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	22	22
II	20=42	20=42
III	24=66	24=66
IV	22=88	22=88
V	24=112	20=108
VI	22=134	18=126
VII	24=158	20=146
VIII	20=178	20=166
Total	178	166

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:** Electrical Technology		3-0-0	3
4.	**CS-1001:** Computer Programming: Concepts and Practices		3-0-0	3
5.	**PH-1001:** Engineering Physics		3-0-0	3
6.	**HS-1001:** Professional Communication		2-0-0	2
7.	**EC-1101:** Electronic Devices & Circuits lab		0-0-3	2
8.	**CS-1101:** Computer Programming Lab		0-0-3	2
9.	**CA-1101:** Co-Curricular Activity I		----	1
Total Credits				**22**

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.	**CS-1002:** Data Structures and Programming Languages		3-0-0	3
4.	**CS-1004:** Discrete Mathematics		3-1-0	4
5.	**HS-1002:** Ethics and Human Values		2-0-0	2
6.	**EC-1102:** Digital Logic & Design Lab		0-0-3	2
7.	**CS-1102:** Data Structures Lab		0-0-3	2
9.	**CA-1102:** Co-Curricular Activity II		----	1
Total Credits				**20**

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.

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:

- To give a multi-dimensional approach to calculus, with concepts, results, and problems being expressed geometrically, numerically, analytically, and verbally.
- To study behavior of functions, different approach of derivatives for the function
- To understand the applications of definite Integral, Improper integrals, Beta functions, Gamma Functions, Error functions in real world
- To understand Application of Laplace and Fourier Transformation in Communication theory.

Course content:

Unit 1

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.

Unit 2

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

Unit 3

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.

Unit 4

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.

Unit 5

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

Unit 6

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. Differential Equations, G. F. Simmons, Tata Mcgraw-Hill.
2. Differential Calculus by Das and Mukherjee, U. N. Dhur
3. Integral Calculus by Das and Mukherjee, U. N. Dhur
4. Advanced Engineering Mathematics by E. Kreyszig. (Wiley)

Reference Book:

1. Calculus by Thomas and Finney, Addition Wesley
2. Advanced Engineering Mathematics by Jain and Iyenger, Narosa Pub. House
3. Higher Engineering Mathematics by B.S. Grewal, Khanna Publishers
4. Advanced Engineering Mathematics by Erwin Kreyszig, John Wiley & Sons.
5. Principles of Mathematical Analysis, Walter Rudin

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.

Course content:

Unit 1

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.

Unit 2

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).

Unit 3

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).

Unit 4

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.

Unit 1

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.

Unit 2

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

Unit 3

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:3-0-2-5

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 a programming 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.

Course content:

Unit 1

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

Unit 2

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

Unit 3

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

Unit 4

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

Unit 5

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

Course outcome:

- Understand fundamental principles of problem solving.
- Familiarize the design and analysis of algorithms.
- Understand and practice the computer 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.

Computer Programming Lab:

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.

Course content:

Unit 1

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.

Unit 2

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.

Unit 3

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.

Unit 4

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.

Unit 5

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.

Course content:

Unit 1

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.

Unit 2

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.

Unit 3

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

Unit 4

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.

Unit 5

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, climate prediction and computer networks etc.

Course content:

Unit 1

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

Unit 2

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

Unit 3

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

Unit 4

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.

Unit 5

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.

Course content:

Unit 1

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.

Unit 2

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.

Unit 3

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

Unit 4

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.

Unit 5

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, 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.

Course content:

Unit 1

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

Unit 2

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

Unit 3

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

Unit 4

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

Unit 5

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 NonLinear data structure.
- Determine and analyze the complexity of given Algorithms.

Text Book:

1. Jon Kleinberg and Eva Tardos; Algorithm Design, Pearson education Inc. 2006.
2. A.M. Tenenbaum, Y. langsum and M.J. Augenstein; Data Structures using C, Prentice Hall of India private. Limited, 2015.

Reference Books:

1. G. Shanker Rao; Mathematical Foundations of Computer Science, I.K. International Publishing House Private Limited, 2006.
2. Robert Sedgewick; Algorithms in C, Addition-Wesley, 1998.

Data Structure Lab:

Demonstration of simple programs execution on Computer. 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: 3-0-0-3

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 1

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 2

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 3

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

Unit 4

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 5

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, Grarph Traversal algorithms. Trees: Rooted Trees, Undirected Trees, Spanning Trees of Graphs, Algorithms for Minimal Spanning Trees.

Unit 6

Modeling of Computation: Language and Grammar. Finite State Machine & Monoid. Russel's Paradox and Incomputability. 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)
   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:

Unit 1

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.

Unit 2

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.

Unit 3

ENGINEERING AS SOCIAL EXPERIMENTATION: Engineering as Experimentation – Engineers as responsible experimenters – Code of ethics – A Balanced Outlook on Law

Unit 4

SAFETY, RERSPONSIBILITIES 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

Unit 5

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 pres, 2001
5. Laura P Hartman and Joe Desjardins, "Business Ethics: Decision making for personal integrity and social responsibility", Mc Graw Hill education, India Pvt, New Delhi, 2013

B.Tech CSE Syllabus

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.

Course Content:

Unit 1

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

Unit 2

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.

Unit 3

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.

Unit 4

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.

Unit 5

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:

Unit 1

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.

Unit 2

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.

Unit 3

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

Unit 4

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.

Unit 5

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.

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

Course content:

Unit 1

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

Unit 2

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

Unit 3

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.

Unit 4

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

Unit 5

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:

- 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, Mc Graw Hill Publishers

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

List of Lab Assignments / Experiments:

Study and design of various adder, subtractor, multiplexer. Design of ALU, simple memory, Associative/Direct mapped cache memory, pipelined processor, Cycle time and pipelining gain. Testing of different hazard cases.

CS-2005	Theory of Computation	L-T-P-C:3-0-0-3

Course content:

Unit 1

Introduction of subject with basics and fundamental concepts, Finite Automata: Introduction, Block diagram and representation. Construction of finite automata, Construction of minimal finite automata(for finite and infinite language), Compound Automata, Non-deterministic finite automata(NFA), Conversion of NFA to DFA, Є-NFA, Є-closure of state, Conversion of Є-NFA to NFA, Conversion of Є-NFA to DFA. Decision property of FA, Comparison algorithm, Optimization and minimization of FA.

Unit 2

Regular language: Prefix, Reverse, Regular expression and its type. Properties of regular expression, Construction of regular expression, Conversion of FA to regular expression (Arden's lemma, State elimination method), Conversion of regular expression to FA (Method of synthesis, Method of Decomposition), Algebraic properties of regular expression, Closure properties of regular expression, Pumping lemma, Weak form of Pumping lemma, Myhill-Nerode theorem.

Unit 3

Finite Automata with output: Moore machine, Mealy machine, Its representation, Construction and Conversion among each other.

Unit 4

Grammar: Introduction, Definition, Types, Construction of grammar, Chomsky hierarchy, Conversion of regular grammar into finite automata, Conversion of FA to RG, Context free grammar and language, Unit production, Є-production, Simplification, Normal form (CNF, GNF), Decision property of CFG, Push Down Automata(PDA): Introduction, block diagram, Deterministic PDA, Non-deterministic PDA, Closure property of CFL, Conversion of CFG to PDA, Pumping lemma for CFL, Turing machine, REG, REL, Block diagram, Turing machine as a transducer, Recursive set and Recursive enumerable set, LBA and CSL.

Unit 5

Undecidability: Introduction, Satisfiability, P vs NP, Cook's Theorem, Reducibility and Undecidable Problem, Rice's theorem, NP- Hard, NP-Complete

Course outcome:	• Understand formal machines, languages and computations • Design finite state machines for acceptance of strings • Design context free grammars for formal languages • Develop pushdown automata accepting strings • Design Turing machine • Distinguish between decidability and undecidability
Text Book:	1. Peter Linz, An Introduction to Formal Languages and Automata, Jones & Bartlett 2. Vivek Kulkarni, Theory of Computation, Oxford University Press
Reference Book:	1. John E. Hopcroft, Rajeev Motwani, Jeffrey D Ullman, Introduction to Automata Theory, Languages and Computation, Pearson 2. Michael Sipser, Introduction to Theory of Computation, 3rd Edition, Course Technology

CS-2007	**Fundamentals of Algorithms**	L-T-P-C:3-0-0-3
Course objective:	• Understand concept of computer algorithms and learn techniques of problem solving • Design algorithms for solving practical problems • Learn analysis of algorithms in terms of complexity theory	

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). Examples.

Unit 2
Asymptotic Notation: Growth of function over input size – Big-Oh, Big-Omega, Big-Theta, Small-Oh, Small-Omega Notations and their relationship. Master's theorem. Recursion tree.

