das, B. C., and B. N. Mukherjee. "Integral calculus—differential equations." UN Dhur & Sons Pvt. Ltd, Kolkata (1996).

Reference Book:

3. Jain, Rajinder Kumar, and Satteluri RK Iyengar. Advanced engineering mathematics. Alpha Science Int'l Ltd., 2007.
4. Grewal, B. S. "Higher engineering mathematics." 2002, Khanna Publishers, New Delhi (1996).
5. Kreyszig, Erwin. "Advanced Engineering Mathematics, 10th Edition." , Wiley India edition (2009).

EC-1001	Electronic Devices & Circuits	L-T-P-C:3-0-0-3

Course objective:

- Use of basic electronic devices in building circuits.
- Apply P-N junction diodes for different applications.
- Apply BJT, FET and MOSFET circuits for different applications.

Module I

Physics of Semiconductor Device: Insulators, semiconductors, and metals classification using energy band diagrams, mobility and conductivity, electrons and holes in intrinsic and extrinsic semiconductors, drift and diffusion, charge densities in semiconductors, Hall effect, continuity equation, law of junction, Fermi Dirac function, Fermi level in intrinsic and extrinsic semiconductors, Effect of Excess Carrier in Semiconductor Device.

Module II

Diode Characteristics and Applications: P-N junction diode and its characteristics, Mathematical analysis of built-in potential, depletion width, peak electric field and diffusion current density, Diode applications (half-wave and full-wave rectifiers, clippers, clampers), Non-ideal diode models, Zener diodes and its applications, Diode capacitance and switching times, Types of diodes (LED, Varactor diode, Schottky diode, Photodiode).

Module III

BJT: Bipolar Junction Transistor (BJT types, operation, configurations, characteristics), Cutoff and saturation operations, Q point, BJT switching times, Applications of BJT.

FET: Field Effect Transistor (FET types, operation, configurations, characteristics), MOS structure, CV characteristics, Metal-Oxide Semiconductor FET, Complimentary MOSFET (CMOS).

Module IV

BJT biasing and small-signal analysis of BJT amplifiers, FET biasing and small-signal analysis of FET amplifiers, Frequency response (low-frequency and high-frequency responses of amplifiers), and Gain bandwidth product.

Course outcome:

Upon Completion of the course, the students will be able to:

- Explain the structure and working operation of basic semiconductor devices.
- Analyze the characteristics of different electronic devices such as diodes and transistors
- Choose and adapt the required components to construct various electronic circuit.

Text Book:

1. Adel S. Sedra, Kenneth C. Smith, "Microelectronic Circuits", Oxford University Press, 7th Edition, 2017.
2. Robert Boylestad, Louis Nashelsky, "Electronic Devices and Circuit Theory", Prentice Hall, 11th Edition, 2015.

Reference Book:

1. Jacob Millman, Christos C. Halkias, "Integrated Electronics: Analog and Digital Circuits and Systems", Tata McGraw Hill, 2nd Edition, 2017.
2. Donald A. Neamen, "Microelectronics: Circuit Analysis and Design", McGraw Hill, 4th Edition, 2010.

EC-1101	Electronic Devices & Circuits lab	L-T-P-C:0-0-3-2

Familiarization with Cathode Ray Oscilloscope, Function generator and various electronic components and Experiments related to Volt-Ampere Characteristics of PN junction diode, Zener Diode and Light Emitting Diode, Zener Voltage regulator characteristics, clipping circuits, clamper circuits, Half-Wave rectifier with and without filter, Full-Wave rectifier with and without filter, Bipolar Junction Transistor, Frequency response of CE amplifier, Characteristics of n-channel/p-channel MOSFETs and CMOS inverter.

Project:

Familiarization with PCB design

EC-1003	Electrical Technology	L-T-P-C:3-0-0-3

Course objective:

- Understand the basic ideas and principles of Electrical and Electronic Circuits.
- Recognize basic elements for electrical and electronic circuits
- Realize the details of electrical power systems, generators, motors etc.

Module I

Electrical Circuit: Circuit Elements Resistance, Inductance & Capacitance, Kirchhoff's Laws, Voltage Source (Definition, Characteristics of Practical Source, and Equivalent Current Source). Magnetic Circuit, Flux, MMF, Reluctance, Analogy with Electric Circuits. Simple Calculations for Composite Magnetic Circuits. Three phase system: Its necessity and advantages, meaning of phase sequence, star and delta connections, balanced supply and balanced load, line and phase voltage/current relation, three phase power measurements.

Module II

Parameters of AC Circuits: Periodic Function, Average & R.M.S., Values, Steady State Behavior With Sinusoidal Excitation, Phasor Representation, Reactance & Impedance, Series & Parallel Circuit, Power Factor, Principle of Generation of Single Phase & Three Phase Voltages, Power in Balanced Three Phase AC System

Module III

Transformers: Necessity of transformer, Principle of operation, Types and construction of transformers. emf equation. Losses, variation of losses with respect to load, efficiency, Condition for maximum efficiency. Domestic Wiring: Service mains, meter board and distribution board. Brief discussion on concealed conduit wiring. Two-way and three-way control Elementary discussion on circuit protective devices: Fuse and Miniature Circuit Breaker (MCB's), electric shock, precautions against shock. Earthing: Pipe and Plate earthing.

Course Outcome:

Upon Completion of the course, the students will be able to:

- Design basic components of Electrical and Electronic Circuits.
- Explain the working principle of Electrical measurements
- Design Transformer and related circuits

Text Book:

1. John Hiley, Keith Brown and Ian Mckenzie Smith, Electrical And Electronic Technology, 10th Edition, 2018, Pearson Publishers.
2. Mittle and Mittal, Basic Electrical Engineering, 2nd Edition, 2019, TMH.

Reference Book:

1. D. P Kothari. and I. J. Nagrath, Theory and Problems 0f Basic Electrical Engineering, 6th Edition, 2018. Prentice. Hall India.
2. D. C Kulshresta, Basic Electrical Engineering, 1st Edition, 2019, TMH India.

CS-1001	Computer Programming: Concepts and Practices	L-T-P-C:3-0-0-3

Course objective:

- To understand the basic concept of writing a program.
- To understand role of constants, variables, identifiers, operators, type conversion and other building blocks of C Language
- To apply the use of conditional expressions and looping statements to solve problems associated with conditions, repetitions and function.
- To analyze the concept of array and pointers dealing with memory management.
- To Evaluate the File handling concepts for permanent storage of data or record.
  To create dynamic data structure applications as self-referential structure.

Module I

Computer fundamentals, Evolution of programming languages, Syntax and semantics, Concurrency, Number systems, Functional Programming and Logic programming languages, Computational complexity

Module II

Programming in C, Pseudo-code, Character set, Identifiers, Keywords, Data Types, Constant and Variables, Operators, expressions and statements, conditional and looping statements.

Module III

Data types, Type Checking and Scopes, Storage Classes, Arrays, Sequential and Linked linear lists, Trees, Trees representations, binary tree traversals, Graphs, Graphs representations.

Module IV

Functions, Structures, Union, Storage Classes, Pointers, Dynamic memory allocations, file handling in C, Pre-processor directives and macros, I/O handling, Header files.

Module V

Sorting and searching algorithms, String algorithms, Pattern search and text editing, Hashing.

Course outcome:

- Understand fundamental principles of problem solving.

- Familiarize the design and analysis of algorithms.
- Understand and practice the C programming language for solving mathematical and scientific problems.

Text Book:

1. K. L.P. Mishra and N. Chandrasekaran; Theory of Computer Science (Automata, Languages and Computation), 2nd Edition, Prentice-Hall Punb.India, 2016.
2. G. Shanker Rao; Mathematical Foundations of Computer Science, I.K. International Publishing House Private Limited, 2006.

Reference Books:

1. A.M. Tenenbaum, Y. langsum and M.J. Augenstein; Data Structures using C, Prentice Hall of India private. Limited, 2015.
2. Robert Sedgewick; Algorithms in C, Addition-Wesley, 2010.

CS-1101	Computer Programming Lab	L-T-P-C:0-0-3-2

Familiarization of a computer and the environment for execution of sample programs involving expression evaluation, Conditionals and branching, Iteration, Functions. Applications of Arrays, Sequential and Linked linear lists, structure, pointer and dynamic memory allocation, String manipulation. Sorting and Searching algorithms and File- handling.

PH-1001	Engineering Physics	L-T-P-C:3-0-0-3

Course objective:

- To apply basic principles of physics to engineering applications.
- To introduce advances in technology for engineering applications.
- To apply the concepts of special theory of relativity in various field of engineering.
- Explain Quantum Mechanics to understand wave particle dualism
- Explain the principles of laser and optical fibers.

Module I

Mathematical Preliminaries: Physical meaning of Gradient, Divergence and Curl. The fundamental theorem of divergences (Gauss's divergence theorem) and curls (Stokes' curl theorem). Curvilinear Coordinates: Polar coordinates, Spherical polar coordinates and Cylindrical polar coordinates. Gradient, divergence and curl in curvilinear coordinates.

Module II

Electrodynamics: Maxwell's equations: differential and integral forms, significance of Maxwell's equations, displacement current and correction in Ampere's law, Electromagnetic waves, EM wave equation, plane electromagnetic waves, Polarization of EM waves, Poynting's theorem.

Module III

Special Relativity: Basics of Special Relativity, Galilean and Lorentz transformations, Michelson- Morley experiment. Postulates of Einstein's special theory of relativity. Time dilation and length contraction, relativistic kinematics and mass-energy equivalence.

Module IV

Quantum Physics: Dual nature of matter, de-Broglie Hypothesis, Heisenberg uncertainty principle and its applications, postulates of quantum mechanics, wave function & its physical significance, probability density, Schrodinger's wave equation, Eigen values & Eigen functions, Application of Schrodinger equation.

Module V

Laser and Fiber Optics: Principles of lasers, Einstein Coefficients and their relations, Types of Lasers and their applications. Concept of optical fibers and types of optical fibers, modes of propagation, fiber optic communication, optical fiber sensors, connector and couplers.

Course outcome: Student will be able to:

- Determine gradient, divergence and curl of scalar and vector fields.
- To formulate and solve the engineering problems on electromagnetism.
- To explain special theory of relativity and apply its concepts in various fields of engineering.
- To explain fundamentals of quantum mechanics and apply it to problems on bound states.
- Describe the basics of laser physics and working of optical fibers.

Text Book:

1. Panofsky & Phillips, Classical Electricity & Magnetism, 2nd ed., Dover Publications, 2005. (Text Book).
2. Optical Fiber communication- G Keiser (McGraw Hill) (Text Book)
3. Neeraj Mehta, Applied Physics for Engineers, PHI Learning Pvt. Ltd., 2011. (Text Book)
4. Perspectives of Modern Physics, A. Beiser (Text Book).

Reference Book:

1. 1.Antennas and Wave Propagation, G.S.N. Raju, Pearson Education (Ref)
2. David J Griffith, Introduction to Electrodynamics, 4th ed. , PHI, 2014. (Ref.).
3. Paul Dirac, Principles of Quantum Mechanics, 4th ed., Oxford Uni. Press, 2004. (Ref.)

HS-1001	**Professional Communication**	**L-T-P-C:2-0-0-2**

Course objective: The course aims to:

- Enhance the Employability and Career Skills of students
- Orient the students towards grooming as a professional
- Make them Employable Graduates
- Develop their confidence and help them attend interviews successfully.

Module I

Communication Fundamentals: Introduction to Verbal and Nonverbal Communication, received pronunciation; how to activate passive vocabulary; technical/non-technical and business presentations; questioning and answer skills; soft skills for professionals; role of body postures, movements, gestures, facial expressions, dress in effective communication; Information/ Desk/ Front Office/ Telephone conversation; how to face an interview/press conference; Group discussions, debates, elocution.

Module II

Interviewing Principles and Skills: Fundamental principles of interviewing, Interview etiquette: dress code, body language, attending job interviews, telephone/skype interview, one to one interview &panel

interview, Success in an interview, Types of Interviews, Improving self-expression Important Non-verbal aspects.

Module III

Group Discussions: Methodology of GD, Improving Group performance, Developing persuasive speaking skills, Listener oriented speaking, Group discussion practice

Module IV

Professional Writing: Kinds of business letters, Job Applications and Resume Writing, Report Writing, Proposal layout and design, E-mail etiquette, Notices, Agenda and Minutes, Technical writing, business writing.

Module V

Delivering Professional Presentations: Elements of effective English, Effective paragraphs, The power of reading, Punctuation and Capitalization

Course outcome:

At the end of the course Learners will be able to

- Make effective verbal and nonverbal communication.
- Participate confidently in Group Discussions.
- Attend job interviews and be successful in them.
- Develop adequate Soft Skills required for the workplace

Text Book:

1. Barun K. Mitra, Effective Technical Communication, Oxford University Press, Delhi.2006.

Reference Book:

1. Business Correspondence and Report Writing - R. C. Sharma
2. Business Communication - M. Balasubramanyam
3. Essentials of Business Communication - R. Pal and Kolahalli
4. Business Communication and Report Writing - Sharma, Mohan
5. Lesikar's Basic Business Communication – Lesikar

Semester II – Common for ECE and CSE

MA-1002	Mathematics II (Probability and Statistics)	L-T-P-C:3-1-0-4

Course objective:

The main objective of this course is to provide students with the foundations of probabilistic and statistical analysis mostly used in varied applications in engineering and science like disease modeling, prediction, computer networks, communication engineering etc.

Module I

Probability Theory: Joint, marginal and conditional distributions, moments and conditional moments, correlation and regression, transformation of variables, bivariate normal and Dirichlet distribution.

Module II

Multivariate distribution: χ^2, t and F distributions. Correlation and regression; Multinomial, uniform distribution on bounded subsets of R^p, multivariate normal and Dirichlet distributions, Cauchy distributions. Order statistics

Module III

Chebyshev's Inequality, Convergence in probability, Bernoulli's theorem, Convergence almost surely, weak law of large numbers, Central and De-Moivre Laplace limit theorems.

Module IV

Statistics: Sampling distribution: χ^2, t and F distributions. Estimation: Method of moments, maximum likelihood estimation, unbiasedness, consistency, comparing two estimators, confidence interval estimation for mean, difference of means, variance, proportions, sample size problems. Test of Hypothesis: Neyman-Pearson Lemma, composite hypothesis, comparison of normal populations, large-sample test, test on multinomial distributions, goodness of fit.

Module IV

Curve fitting and Correlation: Principle of least squares and curve fitting, correlation and regression, scatter diagram, regression lines, bivariate frequency distribution. Theory of errors: Gauss Postulate of arithmetic mean, normal law, error function. Principle of least squares, confidence interval.

Course outcome:

- Develop problem-solving techniques needed to accurately calculate probabilities.
- Apply problem-solving techniques to solving real-world events.
- Apply selected probability distributions to solve problems.
- Present the analysis of derived statistics to all audiences

Text Book:

1. Elements of Probability and Statistics – A.P. Baisnab and M. Jas
2. Probability and Statistics – M. H. Degroof

Reference Book:

1. Mathematics of Statistics Vol I & II – J. F. Kenney & E. S. Keeping
2. Introduction to Statistics – R. G. D. Steel

EC-1002	Digital Logic & Design	L-T-P-C:3-0-0-3

Course objective:

- To prepare students to understand the basic ideas and principles of digital logic levels.
- To prepare students to perform the analysis and designing of various digital electronic circuits.

Module I

Number System, Binary Codes and Boolean Algebra: Conversion of bases, Representation of negative numbers, 1's complement, 2's complement, arithmetic using 2's complement, Hexadecimal code, weighted codes - BCD, Excess-3 code, Gray Code. Logic gates, Boolean Algebra, Standard and canonical representation and minimization of Boolean expressions using Karnaugh map.

Module II

Combinational Logic Circuits: Half Adder, Full Adder, Half Subtractor, Full Subtractor, Full adder using half adder, BDC Adder. Carry Look ahead, Multipliers. Multiplexer/de- multiplexers, Encoders and Decoders, Application of universal logic gates.

Module III

Sequential Logic Circuits: Latches, Edge Triggered Flip Flops: SR, D, JK, Master slave JK. Excitation tables, conversion of Flip Flops. State Diagrams.

Module IV

Counters and Registers: Synchronous and Asynchronous counters, Up/Down Counters, Design of Synchronous counters, Cascaded Counters, Counter Decoding, Counter applications. Shift register functions, Serial in/serial out shift registers, serial in parallel out/shift registers, Parallel In/Parallel out shift registers, bidirectional Shift registers, Shift register counters, Shift register Applications.

Module V

Converters, Logic Families and Wave shaping using IC-555: Design of various Analog to Digital & Digital to Analog Converters. Parameters of Logic Families. Introduction to logic Families: DTL, RTL, TTL, CMOS.555 Timer, astable and monostable multivibrator and bistable multivibrator.

Course outcome:

After studying this course, the students would gain enough knowledge

- Have a thorough understanding of the fundamental concepts and techniques used in digital electronics.
- To understand and examine the structure of various number systems and its application in digital design.
- The ability to understand, analyze and design various combinational and sequential circuits.
- Ability to identify basic requirements for a design application and propose a cost effective solution.
- The ability to identify and prevent various hazards and timing problems in a digital design.
- To develop skill to build and troubleshoot digital circuits.

Text Book:

1. Digital Design 5e, Mano / Ciletti, Pearson
2. Digital Circuits and Design 5e, Salivahanan, Oxford
3. Digital Design: With an Introduction to the Verilog HDL, VHDL, and System Verilog, 6e, Mano, Pearson.

Reference Book:

1. Digital Electronics: Principles and Integrated Circuits, Maini, Wiley
2. Digital Electronics, Kharate, Oxford
3. Digital Design: Principles and Practices, 4e, Wakerly, Pearson

EC-1102	Digital Logic & Design Lab	L-T-P-C:0-0-3-2

Digital Logic and Design Lab includes both software and hardware portion for designing, realization, analysis and implementation of various Digital Logic circuits, such as Half adder, Half subtractor, Full

adder, Full subtractor, Code-converter, Universal Gates based circuit implementation, Digital-Comparator, Multiplexer, De-Multiplexer, Encoder, Decoder, +ve edge triggered Master slave JK-FF, -ve edge triggered Master slave JK-FF, Shift-register - SISO (serial in serial out) - SIPO (serial in parallel out) - PISO (parallel in serial out) - PIPO (parallel in parallel out), ripple UP-counter, ripple DOWN-counter, and various synchronous as well as asynchronous counters.

CS-1002	Data Structure and Programming Languages	L-T-P-C:3-0-0-3

Course objective:

- Understand and remember algorithms and its analysis procedure.
- Introduce the concept of data structures through ADT including List, Stack, and Queues.
- To design and implement various data structure algorithms.
- To introduce various techniques for representation of the data in the real world.
- To develop application using data structure algorithms.
- Compute the complexity of various algorithms.

Module I

Data structures fundamentals, Abstract data types, Arrays, Sequential and linked structures, Stacks, Queues, Dynamic memory allocation, Compaction and Garbage collector, Python fundamentals, Data types, Variables, Boolean values, Operators, Functions, Tuples.

Module II

I/O Operations, Conditional execution, Loops, Logical and bit wise operations, Lists and list processing, Dictionaries and Data processing, Modules, Packages.

Module III

String and List methods, Exceptions, Trees, binary trees, binary tree traversals, Threaded trees, Applications of trees.

Module IV

Graphs, Graphs representations, Depth first and Breadth first search algorithms, minimum spanning trees, Shortest path algorithms, Application of Graphs.

Module V

Sorting and Searching, Merge-sort, Quick-sort, Heap-sort, Binary search, External search, Hashing, String algorithms.

Course outcome:

- Select appropriate data structures as applied to specified problem definition.
- Implement operations like searching, insertion, and deletion, traversing mechanism etc. On various data structures.
- Students will be able to implement linear and Non-Linear data structures.
- Implement appropriate sorting/searching technique for given problem.
- Design advance data structure using Non-linear data structure.
- Determine and analyse the complexity of given Algorithms.

Text Book:

1. Jon Kleinberg and Eva Tardos; Algorithm Design, Pearson education Inc. 2006.
2. John Jelly; Python Programming : An Introduction to Computer Science , 3rd Edition , 2016

Reference Books:

1. G. Shanker Rao; Mathematical Foundations of Computer Science, I.K. International Publishing House Private Limited, 2006.
2. A.M. Tenenbaum, Y. langsum and M.J. Augenstein; Data Structures using C, Prentice Hall of India private. Limited, 2015.
   Robert Sedgewick; Algorithms in C, Addition-Wesley, 1998.

CS-1102	Data Structures Lab	L-T-P-C:0-0-3-2

Demonstration of simple programs execution on Computer in Python. Python application in solving problems on System of n algebraic equations, Matrix manipulations, Prime numbers, Fibonacci sequences, N-Queens problems, Tower of Hanoi, Sudoku puzzles, Magic squares, Sorting and Searching, Sequential and random access files manipulations, Lists, trees and graphs.

CS-1004	Discrete Mathematics	L-T-P-C: 3-1-0-4

Course objective:

- To develop logical thinking and its application to computer. The subject enhances one's ability to reason and ability to present a coherent and mathematically accurate argument.
- To learn the idea behind development of automaton and finite state machines
- To understand about limit of computability.

Course content:

Unit-I

Mathematical Logic: Statements and Connectives, Elementary operations of logic, Well-formed statement formulas, Equivalence of formulas, Principle of duality, Tautologies and Implications, Functional completeness of sets of connectives, Exclusive OR: NAND and NOR, Disjunctive and Conjunctive Normal forms, Propositional Logic; Inference theory, Predicates, Variables and Quantifiers, Predicate formulas, Free and Bound Variables, Universe of Discourse, Valid formulas and Equivalences, Theory of Inference for Predicate Calculus

Unit-II

Sets: Concept of Infinity. Cardinals and Ordinals. Countable and Uncountable Numbers. Cantor's Theorems; Relations, Properties of Relations, Equivalence relations and Partitions, Relation matrices, Counting: Principle of Inclusion and Exclusion, Functions: Characteristic Functions, Permutation Functions, Cycle decomposition of permutations, Even and Odd permutations, Growth of Functions.

Unit-III

Lattices and Boolean Algebra: Partially Ordered sets, Lattices properties of Lattices,
Finite Boolean Algebras.

