Department of Computer Science and Engineering

BoCS Approved
Course Structure and Syllabi

For

4 Yrs. B.Tech Programme CSE
(with specialization of Data Science & Artificial Intelligence)

Effective from 2021-22

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

Proposed course structure
• 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)
• Total credits B.Tech = 162-170 credits B.Tech (Hons.)=174-182 credits
• Common courses for all Branches in first year.
• Two credits is allocated to all laboratory courses.

II. Format of Subject codes

1) Course code AA-XYZZ is explained as

AA - Department

X-Academic year

Y-Theory/Lab; 0 ==Theory and 1== Lab

ZZ-odd/even semester; odd number == odd semester and even number == even semester

2) For project/seminar/comprehensive viva:

AA= PR

X= 1

3) For open electives:

AA= OE

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

Breakup of the credits semester wise

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

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

Semester Wise Courses

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

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

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

Semester IV- Common for B Tech (Hons.) & B Tech.			
S. No.	**CSE**	**L-T-P**	**Credits**
1.	**MA-2002:** Mathematics-IV (Combinatorics and Graph Theory)	3-1-0	4
2.	**CD-2002:** Basic Artificial Intelligence	3-0-0	3
3.	**CD-2004:** Operating Systems	3-0-0	3
4.	**CD-2006:** Compiler Design	3-0-0	3
5.	**CS-2008:** Numerical Methods and Scientific Computing	3-0-0	3
6.	**HS-2002:** Environmental Science & Green Technology	2-0-0	2
7.	**CD-2102:** Basic Artificial Intelligence Lab	0-0-3	2
8.	**CD-2104:** Operating Systems Lab	0-0-3	2
Total Credits			**22**

Semester V-B Tech (Hons.) & B Tech.			
S. No.	**CSE**	**L-T-P**	**Credits**
1.	**CD-3001:** Computer Network	3-0-0	3
2.	**CD-3003:** Fundamental of Data Science	3-0-0	3
3.	**CD-3005:** DBMS	3-0-0	3
4.	**CD-3007:** Software Engineering	3-0-0	3
5.	**Hons. Elective-I**	**3-1-0**	**4**
6.	**HS-3001:** Entrepreneurship Development	2-0-0	2
7.	**CD-3101:** Computer Network Lab	0-0-3	2
8.	**CD-3103:** Fundamental of Data Science Lab	0-0-3	2
9.	**CD-3105:** DBMS Lab	0-0-3	2
Total Credits			**24 (20)**

Semester VI- B Tech (Hons.) & B Tech.			
S. No.	**CSE**	**L-T-P**	**Credits**
1.	**CD-3002:** Data Mining and Visualization	3-0-0	3
2.	**CD-3004:** Machine Learning and its Applications	3-0-0	3
3.	**CD-3006:** Design Thinking	3-0-0	3
4.	Open Elective-I	3-0-0	3
5.	**Hons. Elective-II**	**3-1-0**	**4**
6.	**CD-3102:** Data Mining and Visualization Lab	0-0-3	2
7.	**CD-3104:** Machine Learning and its Applications Lab	0-0-3	2
8.	**CD-3106:** Design Thinking 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**	**L-T-P**	**Credits**
1.	**CD-4001:** Deep Learning and its Applications	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.	**CD-4101:** Deep Learning and its Applications Lab	0-0-3	2
7.	**PR-4101:** Minor Project	----	4
8.	**PR-4103**: Industrial / Internship Seminar	----	2
Total Credits			**24(20)**

Semester VIII - Common for B Tech (Hons.) & B Tech.			
S. No.	**CSE**	**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

Semester wise summary of credits							
I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**
20	24	24	22	24 (20)	22 (18)	24 (20)	20

List of Electives

Hons. Elective I (Fifth Semester)

Offered by CSE
1. **HC-3001:** Computational Intelligence 2. **HC-3003:** Decision Making and Expert System 3. **HC-3005:** Soft Computing 4. **HC-3007:** Advanced Data Structure 5. **HC-3009:** 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 Computing
7. **OE-3014:** Advanced Algorithm

8. **OE-3016:** Advanced Data Structure
9. **OE-3018:** Programming in JAVA
10. **OE-3020:** Object Oriented System Design
11. **OE-3022:** Exploratory Data Science
12. **OE-3024**: Fog and Edge Computing
13. **OE-3026**: Knowledge Representation and Reasoning

Hons. Elective II (Sixth Semester)

Offered by CSE

1. **HC-3002:** Multimedia Systems
2. **HC-3004:** Web System and Technology
3. **HC-3006:** Evolutionary Computing
4. **HC-3008:** Introduction to Cognitive Science
5. **HC-3010:** Financial Analytics with Data Science
6. **HC-3012:** Web Services & E-Commerce
7. **HC-3014:** Business Intelligence
8. **HC-3016:** Legal Aspects of AI

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-4013:** Recommender System
7. **OE-4015:** IOT for Data Analytics
8. **OE-4017:** Advanced Computer Networks
9. **OE-4019:** Cyber Crime
10. **OE-4025:** Lasers and Ultrafast Optics
11. **OE-4027:** Pattern Recognition and Classification
12. **OE-4029:** Modelling and Simulation
13. **OE-4031:** Computer Vision
14. **OE-4033:** Cloud Computing
15. **OE-4035:** Statistical Mechanics
16. **OE-4039:** High Performance Computing
17. **OE-4041:** Recommender System

18. **OE-4043:** IOT for Data Analytics
19. **OE-4045:** Image Processing
20. **OE-4047:** Ethics of Data Science
21. **OE-4049:** Data Stream Mining
22. **OE-4051:** Predictive Analytics
23. **OE-4053:** Graph Based Social Network

Hons. Elective III (Seventh Semesters)

Offered by CSE

1. **HC-4001:** Natural Language Processing
2. **HC-4003:** Nature Inspired Computing
3. **HC-4005:** Big Data Analytics
4. **HC-4007:** Advanced Database Management Systems
5. **HC-4009:** Humanoid Robotics
6. **HC-4011**: Quantum Machine Learning
7. **HC-4013:** Semantic Web
8. **HC-4015:** Human Centred Design

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:3-0-0-3

Course objective:

- To understand the basic concept of writing a program.
- To understand role of constants, variables, identifiers, operators, type conversion and other building blocks of 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.

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

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

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

Course objective:

- To apply basic principles of physics to engineering applications.
- To introduce advances in technology for engineering applications.
- To apply the concepts of special theory of relativity in various fields 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, 2008.

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

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: 3-1-0-4

Course objective:

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

Course content:

Unit 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

CD-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.

CD-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).

CD-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

CD-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.

CD-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

CD-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

CD-2107	**Fundamental of 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 Behaviour**	**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:3-1-0-4
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.

CD-2002	**Basic Artificial Intelligence**	**L-T-P-C:3-0-0-3**

Course objective:	● To have an appreciation for and understanding of both the achievements of AI and the theory underlying those achievements. ● To have an appreciation for the engineering issues underlying the design of AI systems. ● To have a basic proficiency in a traditional AI language including an ability to write simple to intermediate programs and an ability to understand code written in that language.

Course content:

Unit 1: Introduction
Introduction to AI: History, early work, fundamental issues, Progress of Artificial Intelligence, AI techniques, level of model, criteria for success, Turing test Problems, Intelligent System

Unit 2: Problem Spaces & Search
Defining problem as a space, search, production system, problem characteristics, production system characteristics, issues in the design of search programs, Heuristic search

Unit 3: Intelligent agents, Reactive, deliberative, goal-driven, utility-driven, and learning agents Artificial Intelligence programming techniques

Unit 4: Problem-solving through Search
Forward and backward, state-space, blind, heuristic, problem-reduction, A, A*, AO*, minimax, alpha-beta cut off,

Unit 5:
Knowledge Representation:
Propositional Calculus, Predicate Calculus, Rule based knowledge representation, inference rule, unification, forward and backward chaining, resolution

Unit 6:
Neural Network, stochastic and evolutionary search algorithms, genetic algorithm, Application of artificial Intelligence in various domains.

Course outcome:	● To able to design agent and environment problem. ● To able to learn various search methods likes uninformed and informed search. ● Define the concept of combinatorial (optimization or satisfaction) problem. ● Describe the concept of constraint, as used in constraint programming (CP).
Text Book:	1. N.J. Nilsson, "Principles of Artificial Intelligence", Narosa Publishing House. 2. Stuart Russell, Peter Norvig, "Artificial Intelligence – A Modern Approach", Pearson Education / Prentice Hall of India.

Reference Book:	1. Saroj Kaushik, "Artificial Intelligence", Cengage Learning India Pvt Ltd 2. E. Rich and Knight, "Artificial Intelligence", McGraw Hill International.
Lab Code: CD 2102	**Basic Artificial Intelligence Lab** **L-T-P-C:0-0-3-2**
	● Write a program to implement Tic-Tac-Toe game problem. ● Write a program to solve Water Jug Problem (Show the solution path also). ● Implement the Romanian Example using the Depth First Search ● Design a program for the greedy best first search or A* search ● Construct the simulated annealing algorithm over the travelling salesman problem. ● Implement a basic binary genetic algorithm for a given problem ● Experiment the Graph Coloring CSP or Cryptarithmetic Puzzle ● Implement the Tic-Tac-Toe game using any adversarial searching algorithm ● Write a program to solve 4-Queen problem

CD-2004	**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 to Operating Systems. Operating system functions, Evolution of Operating Systems, Different types of O.S.: batch, multi-programmed, time-sharing, real-time, distributed, parallel.

Unit 2

Concept of processes, process scheduling, operations on processes, inter-process communication, Communication in Client-Server Systems, overview & benefits of threads. Process scheduling: scheduling criteria, preemptive & non-preemptive scheduling, scheduling algorithms.

Unit 3

Process Synchronization: background, critical section problem, critical region, synchronization hardware, classical problems of synchronization, semaphore. Deadlocks: system model, deadlock characterization, methods for handling deadlocks, deadlock prevention, deadlock avoidance, deadlock detection, recovery from deadlock.

Unit 4

Memory Management: background, logical vs. physical address space, swapping, contiguous memory allocation, paging, segmentation. Virtual Memory: background, demand paging, page replacement, page replacement algorithms, allocation of frames, thrashing.

Unit 5

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

Disk Management: disk structure, different types of disk scheduling algorithms. Protection and Security, 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. Operating Systems by Stalling, Pearson 2. Milan Milenkovich; Operating Systems: Concepts and Design, McGraw-Hill international edition, Computer Science Series, 2001. 3. Per Brinch Hansen; Operating System Principles, Prentice-Hall Publication, New Delhi,2015.

CD-2104	**Operating Systems Lab**	**L-T-P-C:0-0-3-2**

Familiarization with the 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.