Unit 3
Basic Algorithm Techniques: 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. Role of randomness in computing and average case analysis – Case study: Quick sort. Lower Bound Theory. Hashing.

Unit 4
Other Algorithm techniques: Divide and conquer, Dynamic Programming and Greedy Strategy – when to use what. Examples - Matrix chain multiplication, Knapsack problem (Classical and Fractional), n-Queen problem, Huffman Coding.

Unit 5
Graph Algorithms: Graph Traversal, Minimum Spanning Tree, Single Source Shortest Path, All Pair Shortest Path, Hamiltonian Cycle and Travelling Salesman Problem. Applications of these algorithms.

Unit 6
Limit of Computation: Reducibility. Classes of Problems: P, NP, NP completeness, NP hard problems. Examples. Incomputability.

Course outcome:	• Learn when to use which algorithm techniques and for which kind of problems • Understand lower bound of problems • Design efficient computer algorithm for solving practical problems
Text Book:	1. Introduction to Algorithms – Cormen, Leiserson, Rivest and Stein 2. Fundamentals of Computer Algorithms – Horowitz and Sahni
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

CS-2107	**Algorithms Lab**	**L-T-P-C:0-0-3-2**

Study of time requirements of searching and sorting algorithms; Tally the experimental time requirement with the theoretical time complexity; Understanding of problem size and growth of functions; Understanding best case, worst case and average case analysis.

Text file compression using Huffman coding, Implementation of graph algorithms; Study of data structures' roles in developing efficient algorithms (in connection with graph algorithms), Role of randomness in computing.

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.

Unit 1

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.

Unit 2

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

Unit 3

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.

Unit 4

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

MA-2002	Mathematics-IV: Combinatorics and Graph Theory	L-T-P-C:3-0-0-3

Course objective:

- Students will learn core ideas in combinatorial mathematics.
- Define how graphs serve as models for many standard problems
- Discuss the concept of graph, tree, cut set, flow and networks
- See the applications of graphs in science, business and industry

Course content:

I. Combinatorics:

Unit 1

Mathematical Induction, Fundamental Principles of Counting: The Rules of Sum and Product, The Principle of Inclusion and Exclusion, The pigeonhole principle, Permutations, Combinations – The Binomial Theorem, Binomial coefficients, Combinations with and without Repetition, The Catalan Numbers

Unit 2

Generating Functions: Definition and Examples – Calculation Techniques, Partitions of Integers, the Exponential Generating Function, The Summation Operator

Unit 3

Recurrence Relations: The Method of Generating Functions, Solving Recurrence Relations using Substitution and Generating Functions, Method of Characteristic Roots, Solutions of homogeneous and non-homogeneous recurrence relations

II. **Graph Theory:**

Unit 4

Fundamental Concepts: Definitions and Examples, Subgraphs, Complements, and Graph Isomorphism, Vertex Degree, Euler Trails and Circuits, Hamilton Paths and Cycles. Trees, Rooted Trees, Trees and Sorting, Weighted Trees and Prefix Codes

Unit 5

Planar Graph Theory: Vertex coloring and upper bounds, Structure of k- chromatic Graphs, Chromatic Polynomials, Line Graphs and edge-coloring, Euler's formula and beyond, The five color map theorem, Kuratowski's Theorem, Characterization of Planar graphs, Planar duality, Spanning trees in planar graphs, Planarity-coloring and cycles.

Unit 6

Optimization on Graphs: Transport Networks – Max-flow, Min-cut Theorem, Matching Theory, Optimization of flows, transportation problems, Optimization of spanning trees. Applications: de Bruijn garph and sequences, Random walks on graphs.

Course outcome:	• Learning how to apply combinatorial ideas to practical problems. • Understanding the use of graphs as models. • Understanding of various types of trees and methods for traversing trees. • Solving some real time problems using concepts of graph theory • Analyzing combinatorial objects satisfying certain properties and answer questions related to existence, construction, enumeration and optimization
Text Book:	1. Kenneth H Rosen. Discrete Mathematics and Its Applications. TMH Publishing. 2. C Liu, D. Mohapatra. Elements of Discrete Mathematics: A Computer Oriented Approach. 3. Narsingh Deo. Graph Theory With Applications To Engineering And Computer Science
Reference Book:	1. Lovasz, Pelikan, and Vesztergombi. Discrete Mathematics: elementary and beyond. 2. D. West. Introduction to graph theory, Prentice Hall, 1996 3. Harris, Hirst, & Mossinghoff. Combinatorics and Graph Theory, 2008 4. Michel Townsend. Discrete Mathematics: Applied Combinatorics and graph theory.

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.

Course content:

Unit 1

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.

Unit 2

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

Unit 3

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

Unit 4

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.

Unit 1

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.

Unit 2

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.

Unit 3

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

Unit 4

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.

CS-2002	Compiler Design	L-T-P-C:3-0-0-3

Course content:

Unit 1

Introduction to Compilation: Compilers, Analysis of the source program, Phases of a compiler, Cousins of the Compiler, Grouping of Phases, Compiler construction tools, Lexical Analysis, Role of Lexical Analyzer, Input Buffering, Specification of Tokens, Data structures in compilation, LEX, Lexical analyzer generator

Unit 2

Syntax Analysis: Role of Parser, Writing Grammars, Context-Free Grammars: Top-Down parsing-Recursive Descent Parsing, Predictive Parsing, Bottom-Up parsing-Shift Reduce Parsing, Operator Precedent Parsing; LR Parsers–SLR Parser, Canonical LR Parser, LALR Parser, YACC –Automatic Parser Generator

Unit 3

Semantic Analysis: Intermediate forms of source Programs, Abstract syntax tree, Polish notation & 3-Address codes, Attributed Grammars, Syntax Directed Translation, Conversion of popular programming languages, Constructs into Intermediate code forms, Declarations, Assignments, Statements, Boolean Expressions.

Unit 4

Code Optimization & Run Time Environment: Introduction, Principal sources of optimization, Optimization of basic blocks, Introduction to global data flow analysis, Basic blocks, Flow graphs, Data flow equation, Global optimization, Data flow analysis for structured programs.

Unit 5

Code Generation: Issues in the design of code generator, The target machine, Next-use Information,

A simple Code generator, DAG representation of Basic Blocks, Peephole Optimization.	
Course outcome:	• Understand phases in the design of compiler • Design top-down and bottom-up parsers • Identify synthesized and inherited attributes • Develop syntax directed translation schemes • Develop algorithms to generate code for a target machine
Text Book:	1. O.G. Kakde, Compiler design, Laxmi Publications
Reference Book:	1. Aho, Ravi Sethi, Monica S Lam, Ullman, Compilers -Principles, Techniques and Tools, Pearson 2. Randy Allen, Ken Kennedy, Optimizing Compilers for Modern Architectures, Morgan Kauffmann, 2001. 3. John R Levine, Tony Mason, Doug Brown, Lex and Yacc, Orielly

CS-2102	Compiler Lab	L-T-P-C:0-0-3-2

Generate assembly language code for a block of assignment and arithmetic statements.
Elimination of left recursion and left factoring algorithms and generate predictive parsing table.
Generation of parser program, SLR Parsing table, derivation sequence, Intermediate Code, three address code, Grammar- Construction of Predictive Parsing Table -LR Parsing Tables -Parsing Actions.

CS-2004	Numerical Methods and Scientific Computing	L-T-P-C:3-0-0-3

Course content:

Unit 1

Errors in Numerical Methods: Approximate numbers and Significant figures; Rouding-off numbers; Errors: Absolute, Relative and Percentage; Error in Arithmetical operations; A General Error Formula; Errors in Numerical Computations; Inverse Problems.

Unit 2

Solution of equations in one variable: Bisection method; Iteration method; Regula-Falsi method; Convergence of Regula-Falsi method; Secant method; Newton-Raphson method; Generalised Method for multiple roots; Rate of Convergence of Newton‘s square root formula; Newton‘s Inverse formula; Graffe‘s Root-Squaring method; Ramanujan‘s method; Rate of Convergence and. Computer Programmes for the above methods.

Unit 3

Numerical solution of system of equations: Gauss elimination method; Gauss-Jordan method; Jacobi‘s iteration method; Gauss Sidel method; Ill conditioned problems; Error analysis; Computer programs based for the above methods.

Operators and Difference Equations: Forward difference operator, Backward difference operator, Shift operator, Average operator, Central difference operator and their relations; Factorial Notation; Synthetic division; Missing Term Technique; Basic ideas of Difference Equations.

Unit 4

Interpolation: Newton‘s forward interpolation formula; Newton‘s backward interpolation formula; Stirling‘s Formula; Bessel formula; Lagrange‘s interpolation formula; Divided differences; Newton‘s divided difference formula; Numerical differentiation and applications; Central Difference Interpolation Formulae; Gauss‘ Forward central Difference Formula; Gauss‘ Backward central Difference Formula; Computer Programs for the above formulas.