Unit-IV

Algebraic Structures, Set with one operation: Semi-group, Monoid, Group, Permutation Group; Set with two operations: Ring and Fields. Isomorphism, Automorphism and Homomorphism. Polynomial Rings and Cyclic Codes.

Unit-V

Graphs: Definitions and Representation; Directed Graphs: Matrix representation of Digraphs, Path and Reachability, Transitive Closures and Warshall's Algorithm. Eulerian and Hamiltonian paths and cycles, Graph Traversal algorithms. Trees: Rooted Trees, Undirected Trees, Spanning Trees of Graphs, Algorithms for Minimal Spanning Trees.

Unit-VI

Modeling of Computation: Language and Grammar. Finite State Machine &Monoid. Russel's Paradox and In computability. Tractable and Intractable problems.

Course outcome:

- Expressing a logic sentence in terms of predicates, quantifiers, and logical connectives.
- Distinguishing between different infinite sets and limit of computation
- Understanding the set of naturals, reals, complex numbers and integers and the operations applicable over them to make them Group, Ring or Field
- Using tree and graph algorithms to solve problems.
- Evaluating Boolean functions and simplify expressions using the properties of Boolean algebra.

Text Book:

1. C Liu, D. Mohapatra. Elements of Discrete Mathematics: A Computer Oriented Approach.
2. Narsingh Deo. Graph Theory With Applications To Engineering And Computer Science
3. Kenneth H Rosen. Discrete Mathematics and Its Applications. TMH Publishing.

Reference Book:

1. Tremblay & Manoher: Discrete Mathematical Structures with Applications to Computer Science (Tata McGraw Hill)
2. Kolman, Busby & Ross: Discrete Mathematical Structures (Prentice Hall of India)
3. Mott, Kandel & Baker: Discrete Mathematics for Computer Scientists and Mathematicians (Prentice Hall of India).

HS-1002	Ethics & Human Values	L-T-P-C:2-0-0-2

Course objective:

- To develop a critical ability to distinguish between essence and form, or between what is of value and what is superficial, to life.
- To move from discrimination to commitment. It is to create an ability to act on any discrimination in a given situation.
- It encourages students to discover what they consider valuable. After learning the course, they should be able to discriminate between valuable and the superficial in real situations in their life.

Course content:

Module I

Human Values: Morals, Values and Ethics Integrity- Work ethic- Service learning – Civic virtue – Respect for others - Living peacefully- Caring- Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy- Self-confidence- Character- Spirituality – Introduction to Yoga and meditation for professional excellence and Stress management.

Module II

Engineering Ethics: Senses of Engineering ethics – Variety of moral issues, types of inquiry- Moral dilemmas- Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles – Theories of right action – Self-interest – Customs and Religion – Uses of Ethical theories.

Module III

Engineering as Social Experimentation: Engineering as Experimentation – Engineers as responsible experimenters – Code of ethics – A Balanced Outlook on Law

Module IV

Safety, Responsibilities And Ethics: Safety and Risk – Assessment of Safety and risk, Risk Benefit Analysis and Reducing Risk – Respect for authority – Collective Bargaining – Confidentiality – Conflict of interest –Occupational crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination

Module V

Global Issues: Multinational Corporations – Environmental Ethics – Computer ethics – Weapons Development – Engineers as managers – Consulting engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership – Code of conduct – Corporate Social Responsibility

Course outcome:

- It ensures students sustained happiness through identifying the essentials of human values and skills.
- It facilitates a correct understanding between profession and happiness.
- It helps students understand practically the importance of trust, mutually satisfying human behavior and enriching interaction with nature.
- Ability to develop appropriate technologies and management patterns to create harmony in professional and personal life.

Text Book:

1. Mike W Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003
2. Govindarajan M, Natarajan S, Senthil Kumar V S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004

Reference Book:

1. Charles B Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004
2. Charles E Harris, Michael S Pritchard and Michael J Rabins, "Engineering Ethics-Concepts and Cases", Cengage learning, 2009.
3. John R Boatright, "Ethics and the Conduct of Business", Pearson education, New Delhi, 2003
4. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for scientists and engineers", Oxford university press, 2001
5. Laura P Hartman and Joe Desjardins, "Business Ethics: Decision making for personal integrity and social responsibility", McGraw Hill education, India Pvt, New Delhi, 2013

Semester III

MA-2001	Mathematics-III (Complex variable, Real analysis & Linear Algebra)	L-T-P-C:3-1-0-4

Course objective:

- To equip the students with methods of solving a general system of linear equations.
- To familiarize them with the concept of Eigen values and diagonalization of a matrix which have many applications in Engineering.
- To understand the basic theory of functions of a complex variable and conformal Transformations.

Module I

COMPLEX VARIABLES: Algebra of complex numbers, elementary analytic functions, complex integration, series representations for analytic functions, residue theory and conformal mapping and its applications.

Module II

Elementary set theory, finite, countable and uncountable sets. Real number system as a complete ordered field. Archimedean property, supremum, infimum. Riemann-Stieltjes integral, properties, integration and differentiation, fundamental theorem of calculus. Sequence and Series, convergence, limsup, liminf.

Module III

Bolzano-Weierstrass Theorem. Heine-Borel Theorem. Sequence and Series of Function, pointwise and uniform convergence, Cauchy Criterion for uniform convergence. Weierstrass's M-Test, Abel's and Dirichlet's Test for uniform convergence, uniform convergence and continuity, uniform convergence and Riemann-Stieltjes integration, uniform convergence and differentiation, Weierstrass approximation Theorem. Power Series, uniqueness theorem.

Module IV

Abel's and Tauber's Theorem. Function of Several Variables. Directional derivative, derivative as a linear transformation. Taylor's Theorem, Inverse function and implicit function theorem, Jacobians, extremum problems with constraints. Monotonefunctins, types of discontinuity, functions of bounded variation, Lebesgue measure and Lebesgue integral.

Module V

Linear Algebra: Matrices over a field. Matrix, characteristic and minimal polynomials, eigen values and eigen vectors. Caylay-Hamilton Theorem. Linear transformation (L.T), rank and nullity, dual space and basis, representation of L.T by matrices. Change of basis. Normal form of matrices. Invariant factors and elementary divisors. Unitary similarity, unitary and normal operators on inner product spaces. Triangular, Jordan and rational form of matrices.

Course outcome:

- Solve any given system of linear equations
- Find the Eigen values of a matrix and how to diagonalize a matrix
- Identify analytic functions and Harmonic functions.
- Evaluate real definite Integrals as application of Residue Theorem.
- Identify conformal mappings
- Find regions that are mapped under certain Transformations.

Text Book:

1. Complex Variables and Applications- J. W. Brown and R. V. Churchill.
2. Mathematical Analysis- T. M. Apostol
3. Linear Algebra-G. E. Shiby

Reference Book:

1. Real Analysis- R. R. Goldberg

2.	Linear Algebra-J. H. Kwak & S. Hong

CS-2001	Python Programming	L-T-P-C:3-0-0-3

Course content:

Module I

Introduction, Data Types and Operators: Installation and working with Python, Variables and data types in python, Perform computations and create logical statements using Python's operators: Arithmetic, Assignment, Comparison, Logical, Membership, Identity, Bitwise operators, list, tuple and string operations.

Module II

Python Decision making and Loops: Write conditional statements using If statement, if ...else statement, elif statement and Boolean expressions, While loop, For loop, Nested Loop, Infinite loop, Break statement, Continue statement, Pass statement, Use for and while loops along with useful built-in functions to iterate over and manipulate lists, sets, and dictionaries. Plotting data, Programs using decision making and loops.

Module III

Python Functions and Modules: Defining custom functions, Organizing Python codes using functions, Create and reference variables using the appropriate scope, Basic skills for working with lists, tuples, work with dates and times, get started with dictionaries, Importing own module as well as external modules, Programming using functions, modules and external packages

Module IV

Python File Operations: An introduction to file I/O, use text files, use CSV files, use binary files, Handle a single exception, handle multiple exceptions, Illustrative programs, Exercises.

Module V

MicroPython: Introduction, main difference between MicroPython and Python, Installation of MicroPython on Hardware, MicroPython libraries, GPIO programming on MicroPython Hardware, Sensor Programming using MicroPython.

Course outcome:

The course is designed to provide Basic knowledge of Python. Python programming is intended for software engineers, system analysts, program managers and user support personnel who wish to learn the Python programming language.

Text Book:

1. Introduction to Computation and Programming Using Python, John V Guttag, PHI.
2. Fundamentals of Python – First Programs, Kenneth A. Lambert.

Reference Book:

1. Python Programming Fundamentals- A Beginner's Handbook, Nischay kumar Hegde.
2.

CS-2101	Python Programming Lab	L-T-P-C:0-0-3-2

Control structures, list and tuples, conditional statements and loops, functions, Import a module, plot data, MicroPython and NodeMCU. Configure NodeMCU for MicroPython. MicroPython to send digital data on GPIO pins of NodeMCU and glow LED connected with NodeMCU or any other MicroPython supported board. Connect Digital/Analog I/O module with NodeMCU, Display temperature in MicroPython, Connect NodeMCU with with WiFi Access Point and transmit data from NodeMCU to Cloud. Connect

Digital/Analog I/O module with NodeMCU and send temperature and light data on cloud (Thingspeak, Firebase or any other cloud service).

CS-2003	Computer Organization and Architecture	L-T-P-C:3-0-0-3

Module I

Introduction: Organization and Architecture, Block diagram of digital computer, Structure and function, Register Transfer language, Register transfer Bus and Memory transfer.

Module II

Computer Arithmetic: Arithmetic micro operations, Logic micro operations, Shift micro operations and Arithmetic logic shift unit, Addition and Subtraction, Multiplication Algorithms and Division Algorithms, Floating Point representation and its Operations

Module III

Computer Organization and Design: Instruction codes, Computer Registers, Computer instructions, Instruction cycle, Memory-reference Instructions, Register reference instructions, Input-output and Interrupt, Stack organization, Instruction formats, Addressing modes, Data Transfer and manipulation, Program control, Reduced Instruction set computer.

Module IV

Pipeline Processing and Memory Organization: Pipeline Processing- Parallel Processing, Pipelining, Arithmetic Pipeline, Instruction Pipeline, RISC Pipeline, memory organization – Memory Hierarchy, Main memory, Auxiliary memory, Associative memory, Cache memory, and Virtual memory.

Module V

Input – Output Organization: Peripheral Devices, Input-Output Interface, Asynchronous Data Transfer, Modes of Transfer, Priority Interrupt Direct memory Access, Input-Output Processor, Serial Communication.

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

- Identify functional units, bus structure and addressing modes
- Design the hardwired and micro-programmed control units
- Identify memory hierarchy and performance.
- Design Arithmetic Logic Unit
- Interface I/O devices
- Understand pipelined execution and instruction scheduling

Text Book:

1. M .Morris Mano, Computer System Architecture, Pearson Edu.

Reference Book:

1. William Stallings, Computer Organization and Architecture Designing for Performance, Pearson Education.
2. Carl Hamacher, Computer Organization, McGraw Hill Publishers.

CS-2103	Computer Organization and Architecture Lab	L-T-P-C:0-0-3-2

List of Experiments:

1. Study and design of various adder, subtractor, multiplexer.
2. Design of ALU with at least 8 operations.
3. Design of simple memory with m number of address lines and n number of data lines.
4. Design of Associative/Direct mapped cache memory design
5. Using Xilinx timing analysis tools finding cycle time and pipelining gain. Using Xilinx or ModelSim (Simulator) design a pipelined processor.
6. Write or modify programs to test all the different hazard cases.

EC-2001	Analog & Linear Integrated Circuit	L-T-P-C:3-0-0-3

Course objective:

- Elucidate and design of Analog amplifier and Feedback circuits
- Acquaint with the theoretical & practical aspects of Op-amp with different linear and non-linear applications.
- Illustrates the function of application specific ICs such as Voltage regulators, PLL for different electronic applications.

Module I

Basics of Analog Amplifier: Differential amplifier, configurations, AC analysis, constant current bias, Darlington pair, current mirror, cascaded differential amplifier stages, effect of coupling, level translator.

Power Amplifiers Classification: A, B, AB, C Classes, Efficiency, Push Pull Configuration, Complimentary Symmetry, Second Harmonic & Cross Over Distortion.

Module II

Feedback Amplifier and Oscillator: Concept of feedback, types of feedback – their advantages and disadvantages, effect of feedback on frequency response & impedances, Analysis of different feedback amplifiers. Voltage-series and Current shunt Feedback amplifiers using FET.

Oscillators Stability, Barkhausen Criteria, RC, LC & Crystal Oscillators

Module III

Basics of Operational Amplifier: Op-amp (symbol, equivalent circuit and its analysis, open loop transfer characteristics), Ideal op-amp based basic configurations (inverting amplifier, non-inverting amplifier, voltage follower, summing amplifier using inverting and non-inverting configurations, differential input-differential output amplifier, difference amplifier, instrumentation amplifier, I to V converter, V to I converter, integrator, differentiator, Practical op-amp IC741 characteristics Input/output Impedance, Slew Rate, CMRR etc.

Module IV

Applications of Operational Amplifier: Design and analysis of first and higher order low pass, high pass, band pass (wide and narrow band) and band elimination (wide and narrow band) and all pass active filters;Log and anti-log amplifiers, analog multipliers, precision circuits (half-wave and full wave rectifiers, positive and negative clipper circuits, positive and negative clamper circuits, peak detector circuits), comparator and Schmitt trigger circuits, sample-and-hold circuits.

Sinusoidal oscillators (oscillators based on phase-shift, Wien bridge, Hartley, Colpitt, crystal), Non-sinusoidal oscillators (square and triangular waveform generators), Data converters: Binary weighted, R-2R digital to analog converters, flash type, successive approximation type, counter type, dual slope analog to digital converters.

Module V

Special Function ICs: Timer IC-555, Multivibrators, Voltage controlled oscillator, Phase-locked loop, Voltage regulators, Voltage to Frequency converters, OTA, Opto-couplers and fibre optic IC.

Course outcome:

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

- Design Analog amplifier and feedback circuits
- Infer different characteristics of operational amplifiers and its effect on output and their compensation techniques.
- Demonstrate linear and non-linear applications of an Op-amp and special application ICs.
- Design linear and non-linear applications of operational amplifiers.

Text Book:

1. S. Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", McGraw-Hill Education, 4th Edition, 2016.
2. D. R. Choudhry and S. B Jain, "Linear Integrated Circuits", New Age International, 5th Edition, 2018.
3. Jacob Millman and Christos C. Halkias,"Integrated Electronics: Analog and Digital Circuits and Systems", Tata McGraw Hill Education, 2nd Edition, 2011.

Reference Book:

1. L.K. Maheshwari, M.M.S. Anand, "Analog Electronics", Prentice Hall India, 2nd Edition.
2. Behzad Razavi, "Design of Analog CMOS Integrated Circuits", Tata McGraw Hill, 2nd Edition, 2017.

EC-2101	Analog & Linear Integrated Circuit Lab	L-T-P-C:0-0-3-2

Experiments related to Differential amplifier, Oscillator, Power amplifier, Inverting and non-inverting amplifier, Integrator and differentiator, Zero-crossing detector, Summing amplifier, Logarithmic and antilogarithmic amplifier, Schmitt trigger, Second and third order low and high pass filter, Band pass filter, square wave and triangular wave generators, Astable and monostable multivibrator, RC phase shift oscillator, D/A and A/D converter and PLL.

Project:

Mini project based on operational amplifier applications.

EC-2003	Circuit Analysis & Synthesis	L-T-P-C:3-0-0-3

Course objective:

- Familiarization with laws and methods of network analysis and synthesis.
- Realize the AC steady-state responses and transient response of resistance, inductance and capacitance in terms of impedance.
- Acquaint with Two port networks, Feedback circuit and Amplifier

Module I

Node and Mesh Analysis: Node and mesh equation, matrix approach of complicated networkcontaining voltage and current sources, and reactance, source transformation and duality.

Network Theorems: Superposition, reciprocity, Thevenin's, Norton's, Maximum power Transfer, Millar's theorem, compensation and Tallegen's theorem as applied to AC. circuits.

Module II

First order circuits: RC, RL, and RLC networks with and without initial conditions, with Laplace transforms evaluation of initial conditions, Q factor.

Module III

AC Circuit Analysis: Instantaneous and average power, RMS value, apparent power and power factor, Behavior of series and parallel resonant circuits, Transient behavior, concept of complex frequency, Driving points and transfer functions poles and zeros of immittance function, their properties, sinusoidal response from pole-zero integral solutions, locations, Behavior of series and parallel resonant circuits, Introduction to band pass, low pass, high pass and band reject filters.

Module IV

Two Port Network Analysis:

Z, Y, h, ABCD parameters and circuit analysis, Analysis of a transistor amplifier using h parameters.

Feedback and Amplifiers

Different types of feedback, Amplifiers

Course Outcome:

Upon Completion of the course, the students will be able to:

- Understand the concept of circuit elements, lumped circuits, circuit laws and reduction.
- Analyze AC circuits parameters
- Synthesize networks and model the electronic circuits

Text Book:

1. Charles Alexander and Mathew Sadiku, "Fundamentals of Electric Circuits", 5th Edition, 2014, TMH.
2. Van Valkenburg; Network analysis, 3rd Edition, 2019, Pearson

Reference Book:

1. A. Sudhakar, S.P. Shyammohan, Circuits and Network, 5th Edition, 2017, Tata Mcgraw-Hill New Delhi.
2. Jhon Bird, Electrical Circuit Theory and Technology; 3rd Edition, 2016, PHI.

HS-2001	Management Concepts and Organizational Behavior	L-T-P-C:2-0-0-2

Course objective:

- To expose the students to basic concepts of management.
- To equip the students with requisite knowledge, skills & right attitude necessary to understand behavioral processes at individual, team and organizational level.
- To provide effective leadership in a global environment.

Module I

Introduction of Management- Meaning, definitions, nature of management; Managerial levels, skills and roles in an organization; Functions of Management: Planning, Organizing, staffing, Directing & Controlling, Interrelationship of managerial functions, scope of management & Importance of management.

Module II

Introduction of organization: - Meaning and process of Organization, Management v/s Organization; **Fundamentals of Organizational Behavior:** Concepts, evolution, importance and relationship with other Fields; Contemporary challenges and opportunities of OB. **Individual Processes and Behaviour**- **Personality**- Concept, determinants and applications; **Perception**- Concept, process and applications, **Learning**- Concept (Brief Introduction); **Motivation**- Concept, techniques and importance

Module III

Interpersonal Processes- **Teams and Groups**- Definition of Group, Stages of group development, Types of groups, meaning of team, merits and demerits of team; difference between team and group, **Conflict**- Concept, sources, types, management of conflict; **Leadership:** Concept, function, styles & qualities of leadership. **Communication –** Meaning, process, channels of communication, importance and barriers of communication.

Module IV

Organizational Processes: Organizational structure - Meaning and types of organizational structure and their effect on human behavior; **Organizational culture -** Elements, types and factors affecting organizational culture. **Organizational change:** Concept, types & factors affecting organizational change, Resistance to Change.

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

1. apply the managerial concepts in problem-solving for effectively managing the organizational processes.
2. apply interpersonal skills within and outside of organization effectively.
3. understand the individuals and groups inside organizations.
4. understand the organizational culture and change

Text Book:

1. Robbins, S.P. and Decenzo, D.A. Fundamentals of Management, Pearson.
2. Stoner, J et. al, Management, Prentice Hall of India
3. Moorhead, Griffin, Introduction to Organizational Behaviour, Cengage.
4. Hitt, Miller, Colella, Organizational Behaviour, Wiley
5. Robbins, S.P. & Judge, T.A., Organisational Behaviour, Prentice Hall of India

Reference Book:

1. Ghuman Karminder, Aswathappa K., Management concept practice and cases, Mc Graw Hill.
2. Satya Raju, Management – Text & Cases, PHI.
3. Pareek, Udai, Understanding Organizational Behavior, Oxford
4. K. Awathappa, Organizational Behavior, HPH.
5. Kavita Singh, Organizational Behavior: Text and cases, Pearson.

Semester IV

EC-2002	Electromagnetic Theory	L-T-P-C:3-1-0-4

Course objective:

- To understand the fundamental principles and laws of electromagnetic propagation and radiation effects.
- To understand operation of transmission line and waveguide.

Module I

Introduction to co-ordinate systems:-Cartesian coordinate, Cylindrical Coordinates, Spherical Coordinates, Inter Coordinate Transformation; Differential length, Area and Volume, Line, Surface and Volume Integrals; Divergence Theorem, Stokes's Theorem; Electric Field Intensity:-field of line charge, sheet charge, continuous volume charge distribution; Electric flux density, Gauss Law, Applications of Gauss Law; Definition of Electric potential, work, Energy potential difference, Potential field of different types of charges, Potential gradient, dipole and field due to a dipole, Energy density in the electric field.

Module II

Time Varying Fields and Maxwell's Equation: Gauss's law, Poisson's and Laplace's Equations, Ampere's Circuit Law, Magnetic Flux Density, Faraday's Law, Introduction of Maxwell's equations, displacement current, equations of continuity for time varying field.

Module III

Wave equation in an isotropic homogeneous medium and its solution, phasor notation, polarization of waves, reflection and refraction of plane waves at plane boundaries, Poynting vector.

Module IV

Waveguides and Planar Transmission Lines: Electromagnetic fields in parallel-plate, rectangular, and circular waveguides, TE and TM modes, wave impedance, wave velocities, attenuation in waveguides, Electromagnetic fields in microstrip lines, and co-planar waveguides.

Module V

Transmission Lines: Time-domain analysis of transmission lines; Bounce diagrams; Frequency-domain analysis of transmission lines; Standing waves; Smith chart; Transmission line matching: Single and double-stub matching, Types of antenna and their applications.

Course outcome:

- It will get you ready for advanced courses in antenna, microwave, radar, and wireless Communication.
- Ability to understand and compute Electromagnetic fields and apply them for design and Analysis of electrical equipment and systems.

Text Book:

1. Sadiku Matthew N.O. "Elements of Electromagnetic", Oxford University Press.
2. Hayt, W. H. and Buck J. A., "Engineering Electromagnetics", Tata Mc Graw Hill.

Reference Book:

1. Pozar D.M. "Microwave Engineering", Fourth Edition, John Wiley & Sons Inc.
2. Joseph Edminister, Vishnu Priye," ELECTROMAGNETICS", Schaum's Outline Series.