CD-2006	**Compiler Design**	**L-T-P-C:3-0-0-3**

Course objective:

- To learn the process of translating a modern high-level language to executable code.
- To provide a student with an understanding of the fundamental principles in compiler design and to provide the skills needed for building compilers for various situations that one may encounter in a career in Computer Science.
- To develop an awareness of the function and complexity of modern compilers.
- To apply the code generation algorithms to get the machine code for the optimized code.
- To represent the target code in any one of the code formats
- To understand the machine dependent code
- To draw the flow graph for the intermediate codes.
- To apply the optimization techniques to have a better code for code generation

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

CD-2008	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. ● 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 equipment to solve environmental problem.
- Develop equipment for Green Technology in the society.

Text Book:

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

Reference Book:

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

Semester V

CD-3001	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

CD-3101	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.

CD-3003	Fundamental of Data Science	L-T-P-C:3-0-0-3

Course objective:	● Apply Data Science in Real Time Application ● Learn Basic Statistics and Implement in Python ● Learn Language of Data Science

Course content:

Unit 1: Introduction to data analytics, Python Fundamentals – I, Python Fundamentals – II, Central Tendency and Dispersion – I, Central Tendency and Dispersion - II

Unit 2: Introduction to Probability- I, Introduction to Probability- II, Probability Distributions – I, Probability Distributions – II, Probability Distributions – III, Python Demo for Distributions, Sampling and Sampling Distribution, Distribution of Sample Means, population, and variance, Confidence interval estimation: Single population – I, Confidence interval estimation: Single population – II

Unit 3: Hypothesis Testing- I, Hypothesis Testing- II, Hypothesis Testing- III, Errors in Hypothesis Testing, Hypothesis Testing: Two sample test- I, Hypothesis Testing: Two sample test- II, Hypothesis Testing: Two sample test- III, ANOVA – I, ANOVA – II, Post Hoc Analysis (Tukey's test), Randomize block design (RBD), Two Way ANOVA

Unit 4: Linear Regression – I, Linear Regression – II, Linear Regression – III, Estimation, Prediction of Regression Model Residual Analysis, Estimation, Prediction of Regression Model Residual Analysis – II, MULTIPLE REGRESSION MODEL – I, MULTIPLE REGRESSION MODEL-II, Categorical variable regression, Maximum Likelihood Estimation- I, Maximum Likelihood Estimation-II, LOGISTIC REGRESSION- I, LOGISTIC REGRESSION-II, Linear Regression Model Vs Logistic Regression Model, Confusion matrix and ROC- I, Confusion Matrix and ROC-II, Performance of Logistic Model-III, Regression Analysis Model Building – I, Regression Analysis Model Building (Interaction)- II, Chi - Square Test of Independence – I, Chi-Square Test of Independence – II, Chi-Square Goodness of Fit Test,

Unit 5: Cluster analysis: Introduction- I, Clustering analysis: part II, Clustering analysis: Part III, Cluster analysis: Part IV, Cluster analysis: Part V, K- Means Clustering, Hierarchical method of clustering –I, Hierarchical method of clustering- II, Classification and Regression Trees (CART: I), Measures of attribute selection, Attribute selection Measures in CART : II, Classification and Regression Trees (CART) – III,

Course outcome:	● Students will learn how one can use analytics in their career and life. One of the most important ● Aspects of this course is that hands-on experience creating analytics models will be shared.	
Text Book:	1: Pandas for Everyone: Python Data Analysis, Daniel Y. Chen 2: Python Data Science Handbook: Essential Tools for Working with Data,	
Reference Book:	1. Introduction to Machine Learning with Python: A Guide for Data Scientists, Andreas C. Müller and Sarah Guido	
Lab Code: CD-3103	**Fundamental Data Science Lab**	**L-T-P-C:0-0-3-2**

Python AS CALCULATOR APPLICATION

a. Using with and without Python objects on console

b. Using mathematical functions on console

c. Write an Python script, to create Python objects for calculator application and save in a specified location in disk.

DESCRIPTIVE STATISTICS IN Python

a. Write an Python script to find basic descriptive statistics using summary, str, quartile function on mtcars& cars datasets.

b. Write an Python script to find subset of dataset by using subset (), aggregate () functions on iris dataset.

READING AND WRITING DIFFERENT TYPES OF DATASETS

a. Reading different types of data sets (.txt, .csv) from Web and disk and writing in file in specific disk location.

b. Reading Excel data sheet in Python.

c. Reading XML dataset in Python.

VISUALIZATIONS

a. Find the data distributions using box and scatter plot.

b. Find the outliers using plot.

c. Plot the histogram, bar chart and pie chart on sample data.

CORRELATION AND COVARIANCE

a. Find the correlation matrix.

b. Plot the correlation plot on dataset and visualize giving an overview of relationships among data on iris data.

c. Analysis of covariance: variance (ANOVA), if data have categorical variables on iris data.

REGRESSION MODEL

Import a data from web storage. Name the dataset and now do Logistic

Regression to find out relation between variables that are affecting the admission of a student in a institute based on his or her GRE score, GPA obtained and rank of the student. Also check the model is fit or not. Require (foreign), require (MASS).

MULTIPLE REGRESSION MODEL

Apply multiple regressions, if data have a continuous Independent variable. Apply on above dataset.

REGRESSION MODEL FOR PREDICTION

Apply regression Model techniques to predict the data on above dataset.

CLASSIFICATION MODEL

a. Install relevant package for classification.

b. Choose classifier for classification problem.

c. Evaluate the performance of classifier.

CLUSTERING MODEL

a. Clustering algorithms for unsupervised classification.

b. Plot the cluster data using Python visualizations.

CD-3005	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 principles 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.

CD-3105	**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 tools.
- 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.

CD-3007	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

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

CD-3002	Data Mining and Visualization	L-T-P-C:3-0-0-3
Course objective:	● To learn the essential exploratory techniques for analyzing and visualizing data, and ● To gain hands-on experience of using software tools for data analytics. ● To learn the essential exploratory techniques for analyzing and visualizing data, ● To gain hands-on experience of using software tools for data analysis.	

Course content:

Unit 1:
What is Data Mining, Knowledge Discovery in Database (KDD), Overview of ETL, Need for Online Analytical Processing, OLTP V/s OLAP, Hypercubes OLAP Operations in Multidimensional Data Model,Data Preprocessing- Data Cleaning methods

Unit 2:
Data Warehouse Modeling Vs Operational Database Modeling,Data mart. Data Warehousing architecture and implementation , OLAP Models:- MOLAP, ROLAP, HOLAP, DOLAP, Data Warehouse Modeling: The Star Schema, The Snowflake Schema, Fact Tables and Dimension Tables, The Factless Fact Table.

Unit 3: Introduction to Exploratory Data Analysis and Distributions: Basic Concepts—Population and Sample, Case Study: Visually Inspecting Data to Improve Product Quality, Pareto Diagrams and Dot Diagrams, Frequency Distributions, Graphs of Frequency Distributions, Stem-and-Leaf Displays, Descriptive Measures, Quartiles and Percentiles, calculation of X bar and S, Problems with aggregating data, Sample Spaces and Events, Counting, Probability, The Axioms of Probability, Some Elementary Theorems, Conditional Probability, Bayes' Theorem

Unit 4: Probability Mass Function, Cumulative Distributions and Modeling Distributions: Making a Basic Histogram, Making Multiple Histograms from Grouped Data, Making a Density Curve, Making Multiple Density Curves from Grouped Data, Making a Frequency Polygon, Making a Basic Box Plot, Adding Notches to a Box Plot, Adding Means to a Box Plot, Making a Violin Plot, Making a Dot Plot, Making Multiple Dot Plots for Grouped Data, Making a Density Plot of Two-Dimensional Data, Scatter Plots.

Unit 5: Characterizing Relationships, Correlation, Covariance, Pearson's Correlation, Nonlinear Relationships, Spearman's Rank Correlation, Association rule mining, Introduction to classification and clustering .

Course outcome:	On completion of the course, student will be able to CO1: Understand the philosophy of exploratory data analysis, CO2: List various techniques for efficient visualization, CO3: Apply discrete and continuous probability distributions CO3: Estimate the correlation between variables. CO4: Analyze linear and nonlinear models visually. CO5: Visualize time series and survival evaluation. CO6: Use various visualization structures such as tables, spatial data, time-varying data, tree and network.
Text Book:	1. Think Stats, 2nd Edition: Exploratory Data Analysis, Allen B. Downey, Year:2014, Pages:226, ISBN 13:978-1-49190-733-7 2. Making sense of Data: A practical Guide to Exploratory Data Analysis and Data Mining, by Glenn J. Myatt. 3. Jiawei Han, Micheline Kamber, Jian Pei, Data Mining: Concepts and Techniques, 3rd Edition, Morgan Kaufmann Publishers (ISBN: 978-0-12-381479-1) 4. Arun K. Pujari, Data Mining Techniques, University Press, 2013
Reference Book:	Making Sense of Data II: A Practical Guide to Data Visualization, Advanced Data Mining Methods, and Applications, Glenn J. Myatt, and Wayne P. Johnson. Print ISBN:9780470222805

CD-3102	**Data Mining and Visualization Lab**	**L-T-P-C:0-0-3-2**

LIST OF EXPERIMENT
Practical list should be prepared by Course Instructor based on the content of the subject. Data sets can be taken from standard repositories (https://archive.ics.uci.edu/ml/datasets.html) or constructed by the students.
Preferred Programming Language & Platform: MATLAB, R and Scientific Python (SciPy, NumPy)
1. Introduction to Exploratory Data Analysis and Visualization
A. Overview of the exploratory aspect of data analysis
B. Data acquisition from on-line data sources and preprocessing technique

2. Graphical Visualization
A. Visualizing Clusters
B. Visualization Data Distributions

C. Multivariate Visualization
D. Graph Data Visualization

3. Exploratory Data Analysis and case study for Different Application

1. B. Everitt. An Introduction to Applied Multivariate Analysis with R (Use R), Springer, New York, 2011
2. W. McKinney. Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython, O'Reilly,2012

CD-3004	**Machine Learning and its Application**	**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.	

Course content:

Unit 1

Introduction to machine learning, different forms of learning, Data Objects and Attribute Types, Cross Validation, Recent applications of machine learning, such as robotic control, autonomous navigation, speech recognition, image classification.

Unit 2

Linear and Non-linear Models, under fitting, overfitting, Hyperparameter and validation sets, Performance Evaluation Measures for Classification Models, Bias/Variance Tradeoff,

Loss- function, Classes of estimation, Learning theory, VC theory; large margins

Unit 3

Supervised and Unsupervised learning, Dimension Selection and Reduction Techniques, Classification Methods: Linear Discriminant Analysis, Logistic regression, Support Vector Machines, Decision Tree, Naive Bayes, Multilayer Perceptrons and Back Propagation, Lazy Learners, Ensemble Learning

Unit 4:

Clustering: Partitional Clustering - k-means, k-medoids; Hierarchical Clustering - Agglomerative,

Divisive, Distance measures; Density based clustering.