Unit 5

Numerical integration: A general quadrature formula for equidistant nodes; Trapezoidal rule;

Simpson‘s one-third rule, Simpson‘s three-eight rule; Wedddle‘s rule; Inherent errors in numerical integrations; Newton-Cotes quadrature formula; Euler-Maclaurin formula; Gaussian quadrature formula; Flow charts, Algorithms and Computer Programs to implement the above techniques.

Unit 6

Numerical Methods of Solution of ordinary differential equations: Picard‘s Method of Successive Approximations ; Picard‘s Method for Simultaneous First Order Differential Equations; Euler‘s Method;; Modified Euler‘s Method; Runge-Kutta method; Flow-charts, algorithms and computer programs for the above methods.

Course outcome:	It is not always possible to find exact solutions of algebraic and differential equations. Therefore it is numerical techniques that are an alternative way to find solutions to most of the physical engineering problems. The course aims to provide engineering students with adequate knowledge of numerical techniques
Text Book:	1. Numerical Methods For Scientific And Engineering Computation M. K. Jain, S. R. K. Iyengar And R. K. Jain
Reference Book:	1. An Introduction to Numerical Analysis, Kendall Atkinson

HS-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:

Unit 1

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.

Unit 2

Atmosphere & Air Pollution

Air pollution- Introduction, Segments of environment, Layers of atmosphere and their significance; Mechanism, Causative factors, Consequences and Preventive measures – Ozone depletion, Green house 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.

Unit 3

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,

Unit 4

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, Sterilization

Unit 5

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

Unit 6

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

Unit 7

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:

- Identify formula and solve environmental problems
- Apply engineering equipments to solve environmental problem.
- Develop equipments 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 System (DBMS)	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.

Course content:

Unit 1

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.

Unit 2

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.

Unit 3

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.

Unit 4

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

Unit 5

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.

Unit 6

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. RamezElmasri and Shamkant B. Navathe, “Fundamental Database Systems”, Third

Edition, Pearson Education, 2003.

CS-3101	DBMS Lab	L-T-P-C:0-0-3-2

ER diagrams exercise and SQL, PL-SQL: Modeling exercises for ER Diagrams, Identification of Attributes & Keys. Design Discussions. SQL Commands and Queries , SQL Triggers & Assertions. Perform physical design based above logical design using Oracle/MSSQL on Windows platform and MySQL/PostgreSQL on Linux platform, DML and DDL using all possible SQL commands. Implement a small database application for the above system using suitable front end and back end tool. Create a transaction by embedding SQL into an application program. Generate different useful reports. Implementation of a small databse using NoSQL and/or New SQL database system.

CS-3003	**Operating Systems**	L-T-P-C:3-0-0-3

Course objective:

- To study the design and services provided for managing processes, their synchronization and scheduling.
- To design and use the services provided for memory management and the file system.
- To apply UNIX and WINDOW-2000 as case studies.

Course content:

Unit 1
Introduction, History of OS, Computer H/W, Design of OS, Evolution of OS, Priority-handler, Interrupt-handler and System-call handler.

Unit 2
Serial and concurrent computation, Functional systems, Processes and thread management, Inter-process Communication and Synchronization, Process Scheduling, Deadlocks, Protection and Security.

Unit 3
Memory management, Contiguous and Noncontiguous schemes, Paging and virtual memory and Memory related system calls.

Unit 4
File management system, Contiguous and noncontiguous organization, Chaining and indexing, Address translation, Directories and File related system calls.

Unit 5
Unix and Windows 2000 as case studies.

Course outcome:

1. Able to understand the basic components of an operating system and the interactions among its various components.
2. Able to implement the theory of processes, memory, I/O and files.

Text Book:

1. Silverschatz, Galvin and Gagne; Operating System Concepts, 9th Edition, John Wiley and Sons Inc. 2015.
2. A.S. Tanenbaum; Modern Operating Systems, 2nd Edition, Prentice-Hall, New-Jersey, 2001.

Reference Book:

1. Milan Milenkovich; Operating Systems: Concepts and Design,

	McGraw-Hill international edition, Computer Science Series, 2001. 2. Per Brinch Hansen; Operating System Principles, Prentice-Hall Publication, New Delhi,2015.	
CS-3103	**Operating Systems Lab**	**L-T-P-C:0-0-3-2**
Familiarization with UNIX system calls for process management and inter-process communication. process management (creation, synchronization, and communication); processor scheduling; deadlock prevention, avoidance, and recovery; main-memory management; virtual memory management (swapping, paging, segmentation and page replacement algorithms); control of disks and other input/output devices; file-system structure and implementation; and protection and security.		

CS-3005	**Computer Graphics and Multimedia**	**L-T-P-C:3-0-0-3**
Course objective:	● To introduce the use of the components of a graphics system and become familiar with building approach of graphics system components and algorithms related with them. ● To learn the basic principles of 3- dimensional computer graphics. ● Provide an understanding of how to scan convert the basic geometrical primitives, how to transform the shapes to fit them as per the picture definition. ● Provide an understanding of mapping from a world coordinates to device coordinates, clipping, and projections. ● To be able to discuss the application of computer graphics concepts in the development of computer games, information visualization, and business applications. ● To comprehend and analyze the fundamentals of animation, virtual reality, underlying technologies, principles, and applications.	

Course content:

Unit 1

Basics, applications and scope, Graphics standards, Interaction (sample- and event-driven) and Graphics user Interface (GUI) features. Graphics display devices, Input devices, Rendering pipeline.

Mathematical concepts, Lines and line representations, Polygons and polygon interiors, Dot and cross products, Planes and plane representations, Line-line and line-plane intersections.

Unit 2

Scan Conversion: Line, Circle and Ellipse drawing algorithms-DDA, Bresenham. Polygon scan

conversion, Antialiasing.

Viewing pipeline, Window to viewport co-ordinate transformation , clipping operations , point clipping , line clipping- Cohen and Sutherland line clipping, clipping circles , polygons & ellipse.

Unit 3

2D and 3D Geometrical Transformations – scaling, translation, rotation, shear, Viewing Transformations: parallel and perspective projection, Affine transformation Viewing. Orthographic viewing, Mathematics of perspective, Curve representation, surfaces , designs , Bezier curves , B-spline curves, end conditions for periodic B-spline curves, rational B-spline curves.

Hidden surfaces: Depth comparison, Z-buffer algorithm, Back face detection, BSP tree method, the Printer's algorithm, scan-line algorithm; Hidden line elimination, wire frame methods , fractal - geometry. Illumination and Shading Models. Introduction to Ray-tracing, Human vision and color, Lighting, Reflection and transmission models.

Unit 4

Introduction to Multimedia: Concepts, uses of multimedia, hypertext and hypermedia. Image, video and audio standards.

Introduction to Digital Image: Image formats-JPEG, BMP, TIFF, GIFF. Image evaluation, Layers, Filters, Image manipulation-scaling, cropping, rotation.

Audio: digital audio, MIDI, processing sound, sampling, compression.

Video: MPEG compression standards, compression through spatial and temporal redundancy, inter-frame and intra-frame compression.

Unit 5

Animation: types, techniques, key frame animation, utility, morphing. Virtual Reality concepts.

Course outcome:	● To list the basic concepts used in computer graphics. ● To implement various algorithms to scan, convert the basic geometrical primitives, transformations, Area filling, clipping. ● To describe the importance of viewing and projections. ● To define the fundamentals of animation, virtual reality and its related technologies. ● To understand different types of Multimedia File Format ● To design an application with the principles of virtual reality

Text Book:	1. Computer Graphics (Principles and Practice) by Foley, van Dam, Feiner and Hughes, Addisen Wesley (Indian Edition) 2. Computer Graphics by D Hearn and P M Baker, Printice Hall of India 3. Mukherjee, Fundamentals of Computer graphics & Multimedia, PHI	
Reference Book:	1. Mathematical Elements for Computer Graphics by D F Rogers, McGraw Hill 2. Sanhker, Multimedia –A Practical Approach, Jaico	
CS-3105	**Computer Graphics & Multimedia Lab**	L-T-P-C:0-0-3-2

Study of Fundamental Graphics Functions, Line drawing algorithms: DDA Algorithm, Bresenham's Algorithm, Circle drawing algorithms: Bresenham's Algorithm, Mid-Point Algorithm, Ellipse drawing algorithm.

2D and 3D transformations, Cohen Sutherland and Lian Barsky line clipping algorithm, Bezier curve.

Key frame animation and Path animation, animation of solar system.

CS-3007	**Advanced Computer Architecture**	L-T-P-C:3-0-0-3

Course objective:

- Understand the micro-architectural design of processors.
- Learn about the various techniques used to obtain performance improvement and power savings in current processors.