EC-2004	Microprocessors and Microcontrollers	L-T-P-C:3-0-0-3

Course objective:

- To introduce basics of microcontrollers and microprocessor, their architecture, internal organization and their functions, interfacing an external device with the controllers/processor.
- To provide strong foundation for designing real world applications using microprocessors and microcontroller.

Module I

Introduction to 8085: Microprocessor architecture – Addressing modes – Instruction set and assembler directives – Assembly language programming – Modular Programming – Linking and Relocation – Stacks – Procedures – Macros – Interrupts and interrupt service routines – Byte and String Manipulation.

Module II

System Bus Structure: Basic configurations – System bus timing –System design using 8085 – I/O programming – Introduction to Multiprogramming – System Bus Structure – Multiprocessor configurations – Coprocessor, Closely coupled and loosely Coupled configurations – Introduction to advanced processors

Module III

Memory Interfacing and I/O interfacing – Parallel communication interface – Serial communication interface – D/A and A/D Interface – Interrupt controller – DMA controller – Programming and applications

Module VII

Microcontroller: Architecture of 8051 – Special Function Registers (SFRs) – I/O Pins Ports and Circuits – Instruction set – Addressing modes – Assembly language programming and interfacing-system design using 8051.

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

- Identify a detailed s/w & h/w structure of the Microprocessor.
- Interface different external peripheral devices with microprocessors and microcontrollers.

Text Book:

1. Ramesh Gaonkar, "Microprocessor architecture, programming, and application with the 8085", Penram International, 2002.
2. Mohamed Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Second Edition, Pearson education, 2011.
3. Doughlas V. Hall, Microprocessors and Interfacing, TMH, 2nd edition, 2006.

Reference Book:

4. Ashok Kumar Mukhopadhyay, "Microprocessor, Microcomputer and Their Applications", 3rd Edition, Alpha Science International Limited, 2007.
5. K.Uma Rao, Andhe Pallavi, "The 8051 microcontrollers, architecture and programming and applications", Pearson, 2009.
6. Liu & Gibson, "Microcomputer Systems - The 8086/8088 Family Architecture, Programming and Design", Prentice Hall of India, 2nd Ed, 2006.

EC-2104	Microprocessors and Microcontrollers Lab	L-T-P-C:0-0-3-2

Programming using 8085 kit: Simple programs based on the arithmetic and logical operation; Design of a variable time delay counter (mod 8); Measuring pulse width of a square wave.
Interfacing: stepper motor, matrix keyboard (4×4), traffic light controller; Implementing ADC, Generating triangular saw tooth and square wave; Communication between microprocessors using 8255 PPI chip; Generate various waveforms using DAC.
Simple project using Raspberry Pi and Arduino.
Programming using 8051 kit: Simple programs based on the arithmetic and logical operation; delay generation; Interfacing; waveform generation using DAC.

EC-2006	Signals and Systems	L-T-P-C:3-0-0-3

Course objective:

- Analyze signals and systems to represent real world system in terms of both the time and transform domains.
- Develop the mathematical skills to design solutions to real world problems using convolution, filtering, modulation and sampling.

Module I

Introduction to Signals and Systems: Signal basics, classification of signals, Elementary signals, Transformations of the independent variables, Exponential and Sinusoidal signals, signal operations, signal properties, Sampling and Reconstruction of signals, System basics, classification of systems, Continuous-Time Systems, Discrete-Time Systems, system properties, linearity, time/shift-invariance, causality, stability.

Module II

Linear Time-invariant Systems: Continuous-time Linear Time-invariant (LTI) system, Discrete-time LTI system, Properties of LTI systems, Impulse response and step response, response to an arbitrary input, Convolution, Correlation, System representation through linear constant coefficient differential equations.

Module III

Frequency Analysis of Signal and Systems: Fourier series representation of continuous-time periodic signals, Properties of continuous-time Fourier series, Fourier series and LTI systems, Representation of aperiodic signals, The Fourier transform for periodic signals, Properties of the Continuous-time Fourier transform (CTFT), Convolution and multiplication properties and their effect in the frequency domain. Frequency Analysis of Continuous-Time Signals, Frequency Analysis of Discrete-Time Signals, Properties of Discrete-Time Fourier Transformation (DTFT), Frequency-domain characteristics of Liner-Invariant Systems

Module IV

Laplace Transform and Z -Transform: The Laplace transforms for continuous-time signals and systems, Properties of the Laplace transform, Analysis and characterization of LTI systems using the Laplace transform, z-transformation, Properties of the Z-Transformations, Inversion of the z-transform, The One-Sided Z-transformation, Analysis of Linear-Time-Invariant Systems in the Z-Domain.

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

- Classify signals and systems based on their properties and determine the response of LTI system using convolution.
- Analyze the spectral characteristics of continuous-time periodic and a periodic signals using Fourier analysis.
- Analyze system properties based on impulse response and Fourier analysis.
- Apply the Laplace transform and Z- transform to analyze continuous-time and discrete-time signals and systems.

Text Book:

1. A. V. Oppenheim, A. S. Willsky, and S. H. Nawab, "Signals and Systems", Prentice Hall, 2nd Edition, 2003.
2. B.P. Lathi, "Principles of Linear Systems and Signals", Oxford University Press, 2nd Edition, 2009.

Reference Book:

1. M. J. Roberts, "Fundamentals of Signals & Systems", Tata McGrawHill, 2007.
2. R. E. Zeimer, W. H. Tranter and R. D. Fannin, "Signals & Systems - Continuous and Discrete", Pearson Education, 2007.
3. S. Haykin and B. V. Veen, "Signals and Systems‖ 2nd Edition", Wiley, 2007.

EC-2008	Analog Communication	L-T-P-C:3-0-0-3

Course objective:

- To analyzed nature of transmission and reception of baseband signals.
- To introduce the students to various modulation and demodulation techniques of analog communication i.e. amplitude, angle and pulse modulation.
- To analyze the noise performance of the communication system.

Module I

Introduction to Fourier Series and Fourier Transform; Energy and Power Spectral Densities; Introduction of communication, Elements of Communication System-Transmitters, transmission channels and receivers; Concepts of modulation and need for modulation.

Module II

Amplitude modulation (AM): Time domain expression of baseband signal; modulation index, frequency domain (spectral) representations, phasor diagram, AM transmission bandwidth; AM for a single tone message- carrier and side band components; Transmission requirements for AM, normalized power and side band power. Double side band suppressed carrier modulation (DSB-SC) - time and frequency domain expressions; Transmission requirements for DSB, bandwidth and transmission power for DSB-SC; Generation of DSB-SC, square law modulators, balanced modulators, ring modulators, switching modulators. Single side band modulation (SSB):Basic concept, SSB with suppressed/reduced carrier, advantages and generation of SSB; transmit band width and power, side band filter examples; Vestigial side band modulation (VSB)- Basic concept and application

Module III

Demodulation of AM signals- square law and envelope detectors; The super heterodyne receiver for standard AM radio; Synchronous demodulation of AM, DSB and SSB using synchronous detection, Effects of frequency and phase errors in the local oscillator in DSB and SSB Demodulation of SSB with pilot carrier, use of SSB in telephony. Phase-Locked Loop (PLL): Carrier recovery circuits, Basic operation of PLL, mathematical analysis, applications.

Module IV

Angle Modulation (FM/PM): Instantaneous frequency instantaneous phase, time domain representation for FM and PM; Narrow band angle modulation with frequency and phase, modulation index, Phasor diagram; FM and PM signals for a single tone message, spectral representation, power and effective bandwidth; Generation of wide band FM using Armstrong method, commercial FM requirements. Detection of FM and PM signals, limiter discriminator; Demodulation of PM using PLL; FM broadcasting and stereo FM radio.

Module V

Noise Performance of Analog Communication Systems: Signal-to-noise ratio (SNR) in linear modulation, synchronous detection of DSB; SNR for AM, DSB and SSB; comparison of DSB, SSB and AM; Effect of noise in envelope and square law detection of AM, threshold effects in nonlinear detectors; SNR for FM, SNR improvement using pre-emphasis and de-emphasis. FM threshold effects; Comparison of linear and exponential modulation system for additive white band-limited noise channels.

Module VI

Pulse Modulation, Types of Pulse modulation, PAM (Single polarity, double polarity) PWM: Generation & demodulation of PWM, PPM, Generation and demodulation of PPM.

Course outcome:

This course is designed to cover the fundamentals, principles, concepts, and techniques of analog communication systems like i.e. amplitude, angle and pulse modulation. The outcome of course are:

- Student will understand the various modulation technique and its practical implementation.
- Analyze the communication system in presence of noise in communication the channel.

Text Book:

1. J. G. Proakis and M. Salehi, "Communication Systems Engineering", Pearson Education India; 2nd edition (2015).
2. S. Haykin, "Introduction to Analog & Digital Communication Systems", Wiley, 2nd edition (2012).

Reference Book:

1. T. Schilling, "Principles of Communication system", McGraw Hill Education, 4th edition (2017).
2. G. Kennedy, B. Davis, S. Prasanna, "Electronic Communication Systems", McGraw Hill, 5th edition (2011).
3. B. P Lathi, "Modern Analog & Digital Communication Systems", Oxford; 4th edition (2011)

EC-2108	Analog Communication Lab	L-T-P-C:0-0-3-2

To design, verification and analyses the concepts of Sampling Theorem, Amplitude, DCB-SC, Frequency, Pulse Amplitude, Pulse Width, Pulse Position Modulation and Demodulation through software and hardware equipment. Also, analyses the white noise and limit the wide band & narrow band frequency range of the noise, Analog Multiplexing and Demultiplexing.

EC-2010	Control System	L-T-P-C:3-0-0-3

Course objective:

- To be able to analyze a working mathematical model of control systems.
- To be perform time-domain and frequency-domain analyses of the mathematical model to predict the transient and steady state system performance.
- Design a stable control system satisfying requirements of stability and reduced steady state error.

Module I

Introduction: Motivation, Examples and case studies of control systems, Control system Components: Sensors, Actuators, Computational blocks, And feedback control systems: open loop and closed loop control system.

Mathematical modelling: Mathematical modelling of: electrical systems, mechanical systems, electro-mechanical systems. Laplace transforms, transfer functions, electrical analogues of other dynamical systems. State-space modelling of dynamical systems. Block diagrams, block diagram reductions. Signal flow graph, Mason's gain formula.

Module II

Time-domain analysis of closed loop systems: Test signals, time response of first and second order systems, Time domain performance specifications, e. g. rise time, peak time, settling time, peak overshoot for the second and higher order system. Effects of a Pole and Zero on the Second-Order System, Steady state error and error constants for type 0, type 1 and type 2 system.

Feedback control actions: Proportional, derivative, integral control and PID control.

Module III

Solution of state equation: Eigen values & eigenvectors digitalization state transitive matrix, stability Routh-Hurwitz stability analysis.Characteristics equation of closed loop system root loci, construction of loci, Effect of adding, poles and Zeros on the loci, Stability by root loci

Module IV

Frequency Domain analysis: Bode and Nyquist plots, Effect of adding, poles and Zeros, Polar plot, Nyquist stability analysis, Relative stability: Gain and phase margins.

Module V

Frequency-Domain compensation: lead lag, Lag-lead compensation, Design of compensating networks. State Space Analysis: Transfer Matrix, Controllability and Observability.

Course outcome:

Students will develop the understanding of working control system via mathematical modelling. They can analyze the behavior of the control system in both time and frequency domain. The student will be able to:

- understands the mechanisms of various control systems and analyze their operation,
- develops own mathematical model of feedback control systems,
- Examines the control system model and verify with the concept and its applicability.

Text Book:

1. Nise Norman S., Control Systems Engineering, Wiley India, 7th edition (2018)
2. I. J. Nagrath and M. Gopal, Control system Engineering, New Age International, 5th edition (2009).

Reference Book:

1. Ogata K., Modern Control Engineering, Prentice-Hall of India Pvt Ltd., New Delhi, 3rd edition, (2000).
2. 2. Kuo B.C., Automatic Control Systems, Prentice-Hall of India Pvt Ltd., New Delhi, 6th edition, (1991).

ES-2002	Environmental Sciences & Green Technology	L-T-P-C:2-0-0-2

Course objective:

- To develop an understanding of the environment, resources and climate change issues.
- To enable the students to assess the environmental impact.
- To understand the linkage between biology, physics, chemistry, earth and atmospheric sciences.

Course content:

Module I

Introduction to Environmental Pollution: Introduction to Environmental Pollution: Environmental Awareness, Concept of an ecosystem, structure and function of an ecosystem, energy and nutrient flow, biogeochemical cycles, sources, pathways and fate of environmental pollutants.

Module II

Atmosphere & Air Pollution: Air pollution- Introduction, Segments of environment, Layers of atmosphere and their significance; Mechanism, Causative factors, Consequences and Preventive measures – Ozone depletion, Greenhouse effect and Global warming; Earth's radiation budget, Classification of air pollutants, Indoor air pollution, Smog-photochemical and sulphurous, Acid rain, Air Quality Standards, Human health effects-Bhopal gas tragedy.

Module III

Air Pollution Monitoring & Control: Pollution Sources: Stationary & Mobile Emission Sources, Monitoring & Control of air pollutants using high volume sampler, cyclone separators, wet scrubbers, electrostatic precipitators, etc. automobile emission control,

Module IV

Water Pollution: Water Resource; Water Pollution: Definition, Classification, Sources of Contamination, Pollutants & their Detrimental Effects; Water Quality: Portability limit – WHO and PHED Specification; Water Quality Monitoring, Municipal Water Treatment: Slow and Rapid Sand Filter, Disinfection – Methods, Advantages & Disadvantages, and Sterilization.

Module V

Industrial &Waste Water Treatment: Industrial Water: Specification of boiler feed water, internal and external treatment, ion exchange process, electro-dialysis, and reverse osmosis. Sewage Treatment: composition, aerobic and anaerobic treatment, chemical and biological oxygen demand

Module VI

Soil and Noise pollution: Lithosphere and Soil profile, Soil contamination, sources of soil contamination, Important environmental properties of soil contaminants, Ecological & Health effects, Exposure & Risk Assessment. Noise pollution: Brief introduction to noise pollution, source, measurement and prevention of noise pollution

Module VII

Radioactive Pollution & Solid Waste Management: Radioactive pollutant: units of radiation and instruments for their measurements, types of radioactive pollutants and risk factor associated with these radiations Radioactive waste and their disposal, accidental leakage of radiation from nuclear reactors (discuss Chernobyl and Fukushima) Solid waste management different types of solid waste, composting, biological methods of detoxification of hazardous waste Onsite handling and composting, integrated solid waste management.

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

- Identify formula and solve environmental problems
- Apply engineering equipment to solve environmental problem.
- Develop equipment for Green Technology in the society.

Text Book:

1. De. A. K., Environmental Chemistry: New Age International (P) Ltd. Publishers.
2. Masters, G.M, Introduction to Environmental Engineering.

Reference Book:

1. Miller, T. G. Jr., Environmental Science, Wadsworth Publishing House, USA
2. Connell, D. W., Basic Concepts of Environmental Chemistry

Semester V

CS-3001	Database Management Systems	L-T-P-C:3-0-0-3

Course objective:

- The focus of this course is on database design, architecture, and relational models.
- Normal forms, Internal schema and Database design would also be explored
- Also Focus on DBMS Transactions and Introduction to distributed Databases.

Module I

Introduction: Basic concepts, Advantages of a DBMS over file-processing systems, Data abstraction, Data Models and data independence, Components of DBMS and overall structure of DBMS, Data Modeling, entity, attributes, relationships, constraints, keys E-R diagrams, Components of E-R Model.

Module II

Relational Mode: Relational Model: Basic concepts. Attributes and domains, concept of integrity and referential constraints, schema diagram. Relational Query Languages: Relational Algebra and Relational Calculus: Tuple relational and domain relational calculus.

Module III

SQL: Introduction to SQL, Characteristics and advantages of SQL, SQL Data Types and Literals, DDL, Tables: Creating, modifying, deleting, Views: Creating, dropping, Updating using Views, DML, SQL Operators, SQL DML queries, SELECT query and clauses, Set Operations, Predicates and Joins, Set membership, Tuple variables, set comparison, ordering of tuples, aggregate functions, nested queries, Database modification using SQL Insert, Update and Delete queries, Dynamic and Embedded SQL and concept of stored procedures, Query-by-example.

Module IV

Relational Database Design: Notion of normalized relations, functional dependency, decomposition and properties of decomposition, Normalization using functional dependency, Multi-valued dependency and Join dependency. Storage and File Systems: Secondary Storage, RAID, File Organization, Indices, Static and Dynamic Hashing, B-trees and B+ Trees

Module V

Query Management and Transaction Processing: Measures of query cost, Selection operation, sorting and join operation, Transaction Concept, Components of transaction management, Concurrency and recovery system, Different concurrency control protocols such as timestamps and locking, validation, Multiple

granularity, Deadlock handling, Different crash recovery methods such as log-based recovery, shadow paging, Buffer management and Remote backup system.

Module VI

Object-Based Databases: Nested Relations, Complex Types and Object Orientation, Querying with Complex Types, Creation of Complex Values and Objects, Comparison of Object-Oriented and Object-Relational Databases. Database Architectures: Database system Architecture: Centralized, Client Server, Parallel and Distributed Systems. Web enabled System.

Course outcome:

- Learner would appreciate the systematic design and principals involved in any database development.
- The importance of canonical normal forms and its design in large scale database systems would be a secondary outcome of this course

Text Book:

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, "Database system concepts", 5th Edition, McGraw Hill International Edition.
2. 2. Raghu Ramkrishnan, Johannes Gehrke, "Database Management Systems", Second Edition, McGraw Hill International Editions.

Reference Book:

1. Rob Coronel, "Database systems: Design implementation and management", 4th Edition, Thomson Learning Press.
2. 2. Ramez Elmasri and Shamkant B. Navathe, "Fundamental Database Systems", Third Edition, Pearson Education, 2003.

CS-3101	Database Management Systems Lab	L-T-P-C:0-0-3-2

List of experiments:

1. ER diagrams exercise and SQL, PL-SQL: Modeling exercises for ER Diagrams, Identification of Attributes & Keys. Design Discussions. SQL Commands and Queries (20-25 Queries to be written and data retrieved)
2. Writing SQL Triggers & Assertions.
3. Mini Project implementation (Details of following are given to the students with functional components with project tasks:
4. Draw ER Diagram, Schema of each table required in Project, Normalize all table up to 3NF, Implementation Task: User Interface creation and Report generation.
5. Each student is assigned with a problem. The student is to develop a logical and physical database design for the problem.
6. The logical design performs the following tasks: Map the ER/EER diagrams to a relational schema. Be sure to underline all primary keys, include all necessary foreign keys and indicate referential integrity constraints.
7. Perform physical design based above logical design using Oracle/MSSQL on Windows platform and MySQL/PostgreSQL on Linux platform
8. Perform DML and DDL using all possible SQL commands and with the help anyone host languages like C, C++, VB etc. (i.e. embedded SQL)
9. Perform DML and DLL using PL/SQL and PL/pgSQL for the above problems.
10. Assignment based on object based database.
11. Assignment based on Indexing.
12. Design a mini project for any live problem as per SE constraints and implement using the techniques studied for above assignments.

EC-3001	Digital Communication	L-T-P-C:3-0-0-3

Course objective:

- To present the basic principles that underline the analysis and design of digital communication systems.
- Transmission of information in digital form from a generating source to one or more destinations.
- Analysis and design of communication systems affected by the characteristics of physical channels through which the information is transmitted.

Module I

Representation and processing of signals, Comparison of analog and digital communication, Conversion of analog signal to digital form, Baseband signal, Band pass signal, Block diagram of digital communications, Signal processing operations in digital communications, Quantitative analysis of modulation schemes

Module II

Baseband and Bandpass transmission through AWGN channel, PAM, Pulse code modulation, Delta modulation, Multiplexing, Correlation receiver, Matched filter, Digital modulation schemes- M-ary PSK, M-ary QAM, and M-ary FSK, Coherent and noncoherent modulation techniques

Module III

Receiver structure and error performance, Comparison of modulation schemes. Digital transmission through band-limited (BL) channel, Design of BL signals with zero ISI; Design of BL signals for controlled ISI-partial response signals; Design of transmitter and receiver for known channel, Synchronization.

Module IV

Channel capacity and coding, channel models, channel capacity and bounds on communication, Source coding and channel coding for reliable communication, Multiple Access Communication: TDMA, FDMA, DS SS, FHSS, OFDM and their applications.

Course outcome:

- Model a digital communication system.
- Understanding of the fundamental concepts and techniques, used in the design, performance analysis, and implementation of current communication systems and useful in the development of the communication systems of the future.

Text Book:

1. J. G. Proakis and M. Salehi, Communication Systems Engineering, Pearson.
2. B. Sklar, Digital Communication: Fundamentals and Applications, Pearson, 2001.

Reference Book:

1. B.P. Lathi, Zhi Ding,"Modern Digital And Analog Communication Systems"4th Edition, Oxford press.
2. J. G. Proakis, Digital Communications, McGraw-Hill, 5th Ed.
3. S. Benedetto and E. Biglieri, Principle of Digital Transmissions, Kluwer.
4. Simon Haykin, "Communication System" 5th Edition, John Wiley and sons.
5. A. B. Carlson, Communication Systems: An Introduction to Signals and Noise in Electrical Communication, McGraw-Hill.
6. M. K. Simon, S. M. Hinedi and W. C. Lindsey, Digital Communication Techniques: Signal Design and Detection, PHI.

EC-3101	Digital Communication Lab	L-T-P-C:0-0-3-2

Random binary signals, Unipolar NRZ, Polar NRZ line codes, Unipolar RZ and Polar RZ line codes, Conversion of analog signal into PCM format, Delta Modulator**,** ASK Modulator and demodulator, PSK Modulator and demodulator, FSK Modulator and demodulator, BER calculation using Monte Carlo simulation, Impairments of signals generated for different modulation formats, Multiplexer and de-multiplexer of digital signals.

Project:

Familiarization with digital communication system design

EC-3003	Microelectronics Circuits	L-T-P-C:3-0-0-3

Course objective:

- Be familiar with the MOSFET physical structure and operation, electrical characteristics, circuit models and basic circuit applications.
- To develop the ability to analyze and design microelectronic circuits for both analog and digital applications.