Unit 5:

Full stack Application development, Bioinformatics, NLP, Text and web data processing.

CD-3104	**Machine Learning and its Application Lab**	**L-T-P-C:0-0-2-2**

- Design of experiments in Machine Learning;
- Introduction to popular Machine Learning Datasets and Toolkits
- Experiments on supervised classification using MLP, RBF ANN, SVM and Decision Trees; Application of Classifiers.
- Practical applications of ML techniques in popular datasets.

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. ● 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.

Reference Book:

1. Stephen Marsland, Machine Learning: An Algorithmic Perspective. http://www.amazon.com/Machine-Learning-Algorithmic Perspective Recognition /dp/1420067184 .
2. Christopher M. Bishop, Pattern Recognition and Machine Learning. http://research.microsoft.com/en-us/um/people/cmbishop/prml/.
3. Tom Mitchell, Machine Learning, http://www.cs.cmu.edu/~tom/mlbook.html.

CD-3006	**Design Thinking**	**L-T-P-C:3-0-0-3**

Course objective:	● To immerse students into the world of innovation as a systematic process of tackling relevant business and/or social problems. ● To provide a social and thinking space for the recognition of innovation challenges and the design of creative solutions.

Course content:

Unit 1: Design Thinking - A Primer _Start -Part 1, Design Thinking - A Primer _Start -Part 2, Design Thinking - A Primer _Start -Part 3, Intro to Design Thinking, Case Study - Arcturus IV by John E. Arnold, Course Preview and History of Design Thinking, Discussion (Intro to Demo problem)

Unit 2: Empathize - Lecture 01, Empathize - Workshop 01, Empathize - Workshop 02, Empathize – Skit, Interviews

Unit 3: Analyze - Lecture 01 5Whys, Analyze - 5ys - IIT Stadium levels, Analyze - Lecture 02 Conflict of Interest, Analyze - Workshop - Part 01, Analyze - Workshop - Part 02

Unit 4: Solve - Tea cup story, Solve - Lecture 01, Solve - Workshop 01, **Unit 5:** Elephant and blind men, Test - Lecture 01, Test - Workshop 01, Test-Customer reactions to prototype, The END - Part 1, The END - Part 2, Finale & Appeal for proposals		
Text Book:	● Design Thinking for Beginners, by Langenfeld Kilian ● UnMukt: Science & Art of Design Thinking' by Arun Jain.	
Reference Book:	Design Your Thinking: The Mindsets, Tool sets and Skill Sets for Creative Problem-solving, Pavan Soni (Author)	
CD-3106	**Design Thinking Lab**	**L-T-P-C:0-0-3-2**

1. Empathize (Demonstration)
2. Analyze (Demonstration)
3. Solve (Demonstration)
4. Test (Demonstration
5. SDLC Models and Implementation
6. Software Quality Testing
7. Software Product Testing Experiments

Semester VII

CD-4001	**Deep Learning and its Applications**	**L-T-P-C: 3-0-0-3**
Course objective:	● Introduce major deep learning algorithms, the problem settings, and their applications to solve real world problems. ● Become familiar with neural networks ● This topics course aims to present the mathematical, statistical and computational challenges of building stable representations for high-dimensional data ● Discussing recent models from supervised learning ● Discussing recent models from unsupervised learning.	
Course content: **Unit 1** Introduction to deep learning, Neural Network Basics, Learning XOR, Shallow Neural Network and Deep Neural Networks, cross entropy loss function for neural net. **Unit 2** Neural networks: forward propagation, cost functions, error backpropagation, training by gradient descent, bias/variance and under/overfitting, regularization. **Unit 3**		

Practical aspects of deep learning, Optimization algorithms, Hyperparameter Tuning, Batch Normalization, regularization and under-constraint problem.

Unit 4

Convolutional Networks, Deep Inside Convolutional Networks: Types of CNN, Visualizing Image Classification Models and Saliency Maps, Sequence Modeling, Recurrent Neural Networks, LSTM,

Unit 5

Sparse coding, autoencoders, variational autoencoders, generative adversarial networks, and attention-based models with applications in vision, NLP, and multimodal learning.

CD- 4101	**Deep Learning and its Applications Lab**	**L-T-P-C: 0-0-3-2**

- Introduction to tensorflow, simple ML examples.
- Neural networks. Exercises on NNs, solving a problem with NNs on tensorflow.
- Convolutional networks.
- Exercises on CNNs, solving a problem with CNNs on tensorflow. Students
- Recurrent networks. Exercises on RNNs, solving a problem with RNNs on tensorflow.
- Exercises on LSTM, solving a problem with LSTM on tensorflow.

Course outcome:	● Identify the deep learning algorithms which are more appropriate for various types of learning tasks in various domains. ● Discuss Convolutional Neural Network models to Object Detection and image Retrieval ● Implement deep learning algorithms and solve real-world problems.

Text Book:

1. Deep Learning with Python by François Chollet, Manning Publications Co, ISBN: 9781617294433
2. Deep Learning Ian Goodfellow, Yoshua Bengio, Aaron Courville · 2016

1. Deep Learning - A Practical Approach by Rajiv Chopra, Khana Publications, ISBN: 9789386173416
2. Deep Learning by Ian Goodfellow and Yoshua Bengio and Aaron CourvillePublished by An MIT Press book.

B.Tech CSE_DSAI Electives Syllabus

Hons. Elective I (Fifth Semester)

HC-3001	Computational Intelligence	L-T-P-C:3-1-0-4

Course objective:

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

Module I

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

Module II

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

Module III

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

Module III

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

Text Book:

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

Reference Book:

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

HC-3003	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.,2013.
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, 2008.
2. Judea Pearl; Probabilistic Reasoning in Intelligent Systems: Networks of Plausible Inference, Morgan Kaufmann Publishers Inc., 1988.

HC-3005	Soft Computing	L-T-P-C:3-1-0-4

Course objective:

- Understand Soft Computing concepts, technologies, and applications
- Understand the underlying principle of soft computing with its usage in various applications. .
- 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 systems.

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

HC-3007	Advanced Data Structure	L-T-P-C:3-1-0-4

Course content:

Unit I

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

Unit II

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

Unit III

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

Unit IV

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

Unit V

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

Course outcome:

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

Text Book:

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

Reference Book:

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

HC-3009	Game Theory	L-T-P-C:3-1-0-4

Course content:

Unit I

Games with Perfect Information, Strategic Games, Nash Equilibrium and Existence Properties, Market Equilibrium and Pricing: Cournot and Bertrand Game, Electoral Competition: Median Voter Theorem,

Auctions: Definitions and The role of Knowledge, Auctions: Definitions and The role of Knowledge Mixed Strategy Equilibrium

Unit II

Extensive Form Game with Perfect Information: Theory, Stackelberg Model of Duopoly, Buying Votes, Committee Decision-Making

Unit III

Repeated games: The Prisoner's Dilemma, General Result, Supermodular Game and Potential Game: Supermodular Game and Potential Game.

Unit IV

Strategic Games With Imperfect Information: Bayesian Games, Cournot's Duopoly with Imperfect Information, Radio Spectrum, With Arbitrary Distribution of Valuations,Extensive Games With Imperfect Information: Theory

Unit V

Bargaining:Rubinstein Bargaining Model with Alternating Offers, Nash Bargaining Solution, Auction and Mechanism Design with Applications, Revenue Equivalence:

Course outcome:

- Game theory is a branch of Mathematical Economics that studies strategic interactions amongst rational decision makers. Traditionally, game theoretic tools have been applied to solve problems in Economics, Business, Political Science, Biology, Sociology, Computer Science, Logic, and Ethics. In recent years, applications of game theory have been successfully extended to several areas of engineered / networked system such as wireline and wireless communications, static and dynamic spectrum auction, social and economic networks.
- This course is intended to provide students with a comprehensive treatment of game theory with specific emphasis on applications in Economics and Engineering.

Text Book:

1. (IGT) Martin Osborne, An Introduction to Game Theory, Oxford University Press, 2003

Reference Book:

2. (AT) Vijay Krishna, Auction Theory, Academic Press.
3. (SG) PrajitDutta, Strategies and Games, MIT Press

Hons. Elective II (Sixth Semester)

HC-3002	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

HC-3004	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

HC-3006	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:	3. **Evolutionary Computation 1: Basic Algorithms and Operators** – Bäck, T, Institute of Physics Publishing, Bristol**.** 4. **Evolutionary Computation : Toward a New Philosophy of Machine Intelligence –** Fogel, D.B**.,** 2nd ed. Wiley-IEEE Press**.** 5. **Genetic Algorithms in Search, Optimization, and Machine Learning –** David Goldberg. Addison-Wesley, 1989.	

	6. **Introduction to Evolutionary Computing –** Eiben and Smith. Springer-Verlag, Corrected 2nd printing, 2007

HC-3008	**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
Reference Book:	1. 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. 2. Fromkin, Rodman, and Hyams. An Introduction to Language, Boston, MA: Thomson Wadsworth, 9th edition, 2011, chapters 1-2.

HC-3010	**Financial Analytics with Data Science**	**L-T-P-C:3-1-0-4**
Course objective:	● The field of financial analysis use statistical methods to understand the problems of finance. ● Financial data science combines the traditions of econometrics with the technological components of data science. ● Financial data science uses machine learning, predictive and prescriptive analytics to provide robust possibilities for understanding financial data and solving related problems.	
Course content: **Unit 1: Course Introduction**		

financial analytic techniques. why, when, and how to apply financial analytics in real-world situations. analyze time series data and how to evaluate the risk-reward trade off expounded in modern portfolio theory. While most of the focus will be on the prices, returns, and risks of corporate stocks, the analytical techniques can be leveraged in other domains. Application of Data Science in Finance Industries.

Unit 2: Introduction to Financial Analytics and Time Series Data
Managerial Finance (cash flow, present value, risk and return, portfolios, markets), Fraud Detection, Algorithmic Trading, Financial Data Quality Issues and Data Scrubbing. Feature Extraction and Portability. Data Reduction and Transformation.

Unit 3: Performance Measures and Holt-Winters Model
Web Page Retrieval, Scrapping, Regular Expression Extraction. Case Study: Data and Web Technologies. Similarity and Distances. Impact of High Dimensionality. Impact of Data Distribution. Impact of Local Data Distribution. forecasting performance measures, moving average, exponential smoothing methods, and the Holt-Winters method.