Course content:

Unit 1

FUNDAMENTALS OF COMPUTER DESIGN

Review of Fundamentals of CPU, Memory and IO – Trends in technology, power, energy and cost, Dependability - Performance Evaluation

Pipelining: Basic concepts of pipelining, data hazards, control hazards, and structural hazards; Techniques for overcoming or reducing the effects of various hazards.

Unit 2

INSTRUCTION LEVEL PARALLELISM

ILP concepts – Compiler Techniques for Exposing ILP – Dynamic Branch Prediction – Dynamic Scheduling – Multiple instruction Issue – Hardware Based Speculation – Static scheduling - Multi-threading - Limitations of ILP – Case Studies.

Unit 3

DATA-LEVEL PARALLELISM

Vector architecture – SIMD extensions – Graphics Processing units – Loop level parallelism.

Unit 4

THREAD LEVEL PARALLELISM

Symmetric and Distributed Shared Memory Architectures – Performance Issues –Synchronization – Models of Memory Consistency – Case studies: Intel i7 Processor, SMT & CMP Processors

Unit 5

MEMORY AND I/O

Cache Performance – Reducing Cache Miss Penalty and Miss Rate – Reducing Hit Time – Main Memory and Performance – Memory Technology. Types of Storage Devices – Buses – RAID – Reliability, Availability and Dependability – I/O Performance Measures.

Course outcome:

- Evaluate performance of different architectures with respect to various parameters
- Analyze performance of different ILP techniques
- Identify cache and memory related issues in multi-processors

Text Book:

1. John L Hennessey and David A Patterson, "Computer Architecture A Quantitative Approach", Morgan Kaufmann/ Elsevier, Fifth Edition, 2012.

Reference Book:

1. Kai Hwang and Faye Briggs, "Computer Architecture and Parallel Processing", Mc Graw-Hill International Edition, 2000.
2. Sima D, Fountain T and Kacsuk P, "Advanced Computer Architectures: A Design Space Approach", Addison Wesley, 2000.

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.

Unit 1

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.

Unit 2

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.

Unit 3

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.

Unit 4

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

CS-3002	Artificial Intelligence	L-T-P-C:3-0-0-3
Course objective:	1. To introduce the basic principles, techniques and applications of AI. 2. To study knowledge representation, logic, inference, problem solving, search algorithms, game theory, perception, learning, planning, and agent design.	

Course content:

Unit 1

Introduction, history, foundations and applications of AI. Design and analysis of intelligent Agents and environment, Toy problems. Propositional Logic, First Order Logic (FOL), Forward and Backward chaining.

Unit 2

Uninformed Search, Sensor less problems, Contingency problems, Heuristic Search, local search and optimization, online search.

Unit 3

Constraint Satisfaction Problems, Game Theory, Probability basics, Bayesian Networks, Fuzzy logics, Beliefs, Desires and Uncertainty.

Unit 4
The planning problem, partial order planning, planning graphs and algorithms, Basics of ANN and Prolog Programming.

Unit 5
Expert Systems, Logic and knowledge based systems, Semantic Nets.

Course outcome:	1. Able to demonstrate fundamental understanding of the history and foundations of artificial intelligence. 2. Able to apply basic AI principles in problem solving, inference, perception, knowledge representation and learning. 3. Able to demonstrate fundamental understanding of various applications in intelligent agents, expert systems, artificial neural networks and other machine learning models.
Text Book:	1. S. Russell and P. Norvig, Artificial Intelligence, a modern approach, 2nd Edition, Pearson, 2011. 2. Nils J. Nilson; Principles of Artificial Intelligence, Narosa Publishing House, 2012.
Reference Book:	1. M. Negnevitsky, Artificial Intelligence: A Guide to Intelligent Systems, Addison Wesley. 2. Elaine Rich, Artificial Intelligence, McGraw-Hill International Edition, Computer Science Series, 1983.

CS-3102	**Artificial Intelligence Lab**	**L-T-P-C:0-0-3-2**

Breadth First Search, Depth First Search and Backtracking algorithms, Uniform Cost Search, A* and AO* Algorithms, Constraint Satisfaction Problem, Minimum Remaining Values, Most Constrained Variable and Least Constraining Values Heuristics.

Simple reflex agent for solving a financial problem, Bridge configuration problem. Expert system for solving an industrial problem.

CS-3004	**Software Engineering**	**L-T-P-C:3-0-0-3**
Course objective:	• To discuss the software engineering discipline, its evolution, impact and emergence of software engineering and explain the development and use of different software life cycle models for real-life industrial applications. • To discuss different aspects of software project management, risk management and configuration management and explain various requirement elicitation, analysis and specification techniques. • To discuss various software design methodologies, the impact of cohesion and coupling measures on the goodness of the software design. • To discuss the importance of practicing different coding standards, guidelines and different testing strategies along with software reliability metrics and software quality management techniques &	

	standards.

Course content:

Unit 1

Software development life cycle and Project Management Software development life cycle (SDLC) models, software project management, project planning, project estimation, Halstead's Software Science, project scheduling, staffing, Organization and team structure, risk management, configuration management

Unit 2

Requirements analysis and specification Requirements gathering and analysis, software requirements specification, formal systems specification, axiomatic specification, algebraic specification.

Unit 3

Software Design Outcome of a design process, cohesion and coupling, layered arrangement of modules, approaches to software design, function-oriented software design overview of SA/SD methodology, structured analysis, DFDs, structured design, detailed design, design review, object-oriented software design UML diagrams, use case modelling, unified process, OOD goodness criteria, user interface design, types of user interfaces, component-based GUI development.

Unit 4

Coding and Testing Coding standards and guidelines, code review, software documentation, unit testing, black-box testing, white-box testing, debugging, integration testing, system testing.

Unit 5

Change Requirements, Version control, Change management, scheduling, estimating, etc. Manual and Automatic Test Data Generation for Software Systems/Embedded Systems. Software reliability and Quality management.

Course outcome:	After reading this subject, students will be able to: • Choose a proper life cycle model for different real-life industrial projects, prepare the SRS document, design the software using function-oriented approach (DFDs) and object-oriented approach

	(UML diagrams), code it, and test the developed software using different software testing strategies. • Understand the concepts of computer aided software engineering (CASE) and use different CASE tools in the development, maintenance and reuse of software systems.
Text Book:	1. R. S. Pressman, Software Engineering: A Practitioner's Approach, McGraw Hill Publications , 2006 2. R. Mall, Fundamentals of Software Engineering, PHI Learning , 2014
Reference Book:	1. I. Sommerville, Software Engineering, Pearson Education , 2006 2. A. Behferooz and F. J. Hudson, Software Engineering Fundamentals, Oxford University Press , 2000
Software Engineering Lab: SRS document, Use Case diagrams, Domain Models, Class Diagrams, Sequence Diagrams, Collaboration Diagrams, State Chart Diagrams and Activity Diagrams, Z and Petrinet, cyclomatic complexity, error seeding methodology. Load testing, mutation testing. mutation score, functional testing.	

CS-3006	**Computer Networks**	**L-T-P-C:3-0-0-3**
Course content: **Unit 1** Introduction: Use of computer networks, Network hardware, Network software, Reference models, Example networks. **Unit 2** Physical Layer: Guided transmission media, FDM, TDM, Switching. Data Link Layer: Design issues, Error detection and correction, Elementary data link protocols, Sliding window protocols. MAC Sublayer: The channel allocation problem, Multiple access protocol, Token ring, Ethernet, Wireless LANs, Data link layer switching. **Unit 3** Network Layer: Design issues, Routing algorithms, Congestion control algorithms, Quality of service, Internet working principles, The network layer in the internet-IPv4, IP addresses, IPv6, ICMP, Mobile IP. **Unit 4** Transport Layer: The transport layer services, Elements of transport layer protocols, The internet transport protocols-UDP and TCP. **Unit 5** Application Layer: DNS-Domain name system, E-mail, The World Wide Web, Streaming audio and video, Content delivery networks.		
Course outcome:	• Understand OSI and TCP/IP models • Analyse MAC layer protocols and LAN technologies • Design applications using internet protocols • Implement routing and congestion control algorithms • Develop application layer protocols	

Text Book:	2. Behrouz A Forouzan, Firouz Mosharraf, Computer Networks: A Top - Down Approach	
Reference Book:	2. Andrew S. Tanenbaum, David J Wetherall, Computer Networks, Pearson Edu. 3. Larry L Peterson, Bruce S Davis, Computer Networks, Elsevier	
CS-3106	**Computer Networks Lab**	**L-T-P-C:0-0-3-2**
Study of different types of network cables and practically implement cross wired cable and straight through cable using clamping tool. Study of network devices and network IP in detail. Study of network IP and practically connect the computers in LAN, Study of basic network command and network configuration commands, Configure a network topology using packet tracer software. Configure a network using Distance vector/Link state routing protocol. Simulation of sliding window protocol, ARP and RARP. Implementation of File Transfer Protocol, Half Duplex Chat Using UDP, Full Duplex Chat Using TCP/IP. Simulate the packet transmission over Ethernet LAN and its CSMA/CD protocol.		