Module I

Introduction: Physics of MOS Transistors: Structure, Operation, I-V Characteristics, Second-Order Effects - MOS Capacitance- MOS scaling techniques-MOS Device Models- PMOS Transistor,-CMOS Technology

Module II

CMOS Amplifiers: MOS Amplifier Topologies, Biasing, Realization of Current Sources, Common-Source Stage, Common-Gate Stage, CG Stage with Biasing, Source Follower, Source Follower with Biasing

Module III

Cascode Stages and Current Mirrors: Cascode Stage, Cascode as a Current Source, Cascode as an Amplifier, Current Mirrors, Bipolar Current Mirror, MOS Current Mirror

Module IV

Differential Amplifiers: Differential Signals, Differential Pair, Bipolar Differential Pair, Qualitative Analysis, Large-Signal Analysis, Small-Signal Analysis, MOS Differential Pair, Cascode Differential Amplifiers, Common-Mode Rejection, Differential Pair with Active Load

Module V

Digital CMOS circuit: Static Characterization of Gates, Dynamic Characterization of Gates, Power-Speed Trade-Off, CMOS Inverter: Voltage Transfer Characteristic, Dynamic Characteristics, Power Dissipation, CMOS NOR and NAND gates.

Course outcome:

After studying this course, students will be able to:

- Understand the underlying physics and principles of operation of MOS field effect transistors (MOSFETs).
- Analyze and design microelectronic circuits for linear amplifier & digital applications.
- Design, simulate and optimize analog and digital CMOS circuits with the aid of CAD tools.

Text Book:

1. B. Razavi, "Fundamentals of Microelectronics", 2nd edition, Wiley, 2013.
2. S.M. Kang & Y. Leblebici, "CMOS Digital Integrated Circuits-Analysis & Design"**,** McGraw-Hill, 4th edition, 2016.

Reference Book:

- B. Razavi, "Design of Analog CMOS Integrated Circuits", TMH, 2002
- B.G. Streetman & S. Banerjee, "Solid State Electronic Devices", PHI, 6th edition, 2009.
- Sedra and Smith, Microlectronics Circuits, Oxford University Press, 7th edition, 2017.

EC-3103	Microelectronics Circuits Lab	L-T-P-C:0-0-3-2

Introduction to SPICE Simulation, AC/DC operation, DC sweep transfer function, frequency response, transient response, device models, simulation and analysis of electronic circuits and systems.

Study of PMOS & NMOS Characteristics using SPICE; Static behavior of CMOS inverter; Dynamic behavior of CMOS inverter; Simulation of CMOS gates –NAND, NOR, NAND etc., various MOS amplifier topologies, MOS differential amplifier- various current-mirror circuits.

EC-3005	Microwave Engineering	L-T-P-C:3-0-0-3

Course objective:

- Analyze transmission-line circuits at RF and microwave frequencies
- Use the Smith chart for solving transmission-line problems
- Design impedance matching in transmission-line networks
- Perform transient analysis of transmission-line networks
- Analyze EM transmission characteristics of planar-lines and waveguides
- Design planar-line sections for RF and Microwave circuits

- Perform Scattering parameter analysis of RF networks.

Module I

Introduction: Introduction to Microwave Engineering, Microwave System, Microwave Frequencies, Millimetre waves, Lumped and Distributed Elements, Applications of Microwave Engineering, Maxwell's Equation.

Module II

Microwave Waveguides: General Solutions for TE, TM, TEM waves, Parallel Plate Waveguide, Rectangular Waveguide, and Circular Waveguide, Coaxial line, Strip line, Microstrip line.

Module III

Microwave Components: Hybrid microwave circuits – Waveguide Tees, Magic Tees, Hybrid rings. Microwave Cavities – Circular cavity and Rectangular Cavity Resonator. Circulators, Isolators, Directional Couplers, Power Dividers.

Module IV

Microwave Devices: Schottky diode, PIN diode, Varactor diodes, IMPATT diode, TRAPATT diode, BARITT diode, Tunnel diode, Gunn diode, MBT, HBT

Module V

Microwave Tubes: Klystrons, Multicavity Klystron, Reflex Klystrons, TWTs, Magnetron.

Course outcome:

- This course will provide students with a strong background in microwave and RF engineering enabling them to contribute to research and development for the emerging high speed and wireless information infrastructure.
- Students focused on the communication field or wanting to get involved in the design and applications of RF and microwave circuits and devices will need to take this course.
- Analysis and design techniques at these high frequencies are different from those followed at the lower frequencies as they involve the use of scattering parameters as well as distributed (rather than lumped) analysis approaches.

Text Book:

1. Pozar D.M. "Microwave Engineering", Fourth Edition, John Wiley & Sons Inc., 2012, ISBN: 978-0-470-63155-3.
2. Liao S.Y. "Microwave Devices and Circuits", Third Edition, Prentice Hall (Pearson Education), 2003, ISBN: 978-81-7758-353-3

Reference Book:

1. K. C. Gupta, R. Garg, and I. J. Bahl, "Microstrip Lines and Slot lines",Artech House, Dedham, Mass., 1979.

HS-3001	Entrepreneurship Development	L-T-P-C:2-0-0-2

Course objective:

- To develop entrepreneurial quality and motivation in students for entrepreneurship.
- To enable students to identify and create business opportunities that may be commercialized.
- To make the student understand the stages of the entrepreneurial process and the resources needed for the successful development of entrepreneurial ventures.

Module I

Introduction to Entrepreneurship: Meaning of Entrepreneur, Types of Entrepreneur, Entrepreneurial Traits and skills, Role of Entrepreneurship in Economic Development, Ethics and Social responsibility of Entrepreneurs, Entrepreneurship - its Barriers.

Business Opportunity Identification: Business ideas, methods of generating ideas, and opportunity recognition.

Module II

Enterprises and Ownership Structure: MSME industries, Forms of Business Ownership, Advantages and the disadvantages of the three major forms of ownership: the sole proprietorship, the partnership, and the corporation. Registration of company in India.

Module III

Business: Components of macro and micro business environment. Creating and Starting the Venture Sources of new Ideas. **Business Plan:** The Business Plan Nature and scope of Business plan, Elements of Business Plan: Marketing plan, financial plan and the organizational plan, Writing Business Plan, Evaluating Business plans.

Financing and Managing the new venture Sources of capital: Understanding capital requirements, identifying the sources of finance, angel investing and venture finance, managing cash flow. Break-even analysis, Project analysis.

Marketing and sales controls: Marketing concept and evolution, marketing process, E-commerce, Internet advertising.

Module V

Institutional support to Entrepreneurship: Institutional support towards the development of entrepreneurship in India, DICs, IDC, SFCs, SSIDCs, KVIC, NSIC, SIDBI.

Course outcome:

- The students will be able to understand the systematic process to select and screen a business idea.
- The students will be able to write a business plan.
- The student will aware about industry structure and how to start up a company

Text Book:

1. Khanka. S.S., **Entrepreneurial Development,** S.Chand
2. Nandan, H., **Fundamentals of Entrepreneurship**, PHI

Reference Book:

1. Donald F Kuratko, **Entreprenuership – Theory, Process and Practice**, Cengage
2. Hisrich R D, Peters M P, **Entrepreneurship**, TMH
3. Rajeev Roy, **Entrepreneurship**, Oxford

Semester VI

EC-3002	Measurement & Instrumentation	L-T-P-C:3-0-0-3

Course objective:

- Overview of basic measurement characteristics and system
- Analyze the working principle of electronic instruments.
- Demonstrate ability to select suitable instrument for measurement of physical quantity.

Module I

Basics Measurement Systems: Schematics of Measuring Systems, Performance Characteristics, Order of Instruments, Static/Dynamic Characteristics, Accuracy, Precision, Resolution, Types of Errors, Gaussian Error, Root Sum Squares formula, Dynamic Characteristics, Loading Effect, Sensitivity, Repeatability, Reproducibility, Fidelity.

Module II

Oscilloscopes: Digital storage oscilloscope internal block diagram, horizontal and vertical deflection systems, Ramp Generator, Measurement of amplitude, frequency and phase (Lissajous method), Overview of Mixed Signal Oscilloscope (MSO).

Module III

Electronic Instruments: Fundamentals of Ammeter, Voltmeter and Ohmmeter, Range Changing, Rectifier Based Voltmeter, Digital Voltmeter, True- RMS responding Voltmeter, Low and High Resistance Measurement, DC Bridges, AC Bridge and their Applications, Resistivity measurement using two probe and four probe technique, Digital Frequency Meter, Function Generators, Frequency Synthesizer, Introduction to Noise Measurement techniques.

Module IV

Technology of Sensors and its Signal Conditioning: Active and passive transducers, Measurement of displacement (Resistance, capacitance, inductance; LVDT), Force (strain gauges), Pressure (piezoelectric transducers), Temperature (resistance thermometers, thermocouples, and thermistors), Velocity, pH measurement, Liquid level Measurement, Measurement of Humidity and Moisture, Signal Conditioning Circuits and Data Acquisition System, Digital Processing of Sensing Result.

Module V

Introduction to Modern Sensors: Bio Sensors, Gas Sensor, Optical Sensors, Surface Acoustic Wave Sensors

Course Outcome:

Upon Completion of the course, the students will be able to:

- Understand philosophy of Measurement system
- Recognize internal building blocks of Electronic test and indicating instruments
- Design an instrument as per the requirements of measurand.

Text Book:

1. A.D. Helfrick and W.D. Cooper, "Modern Electronic Instrumentation and Measurement Techniques", 3rd Edition 2016, PHI.
2. David A. Bell, "Electronic Instrumentation and Measurements", 2nd Edition, 2013, Oxford.

Reference Book:

1. J. Prasad, M.N Jayaswal, and V. Priye, "Instrumentation and Process Control", 2nd Edition, 2016, Willey
2. A. K. Ghosh, "Introduction to Measurements and Instrumentation", 4th Edition, 2019, PHI

EC-3102	Measurement & Instrumentation Lab	L-T-P-C:0-0-3-2

List of Experiments:

1. Design Digital Oscilloscope & Function generator.
2. Design Multimeter & Frequency counter.
3. Design System to measure Strain, Displacement, and Temperature etc.
4. Design System to measure Pressure and Level.

5. Develop Interfacing module between Sensing unit and Mobile or PC.
6. Study of data acquisition system using software and test all signal points.

Project:

Determination of characteristics of a solid-state sensor/fibre-optic sensor.

EC-3004	VLSI & MEMS Technology	L-T-P-C:3-0-0-3

Course objective:

- To teach the fundamentals of micromachining and micro fabrication techniques
- Understanding of the different design steps required to carry out a complete digital VLSI (Very-Large-Scale Integration) design in silicon, computer aided simulation and synthesis tool for hardware design.

Module I

Introduction: Moore's Law, VLSI Design flow, Design hierarchy, VLSI Design style: Full custom, Gate array, standard-cell, Macro cell based design, Field programmable devices, design quality

Module II

Process in VLSI: Wafer preparation, Oxidation, Diffusion, Ion implantation, Deposition, Metallization, Etching and Lithography. IC fabrication: nMOS fabrication, n-well and p-well process, Stick diagram. Layout and Layout design rules

Module III

Basic bipolar process technologies: NMOS technology and its limitations, CMOS Technology, advanced CMOS processes. Design rules for NMOS and CMOS technologies for Layouts.

Module IV

Fundamentals of MEMS/NEMS Design & Fabrication: Needs of MEMS, MEMS material, MEMS Features, design limits and safety factors, processing techniques: Lithography, GalvanikAbforming (LIGA), Lift-off, Chemical Mechanical Polishing, Surface micromachining, Bulk micromachining, Deep Reactive Ion Etching, Application of MEMS, Recent trends in MEMS/NEMS. Challenges and opportunities associated with bringing MEMS to market, Basic MEMS operating principles

Course outcome:

At the end of the course the students will be able to:

- Know the basic concepts of micro systems and advantages of miniaturization.
- Design digital systems using MOS circuits (Static and Switching characteristics of inverters).
- Able to learn Layout, Stick diagrams, Fabrication steps.
- Understand the fundamentals of micromachining and micro fabrication techniques.

Text Book:

1. S.M. Sze, "VLSI Technology", TMH, 2nd edition, 2003.
2. S.K. Gandhi, "VLSI Fabrication Principles", John Willey & Sons, 2nd edition, 2008.
3. S.D Senturia, "Microsystems design". Kluwer Academic Publishers, 2001.
4. N.P. Mahalik, "MEMS", Tata McGraw Hills Publishers, 2007.

Reference Book:

1. G.T.A. Kovacs, "Micromachined transducer", McGraw Hill, 1998.

2. Pucknell, Douglas A. and Eshraghian, Kamran, "Basic VLSI Design", Prentice – Hall (India), 3rd edition, 2004.
3. S.M. Kang & Y. Leblebici, "CMOS Digital Integrated Circuits-Analysis & Design", McGraw-Hill, 4th edition, 2016.

EC-3104	VLSI & MEMS Lab	L-T-P-C:0-0-3-2

Device simulation using TCAD tool: NMOS, PMOS, CMOS
Layout extraction & simulation using L-edit: PMOS, NMOS, CMOS inverter, various CMOS gates, CMOS half adder, CMOS full adder.
Simulation and fabrication of MEMS devices.
Fabrication and electrical characterization of various microelectronic devices.

EC-3006	Digital Signal Processing	L-T-P-C:3-0-0-3

Course objective:

- To provide detailed principles and algorithms of digital signal processing.
- Able to have basic knowledge of digital signal processing.

Module I

Introduction: Overview of Discrete time signals and systems Z-Transform: Generalized complex exponentials as eigen signals of LTI systems, z-transform definition, region of convergence (RoC), properties of RoC, properties of the z-transform, inverse z-transform methods-pole-zero plots, time-domain responses of simple pole-zero plots, RoC implications of causality and stability.

Module II

Properties and applications of DFT, implementing linear time invariant systems using DFT, circular convolution, linear convolution using DFT; Fast Fourier Transform, FFT algorithms: Decimation in time, decimation in frequency; Goertzel algorithm; Application of transform in speech, audio, image and video coding, Karhunen-Loeve Transform, JPEG and MPEG coding standards

Module III

IIR and FIR filters, filter design specifications; Design of digital IIR filters: Impulse invariant, and bilinear transformation techniques for Butterworth and Chebyshev filters; Design of FIR filters: Windowing, frequency sampling filter design, optimum approximations of FIR filters.

Module IV

Adaptive systems: Definitions, characteristics, applications, properties, and examples. Adaptive filtering, adaptive equalization, noise cancellation and beam forming.

Module V

Fundamentals of multirate systems, Decimation and interpolation, application of Multirate DSP in sampling rate conversion; Filter banks; Polyphase structures; Quadrature-mirror filter bank; Wavelet transform and its relation to multi-rate filter banks; applications to speech and audio coding.

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

- Understand the discrete time systems and visualize the operation of filters.
- Able to analyze digital systems in time and frequency domain.

Text Book:

1. Proakis, J.G. and Manolakis, D.G., "Digital Signal Processing: Principles, Algorithm and Applications".
2. Alan V. Oppenheim,"Discrite-time signal processing", pearson.

Reference Book:

1. S. K. Mitra, "Digital Signal Processing: A Computer Based Approach", TMH.
2. B. Widrow and S. D. Stearns, "Adaptive Signal Processing", Prentice Hall.

EC-3106	Digital Signal Processing lab	L-T-P-C:0-0-3-2

1. Write a program to generate different signals waveform.
2. Write a program to perform discrete convolution (linear and circular) for a given two sequence and also prove my manual calculation.
3. Write a program to find the Z-Transform of any given sequence.
4. Write a program to compute discrete Fourier transform and inverse discrete Fourier transform of a given sequence using FFT algorithm (DIT-FFT and DIF-FFT).
5. Write a program to design an analog Butterworth filter and Chebyshev filter for a given specification.
6. Write a program to find time and frequency domain response (impulse response and step response) for a given FIR and IIR systems.
7. Record a signal using Raspberry Pi and Perform signal processing on recorded sample of signal.
8. Develop and test the Inverse Discrete Fourier Transform (IDFT), Finite Impulse Response (FIR) filters using Arduino.

Semester VII

EC-4001	Optical Communication	L-T-P-C:3-0-0-3

Course objective:

- To provide in-depth knowledge of modern optical communication systems
- To understand the characteristics and limitations of system components
- To analyse the performance of optical fiber systems

Module I

Optical communication system evolution, Generic optical system, wireless optical systems, Applications and design challenges, Mode theory for circular waveguides,Optical fibers, Wave propagation in optical fiber, Ray and wave theory

Module II

Physical and electrical characteristics of fiber, Fiber nonlinearities, Polarization, Interference, Fiber materials, Fiber fabrication, Attenuation in fibers, Absorption and scattering losses, Bending losses, Dispersion

Module III

Basic concepts of optical sources, semiconductor lasers, distributed feedback lasers, Frequency chirping, LED, Source to fiber power launching, Lensing schemes, Fiber to fiber joints, Fiber splicing, Fiber connectors, Optical modulators

Module IV

Optical detectors, Principles of photo detector, PIN and avalanche photo diode, Phototransistor, Responsivity, Bandwidth, Noise, Optical amplifiers and filters

Module V

Optical transceivers, Direct detection and coherent receivers, Noise in detection process, WDM, Modulation techniques, BER, System design, Power budgeting, Rise time budgeting, OTDR principles, Maximum transmission distance due to attenuation and dispersion, Attenuation and dispersion limits

Course outcome:

- Identify and characterize different components of an optical fiber communication link.
- Compute optical fiber link design parameters
- Design considerations and assess the performance of optical devices and systems

Text Book:

1. G. Keiser, Optical Fiber Communications, McGraw-Hill, 2008.
2. M. Senior, Optical Fiber Communications. Principle and Practice, Prentice Hall.
3. G. P. Agrawal, Fiber-Optic Communication Systems, 3rd Edition, John Wiley & Sons, Inc., 2002.

Reference Book:

1. R.Papannareddy, "Lightwave Communication Systems: A Practical Perspective", Penram International.
2. B. Razavi, "Design of Integrated Circuits for Optical Communications", McGraw-Hill.
3. A. Yariv, "Optical Electronics in Modern Communications", Oxford University Press.
4. Joseph C. Palais , Fiber Optic Communications, 4th Edition, Prentice Hall.

EC-4101	Optical Communication Lab	L-T-P-C:0-0-3-2

Refractive index profile of optical fibers, b-V curve, Dispersion in silica fiber, Modal analysis for a step index and graded index fiber, Modal analysis for a single mode and multimode fiber, Attenuation and fiber loss, Optical fiber communication system design, BER and Q factor, BPSK and QPSK modulated system, Maximum bit rate for RZ/NRZ encoding with different modulation format.

Project:

Familiarization with optical fiber based communication system.

B.Tech ECE electives Syllabus

Hons. Elective I (fifth semester)

EC-3007	Computational Intelligence	L-T-P-C:3-1-0-4

Course objective:

- To provide a strong foundation on fundamental concepts in Computational Intelligence.
- To enable Problem-solving through various searching techniques.
- To apply these techniques in applications which involve perception, reasoning and learning.
- To apply Computational Intelligence techniques for information retrieval and machine learning

Module I

Introduction to soft computing : Soft computing constituents and conventional Artificial intelligence, soft computing characteristics;

Module II

Fuzzy Sets, Fuzzy Rules and Fuzzy reasoning : Introduction, Basic definitions and terminology; Set theory operations : Fuzzy union, Intersection and Complement, Extension principal and fuzzy relations, Fuzzy IF rules, MF formulation and parameterization; Fuzzy interference System : Mamdani fuzzy models, Sugeno fuzzy models, Tsukamoto fuzzy models;

Module III

Artificial Neural Network : Supervised Learning Neural Network, Preceptron, Adaline, multi-layer neural networks, back propagation algorithm, Radial basis function networks; Functional Link Artificial Neural network : update algorithms, trigonometric and power series expansions; Unsupervised Learning Neural Network : Competitive learning networks, Kohonen self-organizing networks, Hopfield network;

Module III

Introduction to NeuroFuzzy Networks : Genetic Algorithm, Adaptive Genetic Algorithm, Ant Colony Algorithm, Bacteria Foraging Algorithm, Particle Swarm Optimization; Introduction to other soft computing technique.

Text Book:

1. Neuro-Fuzzy and soft Computing –J.S.R. Jng, C.T.Sun and E.Mizutani, PHI.
2. Neural Networks A Comprehensive foundation-Simon Haykin, Pearson Education.

Reference Book:

2. Neutral Networks, Fuzzy Logic and Genetic Algorithm Rajasekaran, G.A. Vijayalaksmi, PHI.

EC-3009	Optical Sensors	L-T-P-C:3-1-0-4

Course objective:

- To prepare students to understand concepts of fiber optic sensor technology.
- To acquire the concept of optical sensors working principle, and to have knowledge on the various grating, magnetic, chemical and bio sensors.

Unit-I

Sensor Technology: The Emergence of Fiber Optic Sensor Technology, Optical Fibers, Light Sources, Optical Detectors, Optical Modulators, Intensity-Based and Interferometric Sensors - Fabryperot, Mach Zender, Michelson and Sagnac.

Unit-II

Grating Sensors: Multimode Grating and Polarization Sensors, Sensors Based on Relative Movement of Opposed Gratings, Grating Period Modulation, and Sensors Based on the Photoelastic Effect, Retardation Plates, Fiber Grating Sensors.

Unit-III

Distributed and Magnetic Sensors: Fiber Optic Distributed and Magnetic Sensor, Distributed Sensing, Basic Principles of Sensor Multiplexing, Interferometric Sensor Multiplexing, Faraday effect sensors, Magneto strictive, Lorentz force sensors, Evanescent Field Absorption Sensors

Unit-IV

Chemical and Biosensor: Reagent Mediated sensor, Humidity sensor, pH sensor, Hydrogen sensor, CO_2 sensor, Ammonia sensor, Chloride sensor, Glucose sensor, Oxygen sensor, Surface Plasmonic Resonance based sensor

Unit-V

Applications: Industrial Applications of Fiber Optic Sensors: Temperature, Pressure, fluid level, flow, position, vibration, rotation measurements, Current-voltage measurement, Chemical analysis.