Unit 4: Modern Portfolio Theory
Mining Text Data. Document Preparation and Similarity Computation. Topic Modeling. Time Series Data. Using Decision Tree to Trade Stock. Building a Trading Strategy. Handling Time-Dependent Data in R. Quantile (i.e., Value at Risk) and coherent (i.e., Expected Shortfall) risk measures

Course outcome:	At the end of this Financial Analytics with data science, the Candidate will be an Expert in all the Financial, Analytical Techniques used in the Analysis including Statistical Data Analysis. It will help the Candidate to take up a Job as a Financial Analyst or a Business Analyst in the Business Intelligence Department of an MNC.
Text Book:	Financial Statistics and Data Analytics, Sciprofile link Shuangzhe Liu andSciprofile link Milind Sathye (Eds.)
Reference Book:	● Business Analytics: The Science of Data - Driven Decision Making, U Dinesh Kumar (Author) ● William G. Foote. 2017. Financial Engineering Analytics: A Topical Manual Using R

HC-3012	**Web Services & E-Commerce**	**L-T-P-C:3-1-0-4**
Course objective:	● In e-commerce and business finance. To provide adequate knowledge and understanding about E-Com practices to the students. ... consultant, ● This will help learners to possess knowledge and other soft skills and to react aptly when confronted with critical decision making.	
Course content: **UNIT 1** Introduction to E –commerce		

E –commerce: Definition of e commerce, different types of E-commerce, Examples of E-commerce, E-commerce trade cycle, advantages and disadvantages of Ecommerce, Traditional commerce Vs E -commerce

UNIT 2

Overview of Hardware and Software Technologies for Ecommerce

Overview of Client-side programming (Dream Weaver, Front page) Hardware and, Server-side Programming (PHP), Database Software connectivity, session tracking, middleware technologies for ecommerce perspective and security aspects with respect to e commerce, integration of web services

UNIT 3

Payment System for Ecommerce

Traditional payment model, Characteristics of payment, Online Payment Basics, Payment Cards, Electronic Cash, Electronic Wallets, Stored-Value Cards, SET Protocol for credit card payment, Internet Technologies and the Banking Industry

UNIT 4

Selling and Marketing on Web

Selling on the Web: Revenue Models and Building a Web Presence: Revenue Models, Revenue Models in Transition, Revenue Strategy Issues, Creating an Effective Web Presence, Web Site Usability, Connecting with Customers

Marketing on the Web: Web Marketing Strategies, Communicating with Different Market Segments, Beyond Market Segmentation: Customer Behavior and Relationship Intensity, Advertising on the Web, E-Mail Marketing, Technology- Enabled Customer Relationship Management, Creating and Maintaining Brands on the Web

Online Auctions, Virtual Communities, and Web Portals

UNIT 5

E business: - Introduction to e business and Developing E-business models

Definition of e- business, Characteristics, elements of e business, e business roles, Impact of e business, challenges of e business, difference between e-business and e- commerce, E-business structure, Evolution of E –business and stages, E – business models, Characteristics of Internet based software and e business solutions, Strategic planning process, SCM, CRM, ERP, procurement

Course outcome:	● Understand the basic concepts and technologies used in the field of management information systems ● Understand the processes of developing and implementing information systems ● Be aware of the ethical, social, and security issues of information systems and ● Develop an understanding of how various information systems work together to accomplish the information objectives of an organization
Text Book:	E-Commerce: Fundamentals and Applications, Henry Chan (Author), Raymond Lee (Author), Tharam Dillon (Author), Elizabeth Chang (Author)

Reference Book:	Introduction To E-Commerce And ERP, Pandey A K

HC-3014	**Business Intelligence**	**L-T-P-C:3-1-0-3**
Course objective:	**COURSE OBJECTIVES** • learn Business Intelligence. • This course is intended to provide an integrative foundation in the field of business intelligence at the operational, tactical, and strategic levels. • Topics such as value chain, customer service management, business process analysis and design, will be covered, along with other topics relevant to the field of business intelligence • transaction processing systems, management information systems, and executive information systems will be covered, along with other topics relevant to the field of business intelligence	

Course content:

Unit 1: Introduction to Business Intelligence
Understanding the scope of today's BI solutions and how they fit into existing infrastructure Assessing new options such as SaaS and cloud-based technology. Describe BI, its components & architecture, previewing the future of BI Crafting a better experience for all business users, End User Assumptions, Setting up Data for BI, The Functional Area of BI Tools, Query Tools and Reporting, OLAP and Advanced Analytics, Supporting the requirements of senior executives, including performance management.

Unit 2: Elements of Business Intelligence Solutions
Reports & ad hoc queries; Analyse OLAP data; Dashboards & Scorecards development, Metadata Models; Automated tasks & events; Mobile & disconnected BI; Collaboration capabilities; Real time monitoring capabilities; Software development kit; Consume BI through portals, web applications, Desktop applications.

Unit 3: Building the BI Project
Planning the BI project, Project Resources; Project Tasks, Risk Management and Mitigation, Cost-justifying BI solutions and measuring success,
Collecting User Requirements, Requirements-Gathering Techniques; Prioritizing & Validating BI Requirements, Changing Requirements; BI Design and Development, Best Practices for BI Design; Post-Implementation Evaluations, Maintaining Your BI Environment.

Unit 4: Reporting authoring
Building reports with relational vs Multidimensional data models; Types of Reports – List, crosstabs, Statistics, Chart, map, financial etc; Data Grouping & Sorting, Filtering Reports, Adding Calculations to Reports, Conditional formatting, Adding Summary Lines to Reports. Drill up, drill- down, drill-through capabilities. Run or schedule report, different output forms – PDF, excel, csv, xml etc.

Unit 5: BI Deployment, Administration & Security
Centralized Versus Decentralized Architecture, BI Architecture Alternatives, phased & incremental BI roadmap, System Sizing, Measurements and Dependencies, System Sizing, Measurements, and Dependencies. Setting Early Expectations and Measuring the Results. End-User Provisos. OLAP Implementations. Expanding BI Authentication Authorization, Access Permissions, Groups and Roles, Single-sign on Server Administration, Manage Status & Monitoring, Audit, Mail server & Portal integration, Back Up and Restore.

Course outcome:	On completion of this course, the students will be able to 1. gain knowledge of Business Intelligence 2. build business projects 3. generate and manage BI reports 4. do BI Deployment, Administration & Security.
Text Book:	1. Business Intelligence (IBM ICE Publication). 2. K.P.Soman, Shyam Diwakar and V. Ajay, "Insight into data mining Theory and Practice", Prentice Hall of India, 2006.
Reference Book:	1.Yanchang Zhao, "R and Data Mining", Elsevier, 2013 2. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn and TensorFlow, O'Reilly Media, 2017 3.Http://www.cio.com/article/40296/Business_Intelligence_Definition_and_Solutions.

HC-3016	**Legal Aspect of AI**	**L-T-P-C:3-1-0-4**
Course objective:	You will develop critical thinking and in-depth interdisciplinary knowledge of AI theory and practice through various forms of knowledge transfer and independent study. You will also gain critical insight into the main legal, ethical, and social aspects of AI and you will acquire insight of different research approaches of AI.	
Course content: **Unit 1:** Definitions History and theories of AI and practical, The elements and technologies of AI, AI, human rights and bias, Regulatory and policy developments of AI in the EU **Unit 2:** Social and political issues of AI, Ethics of AI vs AI ethics Legal issues of AI, Legal framework for the assessment of legal status of artificial agents Legal approach to robots as products, Legal approach to artificial agents as animals **Unit 3:** AI criminal justice and law enforcement, AI on Platform Regulation, AI, good governance and democracy **Unit 4:** Artificial intelligence and personal data protection, Prospective legal concepts of artificial intelligence, Machine learning and algorithms of artificial intelligence, Cyber Laws and Artificial Intelligence, Artificial Intelligence in legal operations		
Course outcome:	● Basics of artificial intelligence ● Machine learning and algorithms of artificial intelligence ● Autonomy of an artificial agent ● Legal framework for the assessment of legal status of artificial agents	

	● Legal approach to robots as products ● Legal approach to artificial agents as animals ● Legal approach to artificial agents as natural persons and legal persons ● The concept of liability of artificial agents ● Artificial intelligence and personal data protection ● Prospective legal concepts of artificial intelligence
Text Book:	Legal Aspects of Artificial Intelligence Richard Kemp November 2016
Reference Book:	Legal Aspects of "Artificial Intelligence" (AI) Samuel Klaus and Claudia Jung.

Hons. Elective III (Seventh Semesters)

HC-4001	**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 Machine Translation (MT), NL interfaces, Information Retrieval (IR), etc. Named entity recognition and relation extraction- IE using sequence labelling-Machine Translation - Basic issues in MT-Statistical translation-word alignment- phrase-based translation – Question Answering		
Course outcome:	● To understand the principle of natural language processing and be able to develop a system for conferring one natural language to another. ● 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, 2003. 2. Michael P. Oakes: Statistics for Corpus Linguistics, Edinburgh University Press, 2013. 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

Course code: HC-4003	**NATURE-INSPIRED COMPUTING** **L-T-P-C:3-1-0-4**
Course objective:	This course is about algorithms that are inspired by naturally occurring phenomena and applying them to optimization, design and learning problems across science and engineering. The focus is on the process of abstracting algorithms from the observed phenomenon, their outcome analysis and comparison as well as their "intelligence". This will be done primarily through the lens of evolutionary computation, swarm, intelligence (ant colony and particle-based methods) and neural networks.
Module 1[9L]: Computational Problems, Decision Problem, Optimization Problem, Hardness in Optimization Problems, NP class, NP-Hard, examples for NP-Hard problems, tackling NP-Hard problems, Rationale for seeking inspiration from nature. **Module 2[9L]:** Nature Inspired Solutions, Characteristics of Nature not existing in Traditional Computing, Traditional Computing vs Biological Computing Computations in Nature: Social Insects, Immune System, Evolving Population. **Module 3[9L]:** Evolutionary Intelligence, Collective Intelligence, Social Natural Intelligence. Genetic Algorithm, Ant Colony Optimizations, Bees Algorithm, Bat Algorithm, Paddy Field Algorithm, Cuckoo Search Algorithm, Fire-fly Algorithm etc. **Module 4[9L]:** Recent topics in nature inspired computing. Examples of Case Studies and Applications How ants, birds, and fish compute to find their foods together in nature I. How people socially meet and form interesting communities on the Internet.	
Course outcome:	● Describe the natural phenomena that motivate the discussed algorithms. Understand the strengths, weaknesses and appropriateness of nature-inspired algorithms. ● Understand fundamental concepts of NP-hardness and computational complexity. Prove algorithm convergence rates using probabilistic arguments. ● Perform appropriate analyses on and between the outputs of stochastic algorithms. Analyze outcomes using statistical and information theoretic measures. ● Modern computing aspects, challenges and solutions

Text Book:	Nature-Inspired Optimization Algorithm by Vasuki A Taylor & Francis Ltd, ISBN: 9780367503291
Reference Book:	Nature Inspired Metaheuristics Algorithms by Xin-She yang, 2nd Edition, University of Cambridge, Luniver Press, ISBN:978-1-905986-10-1

HC-4005	**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 database 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

Big data Overvie, Data Analytics Life Cycle, Understand summary statistics of a data set, including sizes, ranges and variations.