Semester VII

CS-4001	**Cryptography and Network Security**	**L-T-P-C: 3-0-0-3**
Course objective:	● Understand OSI security architecture and classical encryption techniques. ● Acquire fundamental knowledge on the concepts of finite fields and number theory. ● Understand various block cipher and stream cipher models. ● Describe the principles of public key cryptosystems, hash functions and digital signature	

Course content:

Unit 1

INTRODUCTION & NUMBER THEORY: System Security Concepts- Information Security, Data and Network Security, Integrity, and Availability, NIST FIPS 199 Standard, Assets and Threat Models. Control Hijacking– Attacks and defenses, Buffer overflow and control hijacking attacks. FINITE FIELDS AND NUMBER THEORY: Groups, Rings, Fields-Modular arithmetic-Euclid‟s algorithm-Finite fields- Polynomial Arithmetic –Prime numbers-Fermat‟s and Euler‟s theorem-Testing for primality -The Chinese remainder theorem- Discrete logarithms.

Unit 2

BLOCK CIPHERS & PUBLIC KEY CRYPTOGRAPHY: Data Encryption Standard-Block cipher principles-block cipher modes of operation-Advanced Encryption Standard (AES)-Triple DES-

Blowfish-RC5 algorithm. Public key cryptography: Principles of public key cryptosystems-The RSA algorithm-Key management – Diffie Hellman Key exchange-Elliptic curve arithmetic-Elliptic curve cryptography.

Unit 3

HASH FUNCTIONS AND DIGITAL SIGNATURES: Authentication requirement – Authentication function – MAC – Hash function – Security of hash function and MAC –MD5 – SHA – HMAC – CMAC – Digital signature and authentication protocols – DSS – EI Gamal – Schnorr.

Unit 4

SECURITY PRACTICE & SYSTEM SECURITY: Authentication applications – Kerberos – X.509 Authentication services – Internet Firewalls for Trusted System: Roles of Firewalls – Firewall related terminology- Types of Firewalls – Firewall designs – SET for E-Commerce Transactions.

Malicious Software and Software Security- Malicious Web, Internet Security Issues, Types of Internet Security Issues, Intrusion detection system, Computer viruses, Spyware, Key-Loggers, Secure Coding, Electronic and Information Warfare, Trusted systems, Practical implementation of cryptography and security.

Unit 5

E-MAIL, IP & WEB APPLICATION SECURITY: E-mail Security: Security Services for E-mail-attacks possible through E-mail – establishing keys privacy-authentication of the source-Message Integrity-Non-repudiation-Pretty Good Privacy-S/MIME. IPSecurity: Overview of IPSec – IP and IPv6-Authentication Header-Encapsulation Security Payload (ESP)-Internet Key Exchange (Phases of IKE, ISAKMP/IKE Encoding).

Web Application Security- SQL injection, Cross-site request forgery, Cross-site scripting, Attacks and Defenses, Generating and storing session tokens, Authenticating users, The SSL protocol, The lock icon, User interface attacks, Pretty Good Privacy.

Course outcome:	● Compare various Cryptographic Techniques ● Design Secure applications ● Inject secure coding in the developed applications
Text Book:	1. Cryptography and Network Security- William Stallings, 6 th Edition, Pearson Education, March 2013. 2. William Stallings, Network Security Essentials: Applications and

	Standards, Prentice Hall, 4th edition, 2010.
Reference Book:	1. Behrouz A. Ferouzan, "Cryptography & Network Security" 2. Cryptography – Theory and practice, Douglas R Simson

CS-4103	**Cryptography and Network Security Lab**	**L-T-P-C:0-0-3-2**

Perform encryption and decryption using Ceaser Cipher, Substitution Cipher, Hill Cipher. DES algorithm logic, BlowFish algorithm, Rijndael algorithm, RSA Algoithm, Diffie-Hellman Key Exchange mechanism. Calculate the message digest of a text using the SHA-1 algorithm.

B.Tech CSE electives Syllabus

Hons. Elective I (fifth semester)

CS-3009	Decision making and Expert System	L-T-P-C:3-1-0-4

Course objective:	1. To learn a variety of reasoning, optimization, and decision-making techniques for developing expert systems. 2. To implement the basic algorithms in reasoning, optimization and learning, decision making and expert systems.

Course content: (consists of at least 4 units**)**

Unit 1 Introduction, Strategic decision making, Propositional and First order logic, Inference in first order logic, Unification, Forward Chaining, Backward Chaining, Resolution, Uncertainty, Probability fundamentals, The axioms of probability, Bayes rules, Representing knowledge in uncertain domain, The Semantics of Bayesian networks, Exact and uncertain inference in Bayesian networks, Other approaches to uncertain reasoning.

Unit 2: Probabilistic reasoning over time**,** Inference in temporal models, Hidden Markov models, Kalman filters, Dynamic Bayesian Networks, Basic utility theory, Utility function, Multi-attribute utility functions, Decision networks, The value of information, decision theoretic expert systems, Sequential decision problems, Value iteration, Policy iteration, Decision with multiple agents.

Unit 3: Learning from observations, Inductive learning, Learning decision trees, Ensemble learning, Computational learning theory, Knowledge in learning, Explanation based learning, Learning using relevance information. Inductive logic programming.

Unit 4: Expert Systems: Introduction, Architecture, Utilization and functionality of expert systems, A toy and Prolog as inference engines, Knowledge bases, Coherence of Knowledge bases, Modeling of uncertain reasoning, Reductions of set of rules, Representation, decomposition, hierarchy and the semiotic analysis of knowledge, Multi-dimensional and augmented transition networks, Object representations and object languages.

Unit 5: Syntactic and semantic analysis of discursive Grammar, The semiotic Square, Applications of semiotic theory of artificial intelligence in Expert systems and temporal reasoning.

Course outcome:	1. Able to model decision making problems using major modeling formalisms of artificial intelligence. 2. Able to evaluate the computational performance of optimization and learning algorithms. 3. Able to design and implement expert systems in several real world problem domains.
Text Book:	1. Stuart Russel and Peter Norvig; Artificial Intelligence: A modern approach, 2nd ed.,Pearson Education Inc.,2003. 2. Jean-Louis Ermine; Expert Systems, Theory and Practice, Prentice-Hall of India, New Delhi, 2015
Reference Book:	1. Robert I. Levine, Diane E. Drangand Berry Edelson; A Comprehensive Guide to AI and Expert Systems, McGraw International Editions, 1988.

	2. Judea Pearl; Probabilistic Reasoning in Intelligent Systems: Networks of Plausible Inference, Morgan Kaufmann Publishers Inc., 1988.

CS-3011	**Advanced Operating Systems**	L-T-P-C:3-1-0-4
Course objective:	1. To learn the distributed computing techniques, 2. To learn techniques of process management, file systems, shared memory and security in distributed operating systems. 3. To learn design principles and the implementation of distributed operating system	

Course content: (consists of at least 4 units**)**

Unit 1 Introduction, evolution, types and various system models, processes communication, RPC, RMI, computing environment and design issues of distributed systems, Remote procedure calls, RPC transparency and messages, Communication Protocols, Exception handling, Server management and parameter passing semantics, Network types, LAN, WAN, ATM technologies, Communication protocols, Internet working, Client and Server threads.

Unit 2: Message Passing, IPC, Synchronization, Buffering, Encoding and Decoding, Process addressing, Election, migration and resilience of processes, Threads, Failure handling, Group communication, Case studies, 4.3 BSD, UNIX IPC mechanism .

Unit 3: Synchronization, Types of clock and their synchronization, mutual exclusion of distributed OS, Consensus and related problems of Various types of consistency, Consistency protocols, Fault tolerances.

Unit 4: Distributed shared memory, Design and implemented issues, Consistency models, Replacement strategies, Thrashing, File systems models, Design principles, File accessing, sharing, caching, replication and atomic transactions, Terminology and concepts of naming, System and Human oriented names, Object locating mechanisms, Name Cache, Naming and security, DCE directive service.

Unit 5: Protection and security in distributed systems, Various types of security techniques, Cryptography, Authentication, Access control, Digital signature, Design principles, DCE security service, Examples of distributed systems.

Course outcome:	• Able to attain knowledge of various architectures used to design distributed systems such as client-server and peer-to-peer. • Able to build distributed systems using various inter-process communication techniques, such as remote method invocation, remote events, distributed mutual exclusion, distributed monitors and tuple spaces. • Able to attain the knowledge of different distributed algorithms such as logical clocks and leader election. • Able to design and analyze distributed operating systems that fulfills requirements with regards to key distributed computing.
Text Book:	1. Pradeep K. Sinha; Distributed Operating Systems: Concepts and Design, PHI Learning Private Limited, New Delhi, 2011.