Course outcome:

After studying this course, the students will be able to

- Describe the fundamentals of optical sensors.
- Describe the advantage and need of fiber optics sensor technology.
- Gain knowledge and understanding about real time applications of optical sensors.

Text Book:

1. Bishnu P. Pal, “Fundamentals of fiber optics in telecommunication and sensor systems”, Wiley Eastern.
2. Dakin J and Culshow B., “Optical fiber sensors”, Artech House.
3. Francis T.S Yu, Shizhuo Yin, “Fiber Optic Sensors”, Marcel Dekker Inc., New York.

Reference Book:

1. Jose Miguel Lopez-Higuera (Ed), “Handbook of optical fiber sensing technology”, John Wiley and Sons Ltd.
2. Eric Udd, William B. Spillman, Jr., “Fiber Optic Sensors: An Introduction for Engineers and Scientists”, John Wiley & Sons.
3. Francis T.S. Yu, Shizhuo Yin, Paul B. Ruffin, “Fiber Optic Sensors”, CRC Press Publisher.

EC-3011	Mobile Communication	L-T-P-C:3-1-0-4

Course objective:

- To realize the vision of "Optimally Connected Anywhere, Anytime" supported by all system levels from access methods and networks to service platforms and services.
- To realize and characterize the systems beyond 3G as a horizontal communication model, where different terrestrial access levels and technologies are combined to complement each other in an optimum way for different service requirements and radio environments.

Course content:

Unit-I

An overview of cellular systems, Introduction, Mobility versus portability, Wireless communication and the layer model, First and Second Generation cellular systems, Cellular communications from 1G to 5G, Road map for higher data rate capability in 5G, Wireless 5G systems, Future wireless networks, Standardization activities for cellular systems.

Unit-II

Cellular system design concepts and fundamentals, Frequency reuse, Channel assignment, Handoff strategies, Interference and system capacity, Trunking and grade of service, Improving coverage and capacity in cellular systems, Mobile radio wave propagation, Large scale path loss and propagation models, Reflection, Diffraction, Scattering, Practical link budget design, Outdoor propagation models, Indoor propagation models.

Unit-III

Small scale fading and multipath propagation, Rayleigh and Ricean distributions. Multiple access techniques for wireless communications, FDMA, TDMA, Spread Spectrum multiple access, FHMA, CDMA, SDMA.

Unit-IV

Packet radio, Pure ALOHA, Slotted ALOHA, CSMA, Reservation ALOHA, PRMA, Capacity of cellular systems, Wireless systems and standards, AMPS and ETACS, IS 54 and IS 136, GSM features, Architecture, Radio subsystems, Traffic channels, Call processing.

Unit-V

CDMA features, Architecture, IS 95, Forward and reverse channels, Power control, System capacity, Wireless Networking, WLAN, PAN, Mobile network layer, Mobile transport layer, Wireless data services, Common channel signaling, Wireless networking, Satellite data communication, Cellular data communications, UMTS system features, WiMAX, RFID.

Course outcome:

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

Text Book:

1. William C Y Lee, “Mobile Cellular Telecommunications, McGraw Hill.
2. Schwartz, Mobile Wireless Communications, Cambridge University Press.

Reference Book:

1. Stallings, Wireless Communications and Networks, Prentice Hall.
2. Theodore S Rappaport, "Wireless Communications Principles and Practice", Prentice Hall.
3. Jochen, Schiller, "Mobile Communication", 2nd Edition, Pearson Education, 2008.

EC-3013	Semiconductor Material & Device Characterization	L-T-P-C:3-1-0-4

Course objective:

- To learn the Measurement of Semiconducting parameters
- To realize the Electrical characterization of Junction based devices
- To understand the physical, optical and structural properties of semiconductor materials and their characterization.

Unit I

Introduction to the Measurement of Semiconducting parameters

Resistivity measurement: Four-point probe, Correction factors, Resistivity of arbitrarily shaped samples, Resistivity profiling: Anodic oxidation-four point probe, spreading resistance, contact less resistivity methods, conductivity type measurements, Carrier and doping concentration measurements: Capacitance measurements, Differential capacitance, Maximum-Minimum MOS-C capacitance, Integral capacitance. Current-Voltage measurements, Second harmonic, MOSFET substrate voltage-gate voltage, MOSFET threshold voltage.

Unit II

Characterization of Junction based Devices

Metal-Semiconductor Contacts: Contact resistance, Measurement techniques (introduction only), Hall effect and Mobility: Mobility, Conductivity mobility, Basic equations for uniform layers or wafers, Magnetoresistance mobility, MOSFET mobility: Effective mobility, field-effect mobility and Saturation mobility, Oxide and interface trapped charge: Characterization using Capacitance-Voltage curves only.

Unit III

Optical Characterization

Optical Microscopy: Resolution, Magnification, Contrast, Differential Interference Contrast, Defect etches, Ellipsometry: theory and applications, Transmission measurements: theory and instrumentation, Fourier Transform Infrared spectroscopy, Reflection Measurements, Line width measurements, Photoluminescence, PL Spectroscopy, UV-Vis Spectroscopy, Raman Spectroscopy, FTIR.

Unit IV

Morphological and Structural Characterization

Scanning Electron Microscopy (SEM), Auger Electron Spectroscopy, Electron Microprobe, Secondary Ion Mass, Spectroscopy and X-ray Photoelectron Spectroscopy (Principle, instrumentation and its applications), Transmission Electron Microscopy (TEM), Electron Beam Induced Current, LEED and RHEED, Scanning Tunneling Microscope (STM), Atomic Force Microscope (AFM), High Resolution X-Ray Diffraction study (HRXRD), Scanning Probe Microscopic Analysis (SPM)

Course outcome:

At the end of this course students will be able to

- Understand the Engineering of the Electrical, Optical, and material characterization.
- Interpret the results obtain from different characterization technique.
- Familiar with the optical and structural characterization techniques and the related lab work

Text Book:

1. Dieter K. Schroder, "Semiconductor Material and Device Characterization" John Wiley & Sons, Second Edition.
2. Ayers J. E "Heteroepitaxy of Semiconductors Theory, Growth, and Characterization" (CRC Press, Taylor & Francis Group, New York, 2007),
3. D. Keith Bowen and Brain K. Tanner, "High Resolution X-ray Diffractometry a Topography" Tailor & Francis.

Reference Book:

6. J.W. Octon and P. Blood, "Technique of Physics, The Electrical Characterization of Semiconductors, Measurement of Minority carrier Properties", Academic Press.
7. S.M. Sze, "VLSI Technology"- McGraw Hill Publications.

Open Elective I (in sixth semester) – open to both CSE & ECE

OE-3002	Embedded Systems	L-T-P-C:3-0-0-3

Course objective:

- Understand architecture and advanced features of embedded processors.
- Understand ARM processor registers, instruction pipeline, interrupts and architecture.
- Understand building blocks of Internet of Things and characteristics.

Course Content:

Unit-I

Introduction to Embedded Systems: Definition of embedded system, classification, embedded systems v/s general computing, details of various embedded components, sensors & actuators, major application area, purpose if embedded system, characteristics and quality attributes of embedded systems

Unit-II

Arduino: The Arduino Platform, Block diagram, Architecture, Pin functions, overview of main features such as I/O Ports, timers, interrupts serial port, PWM and Arduino programming.

Unit-III

ARM: ARM design philosophy, data flow model and core architecture, registers, program status register, instruction pipeline, interrupts and vector table, operating modes and ARM processor families. Instruction Sets: Data processing instructions, addressing modes, branch, load, store instructions, PSR instructions, and conditional instructions, ARM programming and case studies.

Unit-IV

Embedded Firmware Design: Embedded firmware design approaches and development languages.

Operating System for Embedded System: Types of operating system, tasks, process and threads, multiprocessing and multitasking, task scheduling, task synchronization, how to choose an Operating system.

Unit-V

IoT: Internet of Things basics and vision, IoT Platform overview, IoT architecture and applications, Security aspects in IoT, IoT Application protocols, case study & advanced IoT applications.

Course outcome:

Upon Completion of the course, the students will be able to:

- Understand architecture and instruction set for advanced embedded processors and controllers.

- Work with suitable embedded processors for a specific real world application.
- Learn application of IoT in Industrial and Commercial Automation along with Real World Design Constraints.

Text Book:

1. K. V. Shibu, “Introduction to embedded system”, McGraw Hill.
2. R. S. Kaler, “Microprocessors and Microcontrollers”, Wiley, Third Edition.
3. A. N. Sloss, D. Symes, and C. Wright, "ARM system developer's guide: Designing and optimizing system software", Elsevier, 2008
4. Vijay Madisetti and ArshdeepBahga, “Internet of Things (A Hand Approach)”, 1st Edition, VPT, 20142.

Reference Book:

1. Daniel Tabak, “Advanced Microprocessors”, McGraw Hill. Inc., 1995.
2. SteaveFurber, “ARM system-on-chip architecture”, Addison Wesley, 2000.
3. Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1st Edition, A press Publications, 2013.

OE-3004	Sensor and Transducer	**L-T-P-C:3-0-0-3**

Course objective:

- To understand the fundamental concept of sensor and transducer.
- To discuss about units, standards, error analysis and characteristics of measurement systems.
- To describe the principle of operation, construction and characteristics of resistance, inductance and capacitance & other transducers and its applications.

Course content:

Unit-I

Introduction to Sensor- Based Measurement Systems: General Concepts and Terminology, Sensor Classification, General Input-Output Configuration, Static Characteristics Of Measurement Systems, Dynamic Characteristics, Other Sensor Characteristics, Primary Sensors, Materials For Sensors, Microsensor Technology.

Unit-II

Resistive, Reactance Variation, Electromagnetic Sensors: Potentiometers, Strain Gages, Resistive Temperature Detectors (RTDs), Thermistors, Magneto resistors, Light-Dependent Resistors (LDRs), Resistive Hygrometers, Resistive Gas Sensors, Liquid Conductivity Sensors, Signal Conditioning For Resistive Sensors: Resistance Measurement, Voltage Dividers, Dynamic Measurements, Capacitive Sensors, Inductive Sensors, Electromagnetic Sensors.

Unit-III

Flow, Pressure and Level Transducers: Flow Transducers Like Differential Pressure, Variable Area, Positive Displacement, Electromagnetic, Anemometer, Ultrasonic Flow Meter, Turbine Flow Meter, Vortex Flow Meter, Electromagnetic Flow Meter, Coriolis Effect Flow Meter, Pressure Transducers Like Mercury Pressure Sensor, Bellows, Membranes and Thin Plates, Piezoresistive Sensors, Capacitive Sensors, VRP Sensors, Optoelectronic Sensors, Vacuum Sensors, Level Transducers Like Displacer, Float, Pressure

Gages, Balance Method, Time-of-Flight Measurements, Level Measurements By Detecting Physical Properties.

Unit-IV

Self-Generating Temperature Sensors: Thermoelectric Sensors: Thermocouples, Piezoelectric Sensors, Pyroelectric Sensors, Electrochemical Sensors, Acoustic Temperature Sensors, Nuclear Thermometer, Magnetic Thermometer, Semiconductor Types, Thermal Radiation, Quartz Crystal, NQR, Spectroscopic Noise Thermometry, Heat Flux Sensors.

Unit-V

Digital and Semiconductor Sensors: Position Encoders, Resonant Sensors, SAW Sensors, Sensors Based on Semiconductor Junctions, Sensors Based on MOSFET Transistors, Charge-Coupled and CMOS Image Sensors, Fiber-Optic Sensors, Ultrasonic-Based Sensors, Biosensors.

Unit-VI

Sensors for Robotics: Proximity Sensors: Typical Sensor Characteristics, Technologies for Proximity Sensing, Electro-Optical Sensors, Capacitive Sensors, Magnetic Sensors

Course outcome:

After completion of the course student will be able to:

- Idea behind working of measurement systems and different types of sensors and transducers.
- Sensor to measure various physical parameters used in Industry and normal measurement applications.
- Working principle of resistive, inductive and capacitive transducers and their applications.
- Understanding of thermocouples, piezoelectric and pyro-electric transducers and their applications.
- Understanding of acoustic, optical sensors and other sensors and their applications.
- Understanding of digital and proximity sensors and their applications.

Text Book:

1. Patranabis D., "Sensors and Transducers", Prentice-Hall India, 2nd Ed., 2004.
2. Ramon Pallas & John G. Webster, “Sensors and Signal Conditioning”, John Wiley & Sons, 2nd Ed., 2001.
3. Shawhney A. K., “Electrical and Electronics Measurements and Instrumentation”, DhanpatRai& Sons, 1994.

Reference Book:

1. Webster John G., “Instrumentation and Sensors Handbook”, CRC Press, 1st Ed., 1999.
2. Jacob Fraden, “Handbook of Modern Sensors: Physics, Designs and Applications”, Springer, 3rd Ed., 2004.

EC-3006	Information and Coding Theory	L-T-P-C:3-0-0-3

Unit-I

Introduction: Introduction to information theory & error control coding, Information measure, Entropy, Differential Entropy, Conditional Entropy, Relative Entropy, Information rate, Mutual Information, Channel Capacity.

Unit-II

Source Coding: Shannon’s Source Coding Theorem, Prefix Coding, Huffman Coding, Shannon-Fano Coding, Arithmetic Coding, Lempel-Ziv Algorithm, Rate Distortion Theory.

Unit-III

Channel Capacity & Coding: Channel Coding Theorem, Markov Sources, Discrete Channel with discrete Noise, BSC, BEC, Capacity of a Gaussian Channel, channel capacity for MIMO system, Bandwidth-S/N Trade-off.

Unit-IV

Block Codes: Galios Fields, Hamming Weight and Hamming Distance, Linear Block Codes, Encoding and decoding of Linear Block-codes, Parity Check Matrix, and Bounds for block codes, Hamming Codes, Syndrome Decoding.

Unit-V

Cyclic Codes: Introduction to cyclic code, Method for generating Cyclic Codes, Matrix description of Cyclic codes, Cyclic Redundancy Check (CRC) codes, Circuit implementation of cyclic codes, Burst error correction, BCH codes.

Unit-VI

Convolutional Codes: Introduction to Convolutional Codes, Polynomial description of Convolutional Codes, Generating function, Matrix description of Convolutional Codes, Viterbi Decoding of Convolutional code, Introduction to Turbo Code.

Unit-VII

Coding for Secure Communications: Introduction to Cryptography, Overview of Encryption Techniques, Secret-Key Cryptography, Data Encryption, Standard (DES), Public-Key Cryptography, RSA algorithm, Digital signature, One- way Hashing.

Text Books:

1. "Information Theory, Coding & Cryptography", by Ranjan Bose, TMH, Second Edition.
2. "Communication Systems", by S. Haykin, 4th Edition, Wiley-Publication.

Reference Books:

1. "Elements of Information Theory" by Thomas M. Cover, J. A. Thomas, Wiley-Inter science Publication.
2. "Error Correction Coding Mathematical Methods and Algorithms" by Todd K. Moon, Wiley India Edition.
3. "Cryptography and Network Security", Fourth Edition, by William stallings.

EC-3008	Wireless Communication	L-T-P-C:3-0-0-3

Course objective:

- Know the characteristic of wireless channel
- Learn the various cellular architectures
- Understand the concepts behind various digital signaling schemes for fading channels
- Be familiar the various multipath mitigation techniques
- Understand the various multiple antenna systems

UNIT I

WIRELESS CHANNELS: Large scale path loss – Path loss models: Free Space and Two-Ray models - Link Budget design – Small scale fading- Parameters of mobile multipath channels – Time dispersion parameters-Coherence bandwidth – Doppler spread & Coherence time, fading due to Multipath time delay spread – flat fading – frequency selective fading – Fading due to Doppler spread – fast fading – slow fading.

UNIT II

CELLULAR ARCHITECTURE: Multiple Access techniques – FDMA, TDMA, CDMA – Capacity calculations–Cellular concept- Frequency reuse – channel assignment- hand off- interference & system capacity- trunking & grade of service – Coverage and capacity improvement.

UNIT III

DIGITAL SIGNALING FOR FADING CHANNELS: Structure of a wireless communication link, Principles of Offset-QPSK, p/4-DQPSK, Minimum Shift Keying, Gaussian Minimum Shift Keying, Error performance in fading channels, OFDM principle – Cyclic prefix, Windowing, PAPR.

UNIT IV

MULTIPATH MITIGATION TECHNIQUES: Equalization – Adaptive equalization, Linear and Non-Linear equalization, Zero forcing and LMS Algorithms. Diversity – Micro and Macro diversity, Diversity combining techniques, Error probability in fading channels with diversity reception, Rake receiver.

UNIT V

MULTIPLE ANTENNA TECHNIQUES: MIMO systems – spatial multiplexing -System model -Pre-coding – Beam forming – transmitter diversity, receiver diversity- Channel state information-capacity in fading and non-fading channels

Text Books:

1. Rappaport, T. S., "Wireless communications", Second Edition, Pearson Education, 2010.
2. Andreas .F. Molisch, "Wireless Communications", John Wiley – India, 2006

Reference Books:

1. David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press, 2005.
2. Upena Dalal, "Wireless Communication", Oxford University Press, 2009.
3. Van Nee, R. and Ramji Prasad, "OFDM for wireless multimedia communications", Artech House, 2000.

OE-3010	Parallel and Distributed Systems	L-T-P-C:3-0-0-3

Course content:

1. Introduction of Parallel computing: Parallel Computing, Parallel Architecture, Architecture Classification Scheme, Performance of Parallel Computers, Performance metric for Processors, Parallel Programming Models, Parallel Algorithm, Pipeline Processing: Introduction, Pipeline Performance, Arithmetic Pipelines, Pipelined Instruction Processing, Pipeline stage Design, Hazards, Dynamic Instruction Scheduling.
2. Synchronous Parallel Processing: Introduction, SIMD Architecture and Programming Principles, SIMD Parallel Algorithm, Data Mapping and Memory in array processors, Case studies of SIMD Parallel Processor.

3. Introduction to Distributed System: Definition, Issues, Goals, Types of Distributed system models,, Hardware concepts, Software concepts, models of middleware, services offered by middleware, client-server model.
4. Communication: Layered Protocols, Remote Procedure Call, Remote Object Invocation, Message Oriented Communication, Stream Oriented Communication, Resource and Process management: Desirable features of global scheduling algorithm, Task assignment approach, Load balancing approach, Load Sharing approach, Introduction to Process management, Process migration, Threads, Virtualization, clients, servers, code migration.
5. Synchronization: Clock synchronization, Logical Clocks, Election algorithm, Mutual Exclusion, Distributed mutual exclusion, classification of mutual exclusion algorithm, requirements of mutual exclusion algorithms, Performance measures, Non-token based algorithm: Lamport Algorithm, Token based algorithm: Suzuki-Kasami's Broadcast algorithm, Comparative Performance analysis.
6. Consistency and Replication: Introduction, Data centric and client centric consistency model, Replica management, Distributed file systems, file accessing model, file replication, Network file system, Andrew file system, Hadoop distributed file system and Mad Reduce.

Course outcome:

- Design and analyse the parallel algorithms for real world problems and implement them on available parallel computer systems
- Optimize the performance of a parallel program to suit a particular hardware and software environment
- Understand models of distributed computing
- Analyse algorithms for coordination, communication, security and synchronization in distributed systems
- Design and Implement distributed file systems

Text Book:

1. Kulkarni A, Giri N P, Joshi N, Jadhav B, Parallel and Distributed Systems, Wiley

Reference Book:

1. Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar : Introduction to Parallel Computing, Pearson
2. Andrew S. Tanenbaum, Maarten Van Steen, Distributed Systems -Principles and Paradigms, PHI

OE-3012	Quantum Mechanics	L-T-P-C:3-0-0-3

Module I

Introduction: Basic of quantum mechanics, Postulates of Quantum Mechanics-probability and probability current density, conservation of probability, equation of continuity, Schrödinger equation

Module II

Simple potential problems: infinite potential well, step and barrier potentials, finite potential well and bound states; Linear harmonic oscillator, operator algebra of harmonic oscillator, coherent states and their properties

Module III
Three dimensional problems: spherical harmonics, free particle in a spherical cavity, central potential, Three dimensional harmonic oscillator, degeneracy, Hydrogen atom

Module IV
Angular momentum: Commutation relations, spin angular momentum, Pauli matrices, raising and lowering operators, L-S coupling, Total angular momentum, addition of angular momentum, Clebsch-Gordon coefficients; The spin-orbit coupling and its consequences, charged particle in a uniform magnetic field

Text Books:

1. R. Shankar, Principles of Quantum Mechanics, Springer (India) (2008).
2. D. J. Griffiths, Introduction to Quantum Mechanics, 2nd Ed., Pearson Education (2005).

Reference Books:

1. J. Sakurai, Modern Quantum Mechanics, Pearson Education (2002).
2. E. Merzbacher, Quantum Mechanics, John Wiley (Asia) (1999).
3. P. W. Mathews and K. Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw Hill (1995).

OE-3014	Advanced Algorithms	L-T-P-C:3-0-0-3

Course objective:

- Understand advanced concepts of computer algorithms and learn modern techniques of problem solving
- Learn complexity classes and limit of computation
- Learn role of randomness and approximation to solve intractable problems

Course content:

Unit 1: Preliminaries: Problem vs. Solutions. Algorithms vs. Programs. Properties of Algorithm. Complexity Measures. Model of Computation – RAM model (Architecture, instruction set, usage) Turing Machine (concept, usage, DTM and NDTM as lanuage acceptors, Universal TM). Cellular Automata as a natural model of computation. Examples.

Unit 2: Revisit of Asymptotic Notation and Basic Algorithm techniques: Growth of function over input size – Big-Oh, Big-Omega, Big-Theta Notation and their relationship. Master's theorem. Recursion tree. Searching techniques – Linear search vs Binary search. Different sorting techniques – sort by insertion, sort by exchange, sort by selection, sort by merging, special purpose sorting. Lower Bound Theory. Hashing. Divide and conquer vs Greedy Strategy – when to use what. Examples.

Unit 3: Limit of Computation: Classes of languages. Entscheidungs Problem and Decidability. Computability theory: enumerability/countability, Recursively Enumerable vs. Recursive languages, partial and total function, Effectively Computable, Efficient algorithm, Church-Turing Hypothesis,

padding lemma, computability theorems. Russell's Paradox. Halting Problem. Inconsistency. Reducibility. Classes of Problems: P, NP, NPC, NP hard problems. Turing Equivalence and Turing degree. Turing Test. Examples.