UNIT-3

Generating reports on the data, including appropriately constructed graphics and histograms that illustrate important features of the data, Interpret the business significance of the data, what it implies about the business, customers, etc.

UINT-4

Hadoop, Hadoop Overview, Hadoop Ecosystem, spark and data stream processing, NoSQL Database.

UNIT -5

Big Data Computing, Distributed System and Database System, Data Stream System and Stream Mining, Ubiquitous Computing Infrastructure, 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 Morgan Kaufmann; 1 edition (November 21, 2014), ISBN-10: 012411461X | ISBN-13: 978-0124114616 |
2. Big Data and Business Analytics by Marlon Pascual

HC-4007	**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 oriented 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, Addison Wesley 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 2019, Understanding Relational Language Components, Morgan-Kaufmann, 2019.
2. Peter Adams : SQL: The Ultimate Guide from Beginner to Expert - Learn and Master SQL in No Time, Addison Wesley, 2016

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

Course objective:

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

UNIT I-Introduction History of robots,

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

UNIT II- Drive systems and Sensors

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

UNIT III-Kinematics and Dynamics of Robots

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

UNIT IV-Robot Control,

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

Course Outcome:

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

- Compute forward and inverse kinematics for a small serial kinematic chain.
- Consider trade-offs among position control, velocity control, and force control when solving a robot control problem.
- Perform stability analysis of a controller-robot system, and describe why it is important.
- Model uncertainty in robot processes.

Text Book:

[1] Mikell P Groover, Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, "Industrial Robotics, Technology programming and Applications", McGraw Hill, 2012.

[2] Craig. J. J. "Introduction to Robotics- mechanics and control", Addison- Wesley, 1999.

Reference Book:

[1]S.R. Deb, “Robotics Technology and flexible automation”, Tata McGraw-Hill Education., 2009.
[2] Richard D. Klafter, Thomas .A, Chri Elewski, Michael Negin, "Robotics Engineering an Integrated Approach", PHI Learning., 2009.

HC-4011	**Quantum Machine Learning**	**L-T-P-C:3-1-0-4**
Course objective:	• understand how to build both basic and advanced quantum machine learning models • implement classical and quantum algorithms to solve machine learning tasks with Python and Qiskit • learn about roadblocks and challenges of quantum machine learning • explore the future prospects of quantum machine learning	
Course content: **Unit 1**: What is Quantum Machine Learning? - Machine Learning in a Nutshell - Support Vector Machines - Quantum Support Vector Machines - Variational Quantum Classifier **Unit 2:** Training Quantum Machine Learning Models - Approximate Data Loading with Quantum GANs - Quantum Boltzmann Machines - Machine Learning with Qiskit - What is the potential of Quantum Machine Learning? This subject is recent/upcoming research area, there is no book available. The course instructor has to find the relevant topics in this field.		
Course outcome:	• What is quantum machine learning? • What are quantum machine learning algorithms? • What are suitable applications of quantum machine learning? • How can I implement quantum machine learning algorithms? • What are potentials and bottlenecks of quantum machine learning?	
Text Book:	1. Quantum Machine Learning: What Quantum Computing Means to Data Mining by Peter Wittek. 2. Machine Learning with Quantum Computers (Quantum Science and Technology) by Maria Schuld, Francesco Petruccione	

HC-4013	**Semantic Web**	**L-T-P-C:3-1-0-4**
Course objective:	● To learn advanced and cutting-edge state-of-the-art knowledge and implementation in semantic web. ● To read and understand research publications in the technical area of semantic web, beyond that of the traditional textbook level. ● To conduct independent project and to equip for scholarly research in semantic web.	
Course content:		

Unit 1: Foundation of Semantic Web Technologies, Introduction, Current web vs Semantic Web, Semantic Web Technologies, A layered approach, Descriptive Logic: Introduction, Definition of the basic formalism, Reasoning algorithms, Language extensions

Unit 2: Building Models, Calculating with Knowledge, Exchanging Information, Semantic Web Technologies, Layers, Architecture, Components, Types, Ontological Commitments, Ontological Categories, Philosophical Background, Sample Knowledge Representation Ontologies, Top Level Ontologies, Linguistic Ontologies, Domain Ontologies, Semantic Web – Need – Foundation

Unit 3: Ontology Learning for Semantic Web: Taxonomy for Ontology Learning – Layered Approach – Phases of Ontology Learning -Importing and Processing Ontologies and Documents – Ontology Learning Algorithms -Methods for Evaluating Ontologies.

Unit 4: Describing Web Resources: RDF: Introduction, RDF: Basic Ideas, RDF: XML-Based Syntax, RDF serialization, RDF Schema: Basic Ideas, RDF Schema: The Language, RDF and RDF Schema in RDF Schema

Unit 5: Applications
Web Services – Semantic Web Services – Case Study for Specific Domain – Security Issues – Web Data Exchange and Syndication – Semantic Wikis – Semantic Portals – Semantic Metadata in Data Formats – Semantic Web in Life Sciences – Ontologies for Standardizations – Rule Interchange Format.

Course outcome:	● Understand the semantic web Vision and technologies ● Understand about ontology ● Understanding about Data Web(Linked open data Cloud)
Text Book:	1. A Semantic Web Primer by Grigoris Antoniou Frank van Harmelen, The MIT Press Cambridge 2. Foundation of Semantic Web Technologies, Pascal Hitzler, Markus and Sebastian
Reference Book:	1. Linked Data : Evolving the Web into a Global Data space by Tom Heath, Christian Bizer , Morgan & Claypool publication 2. Basic Description Logic by Franz Baader, Warner Nutt 3. Asuncion Gomez-Perez, Oscar Corcho, Mariano Fernandez-Lopez "Ontological Engineering: with Examples from the Areas of Knowledge Management, ECommerce and the Semantic Web", Springer, 2004.

HC-4015	**Human Centered Design**	**L-T-P-C:3-1-0-4**
Course objective:	● Learn to create seamless designs backed by a responsible understanding of the human mind. ● This course examines how human behavior can be used to integrate your product design into lifestyle, rather than interrupt it, and make decisions for the good of those that are using your product.	

Course content:

Unit 1: Introduction:
A brief introduction to the topics and goals of this Interaction Design Specialization

Unit 2: Need finding
This module's videos and assignment cover a really important topic: where can you get good design ideas from? Ideas that help you create meaningful designs that have a real impact on real people's lives. Of course, good ideas come from lots of places. And wherever they come from, great. There are a few strategies I've found that are especially valuable, and that's what we cover in this module's videos. Given our focus on *real* people, we focus on going out, watching what people do, and talking to them. Check out the first video, describing participant observation. Combining observation with interviewing (the second video) provides a powerful foundation for need finding and brain storming. So what happens after you've observed a lot of stuff -- how do you connect the high-level needs to concrete design ideas? To help you bridge this gap, this module closes with a video on Creating Design Goals.

Unit 3: Rapid Prototyping: Wizard of Oz Prototyping
This module's lectures introduce storyboarding and several strategies and media for rapid prototyping, including paper, Wizard of Oz Prototyping, and video. An important part of the creativity of a designer is to think about how you can rapidly prototype and get feedback on your ideas. Because it's almost never the case that the first idea you have will be the best. As a designer, you can learn the most when you're creating and getting feedback on multiple alternatives. Your work will nearly always benefit from thinking broadly to find the right design, and then from lots of polish to get the design right. Prototyping is also a great way to achieve common ground across the design team and other stakeholders. We begin with storyboards, paper prototyping and mockups. Students often ask about the relationship between need finding and prototyping: how closely does one flow into the other? Ultimately the quality of your final design is the real measure and there are lots of ways to get there. While most design work benefits from prototypes directly informed by the need finding process, it's not required. This module seeks to introduce you to doing human-centered design, and walk you through one path that such an approach could take. In both this Specialization and in real life, you are welcome to revise your ideas as much as you like.

Unit 4: Heuristic Evaluation
With this module's we turn our focus from brainstorming and prototyping to the concrete elements of interaction design. We introduce ten key principles of good design -- like the importance of feedback and helping people recover from errors. We call these heuristics -- watch the first video here. I hope you'll find these heuristics practical and applicable to your work both inside and outside class. The lectures discuss these heuristics with a bunch of examples drawn from real-world designs. The goal is to illustrate the many ways that designs can be successful or run into trouble. While heuristic evaluations (HEs) focus on issues that lead to improvement they can also identify areas we think show successful compliance with a heuristic

Course outcome:	• Refine interaction designs by studying the user's experience. • Evaluate and use appropriate tools to create design deliverables. • Apply best practices in information architecture (IA) to iterative design. • Communicate HCI design deliverables to project stakeholders.
Text Book:	1. Rosenfeld, L., Morville, P., & Arango, J. (2015). Information architecture: For the web and beyond (4th ed.). O'Reilly Media 2. Sharp, H., Preece, J., & Rogers, Y. (2019). Interaction design: Beyond human-computer interaction (5th ed.). John Wiley & Sons.
Reference Book:	1. Mindful Design: How and Why to Make Design Decisions for the Good of Those Using Your Product, Scott Riley 2. Human Centered Design, Springer Publication-LNCS5619

B.Tech CSE DSAI Open Electives Syllabus

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., 2005.
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:3-1-0-4

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.

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

Unit-II

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.

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-III

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-IV

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-V

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.

Course Outcome:

- Derive equations for entropy, mutual information and channel capacity for all kinds of channels.
- Implement the various types of source coding algorithms and analyse their performance.
- Explain various methods of generating and detecting different types of error correcting codes
- Understand the fundamentals of Field Theory and polynomial arithmetic

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

Course Outcome:

- Explain the Classification of mobile communication systems
- Analyze the radio channel characteristics and the cellular principle
- Analyze the measures to increase the capacity in GSM systems- sectorization and Spatial Filtering for Interference Reduction
- Ability to analyze improved data services in cellular communication

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 Computing	L-T-P-C:3-0-0-3

Course objective:

- This course aims to provide a first introduction to quantum computing.
- We will highlight the paradigm change between conventional computing and quantum computing, and introduce several basic quantum algorithms.

Module I

Introduction: Elementary quantum mechanics:, linear algebra for quantum mechanics, Quantum states in Hilbert space,The Bloch sphere, Density operators, generalized measurements, no-cloning theorem

Module II

Fundamental concepts- Bits/Qubits, Quantum Gates, Quantum Circuits, Turing Machine, Deutsch's algorithm, analysing quantum algorithms, and implementing quantum circuits via QISKIT

Module III

Simon's problem and the Bernstein -V-azirani algorithm. Grover's quantum search algorithm, the BBBV Theorem, and applications of Grover's algorithm. RSA, and Shor's integer factorisation algorithm

Module IV

Quantum entanglement, Quantum Teleportation, Quantum Fourier Transform, QSA. The spin-orbit coupling and its consequences, charged particle in a uniform magnetic field Bell inequalities and entanglement, Schmidt decomposition, superdense coding, teleportation.