	2. Paul J. Fortier; Design of Distributed Operating Systems, Concepts and Technology, McGraw-Hill International Editions, 1996.
Reference Book:	1. George Coulouris, Jean Dollimore and Tim Kindberg; Distributed Systems: Concepts and Design, 3rd Ed., Pearson Education Limited,2001. 2. Mukesh Singhal and Niranjan G.Shivaratri; Advanced Concepts in operating Systems, Distributed, database and Multiprocessor Operating Systems, Tata McGraw-Hill Edition, 1994.

CS-3013	**Queueing Theory and Data Networks**	**L-T-P-C:3-1-0-4**
Course objective:	1. To understand the basic concepts of probability of one and two dimensional random variables, some standard distributions and random processes used in IT. 2. To understand the concept and significance and applications of queueing models and their applications to engineering problems of real life phenomenon. 3. To learn about the basic concepts of how digital data is transferred across various types of data communication links.	

Course content: (consists of at least 4 units**)**

Unit 1: Probability theory, Axioms of probability, Conditional probability, Baye's theorem, Discrete and continuous random variables, Moments, Moment generating functions, Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions.

Unit 2: Joint distributions, Marginal and conditional distributions, Covariance, Correlation and linear regression, Transformation of random variables, Central limit theorem for independent and identically distributed random variables, Markov chain theory.

Unit 3: Queueing model fundamentals, Little's law, M/M/1 and its variants M/G/1, G/M/1 and priority queues. Time-reversibility and multidimensional queueing models, Queueing networks, Jackson's theorem and product form.

Unit 4: Introduction to communications networks, Bit rate, Baud rate, Sampling, Nyquist bit rate, Shannon Theorem, Bandwidth, Throughput. PCM, Delta Modulation, Serial & parallel transmission, Amplitude modulation, frequency modulation and phase modulation, ASK, BPSK, QPSK, FSK, QAM, Multiple access control and ARQ.

Unit 5: Modems, Multiplexing, Spread spectrum modulation, Pseudo noise sequences, DS & FH spread spectrum, Synchronous and asynchronous transmission, Line coding scheme, Error detection and correction.

Course outcome:	1. Understand the various Queueing models and random processes and signals. 2. Learn the concepts of digital data transfer across various types of data communication links.

	3. Understand and compute quantitative metric performance for queueing systems.
Text Book:	1. Mischal Schwartz; Telecommunications Networks: Protocols Modeling and Analysis by, Addison-Wesley, 1987. 2. Arnold Q. Allen; Probability, Statistics and Queueing theory with Computer Science Applications, 2nd.Ed., Academic Press, 1990.
Reference Book:	1. L. Kleinrock; Queueing Systems, by John Wiley & Sons, 1975. 2. D. Bertsekas and R. Gallager; Data Networks, 2nd Edition, Prentice-Hall, 1992.

CS-3015	**Game Theory**	**L-T-P-C:3-1-0-4**
Course content: **Unit I:** Non-cooperative Game Theory: Games in Normal Form - Preferences and utility, examples of normal-form, Analysing games: Pareto optimality, Nash equilibrium, Maxmin and minmax strategies, dominated strategies, Rationalizability, Correlated equilibrium **Unit II:** Computing Solution Concepts of Normal-Form Games: Computing Nash equilibria of two- player, zero-sum games, Computing Nash equilibria of two-player, general-sum games, Complexity of computing Nash equilibrium, Lemke–Howson algorithm, Searching the space of supports, Computing Nash equilibria of n-player, general-sum games, Computing maxmin and minmax strategies for two-player, general-sum games, Computing correlated equilibria **Unit III:** Games with the Extensive Form: Perfect-information extensive-form games, Subgame-perfect equilibrium, Computing equilibria, Imperfect-information extensive-form games, Sequential equilibrium, Other Representations: Repeated games: Finitely repeated games, Infinitely repeated games, automata, Stochastic games Bayesian games: Computing equilibria **Unit IV:** Coalitional Game Theory: Transferable Utility, Analysing Coalitional Games, The Shapley Value, The Core, Mechanism Design: Strategic voting, unrestricted preferences, Implementation, quasi linear setting, Efficient mechanisms, Computational applications of mechanism design, Task scheduling, Bandwidth allocation in computer networks **Unit V:** Auctions: Single-good auctions, Canonical auction families, Bayesian mechanisms, Multiunit auctions, Combinatorial auctions.		
Course outcome:	• Analyse games based on complete and incomplete information about the players • Analyse games where players cooperate • Compute Nash equilibrium • Apply game theory to model network traffic • Analyse auctions using game theory	
Text Book:	1. Nisan, N., T. Roughgarden, E. Tardos, and V. Vazirani (Eds.). Algorithmic Game Theory. Cambridge University Press, 2007. 2. Shoham, Y. and Leyton–Brown, K. Multiagent Systems: Algorithmic, Game Theoretic, and Logical Foundations. Cambridge University Press, 2008.	
Reference Book:	Osborne, M. J., and Rubinstein, A. A Course in Game Theory. Cambridge, MA: MIT Press, 1994.	

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.

OE-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.

OE-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:

Unit 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.

Unit 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.

Unit 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.

Unit 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.

Unit 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.

Unit 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 1. Elementary Structures: Stack, Queue, Double-Ended Queue, Dynamical Allocation of Nodes, Shadow Copies of Array-Based Structures.

Unit 2. 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 Nonunique Keys, Queries for the Keys in an Interval, Building Optimal Search Trees, Converting Trees into Lists, Removing a Tree.

Unit 3. 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 4. 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 5. 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 1. 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 2. 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 3. 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 4. 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 5. 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 1: 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 2: 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 3: Structural modeling classes, relationships, interfaces, class diagrams, and object diagrams, in UML. Behavioral/Functional modeling use case diagrams, sequence diagrams, in UML.

Unit 4: Dynamic modeling: State charts, Architectural modeling, Analysis patterns, Design patterns. Distributed object model: CORBA and COM / DCOM

Unit 5: 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)

CS-3008	Multimedia Systems	L-T-P-C:3-1-0-4

Course content:

Unit I: Introduction to multimedia systems: Broad characteristics, requirements, and what makes them different, Operating system requirements, disc layout and scheduling, Multimedia databases

Unit II: Media characteristics & Compression techniques: Images, Audio, Video, 3D Models and 3D Motions, Metadata generation: Image and Video Segmentation, Shape based 3D retrieval.

Unit III: Indexing Structures: R-tree family, Interval tree family, special structure for 3D motion data indexing

Unit IV: Streaming Multimedia Data: Video streaming, 3D models streaming, 3D animation streaming.

Unit V: Watermarking techniques and Security: General strategies , emphasis on 3D watermarking, Security Architectures, Multimedia server architecture	
Course outcome:	• Understand big data challenges in different domains including social media, transportation, finance and medicine • Analyse scalability and performance of relational model, SQL and emergent systems. • Comprehend machine learning and algorithms for data analytics. • Understand the capability of No-SQL systems • Build secure big data systems • Analyse Map-Reduce programming model for better optimization
Text Book:	1. Multimedia Systems Design, Prabhat K. Andleigh, Kiran Thakrar, Pearson India Publishers
Reference Book:	1. Multimedia Databases Management Systems, B. Prabhakaran, Kluwer Academic Publishers 2. Multimedia Systems, Ralf Steinmetz and Klara Nahrstedt, X.Media Publishing

CS-3010	**Web System and Technology**	**L-T-P-C:3-1-0-4**

COURSE OBJECTIVES:

The main objectives of this course are

- Understanding the concept of web technologies.
- Creating web pages by using HTML
- Applying JavaScript validations
- Understanding the use of XML in Advanced Web Technologies
- Understanding the importance of Java Beans in Architectures like MVC
- Creating interactive web pages by Using Servlets.
- Understanding the advantages of JSP over Servlets and MVC Architecture
- Understanding Database Connectivity

Course content:

Unit 1: HTML Introduction, Common tags - Lists, Tables, images, forms, Frames; Cascading Style sheets; Introduction to Java Script, Events & Objects in Java Script, Dynamic HTML with Java Script.

Unit 2: XML: Document Type Definition, XML Schemas, Document Object Model, Presenting XML, Using XML Processors: DOM and SAX.

Unit 3: Installing the Java Software Development Kit, Tomcat Server & Testing Tomcat Introduction to Servlets: Lifecycle of a Servlet, The Servlets API, The javax.servlet Package, Reading Servlets parameters, Reading Initialization parameters, The javax.servlet.http package, Handling HttpRequest & Responses, Using Cookies & Session Tracking, Security Issues.