Unit 4: Randomized Algorithms: Use of randomness in computing. Average case analysis – Case study: Quick sort.

Unit 5: Approximation Algorithms: Optimization Problems – Efficiently solvable and Intractable optimization problem, Pseudo-polynomial time algorithm, Weakly and Strongly NP-Completeness. Approximation ratio, Absolute approximation, Relative Approximation, Approximation scheme – Polynomial time approximation scheme, fully polynomial time approximation scheme (FPTAS). Example – Solution of Travelling Salesperson Problem using Triangular Inequality, FPTAS solution for Knapsack problem

Text Book:

1. Introduction to Algorithms – Cormen, Leiserson, Rivest and Stein
2. Fundamentals of Computer Algorithms – Horowitz and Sahni
3. The Design of Approximation Algorithms – David P. Williamson and David B. Shmoys, First Edition, 2011.

Reference Books:

1. The Design and Analysis of Computer Algorithms – Aho, Hopcroft and Ullman
2. The Art of Computer Programming (Vol 1 & 3) – Donald E Knuth
3. Approximation Algorithms – Vijay V. Vazirani, First Edition.
4. A New Kind of Science – Stephen Wolfram

OE-3016	Advanced Data Structure	L-T-P-C:3-0-0-3

Course content:

Unit I

Elementary Structures: Stack, Queue, Double-Ended Queue, Dynamical Allocation of Nodes, Shadow Copies of Array-Based Structures.

Unit II

Search Trees: Two Models of Search Trees, General Properties and Transformations, Height of a Search Tree, Basic Find, Insert, and Delete, Returning from Leaf to Root, Dealing with Non unique Keys, Queries for the Keys in an Interval, Building Optimal Search Trees, Converting Trees into Lists, Removing a Tree.

Unit III

Balanced Trees: AVL Trees- Maximum Height of an AVL Tree, Insertions and Deletions, Splay trees, 2-3 trees, 2-3-4 trees, Red-black trees Insertion, Deletion.

Unit IV

Text Processing: Pattern matching algorithms-Brute force, the Boyer Moore algorithm, the Knuth-Morris-Pratt algorithm. Tries: Definition and concepts of digital search tree, Binary trie, Patricia, Multi-way trie.

Unit V

Dictionaries –Sets, Hash tables representation, hash functions (Division Method, Multiplication Method, Universal Hashing), collision resolution-separate chaining, open addressing-linear probing, quadratic probing, double hashing, rehashing. Skip lists and analysis of Skip List.

Course outcome:

- Implement a fully encapsulated perfect and non-perfect hashed structure accessed in the key field mode.
- Implementation of hash tables, including collision avoidance and resolution schemes.
- Analyze how to balance a binary search tree using rotation methods and color changing methods
- Solve problems using graph algorithms, including single-source and all-pairs shortest paths, and minimum spanning tree algorithms.
- Relates all binary heap trees to form a large binomial queue for large data structures creation.
- Generates new searching algorithms for websites to match the specified string, numeric or both in an application.
- Reconstructs such applications that take the advantage of a trie's ability to quickly search for, insert, and delete entries into the dictionary.

Text Book:

1. Advanced Data Structures, PETER BRASS, Cambridge University Press.

Reference Book:

1. Data structures, Algorithms and Applications in C++, S.Sahni, University Press (India) Pvt.Ltd, 2nd edition, Universities Press Orient Longman Pvt. Ltd.

OE-3018	Programming in JAVA	L-T-P-C:3-0-0-3

Course content:

Unit I

Introduction: OOP Principles, Encapsulation, Inheritance and Polymorphism, data types, variables, declaring variables, scope and life time of variables, arrays, operators, control statements, type conversion and casting.

Unit II

Classes and Objects : Concepts of classes and objects, class fundamentals Declaring objects, introducing methods, constructors, usage of static with data and methods, access control, this key word, garbage collection, overloading methods and constructors, parameter passing – call by value, recursion.

Unit III

Inheritance: Basic concepts, member access rules, usage of super key word, types of inheritance, method overriding, abstract classes, dynamic method dispatch, final keyword. Packages and Interfaces : Defining, Creating and Accessing a Package, Understanding CLASSPATH, importing packages, differences between classes and interfaces, defining an interface, implementing interface, applying interfaces, variables in interface and extending interfaces.

Unit IV

Exception Handling and Multithreading : Concepts of Exception handling, types of exceptions, usage of try, catch, throw, throws and finally keywords, Built-in exceptions, creating own

exception sub classes, Concepts of Multithreading, differences between process and thread, thread life cycle, creating multiple threads using Thread class, Runnable interface, Synchronization, thread priorities, inter thread communication, deadlocks.

Unit V

Event Handling: Events, Event sources, Event classes, Event Listeners, Delegation event model, handling mouse and keyboard events, Adapter classes. Applets and swings: Applets – Concepts of Applets, differences between applets and applications, life cycle of an applet, types of applets, creating applets, passing parameters to applets, graphics class. Swings – JApplet, JFrame and JComponent, Icons and Labels, text fields, buttons –The JButton class, Check boxes, Radio buttons, Combo boxes, Tabbed Panes, Scroll Panes, Trees, and Tables.

Course outcome:

Upon completion of this course, students should be able to:

- Understand the concept of OOP as well as the purpose and usage principles of inheritance, polymorphism, encapsulation and method overloading.
- Identify classes, objects, members of a class and the relationships among them needed for a specific problem
- To demonstrate the ability to understand and use Exception handling and file handling mechanism
- Arrange the concrete and abstract classes in an appropriate hierarchy.
- Develop efficient Java applets and applications using OOP concept

Text Book:

1. The Complete Reference Java J2SE 5th Edition, Herbert Schildt, TMH Publishing Company Ltd, New Delhi.
2. "Learn Object Oriented Programming Using Java: An UML Treatment using Live Examples from Science and Engineering," Dr. N.B. Venkateswarlu, Dr. E.V. Prasad, S Chand, New Delhi.

Reference Book:

1. Java How to Program, Sixth Edition, H.M.Dietel and P.J.Dietel, Pearson Education/PHI

OE-3020	Object Oriented System Design	L-T-P-C:3-0-0-3

Course content:

Unit I: Fundamental concepts of object oriented programming: Introduction to the principles of object-oriented programming (classes, objects, messages, encapsulation, inheritance, polymorphism, exception handling, and object-oriented containers).

Unit II: Object design implementation in a programming language, e.g., C++ or Java. Object oriented analysis, modeling and design: UML may be introduced. Use cases, use case driven analysis.

Unit III: Structural modeling classes, relationships, interfaces, class diagrams, and object diagrams, in UML. Behavioral/Functional modeling use case diagrams, sequence diagrams, in UML.

Unit IV: Dynamic modeling: State charts, Architectural modeling, Analysis patterns, Design patterns. Distributed object model: CORBA and COM / DCOM

Unit V: Object oriented database systems: Object oriented data model, query languages, storage organization and indexing techniques; object relational databases.

Course outcome:
This course will cover object-oriented approach to modeling, problem solving, requirement analysis, system design, system implementation, database design, system engineering and software engineering.

Text Book:	1. Bertrand Meyer, Object Oriented Software Construction, Prentice-Hall. 2. Grady Booch, Object Oriented Analysis and Design, Addison-Wesley.
Reference Book:	Kim Bruce, Foundations of Object Oriented Languages, Prentice-Hall.

Hons. Elective II (sixth semester)

EC-3008	VLSI Testing & Testability	L-T-P-C:3-1-0-4

Course objective:

- To provide an in-depth understanding of the testing and verification of faults affecting VLSI circuits
- To provide a basic idea on fault tolerance after testing.

Course content:

Unit-I

Physical Faults and their modeling; Stuck at Faults, Bridging Faults; Fault collapsing; Fault Simulation: Deductive, Parallel, and Concurrent Fault Simulation.

Unit-II

ATPG for Combinational Circuits: D-Algorithm, Boolean Differences, PODEM Random, Deterministic and Weighted Random Test Pattern Generation; Aliasing and its effect on Fault Coverage.

Unit-III

PLA Testing, Cross Point Fault Model and Test Generation.

Unit-IV

Memory Testing- Permanent, Intermittent and Pattern Sensitive Faults, Marching Tests; Delay Faults.
ATPG for Sequential Circuits: Time Frame Expansion; Controllability and Observability Scan Design, BILBO, Boundary Scan for Board Level Testing; BIST and Totally self-checking circuits.

Unit-V

System Level Diagnosis & repair- Introduction; Concept of Redundancy, Spatial Redundancy, Time Redundancy, Error Correction Codes. Reconfiguration Techniques; Yield Modeling, Reliability and effective area utilization.

Course outcome: After completion of the course students will be able to uunderstand testing and verification related concepts in VLSI circuits.

Text/ Reference Book:

1. Abramovici, M., Breuer, M. A. and Friedman, A. D. Digital systems testing and testable design. IEEE press (Indian edition available through Jayco Publishing house), 2001.
2. Bushnell and Agarwal, V. D. VLSI Testing. Kluwer.
3. Agarwal, V. D. and Seth, S. C. Test generation for VLSI chips. IEEE computer society press.
4. Hurst, S. L. VLSI testing: Digital and mixed analog/digital techniques. INSPEC/IEE, 1999

EC-3010	Optoelectronics & Photonics	L-T-P-C:3-1-0-4

Course objective:

- To develop an in-depth knowledge about major building blocks of optoelectronics and photonics.
- To introduce students to a broad range of modern optoelectronic devices and applications.

Course content:

Unit-I

Review of basic principles from physics, optical wave representation, interferometers, optical resonators, wave nature of light, polarization, interference, diffraction, light source, quantum mechanical concept, review of solid state physics, review of semiconductor physics, confinement, Gaussian beams, photons and matter, energy levels.

Unit-II

Photon optics: interactions of photons and atoms, population inversion, spontaneous and stimulated emission; lasers: gain mechanism, rate equations, pumping, gain and gain coefficient, laser oscillation theory, laser types, power and spectral distribution, mode selection, light emitting diodes, fabry-perot lasers.

Unit-III

Erbium doped fiber amplifiers (EDFA), photo detectors: properties of photo detectors, photoconductors, photodiodes, and avalanche photodiodes.

Unit-IV

Electro-optic modulators, magneto optic devices, acoustoptic devices, optical, switching, logic devices, physical origin of nonlinear optical coefficients, optical nonlinearity, four wave mixing and optical phase conjugation.

Unit-V

Phototransistors and noise mechanisms, signal-to-noise analysis, modulation of optical signals, formats, and receivers, noise and detection: types of noise and distortion which affects optical signals, methods of reducing effects of noise and distortion, optimal detection methods and devices, overview of opto-electronic networks: FDDI, fiber channel, sonnet.

Course outcome:

- To enable the student to understand the wave nature of light, study the quantum mechanical treatment of light.
- Analyze mechanism of operation of lasers, photo detector, photo conductors, photo diodes, amplifier, modulators, phototransistor and their performance.
- To enable the student to explore effects of noise, distortion and optimal detection methods.

Text Book:

5. Saleh and Teich, “Fundamentals of Photonics,” Wiley Inter science, 2nd edition, 2007.

6. J. Senior, “Optical Fiber Communications. Principle and Practice,” Prentice Hall, 2011.
7. R P Khare, Fiber Optics and Optoelectronics, Oxford University Press, 2004.

Reference Book:

1. Wilson and Hawkes, “Optoelectronics: An Introduction, 3rd. Ed., Prentice Hall, 1997.
2. A. Ghatak & K. Thyagarajan, Optical Electronics, Cambridge University Press, 2004.

EC-3012	DSP System Design	L-T-P-C:3-1-0-4

Unit I

Introduction to the DSP Systems: Typical DSP algorithms, DSP applications demands and scaled CMOS technologies.

DSP Architecture: Single Core and Multicore; Digital Signal Processors and the associated interface hardware and software systems

Unit II

Pipelining and Parallel Processing; Pipelining of FIR digital filters, Parallel Processing, Pipelining and Parallel Processing for low power

Unit II

DSP algorithms: Convolution, Correlation, FIR/IIR filters, FFT, adaptive filters, sampling rate converters, DCT, Decimator, Expander and Filter Banks.

Unit IV:

DSP applications: in wireless and mobile communication, multimedia technology and communication, control systems, power electronics and power systems, measurement and instrumentation.

Course outcome: Students will have the in depth knowledge of hardware they have used, how to pipeline/parallelize the algorithms on the hardware to have either reduce the power consumption or increase the speed of operation of algorithms

Text/ Reference Book:

1. Rulph Chassaing, Digital signal processing and applications with C6713 and C6416 DSK, Wiley, 2005
2. Keshab K Parhi, VLSI Digital Signal Processing Systems: Design and Implementation, student Edition, Wiley, 1999.
3. Nasser Kehtarnavaz, Digital Signal Processing System Design: LabVIEW-Based Hybrid Programming, Academic Press, 2008

EC-3014	RF IC Design	L-T-P-C:3-1-0-4

Course objective:

- To familiarize the basic concepts in RF design on the characterization of nonlinearity, noise, scattering parameters.
- To acquaint the student will knowledge of wireless standards and their specifications.
- To impart the knowledge of different transceiver architectures and their tradeoffs.
- To introduce the design of low noise amplifiers and mixers.

- To expose the design issues in oscillators, frequency synthesizers and RF power amplifiers.

Course content:

Unit-I

Introduction to RF and Wireless Technology: Complexity comparison, Design bottle necks, Applications, Analog and digital systems, Choice of Technology. BASIC CONCEPTS IN RF DESIGN: Nonlinearity and time variance, ISI, Random process and noise, sensitivity and dynamic range, passive impedance transformation.

Unit-II

Multiple Access: Techniques and wireless standards, mobile RF communication, FDMA, TDMA, CDMA, Wireless standards.

Unit-III

Transceiver Architectures: General considerations, receiver architecture, Transmitter Architecture, transceiver performance tests, case studies.

Unit-IV

Amplifiers, Mixers And Oscillators: LNAs, down conversion mixers, Cascaded Stages, oscillators, Frequency synthesizers.

Unit-V

Power Amplifiers: General considerations, linear and nonlinear Pas, classification, High Frequency power amplifier, large signal impedance matching, linearization techniques.

Text Book:

4. Behzad Razavi, RF Microelectronics, 2/e, Pearson Education, 2011.

Reference Book:

1. Leung Bosco, VLSI for Wireless Communication, 2/e, Springer 2011.
2. Thomas Lee, Design of CMOS Radio Frequency Integrated Circuits, Cambridge University Press, 2013

Open Elective II/III/IV (in seventh semester) – open to both CSE & ECE

OE-4001	Satellite and Radar Communication	L-T-P-C:3-0-0-3

Course objective: To become familiar with satellite, launching and its services.

Course content:

Unit-I

Overview of Principles of communication, modulation and receiver, historical Developments, Elements of Satellite Communication, Orbital mechanics, look angle and orbit determination, launches and lauch vehicle, orbital effects, Introduction to geosynchronous and geo-stationary satellites.

Unit-II

Satellite sub-systems: Attitude and Orbit control systems, Telemetry, Tracking and command control system, Power supply system, Introduction to satellite link design, basic transmission theory, system noise temperature and G/T ratio, design of down link and uplink, design of satellite links for specified C/N, satellite data communication protocols.

Unit-III

Direct broadcast satellite television and radio, satellite navigation and the global positioning systems, GPS position location principle, GPS receivers and codes, Satellite Signal Acquisition, GPS navigation Message, GPS Signal Levels, Timing Accuracy, GPS Receiver Operation.

Unit-IV

Introduction to radar, radar block diagram and operation, radar frequencies, Applications of radar, The Radar Equation: Detection of signals in noise , Receiver noise and the signal to noise ratio, Probabilities of detection and false alarm, Integration of Radar Pulses, Radar cross section of targets, Radar cross section fluctuations, Transmitter Power, Pulse Reception Frequency , Antenna Parameters, System Losses.

Unit-V

Tracking Radar: sequential lobbing, conical scan, mono-pulse Tracking, low angle tracking, tracking in range. MTI and Pulse Doppler Radar: Introduction to Doppler and MTI Radar, Delay Line cancellers, Staggered Pulse Reception Frequencies, Doppler Filter Banks, Digital MTI Processing, Moving Target Detector, Limitations to MTI Performance.

Course outcome:

After studying this course, the students will be able to

- Understand the orbital and functional principles of satellite communication systems.
- Select an appropriate modulation, multiplexing, coding and multiple access schemes for a given satellite communication link

Text Book:

1. T. Pratt, C. Bostian and J. Allnutt, "Satellite Communications," 2nd Edition, Wiley India, 2006.
2. W. L. Pritchart, H. G. Suyderhoud and R. A. Nelson, "Satellite Communication Systems Engineering," 2nd Edition., Pearson Education, 2012.

Reference Book:

1. G. Gordon and W. Morgan, "Principles of Communications Satellites,"
2. D. I. Dalgleish "An Introduction to Satellite Communications", IET Publisher.

OE-4003	Digital System Design with VHDL	L-T-P-C:3-0-0-3

Course objective:

- To prepare students to understand the use and application of Boolean algebra in the areas of digital circuit reduction, expansion, and factoring.
- To acquire the concept of the IEEE Standard in Hardware Description Language and be able to simulate & debug digital systems described in VHDL.
- To have knowledge to synthesize complex digital circuits at several level of abstractions.

Course content:

Unit 1:

VLSI Design Flow, Gajski-Y chart, Basic concepts of hardware description languages. Design flow for VHDL/Verilog based RTL/logic synthesis. Hierarchy, Concurrency, Logic, and Delay modeling, Structural, Data-flow and Behavioral styles of hardware description. Architecture of event driven simulators.

Unit 2:

Syntax and Semantics of Verilog/VHDL. Variable, signal types, arrays, attributes and tables. Data types, Operators, expressions and signal assignments. Entities, architecture specification and configurations. Component instantiation.

Unit 3:
Use of Procedures, Tasks and functions, Memory Modelling, Examples of design using Verilog/ VHDL.

Unit 4:
Concurrent and sequential constructs. Examples of design using Verilog. Sequential Circuit design, Finite State Machine Modeling.

Unit 5:
Synthesis of combinational and sequential circuits.

Course Outcome: After studying this course, the students will be able to

- understand basics of hardware description languages.
- implement various examples of digital IC designs using hardware description languages.
- account for the syntax and behavior of the VHDL language.
- use modern development tools to design complex digital circuits

Text Book:

1. S. Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", Prentice Hall NJ, USA, 1996.
2. Z. Navabi, "VHDL: Analysis and Modeling of Digital Systems", McGraw Hill International Ed. 1998.

Reference Book:

1. Michael D. Ciletti "Advanced Digital Design with the Verilog HDL", Prentice Hall India, 2005.
2. J. Bhaskar, "VHDL Primer", Pearson Education Asia, 2001.
3. Peter Ashenden, "Digital Design using VHDL", Elsevier, 2007.

OE-4005	Advanced Semiconductor Devices	L-T-P-C:3-0-0-3

Course objective:

- To learn how to design advance semiconductor devices.
- To learn techniques and tools for semiconductor device measurement
- To understand the limitations and difficulties in modern semiconductor devices, including wiring constraints, high-speed, etc.

Unit-I

Introduction of Semiconductor Devices: Introduction, Ohmic contact, Rectifying contact, Current transport across a metal-semiconductor boundary, Metal-Insulator-Semiconductor(MIS) System, Metal-Semiconductor-Field-Effect-Transistor (MESFET), Charge Coupled Devices (CCDs), Microwave transistors, Gunn Diode, Impatt Diode.

Unit-II

Semiconductor Tunnel Devices: Tunneling from the point of view of quantum measurement, Analysis of the Tunneling effect; Tunneling probability, Tunneling current density, Resonant tunneling.

Tunnel Diodes; Qualitative and quantitative explanation of the Tunnel Diode I-V characteristics, Indirect tunneling, Excess current, Thermal current in a tunnel diode, Dependence of tunnel diode characteristics on various parameters.

Unit-III

Physics of Advance MOSFET Structures: Non-uniform Doping and Buried Channel Devices, Background on hetero-structure, Quantum well, Two-dimensional electron gas (2DEG), Super lattice, Coulomb blockade effect, Quantized transport, Ballistic transport, and Quantum capacitance.

Unit-IV

MOSFET Structures: Thin Film Transistor (TFT), Silicon on Insulator (SOI), High electron-mobility transistor (HEMT), Modulation-doped FET (MODFET), Recessed-Channel MOSFET, Floating gate MOSFET, Ballistic Transistor, Single-electron Transistor (SET), Negative Capacitor Field Effect Transistors (NC-FETs).

Unit-V

BJT Structures: Heterojunction bipolar transistor (HBT), Super lattice Devices, Planar Doped Barrier Devices, Real Space Transfer and Hot Electron Injection Transistors, Polysilicon Emitter Structure, Sidewall Base **Contact Structure, and High Frequency Transistor.**

Photonic Devices: Light-emitting diodes (LEDs), OLEDs, Laser diodes, Photodetectors, and Solar cells

State-of-the-art Semiconductor Devices: Emerging non-volatile memory materials and devices (Memristor), Carbon nanotube/nanowire, graphene, and MoS2 based electronic devices, Introduction of Neuromorphic computing.

Course Outcome: Upon Completion of the course, the students will be able to:

- Design Advance Semiconductor devices.
- Learn Technology of Modern semiconductor devices and application

Text Book:

1.S. M. Sze and Kwok K. Ng, "Physics of Semiconductor Physics (3rd)", Wiley, 2007
2.Supriyo Datta, "Quantum Transport Atom to Transistor", Cambridge University Press, 2005

Reference Book:

1. Physics of Semiconductor Devices, Michael Shur, PHI

OE-4007	Optimization Techniques	L-T-P-C:3-0-0-3

Course objective:

- To acquire the knowledge of optimization techniques and application ofunderstanding to transportation, assignment, sequencing, and scheduling problems.
- To prepare students to understand various linear and non-linear programming problems applicable in industries.

Course content:

Unit-I

Introduction: Introduction to optimization techniques; classification of optimization problem based on objective function, constraints, and variables; classical optimization techniques, constrained, unconstrained, multivariable problems.