Module V

The IBMQ, coding a quantum computer using a simulator to carry out basic quantum measurement and state analysis.

Course outcome:

On successful completion, students will gain understanding of:

- The basic principles of quantum computing.
- The fundamental differences between conventional computing and quantum computing.
- Several basic quantum computing algorithms.
- The classes of problems that can be expected to be solved well by quantum computers.

Text Books:

1. Michael A. Nielsen & Isaac L. Chuang, Quantum Computation and Quantum Information: 10th Anniversary Edition, Cambridge University Press, 2010
2. R. Shankar, Principles of Quantum Mechanics, Springer (India) (2008).

Reference Books:

1. Quantum Computation and Quantum Information, M. A. Nielsen & I.Chuang, Cambridge University Press (2013).
2. Jack D. Hidary, Quantum Computing: An Applied Approach (2021).
3. J. Sakurai, Modern Quantum Mechanics, Pearson Education (2002).

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

Course Outcome:

- Understand the key techniques and theory behind the type of random variable and distribution
- Use effectively the various algorithms for applications involving probability and statistics in computing (data analytics)
- Evaluate and Perform hypothesis testing and to conclude

Text Book:

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

Reference Books:

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

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

Course content:

Unit I

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

Unit II

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

Unit III

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

Unit IV

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

Unit V

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

Course outcome:

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

Text Book:

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

Reference Book:

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

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

Course content:

Unit I

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

Unit II

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

Unit III

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

Unit IV

Exception Handling and Multithreading : Concepts of Exception handling, types of exceptions, usage of try, catch, throw, throws and finally keywords, Built-in exceptions, creating own exception sub classes, Concepts of Multithreading, differences between process and thread, thread life cycle, creating multiple threads using Thread class, Runnable interface, Synchronization, thread priorities, inter thread communication, deadlocks.

Unit V

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

Course outcome:

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

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

Text Book: 1. The Complete Reference Java J2SE 5th Edition, Herbert Schildt, TMH Publishing Company Ltd, New Delhi. 2. "Learn Object Oriented Programming Using Java: An UML Treatment using Live Examples from Science and Engineering," Dr. N.B. Venkateswarlu, Dr. E.V. Prasad, S Chand, New Delhi.
Reference Book: 1. Java How to Program, Sixth Edition, H.M.Dietel and P.J.Dietel, Pearson Education/PHI

OE-3020	**Object Oriented System Design**	**L-T-P-C:3-0-0-3**
Course objective:	● To understand the Object-based view of Systems ● To develop robust object-based models for Systems ● To inculcate necessary skills to handle complexity in software design	
Course content: **Unit I:** Fundamental concepts of object oriented programming: Introduction to the principles of object-oriented programming (classes, objects, messages, encapsulation, inheritance, polymorphism, exception handling, and object-oriented containers). **Unit II:** Object design implementation in a programming language, e.g., C++ or Java. Object oriented analysis, modeling and design: UML may be introduced. Use cases, use case driven analysis. **Unit III:** Structural modeling classes, relationships, interfaces, class diagrams, and object diagrams, in UML. Behavioral/Functional modeling use case diagrams, sequence diagrams, in UML. **Unit IV:** Dynamic modeling: State charts, Architectural modeling, Analysis patterns, Design patterns. Distributed object model: CORBA and COM / DCOM **Unit V:** Object oriented database systems: Object oriented data model, query languages, storage organization and indexing techniques; object relational databases.		
Course outcome: This course will cover object-oriented approach to modeling, problem solving, requirement analysis, system design, system implementation, database design, system engineering and software engineering.		
Text Book:	1. Bertrand Meyer, Object Oriented Software Construction, Prentice-Hall. 2. Grady Booch, Object Oriented Analysis and Design, Addison-Wesley.	
Reference Book:	Kim Bruce, Foundations of Object Oriented Languages, Prentice-Hall.	

OE-3022	**Exploratory Data Science**	**L-T-P-C:3-0-0-3**

Course objective:	This course covers the basic concepts of Data Science to help the student to learn, understand and practice data analytics encompassing concepts from descriptive, inferential statistics and predictive techniques and big data concepts.

Course content:

Unit 1: Introduction to relevant industry applications and analytics – Descriptive Statistics – Data Visualization & Interpretation -Measures of Central Tendency & Dispersion -

Unit 2: Basic and advanced plots such as Stem-Leaf Plots, Histograms, Pie charts, Box Plots, Violin Plots etc. – Merits of Demerits & Interpretation

Unit 3: Inferential Statistics – Hypothesis Testing - Tests of Significance – Analysis of Variance - Regression – Linear and Logistic

Unit 4: Predictive Analytics – Supervised and Unsupervised – Association Rules, Classification, Clustering, Outlier Analysis, Time Series Modeling

Unit 5: Big Data Characteristics – Map Reduce – Deduplication, Distributed Storage, Implementation using Hadoop / Pyspark platforms

Course outcome:	● Ability to identify the characteristics of datasets; Ability to select and implement machine learning techniques suitable for the respective application. ● Ability to solve problems associated with big data characteristics such as high dimensionality; ● Ability to integrate machine learning libraries and mathematical and statistical tools
Text Book:	1. J Han, M Kamber, Data Mining Concepts & Techniques, Elsevier, 3rd Edition, 2. Joel Grus, Data Science from Scratch, Orielly, 2nd Edn, 2019, ISBN 9781492041139
Reference Book:	1. Leskovec, Anand Rajaraman,, Ullmann, Mining of Massive Data Sets, Cambridge University Press, Open Source free version , ISBN 9781107015357 2. P Bruce, Practical Statistics for Data Scientists, O'Reilly, 2017, ISBN 9789352135653

Course code: OE-3024	**FOG AND EDGE COMPUTING** **L-T-P-C:3-0-0-3**
Course objective:	Fog and Edge Computing: Principles and Paradigms provides a comprehensive overview of the state-of-the-art of modern computing applications and architectures driving this dynamic field of computing while highlighting potential research directions and emerging technologies.

Module 1[9L]:
Introduction IoT, Fog, Edge and Cloud Infrastructures, Fog and Edge Computing Completing the Cloud, Advantages and issues in FEC: Hierarchy of Fog and Edge Computing, Opportunities and Challenges FEC.

Module 2[9L]:

Integrating IoT, Fog, and Cloud Infrastructures: Middleware for Fog and Edge Computing: Design Issues-architectural and computational. System Modeling to address faster completion of tasks, proper utilization of deployed resources in FEC.

Module 3[9L]:
Architectural aspects of FEC, Data initiation, sending, receiving, processing by the FEC, Resource Management in Fog Computing, Toward Taxonomy of Optimization Problems in FEC.

Module 4[9L]:
Case studies- Real time task execution in N-Tire based FEC, Various scheduling aspect during impletion as energy consumption, Quality of Services, Reliability etc.

Course outcome:	● Provides insights on transitioning from current Cloud-centric technologies to IoT, Edge and Fog Computing ● Understanding major components of Fog and Edge computing architectures such as middleware, interaction protocols, and autonomic management ● Broader insights to examine methods to optimize virtualized, pooled, and shared resources, potential technical challenges and possible solutions ● Provides knowledge of real time task execution situation satisfying several performance objectives
Text Book:	Fog and Edge Computing: Principles and Paradigms by Rajkumar Buyya, Satish Narayana Srirama. Wily, ISBN: 978-1-119-52498-4
Reference Book:	Blockchain-enabled Fog and Edge Computing: Concepts, Architectures and Applications Concepts, Architectures and Applications by Muhammad Maaz Rehan, Mubashir Husain Rehmani, Published April 1, 2022 by CRC Press, ISBN 9780367507442

OE-3026	**Knowledge Representation & Reasoning**	**L-T-P-C:3-0-0-3**
Course objective:	● be able to model simple application domains in a logic-based language; ● understand the notion of a reasoning service; ● master the fundamentals of the reasoning algorithms underlying current systems; ● understand the fundamental trade-off between representation power and computational properties of a logic-based representation language;	

Course content:

Unit 1: KR&R WITH PROPOSITIONAL AND FIRST ORDER LOGIC
Introduction to knowledge-based technologies and knowledge representation, Propositional Logic as a simple knowledge representation language, Representing Knowledge in First Order Predicate Logic, Limitations of Propositional and First Order Predicate Logic

Unit 2: FRAGMENTS OF FIRST ORDER LOGIC
Description Logics as Knowledge Representation Languages, Reasoning in Description Logics
Lightweight description logics. Horn Fragments of First Order Logic. Rule-based Knowledge Representation and Reasoning, Horn Fragments of First Order Logic

Unit 3: Object-oriented representation, Structured descriptions, Ontologies and Ontology Languages. Other Decidable Fragments of First Order Logic for Knowledge Representation, Ontologies and representation of Domain Knowledge, Ontology Languages and the Semantic Web. **Unit 4:** NON-MONOTONIC LOGICS Defaults and Negation, Answer Set Programming, Abductive Reasoning, Qualitative Reasoning, **Unit 5:** Abstraction, Reformulation and Approximation, Classical vs non-monotonic logic, Ways to achieve non-monotonicity, Stable Model Semantics	
Course outcome:	● be conversant with several widely used knowledge representation languages; and ● understand how the theoretical material covered in the course is currently being applied in practice.
Text Book:	2. Handbook of Knowledge Representation. Frank van Harmelen, Vladimir Lifschitz and Bruce Porter (Eds). Foundations of Artificial Intelligence, 2008. 3. An Introduction to Description Logic. Franz Baader, Ian Horrocks, Carsten Lutz, Uli Sattler
Reference Book:	4. Foundations of Semantic Web Technologies. Chapman & Hall/ CRC Textbooks in Computing. Pascal Hitzler, Markus Kroetsch, and Sebastian Rudolph, 2009. 5. Logic for Computer Scientists. Uwe Schoning. Modern Birkäuser Classics, Reprint of the 1989 edition.

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

Course objective:

This module aims to provide a broad coverage of some new advanced topics in the field of computer networks (IPv6, mobile networks, Traffic Engineering/ Quality of Service in IP, Software Defined Networking, etc.)

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" – 3rd Edition, Cengage, 2010 BBS.

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

Module I

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

Module II

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

Module III

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

Text Books:

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

Reference Books:

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

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

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

Course objective:

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

Course content:

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

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

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

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

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

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

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

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

Text Book:

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

Reference Book:

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

OE-4029	**Modelling and Simulation**	**L-T-P-C:3-0-0-3**

Course objective:

- Students will understand the techniques of modeling in the context of hierarchy of knowledge about a system and develop the capability to apply the same to study systems through available software.
- Students will learn different types of simulation techniques.
- Students will learn to simulate the models for the purpose of optimum control by using software.