Introduction to JSP: The Problem with Servlets, The Anatomy of a JSP Page, JSP Processing. JSP Application Design with MVC.

Unit 4: JSP Application Development: Generating Dynamic Content, Using Scripting Elements, Implicit JSP Objects, Conditional Processing – Displaying Values Using an Expression to Set an Attribute, Declaring Variables and Methods Error Handling and Debugging Sharing Data Between JSP pages, Requests, and Users Passing Control and Date between Pages.

Unit 5: Database Access: Database Programming using JDBC, Studying Javax.sql package, accessing a Database from a JSP Page, Application Specific Database Actions.	
Course outcome:	The above exercise shall make the students competent in the following ways and will be able to learn following parameters at the end of the course. • Able to build Web pages using HTML • Able to Validate the forms using JavaScript • Able to applying styles to web pages • Able to retrieve data from XML Files Using Parsers • Able to develop the web applications by using MVC Architecture • Students should be able to apply their computer science skills to the create a website with some understanding of the legal, security, commercial, marketing and other issues involved. • Recognize and understand ways of using different web technologies • Able to create Database Applications.
Text Book:	1. Web Programming, building internet applications, Chris Bates 2nd edition, WILEY Dreamtech 2. The complete Reference Java 2 Fifth Edition by Patrick Naughton and Herbert Schildt. TMH
Reference Book:	1. Programming world wide web-Sebesta, Pearson

CS-3012	**Evolutionary Computing**	**L-T-P-C:3-1-0-4**
Course objective:	• Gain understanding of various evolutionary computation techniques • Identify algorithms suitable for solving certain evolutionary-computation problems • Apply evolutionary computation techniques to optimization, learning, and design • Implement at least one algorithm from each of the following groups: generic algorithms, representations, selections, and search operators • Compare and contrast algorithms in each group mentioned above	
Course content: **Unit 1: Introduction to Evolutionary Computation:** Biological and artificial evolution, Evolutionary computation and AI, Different historical branches of EC, e.g., GAs, EP, ES, GP, etc. A simple evolutionary algorithm **Unit 2: Search Operators:** Recombination/Crossover for strings (e.g., binary strings), e.g., one-point, multi-point, and uniform crossover operators, Mutation for strings, e.g., bit-flipping, Recombination/Crossover and mutation rates, Recombination for real-valued representations, e.g., discrete and intermediate recombination, Mutation for real-valued representations, e.g., Gaussian and Cauchy mutations, self-adaptive mutations, etc.		

Unit 3: Selection Schemes: Fitness proportional selection and fitness scaling, Ranking, including linear, power, exponential and other ranking methods, Tournament selection, Selection pressure and its impact on evolutionary search

Unit 4: Evolutionary Combinatorial Optimization: Evolutionary algorithms for TSPs, Evolutionary algorithms for lecture room assignment, Hybrid evolutionary and local search algorithms

Unit 5: Genetic Programming: Trees as individuals, Major steps of genetic programming, e.g., functional and terminal sets, initialization, crossover, mutation, fitness evaluation, etc. Search operators on trees, Automatically defined functions, Issues in genetic programming, e.g., bloat, scalability, etc. Examples.

Course outcome:	• Formulate a problem as an evolutionary computation search/optimization by specifying representations, selection and variation operators. • Write a program or use a package to implement an evolutionary algorithm. • Conduct evolutionary optimization experiments and properly report and discuss the results.
Text Book:	1. **An Introduction to Genetic Algorithms**, Melanie Mitchell, MIT Press, 1996. 2. **Genetic Programming**, John Koza, MIT Press, 1992. 3. **Evolutionary Computation**, The Fossil Record, David Fogel, IEEE Press, 1998.
Reference Books:	5. **Evolutionary Computation 1: Basic Algorithms and Operators** – Bäck, T, Institute of Physics Publishing, Bristol**.** 6. **Evolutionary Computation : Toward a New Philosophy of Machine Intelligence –** Fogel, D.B.**,** 2nd ed. Wiley-IEEE Press**.** 7. **Genetic Algorithms in Search, Optimization, and Machine Learning –** David Goldberg. Addison-Wesley, 1989. 8. **Introduction to Evolutionary Computing –** Eiben and Smith. Springer-Verlag, Corrected 2nd printing, 2007

CS-3014	**Introduction to Cognitive Science**	**L-T-P-C:3-1-0-4**
Course objective:	The main goal of this course is to introduce basic concepts of cognitive science, the basic methods of cognitive science and the main researches in the field of cognitive science.	

Course content:

Unit 1: Introduction to Cognitive Science: Introduction to the study of cognitive sciences. A brief history of cognitive science. Methodological concerns in philosophy, artificial intelligence and psychology.

Unit 2: Psychology, Nervous system and brain: Structure and constituents of the brain; Brief history of neuroscience; Mathematical models; Looking at brain signals. Brain and sensory motor information: Processing of sensory information in the brain. Representation of sensory information: Neural Network Models; Processing of sensory information in the brain; motor and sensory areas; Brain Imaging, fMRI, MEG, PET, EEG.

From Sensation to Cognition; Roots of Cognitive Science: Multisensory integration in cortex; information fusion; from sensation to cognition, cybernetics; From physics to meaning; Analog vs. Digital: Code duality.

Unit 3: Language

What is language?; Linguistic knowledge: Syntax, semantics, (and pragmatics); Generative linguistics;

Brain and language; Language disorders; Lateralization; The great past tense debate. Embodiment : Cognitivist and emergent standpoints ; A robotic perspective.

Unit 4: Affordances in biological and artificial systems: Affordances, direct perception, Ecological Psychology, affordance learning in robotics. Cognitive Development: Development, child and robotic development.

Attention: Attention and related concepts; Human visual attention; Computational models of attention; Applications of computational models of attention.

Unit 5: Learning: Categories and concepts; Concept learning; Logic; Machine learning. Memory: Constructing memories; Explicit vs. implicit memory; Information processing (three-boxes) model of memory; Sensory memory; Short term memory; Long term memory. Reasoning: Rationality; Bounded rationality; Prospect theory; Heuristics and biases; Reasoning in computers. Social Cognition: Key points in social cognition; Context and social judgment; Schemas; Social signals

Course outcome:	At the end of the course student will ● Know the subject and main concepts of cognitive science, its fields, connections with other disciplines, and how it bridges knowledge from multiple perspectives. ● Know basic contribution of disciplines such as philosophy, psychology, neuroscience and artificial intelligence to cognitive science. ● Know the basic methods and researches in the field of cognitive science ● Know the essence of the main methodological problems of cognitive science ● Be able to choose an adequate method of cognitive science, in accordance with the research task. ● Be able to critically and orally present on content from various approaches and interpret with respect to cognitive science.
Text Book:	1. Gardner, The Mind's New Science, chapters 2,3,4. Gardner, Howard E. The mind's new science: A history of the cognitive revolution. Basic books, 2008. 2. Chapter 1 and section 2.3, Bermúdez, José Luis. Cognitive science: An introduction to the science of the mind. Cambridge University Press, 2014.

	3. Lecture notes for McCullogh-Pitts and Rosenblatt Neural Networks: http://ecee.colorado.edu/~ecen4831/lectures/NNet2.html 4. Stein, B. E., Meredith, M. A., Huneycutt, W. S., & McDade, L. (1989). Behavioral indices of multisensory integration: orientation to visual cues is affected by auditory stimuli. Journal of Cognitive Neuroscience, 1(1), 12-24. 5. Fromkin, Rodman, and Hyams. An Introduction to Language, Boston, MA: Thomson Wadsworth, 9th edition, 2011, chapters 1-2. 6. Calvo & Gomila, "Handbook of cognitive science", 2008 7. Introduction to Psychology, Chapter 3, pg. 68-86. 8. Vecera & Luck, Attention, Encyclopedia of the Human Brain, Pages 269-284 9. Atkinson&Hilgard's Introduction to Psychology, Chapter 8, Memory 10. Atkinson et al., Intro. To Psychology, chapter 9 11. Kasslin, chap 11: Social and Cultural Influences
Reference Book:	

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.

Unit 1

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.

Unit 2

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

Unit 3

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.

Unit 4

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

Unit 5

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

Different signals waveform, Discrete convolution (linear and circular), Z-Transform , Discrete Fourier transform and inverse discrete Fourier transform using FFT algorithm (DIT-FFT and DIF-FFT). Analog Butterworth filter and Chebyshev filter, time and frequency domain response (impulse response and step response) for a given FIR and IIR systems. Record a signal using Raspberry Pi and Perform signal processing on recorded sample of signal. Develop and test the Inverse Discrete Fourier Transform (IDFT), Finite Impulse Response (FIR) filters using Arduino.

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 of understanding 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:

Unit 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

Unit 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.