Unit-II

Linear Programming Problem: Introduction to Linear Programming Problem (LPP), Formulation, Graphical method, corner point method, ISO profile method, Simplex and Revised simplex method, Big-M method, Two-phase method, Standard primal form and canonical form, Duality, Dual Simplex Method.

Unit-III

Post Optimality Analysis: Sensitivity analysis; change in technological coefficients, costs and availabilities; Addition of new variable and constraints; Deletion of constraints and variable.

Unit-IV

Optimization Problems: Formulation of transportation problem, basic feasible solution, North-West corner method, Least cost entry method, Vogal's approximation method, Test of optimality. Formulation of Assignment problem, Hungarian algorithm, travelling salesman problem. Sequencing problem with jobs and machines. Project scheduling, network diagrams, critical path method, time cost optimization algorithm.

Unit-V

Non-Linear Programming Problem: Unconstrained non-linear programming problems; direct search methods – univariate method, pattern search method; Indirect search methods – steepest descent method; constrained optimization problems; direct method – complex method, Zoutendijk method; indirect method – transform techniques, penalty function method.

Course outcome:

After studying this course, the students will be able to

- understand importance of optimization of industrial process management.
- apply basic concepts of mathematics to formulate an optimization problem.
- Model engineering minima/maxima problems as optimization problems.
- analyze and appreciate variety of performance measures for various optimization problems.

Text Book:

1. Rao S. S., 'Engineering Optimization, Theory and Practice' - New Age International Publishers.
2. Chander Mohan, Kusum Deep, "Optimization Techniques", New Age International Private Limited.
3. S. K. Yadav, S. R. Yadav, A. K. Malik, "Optimization Techniques", I K International Publishing House.

Reference Book:

1. E. K. P. Chong and S. Zak, "An introduction to optimization" John Wiley and Sons (Asia) Pvt. Ltd., Singapore.
2. R. Fletcher, "Practical methods of optimization", Wiley, New York.
3. J. Nocedal and S. Wright, "Numerical optimization", Springer-Verlag, New York.
4. R. K. Sundaram, "A first course in optimization theory", Cambridge University Press, Cambridge.

OE-4009	Research Methodology & Intellectual Property Rights	L-T-P-C:3-0-0-3

Course objective:

- Present research methodology and the technique of defining a research problem.
- Learn the meaning of interpretation, techniques of interpretation, precautions is to be taken in interpretation for research process,
- Application of statistical methods in research
- Learn intellectual property rights and its constituents.

Course content:

Unit-I

Introduction to research, Definitions and characteristics of research, Types of Research, Research Process, Problem definition, Objectives of Research, Research Questions, Research design, Quantitative vs. Qualitative Approach, Building and Validating Theoretical Models, Exploratory vs. Confirmatory Research, Experimental vs. Theoretical Research, Importance of reasoning in research.

Unit-II

Problem Formulation, Understanding Modeling & Simulation, Literature Review, Referencing, Information Sources, Information Retrieval, Indexing and abstracting services, Citation indexes, Development of Hypothesis, Measurement Systems Analysis, Error Propagation, Validity of experiments, Statistical Design of Experiments, Data/Variable Types & Classification, Data collection, Numerical and Graphical Data Analysis: Sampling, Observation, Interpretation of Results.

Unit-III

Statistics: Probability & Sampling distribution, Estimation, Measures of central Tendency, Arithmetic mean, Median, Mode, Standard deviation, Co-efficient of variation (Discrete serious and continuous serious), Hypothesis testing & application, Correlation & regression analysis, Orthogonal array, ANOVA, Standard error, Concept of point and interval estimation, Level of significance, Degree of freedom, Analysis of variance, One way and two way classified data, 'F'-test.

Unit-IV

Preparation of Dissertation and Research Papers, Tables and illustrations, Guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript. References, Citation and listing system of documents.

Unit-V

Intellectual property rights (IPR) - patents-copyrights-Trademarks-Industrial design geographical indication. Ethics of Research- Scientific Misconduct- Forms of Scientific Misconduct. Plagiarism, Unscientific practices in thesis work, Ethics in science.

Course outcome:

- Design and formulation of research problem.
- Analyze research related information and statistical methods in research.
- Carry out research problem individually in a perfect scientific method
- Understand the filing patent applications- processes, Patent search, and various tools of IPR, Copyright, and Trademarks.

Text Book:

1. K. S. Bordens, and B. B. Abbott, , "Research Design and Methods – A Process Approach", 8th Edition, McGraw-Hill, 2011
2. C. R. Kothari, "Research Methodology – Methods and Techniques", 2nd Edition, New Age International Publishers
3. Douglas C. Montgomary & George C. Runger, Applied Statistics & probability for Engineers, 3rd edition,2007,Wiley
4. Robert P. Merges, Peter S. Menell, Mark A. Lemley, and "Intellectual Property in New Technological Age". Aspen Law & Business; 6th edition July 2012

Reference Book:

1. Michael P. Marder," Research Methods for Science", Cambridge University Press, 2011

2. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008.
3. G.W. Snedecor and W.G. Cochrans, Lowa, Statistical Methods, state University Press, 1967.
4. Davis, M., Davis K., and Dunagan M., “Scientific Papers and Presentations”, 3rd Edition, Elsevier Inc.

OE-4011	Antenna Design	L-T-P-C:3-0-0-3

Module I

Antenna Fundamentals: Introduction, Types of Antennas, Radiation Pattern and mechanism, Antenna Parameters, Antenna Losses, Duality Theorem, Reciprocity Theorem.

Module II

Elementary Antennas: Linear Wire Antennas, Monopole, Infinitesimal Dipole, Small Dipole, Finite Length Dipole, Half Wavelength Dipole, Loop Antenna, Small Circular Loop.

Module III

Aperture and Broadband Antennas: Huygens’ Principle, Radiation from Rectangular and Circular Apertures, Babinet’s Principle, E-Plane and H-Place Sectorial Horn, Pyramidal Horn, Conical Horn, Broadband Antennas.

Module IV

Microstrip Antennas: Basic Characteristics of Microstrip Antennas, Antenna Miniaturization, Feeding Methods, Introduction to Patch and its types, Methods of Analysis, Design of Rectangular and Circular Patch Antennas. Quality Factor, Bandwidth, Efficiency.

Module V

Reflector and Smart Antennas: Plane, Corner, Parabolic and Spherical Reflector, Introduction to Smart Antennas, Switched Beam Systems, Adaptive Array Systems, Spatial Division Multiple Access, MANETs.

Text Book:

1. Balanis C.A., "Antenna Theory and Design", 3rd Edition, John Wiley & Sons. 2005, ISBN: 978-81-265-2422-8.

Reference Book:

1. Stutzman W.L., and Thiele G.A., "Antenna Theory and Design", 2nd Edition. John Wiley & Sons. 1998.
2. Elliot R.S., "Antenna Theory and Design", Revised Edition, Wiley-IEEE Press, 2003.

OE-4013	Data Mining	L-T-P-C:3-0-0-3

Course objective:

- To learn embedded system architecture.
- Study in detail process management and memory management.
- To learn Real Time Operating system principles and its components.
- Study in detail Linux kernel and Linux files systems.
- Study in detail device drivers.

Course Content:

1. General Introduction of Warehousing: Historical Perspective, characteristics of data warehousing. Data Warehousing: its architecture, Logical design, Data Preprocessing- Data Cleaning methods, Descriptive Data Summarization, Data Reduction, Data Discretization and Concept hierarchy generation
2. Multidimensional data model, Attribute oriented induction, Overview of ETL and OLAP, Comparison of OLAP and OLTP systems, Data mart. Data mining vs Database, Data Warehousing architecture and implementation, Data mining as a component of data warehouse.
3. Data Mining Techniques: Basic concepts of Association Rule Mining, Frequent Item set mining, Mining various kinds of association rules, Classification by decision tree induction
4. Bayesian Classification, Rule-based Classification, Classification Back-propagation, Associative Classification, Lazy Learners, Rough set approach, Clustering methods
5. Data Objects and Attribute Types, Basic Statistical Descriptions of Data, Measuring Data Similarity and Dissimilarity Partition based Clustering, Hierarchical based clustering, Density based clustering.

Course Outcome:

On completion of the course, student will be able to

- Understand formal machines, languages
- Understand stages in building a Data Warehouse
- Apply pre-processing techniques for data cleansing
- Analyse multi-dimensional modelling techniques
- Analyse and evaluate performance of algorithms for Association Rules
  Analyse Classification and Clustering algorithms

Text Book:

1. Arun K. Pujari, Data Mining Techniques, University Press, 2001
2. Vipin Kumar, Introduction to Data Mining - Pang-Ning Tan, Michael Steinbach, Addison Wesley, 2006.
3. Paulraj Ponniah, Data Warehousing: Fundamentals for IT Professionals, Wiley Pb. Linux", Packt Publishing, 1st Edition, 2017.

Reference Book:

1. Jiawei Han and M Kamber , Data Mining Concepts and Techniques, , Second Edition, Elsevier Publication, 2011.

OE-4015	**Software Project Process and Quality Management**	**L-T-P-C:3-0-0-3**

Course objective:

- To learn the basic project attributes such as size, effort, cost etc.
- To get an overview of the project planning activities and organization of the project plan document.
- To learn the different project estimation and scheduling techniques.
- To know project risk and configuration management.

Course content:

Module I

Introduction to S/W project management, S/W project management competencies, responsibilities of a software project manager, Software process, S/W process models, project planning, organization of project team.

Module II

Estimation Techniques: S/W size estimation, estimation of effort & duration. COCOMO models, Putnam's work, Jensen's model, Halstead's software Science.

Module III

Dependency & scheduling: PERT, CPM, Gantt Chart, staffing, Organizing a software engineering project.

Module IV

S/W configuration management, monitoring & controlling S/W projects, developing requirements, risk management, project tracking & control, communication & negotiating.

Module V

S/W quality, S/W quality engineering, defining quality requirements, quality standards, practices & conventions, ISO 9000, ISO 9001, S/W quality matrices, managerial and organization issues, defect prevention, reviews & audits, SEI capability maturity model, PSP, six sigma.

Course outcome:

After reading this subject, students will be able to:

- Understand basic project attributes such as size, effort, cost etc.
- Learn the desirable responsibilities of a good project manager.
- Measure length , volume, effort, time and cost of a project.
- Schedule project activities using PERT and GANTT chart.
- Handle various project risks and configuration management.

Text Book:

1. B. Hughes, M. Cotterell, Rajib Mall, Software Project Management, McGraw Hill , 2015
2. R. Walker, Software Project Management, Pearson , 2003

Reference Book:

1. R. H. Thayer, Software Engineering Project management, IEEE CS Press , 1988
2. R. Pressman, Software Engineering: A Practitioner's approach, McGraw Hill , 2005

OE-4017	Advanced Computer Networks	L-T-P-C:3-0-0-3

Course content:

Module I

IPv6: The next generation internet – trend of the future and many other aspects. The basic IPv6 protocol with its new auto-configuration scheme. The transition technologies for moving from IPv4 to IPv6.

Module II

Mobile IP and Mobile IPv6. Basic mobile IPv4 protocol and triangular and optimized routing. Mobile IPv6 protocol and difference from mobile IPv4.

Module III

Traffic Engineering (TE)/Quality of Service(QOS) in IP: Considering the latest trend towards VoIP. Basic concepts of QoS and the various proposals to achieve QoS: diffserv and intserv. MPLS and how it is useful in QoS. Basic concepts of traffic engineering and how this can be achieved with MPLS.

Module IV

Software Defined Networking (SDN): Motivation for introducing SDN, Data plane abstraction, control plane abstraction and network virtualization concepts. (This is entirely based on research papers as of now.)

Course outcome: At the end of this course, student will able to

- Understand the IPv6 and its implementation.
- Understand various mobile IP allocation and use-cases.
- Understanding network traffic engineering and Quality of Service.
- Understanding the new era of networking as SDN.

Text Book:

1. TCP/IP Protocols Suits, Behrouz A. Forouzan, Mc Graw Hill

Reference Book:

1. RFCs for IPv6 and Microsoft documents on IPv6.
2. Mobile IP, Design Principles and Practices by Charles Perkins
3. Mobile IPv6 by Hesham Soliman
4. MPLS and Label Switching Networks by Uyless Black
5. MPLS by Bruce Davie and Yakov Rekhter
6. QoS control in High Speed Networks by H.Jonathan Chao, Xiaolei Guo
7. SDN Papers

OE-4019	Cyber Crime	L-T-P-C:3-0-0-3

Course content:

Unit 1: Cyber Crime- Overview, Internal and External Attacks, Attack Vectors. Cybercrimes against Individuals – E-mail spoofing and online frauds, Phishing and its forms, Spamming, Cyber-defamation, Cyberstalking, Cyber Bullying and harassment, Computer Sabotage, Pornographic offenses, Password Sniffing. Keyloggers and Screenloggers. Cyber Crimes against Women and Children.

Unit 2: Cybercrime against organization – Unauthorized access of computer, Password Sniffing, Denial-of-service (DOS) attack, Backdoors and Malwares and its types, E-mail Bombing, Salami Attack, Software Piracy, Industrial Espionage, Intruder attacks.

Security policies violations, Crimes related to Social Media, ATM, Online and Banking Frauds. Intellectual Property Frauds. Cyber Crimes against Women and Children.

Unit 3: A global perspective on cybercrimes, Phases of cyber attack – Reconnaissance, Passive Attacks, Active Attacks, Scanning, Gaining Access, Maintaining Access, Lateral movement and Covering Tracks. Detection Avoidance, Types of Attack vectors, Zero-day attack, Overview of Network based attacks.

Unit 4: Cybercrime and cloud computing, Different types of tools used in cybercrime, Password Cracking – Online attacks, Offline attacks, Remote attacks, Random Passwords, Strong and weak passwords. Viruses and

its types. Ransomware and Cryptocurrencies. DoS and DDoS attacks and their types. Cybercriminal syndicates and nation state groups.

Course outcome: At the end of this course, student will able to

- Analyze and evaluate the cyber security needs of an organization.
- Determine and analyze software vulnerabilities and security solutions to reduce the risk of exploitation.
- Measure the performance and troubleshoot cyber security systems.
- Implement cyber security solutions and use of cyber security, information assurance, and cyber/computer forensics software/tools.
- Comprehend and execute risk management processes, risk treatment methods, and key risk and performance indicators
- Design and develop a security architecture for an organization.
- Design operational and strategic cyber security strategies and policies.
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Text Book:

1. William Stallings; "Cryptography and Network Security: Principles and Practices", Fifth Edition, Prentice Hall Publication Inc., 2007.
2. Atul Jain; "Cyber Crime: Issues, Threats and Management", 2004.

Reference Book:

1. Nina Godbole and Sunit Belapore; "Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", Wiley Publications, 2011.
2. Shon Harris, "All in One CISSP, Exam Guide Sixth Edition", McGraw Hill, 2013.
3. Bill Nelson, Amelia Phillips and Christopher Steuart; "Guide to Computer Forensics and Investigations" – 3rd Edition, Cengage, 2010 BBS.

CS-4021	Advances In Software Testing	L-T-P-C:3-0-0-3

Course objective:

- To learn the evolution of software testing techniques, Myths and facts of software testing, Models for testing processes, various types of software testing.
- To design test cases using black-box and white-box testing techniques.
- To understand basic concepts of regression testing, Problems of regression testing, and types of Regression testing techniques.
- To learn the strategies for testing of object-oriented applications and web-based applications.

Course content:

UNIT-1

Introduction to software testing, Basic concepts, Verification and Validation, Black box testing: Boundary value testing, Equivalence class testing, State Table Based Testing,Decision Table Based Testing, Cause-Effect Graph based Testing, Positive and Negative Testing, Orthogonal Array Testing.

UNIT-2

White box testing: statement coverage, Branch coverage, condition coverage, MC/DC, path coverage, McCabe's cyclomatic complexity Data flow based testing, Mutation testing.

UNIT-3

Static testing, Integration testing, System testing, Interaction testing, Performance testing, Regression testing, Error seeding, Debugging.

UNIT-4

Object-oriented software testing: issues in object-oriented testing, Fault based testing, test cases and class hierarchy, Scenario based Test design, Class testing: Random testing for object-oriented classes, Partition testing at the class level Inter class test case design: multiple class testing, tests derived from behavioral models, Testing web based systems, Testing tools.

Course outcome:

After reading this subject, students will be able to:

- Understand the evolution of software testing techniques, their goals and learn the various models of software testing.
- Generate test cases for software systems using black box and white box testing techniques.
- Carry out regression testing of software systems.
- Test conventional, object-oriented and web based software.
- Understand debugging software and types of debuggers.

Text Book:

3. C. J. Paul, Software testing: A craftsmen's approach, CRC Press , 2013
4. S. Desikan, R. Gopalswamy, Software Testing: Principles and Practices, Pearson , 2006

Reference Book:

1. N. Chauhan, Software Testing: Principles and Practices, Oxford University Press , 2017
2. G. J. Myers, The art of software testing, Wiley Interscience New York , 2011

CS-4023	Soft Computing	L-T-P-C:3-0-0-3

Course objective:

- Understand Soft Computing concepts, technologies, and applications
- Understand the underlying principle of soft computing with its usage in various application. .
- Understand different soft computing tools to solve real life problems.

Course content:

UNIT-1

Overview of Soft Computing, Difference between Soft and Hard computing, Brief descriptions of different components of soft computing including Artificial intelligence systems Neural networks, fuzzy logic, genetic algorithms. Artificial neural networks Vs Biological neural networks, ANN architecture, Basic building block of an artificial neuron, Activation functions, Introduction to Early ANN architectures (basics only)- McCulloch & Pitts model, Perceptron, ADALINE, MADALINE

UNIT-2

Artificial Neural Networks: Supervised Learning: Introduction and how brain works, Neuron as a simple computing element, The perceptron, Backpropagation networks: architecture, multilayer perceptron, backpropagation learning-input layer, accelerated learning in multilayer perceptron, The Hopfield network, Bidirectional associative memories (BAM), RBF Neural Network.

UNIT-3

Artificial Neural Networks: Unsupervised Learning: Hebbian Learning, Generalized Hebbian learning algorithm, Competitive learning, Self- Organizing Computational Maps: Kohonen Network.

UNIT-4

Fuzzy Logic Crisp & fuzzy sets fuzzy relations fuzzy conditional statements fuzzy rules fuzzy algorithm. Fuzzy logic controller.

UNIT-5

Genetic algorithms basic concepts, encoding, fitness function, reproduction-Roulette wheel, Boltzmann, tournament, rank, and steady state selections, Convergence of GA, Applications of GA case studies. Introduction to genetic programming- basic concepts.

Course outcome:

Upon successful completion of this course students should be able to:

- Develop application on different soft computing techniques like Fuzzy, GA and Neural network
- Implement Neuro-Fuzzy and Neuro-Fuzz-GA expert system.

Text Book:

1. R. Rajasekaran and G. A and Vijayalakshmi Pa, Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications, Prentice Hall of India
2. D. E. Goldberg, Genetic Algorithms in Search, Optimisation, and Machine Learning, Addison-Wesley

Reference Book:

1. L. Fausett, Fundamentals of Neural Networks, Prentice Hall
2. T. Ross, Fuzzy Logic with Engineering Applications, Tata McGraw Hill

OE-4025	Lasers and Ultrafast Optics	L-T-P-C:3-0-0-3

Module I

Laser Physics: The Einstein coefficients, light amplification, the threshold condition, laser rate equations, line broadening mechanisms, cavity modes, optical resonator, quality factor, mode selection, Introduction to gas lasers, solid state lasers, and semiconductor lasers.

Module II

Ultrafast optics: Introduction to ultrashort pulses (nano-, pico-, femto-, attosecond pulses): generation and propagation; principles of mode locking; pulse compression; laser amplifiers; interferometric autocorrelation; ultrafast measurement techniques: time resolved measurement, electro-optic sampling.

Module III

Applications: Nonlinear optical susceptibilities, second harmonic generation, self-focusing;, Step index and graded index optical fibers, attenuation and dispersion, brief introduction to fiber optic communications; Optical solitons,working principle: terahertz spectroscopy, laser ablation, multiphoton absorption.

Text Books:

1. W. T. Silfvast, Laser Fundamentals, 2nd Ed., Cambridge University Press, 2004.
2. B.E.A. Saleh and M.C.Teich, Fundamentals of Photonics, 2nd Ed., Wiley, 2007.

Reference Books:

1. Ultrafast Optics -Andrew Weiner (John Wiley & Sons).

2. Ultrashort Laser Pulse Phenomena -J.-C. Diels and W. Rudolph (Academic Press).
3. R.W. Boyd, Nonlinear Optics, 3rd Ed., Academic Press, 2007.
4. A. Ghatak and K. Thyagarajan, Optical Electronics, Cambridge University Press, 2009.

OE-4027	Pattern Recognition and Classification	L-T-P-C:3-0-0-3

Course objective:

The objective of the course is to understand the algorithms for Pattern Recognition. The representation of patterns and classes and the similarity measures are an important aspect of pattern recognition. Pattern recognition involves classification and clustering of patterns. The two well-known paradigms of machine learning namely, learning from examples or supervised learning and learning from observations or clustering covered in this course. When the data sets are very large it is meaningful to reduce the data and use this reduced data for pattern classification. The details of feature extraction and feature selection are also covered in this course.

Course content:

Unit 1: Introduction: Basics of Probability and Statistics, Linear Algebra, Linear Transformations, Components of Pattern Recognition System, Learning and adaptation, Supervised Learning (Classification) and Unsupervised Learning (Clustering)

Unit 2: Bayesian Decision Theory: classifiers, discriminant functions, decision surfaces, Discriminant functions for Normal density, Error bounds for Normal density, Maximum Likelihood and Bayesian Parameter Estimation, Principal Component Analysis, Fisher Linear Discriminant, Hidden Markov Models.

Unit 3: Non-parametric Techniques: Parzen window estimation, *k*-nearest neighbour classification, Perceptron classifier, Support Vector Machines, Decision Tree based classifiers

Unit 4: Back propagation networks : (BPN) Architecture of feed forward network, single layer ANN, multilayer perceptron, back propagation learning, input – hidden and output layer computation, back propagation algorithm, applications, selection of tuning parameters in BPN, Numbers of hidden nodes, learning.