Course content:

Unit 1

Fundamentals: Definition and reasons for simulation, Continuous (time-oriented) and discrete (event) systems, Modeling/programming simple deterministic systems, Rates and system dynamics.

Unit 2

Concepts in Simulation: Stochastic variables; discrete vs continuous probability, Monte Carlo Simulations; Monte Carlo methods, Normally distributed random numbers, Monte Carlo V/S Stochastic Simulations.

Unit 3

Queuing Models Single server queuing system, introduction to arrival and departure time, flowcharts for arrival and departure routine. Event graphs of queuing models. Determining the events and variables, Event graphs for inventory model. Random Numbers: Introduction to Random Numbers, Importance of Random

Numbers in Simulation, Mid-Square random number generator, Residue method, Arithmetic Congruential generator, Testing Numbers for Randomness, Chi-Square Test.

Unit 4

Discrete Event System Simulation Discrete events; representation of time; queues and servers; generation of arrival patterns; resource seizing; departures simulation of a telephone system and computer networks; simulating components of an operating system; delayed calls; modeling policies; priority queues; tasks; gathering statistics; counters and summary statistics; measuring utilization and occupancy; recording distributions and transit times.

Unit 5

Introduction to a Simulation Languages Simulation in C++, GPSS/ MATLAB/Network Simulators.

Course outcome:

- Modelling and Simulation has become an essential tool for engineers for optimum design and the course aims to impart an overview of the modeling and simulation approaches with emphasis on applications using MATLAB.

Text Book:

1. Law and Kelton, "Simulation Modeling and Analysis", McGraw-Hill.

2. J. Banks, J. Carson and B. Nelson, "Discrete-Event System Simulation", Prentice-Hall.

Reference Book:

1. K.A. Dunning "Getting Started in GPSS", Engineering Press, San Jose, CA.
2. P. Fishwick, "Simulation Model Design and Execution", Prentice-Hall.

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 1:

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 2:

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 3:

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 4:

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.

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 systems (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.

Course Outcome:

Upon successful completion of this course, students will be able to:

- understand the basic properties of thermodynamics and statistical mechanics.
- understand the black-body radiation and distribution functions.
- distinguish between classical and quantum radiation

Text Books:

1. Federic Reif, ``Fundamentalsof Statistical and thermal physics.'', Sarat Book Distributors, 2010.
2. R. K. Pathria, ``Statistical mechanics.'', 3rd Ed, Elsevier, 2011.
3. Nigel Goldenfeld, ``Lectures on phase transitions and the renormalization group.'', Sarat Book House, 2005.

Reference Books:

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

OE-4039	High Performance Computing	L-T-P-C:3-0-0-3

Course Objective

- Understand the fundamental questions about computing to high performance computing and analyze different solutions to these questions.
- Understand different parallel and distributed system architecture, programming paradigms and algorithms which can be verifiable by real implementation.

Course Contents

Module 1 [8L]: Introduction; Need; Parallelism in uniprocessors systems; Pipeline-MIMD/SIMD, Distributed systems Versus Parallel systems vs High Performance Computing, Happened Before and Potential Causality Model, Models based on States.

Module 2 [8L]: High performance Distributed algorithms and applications, Clock synchronization algorithms; - Logical clocks, Vector clocks, Verifying clock algorithms, Direct dependency clocks. Fault Tolerance; Fault tolerant, termination detection algorithms and leader election algorithms.

Module 3 [12L]: Parallel algorithms: prefix sum computation, matrix multiplication; Ranking, Searching, Traversal and Sorting; Programming models-I (data parallel, task parallel, shared memory, distributed memory- Message Passing): Message passing interface (MPI), Communication Types- Block and Nonblocking, Buffered and Non-buffered; OpenMP programming.

Module 4[8L]: Co-processors parallel systems, GPGPU, CUDA Kernels and Threads, CUDA devices memories, Blocks, Threads and indexes. OpenCL programming, CUDA vs OpenCL.

Course Objective:

i. appreciate the concepts used in Modern Processors for increasing the performance.
ii. appreciate Optimization techniques for serial code.
iii. appreciate Parallel Computing Paradigms.
iv. iv. identify the performance issues in Parallel Programming using OpenMP and MPI.

Text Books:

1. Georg Hager, Gerhard Wellein, Introduction to High Performance Computing for Scientists and Engineers, Chapman & Hall / CRC Computational Science series, 2011.
2. Introduction to Parallel Computing, by Kumar, Grama, Gupta and Karypis, Benjamin Cummings Publishing Co., 2nd Ed., 2003.

Reference Book:

1. Highly Parallel Computing, by George S. Almasi and Alan Gottlieb
2. Scalable Parallel Computing, by Kai Hwang, McGraw Hill 1998.

OE-4041	Recommender System	L-T-P-C:3-0-0-3

Course objective:

- The basic concepts behind recommender systems--software tools to recommend or evaluate products, information, or other options for users
- The use of recommender systems in practice
- Techniques for making recommendations, including non-personalized, content-based, and collaborative recommendation technique.
- To provide an overview of recommender systems, including content-based and collaborative algorithms for recommendation, programming of recommender systems, and evaluation and metrics for recommender systems.

Course content:

Unit 1: Introduction, Non-Personalized Recommendations, Content-Based Recommendations
Unit 2: User-Based Collaborative Filtering, Evaluation, Metrics and Evaluation II & Experimental Methods,

Latent Factor Methods I, Latent Factor Methods II, Item-Based Collaborative Filtering

Unit 3: Matrix Factorization, Advanced Topics, Explicit rating vs. implicit feedback

Unit 4: Learning (to Rank and Beyond), Explicit ratings: SVD++ and timeSVD++, Implicit feedback – MF (negative sampling), WRMF, Loss types, learning to rank – BPR

Unit 5: Evaluation metrics, Beyond accuracy – coverage, novelty, serendipity, diversity, persistency, Advanced topics – cold start, incorporate user preferences, Multiple feedback types, context aware recommendations

Course outcome:

- Understand the semantic web Vision and technologies
- Understand about ontology
- Understanding about Data Web(Linked open data Cloud)

Text Book:

1. Recommender Systems, by charu C Agrawal, Springer, 28-Mar-2016

2. Recommender Systems: An Introduction by Jannach, Zanker, Felfernig, and Friedrich (Cambridge, ISBN 978-0-52-149336-9.

Reference Book:

3. Collaborative Filtering Recommender Systems by Ekstrand, Riedl, and Konstan (now publishers; Foundations and Trends in Human-Computer Interaction 4(2))

OE-4043	IOT for Data Analytics	L-T-P-C:3-0-0-3

Course objective:

- This course is designed for Engineers we also train basic knowledge in C Programming to Implement IoT Solutions.
- IOT realtime project using Ardunio
- IOT Protocol Suite & Its Connectivity
- Wireless IOT
- Cloud Computing IOT

Course content:

Unit 1:
Introduction to IOT, Understanding IoT fundamentals, IOT Architecture and protocols, Various Platforms for IoT, Real-time Examples of IoT, Overview of IoT components and IoT Communication Technologies, Challenges in IoT
Unit 2:
Arduino Simulation Environment, Arduino Uno Architecture, Setup the IDE, Writing Arduino Software, Arduino Libraries, Basics of Embedded C programming for Arduino
Interfacing LED, push-button and buzzer with Arduino Interfacing Arduino with LCD

Unit 3:
Sensor & Actuators with Arduino, Overview of Sensors working
Analog and Digital Sensors, Interfacing of Temperature, Humidity, Motion, Light and Gas Sensor with Arduino, Interfacing of Actuators with Arduino., Interfacing of Relay Switch and Servo Motor with Arduino
Unit 4:
Data Collection using IoT Devices, Data Analysis and Data Visualization, Collecting Data from sensors locally, Sending Sensor Data to IoT Cloud (Thingspeak), Thingspeak IoT Cloud Overview, Thingspeak Account Creation, Thingspeak API
Unit 5:
Cloud Platforms for IOT, Virtualization concepts and Cloud Architecture, Cloud computing, benefits Cloud services — SaaS, PaaS, IaaS, Anamoly Detection, Z score Analysis,

Course outcome:	● To learn IoT and Data Analytics ● Learn how to program NOdeMCU (ESP8266), collecting data and data analysis.
Text Book:	1. Andrew Minteer, Analytics for the Internet of Things (IoT): Intelligent analytics for your intelligent devices 2. Anand Tamboli, Build Your Own IoT Platform: Develop a Fully Flexible and Scalable Internet of Things Platform in 24 Hours 3. Hwaiyu Geng, Internet of Things and Data Analytics Handbook, John Wiley & Sons

OE-4045	**Image Processing**	**L-T-P-C:3-0-0-3**
Course objective:	This course is an introduction to the fundamental concepts and techniques in basic digital image processing and their applications to solve real life problems. The topics covered include Digital Image Fundamentals, Image Transforms, Image Enhancement, Restoration and Compression, Morphological Image Processing, Nonlinear Image Processing, and Image Analysis. Application examples are also included.	

Course content:

Unit 1

Digital Image Fundamentals: A simple image model, Sampling and Quantization, Imaging Geometry, Digital Geometry, Image Acquisition Systems, Different types of digital images.

Unit 2

Bilevel Image Processing: Basic concepts of digital distances, distance transform, medial axis transform, component labeling, thinning, morphological processing, extension to grey scale morphology.

Binarization and Segmentation of Grey level images: Histogram of grey level images, Optimal thresholding using Bayesian classification, multilevel thresholding, Segmentation of grey level images, Water shade algorithm for segmenting grey level image.

Unit 3

Detection of edges and lines in 2D images: First order and second order edge operators, multi-scale edge detection, Canny's edge detection algorithm, Hough transform for detecting lines and curves, edge linking.

Images Enhancement: Point processing, Spatial Filtering, Frequency domain filtering, multi-spectral image enhancement, image restoration.

Unit 4

Color Image Processing: Color Representation, Laws of color matching, chromaticity diagram, color enhancement, color image segmentation, color edge detection, color demosaicing.

Image Registration and depth estimation: Registration Algorithms, Setreo Imaging, Computation of disparity map.

Unit 5

Image compression: Lossy and lossless compression schemes, prediction based compression schemes, vector quantization, sub-band encoding schemes, JPEG compression standard, Fractal compression scheme, Wavelet compression scheme.

Course outcome:	**At the end of the course student will** ● be familiar with basic image processing techniques for solving real problems. Student will also have sufficient expertise in both the theory of two-dimensional signal processing and its wide range of applications, for example, image restoration, image compression, and image analysis.
Text Book:	1. Gonzalez and Woods, Digital Image Processing, Prentice-Hall.
Reference Book	1. *Digital Image Processing*, S. Jayaraman, S. Esakkirajan and T. Veerakumar's, published by McGraw Hill Education, 2020. 2. Image Processing: Dealing with Texture by Maria M. P. Petrou, Seiichiro Kamata, wiley, 2021.