Unit 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

Unit 4: Bayesian Classification, Rule-based Classification, Classification Back-propagation, Associative Classification, Lazy Learners, Rough set approach, Clustering methods

Unit 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:

Unit 1

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.

Unit 2

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

Unit 3

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

Unit 4

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

Unit 5

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:

Unit 1

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.

Unit 2

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

Unit 3

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.

Unit 4

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.

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" – 3 rd 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:	1. C. J. Paul, Software testing: A craftsmen's approach, CRC Press , 2013 2. 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.

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.

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.'

Hons. Elective III (seventh semesters)

CS-4007	Natural Language Processing	L-T-P-C:3-1-0-4
Course objective:	• To develop a good understanding of all aspects of Natural Language Processing (NLP) from both linguistic and statistical point of view and to provide solid grounding in selected topics.	

Course content:

Unit I: Introduction, origins and history, Natural Language Processing tasks in syntax, semantics, and pragmatics, Issues, Applications - The role of machine learning, Probability Basics –Information theory, Collocations, N-gram Language Models, Estimating parameters and smoothing, Evaluating language models.

Unit II: Current status and future challenges. Corpus processing, computational lexicography, morphology and syntax with an emphasis on English as well as Indian Languages. Markov Models, Hidden Markov Models, Transformation based Models, Maximum Entropy Models, Conditional Random Fields

Unit III: Syntax Parsing - Grammar formalisms and treebanks, Parsing with Context Free Grammars, Features and Unification, Statistical parsing and probabilistic CFGs (PCFGs), Lexicalized PCFGs

Unit IV: Semantic Analysis: Representing Meaning, Semantic Analysis, Lexical semantics, Word-sense disambiguation, Supervised, Dictionary based and Unsupervised Approaches, Compositional semantics-Semantic Role Labelling and Semantic Parsing, Discourse Analysis

Unit V: Applications to MT, NL interfaces, Information Retrieval (IR), etc. Named entity recognition and relation extraction- IE using sequence labelling-Machine Translation (MT) - Basic issues in MT-Statistical translation-word alignment- phrase-based translation – Question Answering

Course outcome:	• To understand the use of CFG and PCFG in NLP • To understand the role of semantics of sentences and pragmatics • To apply the NLP techniques to IR applications
Text Book:	1. James Allen: Natural Language Understanding, The Benjamin/Cummings Publishing Co, Inc. 2. Daniel Jurafsky and James H. Martin Speech and Language Processing (2nd Edition), Prentice Hall; 2 edition, 2008
Reference Book:	1. Eugene Cherniak: Statistical Language Learning, MIT Press, 1993. 2. Michael P. Oakes: Statistics for Corpus Linguistics, Edinburgh University Press, 1998. 3. NLTK – Natural Language Tool Kit - http://www.nltk.org/ 4. Pierre M. Nugues, An Introduction to Language Processing with Perl and Prolog: An Outline of Theories, Implementation, and Application with Special Consideration of English, French, and German (Cognitive Technologies) Softcover reprint, 2010

CS-4009	**Quantum Computing**	**L-T-P-C:3-1-0-4**
Course objective:	• To study the mathematics and computer science aspect of quantum computing • To study the basics of linear algebra and computer science needed to understand the theory of quantum computation. • To learn about quantum circuit model in which most of the quantum algorithms are designed. • To look at quantum algorithms and the advantage they offer over classical counterparts.	

Course content:

Unit 1: Foundations of quantum theory: States, observables, measurement and unitary evolution. Qubits versus classical bits, spin-half systems and photon polarisations. Pure and mixed states, density matrices.

Unit 2: Background Mathematics and Physics: Hilber space, Probabilities and measurements, entanglement, density operators and correlation, basics of quantum mechanics, Measurements in bases other than computational basis. Introduction to classical information theory and generalization to quantum information.

Unit 3: Quantum Circuits: single qubit gates, multiple qubit gates, design of quantum circuits. Turing machines and computational complexity. Reversible computation. Universal quantum logic gates and circuits.

Unit 4: Quantum Information and Cryptography: Comparison between classical and quantum information theory. Bell states. Quantum teleportation. Quantum Cryptography, no cloning theorem. Quantum error correction, fault-tolerant computation. Physical implementations of quantum computers.

Unit 5: Quantum algorithms: Classical computation on quantum computers. Relationship between quantum and classical complexity classes. Deutsch's algorithm, Deutsch's-Jozsa

algorithm, Shor factorization, database search, FFT and prime factorization. Simon's algorithm, The prime factorization algorithm, Grover's search algorithm	
Course outcome:	• Students would learn the framework of quantum computation, and how that may be useful for future quantum technologies
Text Book:	4. *Quantum Computation and Quantum Information* – Nielsen, Michael A., and Isaac L. Chuang. Cambridge, UK: Cambridge University Press, September 2000. ISBN: 9780521635035. 5. *Quantum Theory: Concepts and Methods* – Peres, Asher. New York, NY: Springer, 1993. ISBN: 9780792325499.
Reference Books:	9. An Introduction to Quantum Computing – P Kaye, R Laflamme and M Mosca. 10. Linear Algebra and its Applications – G. Strang. 11. Principles of Quantum Computation and Information, Vol. I: Basic Concepts, Vol II: Basic Tools and Special Topics – Benenti G., Casati G. and Strini G., World Scientific. 2004 12. An Introduction to Quantum Computing Algorithms – Pittenger A. O.

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, Homogeneious Transformations, Inverse kinematics of Robot, Robot Arm dynamics, D-H representationof 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, ChriElewski, Michael Negin, "Robotics Engineering an Integrated Approach", PHI Learning., 2009.

CS-4015	**Big Data Analytics**	**L-T-P-C:3-1-0-4**
Course objective:	• To gain an understanding of Relational Database Management Systems • To gain an understand and use Structured Query Language • To gain an understanding of Data Analytics and Visualization • To gain an understanding of how managers use analytics to formulate and solve business problems and to support managerial decision making.	
Course content: **UNIT-1** Understanding Relational Database Management Systems; The databse Normalization process; Implementation of Referential Integrity; Using SQL Data Manipulation Language (DML): Used to retrieve, update and delete contents of a database; Using SQL Data Definition Language (DDL): Used to create database		

objects such as tables, stored procedures, cursors, indexes, etc. Using SQL Queries: Using SQL syntax to execute queries; and getting and using data result sets; **UNIT-2** Understand summary statistics of a data set, including sizes, ranges and variations. **UNIT-3** Interpret the business significance of the data, what it implies about the business, customers, etc. **UINT-4** Generating reports on the data, including appropriately constructed graphics and histograms that illustrate important features of the data. **UNIT -5** Machine Learning Algorithms Application in Data Analysis	
Course outcome:	Upon successful completion of this course students should be able to: • These conclusions are made possible by using the various analytic tools currently available, i.e. MS Power • Business Intelligence (BI), Hadoop, Tableau, Excel, SAS, etc.
Text Book: 1. Business Intelligence Guidebook - From Data Integration to Analytics, First Edition, Rick Sherman 2. Morgan Kaufmann; 1 edition (November 21, 2014), 550 pages ISBN-10: 012411461X | ISBN-13: 978-0124114616 |	

CS-4017	**Advanced Database Management Systems**	**L-T-P-C:3-1-0-4**
Course objective:	• To evaluate emerging architectures for database management systems. • To develop an understanding of the manner in which relational systems are implemented and the implications of the techniques of implementation for database performance. • To assess the impact of emerging database standards on the facilities which future database management systems will provide.	

Course content:

UNIT-1 Theoretical concepts, Relational model conformity and Integrity, Advanced SQL programming

UNIT-2 Query optimization, Concurrency control and Transaction management, Database performance tuning, Distributed relational systems and Data Replication

UNIT-3 Object oriented, deductive, spatial, temporal and constraint database management systems, New database applications and architectures: e.g. Data Warehousing; Multimedia; Mobility; NoSQL, Native XML databases (NXD), Document orientated databases

UNIT-4 SQL standards development, Standards for interoperability and integration e.g. Web Services

UINT-5 Database security - Data Encryption, redaction and masking techniques. Authentication and authorization. Database auditing

Course outcome:	After reading this subject, students will be able to: • Critically assess new developments in database technology • Interpret and explain the impact of emerging database standards • Evaluate the contribution of database theory to practical implementations of database management systems.

Text Book:

1. Date C. J., An Introduction to Database Systems, AddisonWesley Longman (8th Ed), 2003
2. Silberschatz A., Korth H., and Sudarshan S., Database System Concepts, McGraw-Hill (6th Ed), 2010

Reference Book:

1. Melton, J., & Simon A., SQL 1999, Understanding Relational Language Components, Morgan-Kaufmann, 2003.
2. Peter Adams : SQL: The Ultimate Guide from Beginner to Expert - Learn and Master SQL in No Time, Addison Wesley, 2016