Activation & Synaptic Dynamics : Introduction, Activation Dynamics models, synaptic Dynamics models, stability and convergence, recall in neural networks. Basic functional units of ANN for pattern recognition tasks: Basic feed forward, Basic feedback and basic competitive learning neural network. Pattern association, pattern classification and pattern mapping tasks.

Unit 5: Competitive learning neural networks : Components of CL network pattern clustering and feature. Mapping network, Unsupervised Learning/Clustering: distance/similarity measures, K-means clustering, single linkage and complete linkage clustering. Applications of ANN: Pattern classification – Recognition of Olympic games symbols, Recognition of printed Characters. Neocognitron -Recognition of handwritten characters.

Course outcome:

At the end of the course student will be able to

- design systems and algorithms for pattern recognition
- analyze a given pattern recognition problem, and determine which algorithm to use
- modify existing algorithms to engineer new algorithms
- solve a particular problem at hand from a wide variety of application domains
- gain a working knowledge of some of the most recent developments in pattern recognition, such as incremental learning and learning in nonstationary environments

Text Book:

1. Pattern Recognition and Machine Learning, C. M. Bishop
2. Artificial Neural Network, B. Yegnarayana

Reference Book:

1. Pattern Classification, R. O. Duda, P. E. Hart, D. G. Stork

OE-4029	**Machine Learning**	**L-T-P-C:3-0-0-3**

Course objective:

- Machine learning uses interdisciplinary techniques such as statistics, linear algebra, optimization, and computer science to create automated systems that can sift through large volumes of data at high speed to make predictions or decisions without human intervention.
- Machine learning as a field is now incredibly pervasive, with applications spanning from business intelligence to homeland security, from analyzing biochemical interactions to structural monitoring of aging bridges, and from emissions to astrophysics, etc.
- This class will familiarize students with a broad cross-section of models and algorithms for machine learning, and prepare students for research or industry application of machine learning techniques.

Module I

Based on fundamental knowledge of computer science principles and skills, probability and statistics theory, and the theory and application of linear algebra. This course provides a broad introduction to machine learning and statistical pattern recognition.

Module II

Supervised learning (generative/discriminative learning parametric/nonparametric learning, neural networks, and support vector machines);
Unsupervised learning (clustering, dimensionality reduction, kernel methods);
Learning theory (bias/variance tradeoffs; VC theory; large margins);
Reinforcement learning and adaptive control.

Module III

Applications of machine learning, such as to robotic control, data mining, autonomous navigation, speech recognition.

Module IV

Bioinformatics, NLP, Text and web data processing.

Course outcome:

Develop an appreciation for what is involved in learning models from data.

- Understand a wide variety of learning algorithms.
- Understand how to evaluate models generated from data.
- Apply the algorithms to a real-world problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models.

Text Book:

1. Ethem Alpaydin, Introduction to Machine Learning, Second Edition. http://mitpress.mit.edu/catalog/item/default.asp?ttype=2&tid=12012. This book will cover all the material in the course.

Reference Book:

1. Stephen Marsland, Machine Learning: An Algorithmic Perspective.
2. Christopher M. Bishop, Pattern Recognition and Machine Learning.
3. Tom Mitchell, Machine Learning, http://www.cs.cmu.edu/~tom/mlbook.html.

OE-4031	Computer Vision	L-T-P-C:3-0-0-3

Course objective:

- Be familiar with both the theoretical and practical aspects of computing with images;
- Have described the foundation of image formation, measurement, and analysis;
- Have implemented common methods for robust image matching and alignment;
- Understand the geometric relationships between 2D images and the 3D world.
- Have gained exposure to object and scene recognition and categorization from images;
- Able to develop the practical skills necessary to build computer vision applications.

Course content:

Unit-I

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

Unit-II

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

Unit-III

Shape Representation, Segmentation and Object Recognition: Shape Representation and Segmentation, Deformable curves and surfaces, Snakes and active contours, Level set representations, Fourier and Wavelet Descriptors, Medial Representations ,Multiresolution analysis, Hough transforms and other simple object recognition Methods, Shape Correspondence and Shape Matching, Shape priors for recognition.

Unit-IV

Motion Estimation: Regularization Theory, Optical Computation, Stereo Vision, Motion Estimation, Structure from Motion.

Course outcome:

- Able to demonstrate knowledge and understanding of Human and computer vision systems.
- Understand current approaches to image formation and image modeling.
- Analyze and design a range of algorithms for image processing and computer vision
- Develop and evaluate solutions to problems in computer vision

Text Book:

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.
2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003.
3. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.
4. K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990.
5. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992.

Reference Book:

1. IEEE-T-PAMI (IEEE Transactions on Pattern Analysis and Machine Intelligence).
2. IJCV (International Journal of Computer Vision) - Springer.

OE-4033	**Cloud Computing**	**L-T-P-C:3-0-0-3**

Course objective:

- To impart basic concepts in the area of cloud computing.
- Bring in-depth understanding on architectures and models for Cloud Computing with Internet of Things.
- To impart knowledge in web-based applications of cloud computing

Course content:

Unit 1: Introduction to Cloud Computing: Nutshell of cloud computing, feature Characteristics and components of Cloud Computing. Challenges, Risks and Approaches of Migration into Cloud. Evaluating the Cloud's Business Impact and economics, Future of the cloud.

Unit 2: Networking Support for Cloud Computing. Ubiquitous Cloud and the Internet of Things. Cloud Computing Architecture: Cloud Reference Model, Layer and Types of Clouds, Services models, Data center Design and interconnection Network, Architectural design of Computer and Storage Clouds.

Unit 3: Cloud Programming and Software: Fractures of cloud programming, Parallel and distributed programming paradigms, High level Language for Cloud. Introduction to Map Reduce, GFS, HDFS, Hadoop Framework.

Unit 4: Virtualization Technology: Definition, Understanding and Benefits of Virtualization. Implementation Level of Virtualization, Virtualization Structure/Tools and Mechanisms, Hypervisor, VMware, KVM, Xen. Virtualization of CPU, Memory, I/O Devices, Virtual Cluster and Resources Management, Virtualization of Server, Desktop, Network, and Virtualization of data-center.

Unit 5: Web-Based Application, Pros and Cons of Cloud Service Development, Types of Cloud Service Development, Software as a Service, Platform as a Service, Web Services, On-Demand Computing,

Discovering Cloud Services, Development Services and Tools, Amazon Ec2, GoogleApp Engine, IBM Clouds.

Course outcome:

At the end of the course student will be able

- Have an overall understanding on various hardware and software necessary for cloud computing.
- Design and develop various cloud computing applications.

Text Book:

1. Cloud Computing: Principles and Paradigms, Raj Kumar Buyya, JemesBroberg, Andrzej M.Goscinski.
2. Dan C Marinescu, Cloud Computing, Theory and Practice, MK, Elsevier

Reference Book:

1. Distributed and Cloud Computing : Kai Hawang, Geoffrey C. Fox, Jack J. Dongarra

OE-4035	**Statistical Mechanics**	**L-T-P-C:3-0-0-3**

Module I

Probability concept: One dimensional random walk problem and any other relevant examples; Different probability distributions: Binomial, Gaussian and Poisson distributions and their region of validity.

Module II

Concepts of ensemble and microstates (Quantum and Classical):Phase space, phase cell; Counting of microstates for some examples (using both quantum and classical concepts); Postulate of equal a priori probability; Liouville's theorem; Ergodic hypothesis; Boltzmann H-theorem. Different types of interactions: Thermal interaction, mechanical interaction, Diffusion.

Module III

Ensembles: Microcanonical ensemble; Canonical ensemble; Grand canonical ensemble. Equipartition and virial theorems. Gibbs paradox.

Module IV

Quantum Statistics: quantum mechanical ensemble theory for all ensembles, Wave function for quantum many body system (Bosons and Fermions).

Quantum gases: Ideal Bose gas, Bose-Einstein condensation, black body radiation, phonons; Ideal Fermi gas, Pauli paramagnetism, thermionic emissions, white dwarf.

Module V

Critical Phenomena: Van der Waals equations of state and phase transition, critical exponents, Landau model, one dimensional Ising model and its solution by transfer matrix method.

Text Books:

1. Federic Reif, ``Fundamentalsof Statistical and thermal physics.'', Sarat Book Distributors, 2010.

2. R. K. Pathria, ``Statistical mechanics.'', 3rd Ed, Elsevier, 2011.
3. Nigel Goldenfeld, ``Lectures on phase transitions and the renormalization group.'', Sarat Book House, 2005.

Reference Books:

1. M. Toda, R.K. Kubo and N. Saito, ``Statistical Physics I.'', Springer-Verlag Berlin and Heidelberg GmbH & Co. K; 2nd ed, 1998 edition.
2. H. Eugene Stanley, ``Introduction to Phase transitions and critical phenomena.''
3. W. Greiner, L Neise, and H. Stocker, ``Thermodynamics and Statistical Mechanics.'

OE-4037	Data Communication & Networks	L-T-P-C:3-0-0-3

Course objective:

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

- Build an understanding of the concepts of computer networking and internet protocols.
- Familiarize with the basic taxonomy and terminology of digital and analog transmission used in computer networking area.
- Introduce the student to fundamental networking concepts with various multiplexing techniques and the importance of error correcting codes in data transmission.
- Allow the student to gain expertise in some specific areas of networking such as the design and maintenance of individual networks.

Module I

Introduction to Data Communication & Networks: Data communication: components of a data communications system, data flow; networks: network criteria, physical structures, network topology, transmission modes: parallel, serial; categories of networks - Local Area Network (LAN), Wide Area Network (WAN), Metropolitan Area Network (MAN); organization of the internet, internet service providers (ISPs).

Module II

Network Models and Internet Protocols: Open Systems Interconnection (OSI) model, TCP/IP model, layered architectures, peer-to-peer processes, encapsulation; addressing: physical addresses, logical addresses, port addresses, specific addresses; IPv4: class, address, mask, gateway, subnetting, super-netting; internetworking devices: hub, switch, router; Dynamic Host Configuration Protocol (DHCP), Network Address Translation (NAT); comparison between IPv4 and IPv6, IPv6 address format.

Module III

Client Server Interaction: Uniform Resource Locator (URL), Secure Shell (SSH), Post Office Protocol (POP), Internet Message Access Protocol (IMAP); Application layer protocol: Hypertext Transfer Protocol (HTTP), File Transfer Protocol (FTP), Domain Name System (DNS), Simple Mail Transfer Protocol (SMTP), Telnet, Dynamic Host Configuration Protocol (DHCP); Transport Layer Protocol: Transmission Control Protocol (TCP) and User Datagram Protocol (UDP); Internetwork layer protocol: Internet Protocol (IP); Transport layer port numbers.

Module IV

Bandwidth Utilization: Multiplexing and spreading, multiplexing, spread spectrum, transmission media, guided media, unguided media: wireless, switching, circuit-switched networks, datagram networks, virtual-

circuit networks, structure of a switch, using telephone and cable networks for data transmission, telephone networks, dial-up modems, Digital Subscriber Line (DSL), Cable TV networks, Cable TV for data transfer

Module V

Error Detection and Correction: Introduction, block coding, liner block codes, cyclic codes, checksum, data link control, framing, flow and error control, protocols, noiseless channels, HDLC, Point-to-Point protocol, multiple access, random access, aloha, controlled access, channelization, IEEE Standards, standard ethernet, changes in the standard, fast ethernet, Gigabit ethernet, IEEE 802.11, Bluetooth

Module VI

Connecting LANs: Backbone networks, and virtual LANs, connecting devices, backbone networks, virtual LANs, cellular telephony, satellite networks, Sonet/SDH, Architecture, Sonet layers, Sonet frames, STS multiplexing, Sonet networks, Virtual tributaries, Virtual-Circuit networks: Frame relay and ATM, Frame relay, ATM, ATM LANs

Course outcome:

After Completion of the course the student shall be able to:

- Describe the layers of OSI model, TCP/IP model associated with data communication and able to define its functions.
- Design different types of network topology associated with IPv4.
- Analyze IPv4 and IPv6 addresses, Routing at network layer.
- Illustrate transport layer protocols and DNS protocols.
- Apply Ethernet based wired & different wireless standards and different techniques for connecting networking devices for LANs, Virtual Networks & backbone networks.
- Design and implement error correction and detection codes for correct transmission of data.
- Apply data communication concepts in practical areas.

Text Book:

1. Data Communications and Networking, Behrouz A Forouzan, Fourth Edition. TMH.
2. Computer Networks, A. S. Tanenbaum, 4th edition, Pearson education.

Reference Book:

1. Introduction to Data Communications and Networking, Wayne Tomasi, Pearson Education.
2. Computer Communications and Networking Technologies, Gallow, Second Edition Thomson
3. Computer Networking and Internet, Fred Halsll, Lingana Gouda Kulkarni, Pearson Education
4. Data and Computer Communications, William Stallings, Pearson Education India.

Hons. Elective III (seventh semesters)

EC-4003	CAD for VLSI	L-T-P-C:3-1-0-4

Course objective: In this course the students will learn VLSI CAD tools and its related concepts, algorithms, Design automation of FPGA and high level synthesis.

Course content:

Unit-I

Introduction: VLSI design flow, challenges. Verilog/VHDL: introduction and use in synthesis, modeling combinational and sequential logic, writing test benches.

Unit-II

Logic synthesis: two-level and multilevel gate-level optimization tools, state assignment of finite state machines. Basic concepts of high-level synthesis: partitioning, scheduling, allocation and binding. Technology mapping.

Unit-III

Synthesis of reversible logic circuits. Basic concepts of reversible circuits and synthesis. Exact, transformation based, and ESOP based synthesis methods.

Unit-IV

Physical design automation. Review of MOS/CMOS fabrication technology. VLSI design styles: full-custom, standard-cell, gate-array and FPGA. Physical design automation algorithms: floor-planning, placement, routing, compaction, design rule check, power and delay estimation, clock and power routing, etc. Special considerations for analog and mixed-signal designs.

Course outcome:

After studying this course, students will be able to:

- understand VLSI Design Automation.
- acquire knowledge about CAD tools used for VLSI design.
- able to understand the Algorithms for VLSI Design Automation.
- use highlevel synthesis.

Text Book:

1. Pucknell, Douglas A. and Eshraghian, Kamran, "Basic VLSI Design", Prentice – Hall (India).
2. S.M. Kang & Y. Leblebici, "CMOS Digital Integrated Circuits-Analysis & Design", McGraw-Hill.
3. J. Bhasker, "Verilog VHDL synthesis: a practical primer", B S Publications, 1998.

Reference Book:

1. M.J.S. Smith, "Application-specific integrated circuits", Addison-Wesley Pub. Co., 1997.
2. S. Ramachandran, "Digital VLSI systems design", Springer, 2007.
3. D.D. Gajski, N.D. Dutt, A.C. Wu and A.Y. Yin, "High-level synthesis: introduction to chip and system design", Kluwer Academic Publishers, 1992.
4. N.A. Sherwani, "Algorithms for VLSI physical design automation", Kluwer Academic Publishers, 1999.

EC-4005	Wireless Sensors Networks	**L-T-P-C:3-1-0-4**

Course objective:

- To understand the fundamental concept of wireless sensor network protocol.
- To deliberate importance of wireless communication protocols. To explain challenges in routing protocol and overview of different layer protocols.
- To aware with current applications of wireless sensor network in difference field.

Course content:

Unit-I

Introduction: Basic concept of Wireless Sensor Networks – History, Motivation, Design Objectives, Characteristics, Challenges, Applications, Technological Background – Transmission Fundamental, Actuator, MEMS Technology, Wireless Sensor: Topology, Sensor Network Architectures and Protocol Stack, Network Standards.

Unit-II

Medium Access Control: Fundamentals of MAC protocols, Objectives of MAC design, Energy efficiency in MAC design, MAC protocols for wireless sensor networks – Contention based protocols, Contention free protocols, Hybrid protocols. WSN protocols: synchronized, duty cycled.

Unit-III

Network and Transport Layer: Overview, Fundamentals and Challenges of Routing protocol, Issues with the adoption of ad hoc Location-aided protocols, Layered and In-network processing-based protocols, Data centric and multipath Protocols. Traditional transport protocols, Traditional Transport protocols for sensor networks: Principles, Performance Metrics, Congestion Control, Reliability, Loss Recovery, Design Guidelines, Case study- Implementation and analysis of Routing protocol or transport layer protocol in Tiny OS.

Unit-IV

Network Security and Attack Défense: Fundamentals of network security-challenges and attacks - Protocols and mechanisms for security. Confidentiality, Integrity, Authenticity, Nonrepudiation, Freshness, Availability, Intrusion Detection, Key Management Case study- Handling attacks in Tiny OS.

Unit-V

Applications Of WSN**:** WSN Applications - Home Control - Building Automation - Industrial Automation - Medical Applications - Reconfigurable Sensor Networks - Highway Monitoring - Military Applications - Civil and Environmental Engineering Applications - Wildfire Instrumentation - Habitat Monitoring - Nanoscopic Sensor Applications – Case Study: IEEE 802.15.4 LR-WPANs Standard - Target detection and tracking - Contour/edge detection - Field sampling.

Course outcome:

After completion of course students can be able to:

- To understand technological background of sensor networks.
- To design and apply various existing routing protocols of sensor networks.

Text Book:

1. Jun Zheng, Abbas, “Wireless sensor networks A networking perspective”, WILEY, 2009.
2. Kazem Sohraby, Daniel Minoli, &Taieb Znati, “Wireless Sensor Networks-Technology, Protocols, And Applications”, John Wiley, 2007.

Reference Book:

1. Thomas Haensel Mann, “Wireless Sensor Networks: Design Principles for Scattered Systems”, Oldenbourg Verlag, 2011.
2. E. H. Callaway, E. H. Callaway, “Wireless Sensor Networks Architecture and Protocols”, CRC Press, 2009.
3. F. Zhao and L. Guibas, “Wireless Sensor Network: Information Processing Approach”, Elsevier, 2009.
4. A. Hac, “Wireless Sensor Network Designs”, John Wiley & Sons, 2009.

EC-4007	Adaptive Signal Processing	L-T-P-C:3-1-0-4

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

Unit-I

Adaptive systems: Definitions, characteristics, applications, properties, and examples. Linear optimum filtering and adaptive filtering, linear filter structures, adaptive equalization, noise cancellation and beam forming. Optimum linear combiner and Wiener-Hopf equations, orthogonality principle, minimum mean square error and error performance surface.

Unit-II

LMS algorithm and its applications, learning characteristics and convergence behaviour, misadjustment. Normalized LMS and affine projection adaptive filters. Frequency domain block LMS algorithm.

Unit-III

Least squares estimation problem and normal equations, projection operator, exponentially weighted RLS algorithm, convergence properties of RLS algorithm. Kalman filter as the basis for RLS filter. Square-root adaptive filtering and QR- RLS algorithm. Systolic-array implementation of QR –RLS algorithm.

Unit-IV

Forward and backward linear prediction. Levinson-Durbin algorithm, Lattice predictors, gradient-adaptive lattice filtering, least-squares lattice predictor, QR-decomposition based least-squares lattice filters.

Unit-V

Adaptive coding of speech, Adaptive equalization of wireless channels, Antenna array processing.

Course Outcome: Students will become familiar with the concepts, algorithms and applications of adaptive signal processing in wireless communication systems.

Text Book:

1. Simon Haykin., "Adaptive Filter Theory", Pearson Education, 4th Edition, 2002.
2. Widrow, B. and Stearns, S.D., "Adaptive Signal Processing", Pearson Education, 1st Edition, 2002.

Reference Book:

1. Sayed Ali, H., "Fundamentals of Adaptive Filtering", John Wiley & Sons, 2003
2. Diniz, P.S.R., "Adaptive Filtering: Algorithms and Practical Implementation", Kluwer Academic Publishers, Boston, MA, 2nd Edition, 2002.

EC-4009	Robotics	L-T-P-C:3-1-0-4

Course objective:

- Describe the different physical forms of robot architectures.
- Kinematically model simple manipulator and mobile robots.
- Mathematically describe a kinematic robot system.
- Analyze manipulation and navigation problems using knowledge of coordinate frames, kinematics, optimization, control, and uncertainty.

Unit- I

Introduction History of robots: Classification of robots, Present status and future trends. Basic components of robotic system. Basic terminology- Accuracy, Repeatability, Resolution, Degree of freedom. Mechanisms and transmission, End effectors, Grippers-different methods of gripping, Mechanical grippers-Slider crank mechanism, Screw type, Rotary actuators, Cam type gripper, Magnetic grippers, Vacuum grippers, Air operated grippers; Specifications of robot.

Unit-II

Drive systems and Sensors: Drive system- hydraulic, pneumatic and electric systems Sensors in robot – Touch sensors, Tactile sensor, Proximity and range sensors, Robotic vision sensor, Force sensor, Light sensors, Pressure sensors.

Unit-III

Kinematics and Dynamics of Robots: 2D, 3D Transformation, Scaling, Rotation, Translation, Homogeneous coordinates, multiple transformation, Simple problems. Matrix representation, Forward and Reverse Kinematics Of Three Degree of Freedom, Homogeneous Transformations, Inverse kinematics of Robot, Robot Arm dynamics, D-H representation of robots, Basics of Trajectory Planning.

Unit-IV

Robot Control: Programming and Applications Robot controls-Point to point control, Continuous path control, Intelligent robot, Control system for robot joint, Control actions, Feedback devices, Encoder, Resolver, LVDT, Motion Interpolations, Adaptive control. Introduction to Robotic Programming, On-line and off-line programming, programming examples. Robot applications-Material handling, Machine loading and unloading, assembly, Inspection, Welding, Spray painting.

Course Outcome:

Upon Completion of the course, the students will be able to:

- Compute forward and inverse kinematics for a small serial kinematic chain.
- Consider trade-offs among position control, velocity control, and force control when solving a robot control problem.
- Perform stability analysis of a controller-robot system, and describe why it is important.
- Model uncertainty in robot processes.

Text Book:

[1] Mikell P Groover, Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, “Industrial Robotics, Technology programming and Applications", McGraw Hill, 2012.

[2] Craig. J. J. “Introduction to Robotics- mechanics and control”, Addison- Wesley, 1999.

Reference Book:

[1]S.R. Deb, “Robotics Technology and flexible automation”, Tata McGraw-Hill Education., 2009.

[2] Richard D. Klafter, Thomas .A, Chri Elewski, Michael Negin, "Robotics Engineering an Integrated Approach", PHI Learning. 2009.