OE-4047	**Ethics of Data Science**	**L-T-P-C:3-0-0-3**
Course objective:	We will explore the moral, social, and ethical ramifications of the choices we make at the different stages of the data analysis pipeline, from data collection and storage to understand feedback loops in analysis.	

Course content:

Unit1: What is Ethics?, Data science needs ethics, History, concept of informed Consent, Data Ownership.

Unit 2: Introduction and Data Privacy, ethics vs. law/compliance/public relations; cultural relativism; "professional" ethics in data science; individuals vs. collectives; the "nothing to hide" argument; the "Fair Information Practice Principles" and their problems; The Belmont Report principles; informed consent; privacy dependencies

Unit 3: Bias and Classification, Cumulative Disadvantage and Protected Classes, What is a "harm"? harm without intent; objectivity/neutrality; bias toward the majority; error analysis; team diversity

Unit 4: Accountability and Governance How Transparency Works and Doesn't Work, Algorithm Auditing, External Auditing, and Reverse Engineering, governance; accountability workflows; consequences predictable by experts vs. discoverable by users; approaches to auditing; algorithmic accountability reporting; reverse engineering.

Unit 5: Data Provenance and Aggregation; provenance (a.k.a. origination); sampling bias; aggregation; retention; disposition; forgetting / erasure; building ethics into a data science culture

Course outcome:	This course will help you answer questions such as who owns data, how do we value privacy, how to receive informed consent and what it means to be fair. Data scientists and anyone beginning to use or expand their use of data will benefit from this course.
Text Book:	1. Loukides, Mike, Hilary Mason, and DJ Patil. 2018. Ethics and Data Science. Sebastopol, CA: O'Reilly Media. Chapter 1, "Doing Good Data Science" Ananny, Mike. 2016. 2. Toward an Ethics of Algorithms: Convening Observation , Probability , and Timeliness." Science, Technology, & Human Values 41(1):93–117.
Reference Book:	1. Solove, Daniel J. 2013. "Introduction: Privacy Self-Management and the Consent Dilemma." Harvard Law Review 126(7):1880–1903. Read the following section ONLY: I. pp. 1882 – 1893.

OE-4049	**Data Stream Mining**	**L-T-P-C:3-0-0-3**
Course objective:	COURSE OBJECTIVES ● Objective of the course is to empower students with its knowledge and skills so it can be used in biodiversity, vaccine development, environmental biotechnical etc.	

Course content:

Unit 1

Introduction: Evolution and Importance of Data Mining-Types of Data and Patterns Mined-Technologies-Applications-Major Issues in Data Mining. Knowing about Data-Data Preprocessing: Cleaning–Integration–Reduction–PCA, Data Transformation and Discretization. Mining Frequent Patterns: Basic Concept – Frequent Item Set Mining Methods – Mining Association Rules – Association to Correlation Analysis.

Unit 2

Classification and Prediction: Issues – Decision Tree Induction – Bayesian Classification – Rule Based Classification – k-Nearest-Neighbour Classification – Linear SVM – Regression – Linear, Logistic – Accuracy and Error measures –Introduction to Ensemble methods

Unit 3

Clustering: Overview of Clustering – Types of Data in Cluster Analysis – Major Clustering Methods- Partitioning Methods- k-Means, k-Medoids. Hierarchical Methods-Agglomerative and Divisive hierarchical clustering. Density-Based Methods-DBSCAN, Graph-based clustering (CHAMELEON), Evaluation in Clustering

Unit 4

Mining Data Streams- Mining Time-Series Data- Mining Sequence Patterns in Biological Data- Graph Mining – Social network Analysis – Text Mining – Mining the World Wide Web, Applications and Trends in Data Mining Tools: Implementation of Data mining algorithms using Latest Open Source Data mining Tools. Tensorflow, python, R

Unit 5

Network security: At application layer – Email, PGP, S/MIME. At transport layer – SSL architecture, handshake protocol, change cipherspec protocol, Alert protocol, Record protocol, SSL message format, Transport layer security. At network layer – modes, security protocols, security associations, security policy, Internet key exchange, ISAKMP.

Course outcome:	On completion of the course, student will be able to ● Understand the philosophy of exploratory data analysis, ● List various techniques for efficient visualization, ● Apply discrete and continuous probability distributions ● Estimate the correlation between variables. ● Analyze linear and nonlinear models visually. ● Visualize time series and survival evaluation. ● Use various visualization structures such as tables, spatial data, time-varying data, tree and network.
Text Book:	1 .Jiawei Han, Micheline Kamber and Jian Pei, "Data mining concepts and Techniques", Third Edition, Elsevier Publisher, 2006. 2. K.P.Soman, ShyamDiwakar and V.Ajay, "Insight into data mining Theory and Practice", Prentice Hall of India, 2006.
Reference Book:	1.Yanchang Zhao, "R and Data Mining", Elsevier, 2013 2. AurélienGéron, Hands-On Machine Learning with Scikit-Learn and TensorFlow, O'Reilly Media, 2017 3. Itay Lieder, YehezkelResheff, Tom Hope, Learning TensorFlow, O'Reilly Media, 2017

OE-4051	**Predictive Analytics**	**L-T-P-C:3-0-0-3**
Course objective:	The Candidate will understand key concepts of statistical learning. The Candidate will understand key concepts concerning generalized linear models. The Candidate will understand key concepts concerning regression-based time series models. The Candidate will understand key concepts concerning cluster analysis.	
Course content: **Unit 1:** Basics of Statistical Learning, Simulating behaviours for predictive analytics, predictive Methodologies		

Unit 2: Introduction to model performance, classification tree, Tree and False negative, Recommendation, Collaborative Filtering, Recommendation example.

Unit 3: Time Series Models, Introduction to rule, K-nearest neighbor, k-nearest neighbor classifier Bayes Rules.

Unit 4: Principal Components Analysis, Decision Trees, Introduction to discriminative Classifiers, Model complexity, Rule based classifiers, Entropy and Decision Tree, Classification tree example, regression tree example, introduction to forest. Agent-based modelling for predictive analytics

Unit 5: Cluster Analysis: introduction to clustering, Application of clustering, how to cluster, Introduction to K-mean, Hierarchical Clustering, Agglomerative Clustering, Measuring similarity between clustering, Real World Clustering example

Course outcome:	The students will be able to: a) Explain the types of modeling problems and methods, including supervised versus unsupervised learning and regression versus classification. b) Explain the common methods of assessing model accuracy. c) Employ basic methods of exploratory data analysis, including data checking and validation.
Text Book:	Regression Modeling with Actuarial and Financial Applications, Edward W. Frees, 2010, New York: Cambridge. ISBN: 978-0521135962. An Introduction to Statistical Learning, with Applications in R, James, Witten, Hastie, Tibshirani, 2013, New York: Springer
Reference Book:	1. Leskovec, Anand Rajaraman,, Ullmann, Mining of Massive Data Sets, Cambridge University Press, Open Source free version , ISBN 9781107015357 2. P Bruce, Practical Statistics for Data Scientists, O'Reilly, 2017, ISBN 9789352135653

OE-4053	**Graph based Social Network**	**L-T-P-C:3-0-0-3**
Course objective:	This course provides a broad introduction to the empirical and theoretical study of social networks. Cover classic and contemporary studies, beginning with fundamental definitions and models.	
Course content: **Unit 1:**		

Fundamentals and background, collaborative networks; personal networks; online networks Sampling, data collection, statistics,

Unit 2:

Network models, connectivity, and small worlds, Communities, social capital, SOWT, , Representing Social Networks, Multi-Relational characterization of dynamic social network communities

Unit 3:

Network formation, homophily, Network formation, Kinship networks, Network formation,

Unit 4:

collaboration and cooperation Contagion and influence - simple contagion and epidemics; methodological challenges, Contagion and influence - complex contagion

Unit 5:

Graph theory – Centrality – Clustering – Node-Edge Diagrams – Matrix representation – Visualizing online social networks, Visualizing social networks with matrix-based representations – Matrix and Node-Link Diagrams – Hybrid representations – Applications – Cover networks

Course outcome:	• This course provides a broad introduction to the empirical and theoretical study of social networks. • This will cover classic and contemporary studies, beginning with fundamental definitions and models. • Also moving through a range of topics, including models of network formation and structure (homophily, foci, communities); dynamic processes on networks.
Text Book:	1. Carter T. Butts, "Revisiting the Foundations of Network Analysis," Science 325, no. 5939 (2009): 414. 2. Mark Newman, Networks: An Introduction (Oxford University Press, 2010), ch. 6. - some mathematical background
Reference Book:	1. Stephen P. Borgatti et al., "Network Analysis in the Social Sciences," *Science* 323, no. 5916 (2009): 892–895 2. David Lazer et al., "Computational Social Science," Science 323, no. 5915 (February 2009): 721–723. 3. Social Network Analysis with Content and Graphs William M. Campbell, Charlie K. Dagli, and Clifford J. Weinstein

OE-4055	**Business Intelligence**	**L-T-P-C:3-0-0-3**

Course objective:	COURSE OBJECTIVES ● learn Business Intelligence. ● This course is intended to provide an integrative foundation in the field of business intelligence at the operational, tactical, and strategic levels. ● Topics such as value chain, customer service management, business process analysis and design, will be covered, along with other topics relevant to the field of business intelligence ● transaction processing systems, management information systems, and executive information systems will be covered, along with other topics relevant to the field of business intelligence

Course content:

Unit 1: Introduction to Business Intelligence
Understanding the scope of today's BI solutions and how they fit into existing infrastructure Assessing new options such as SaaS and cloud-based technology. Describe BI, its components & architecture, previewing the future of BI Crafting a better experience for all business users, End User Assumptions, Setting up Data for BI, The Functional Area of BI Tools, Query Tools and Reporting, OLAP and Advanced Analytics, Supporting the requirements of senior executives, including performance management.

Unit 2: Elements of Business Intelligence Solutions
Reports & ad hoc queries; Analyse OLAP data; Dashboards & Scorecards development, Metadata Models; Automated tasks & events; Mobile & disconnected BI; Collaboration capabilities; Real time monitoring capabilities; Software development kit; Consume BI through portals, web applications, Desktop applications.

Unit 3: Building the BI Project
Planning the BI project, Project Resources; Project Tasks, Risk Management and Mitigation, Cost-justifying BI solutions and measuring success,
Collecting User Requirements, Requirements-Gathering Techniques; Prioritizing & Validating BI Requirements, Changing Requirements; BI Design and Development, Best Practices for BI Design; Post-Implementation Evaluations, Maintaining Your BI Environment.

Unit 4: Reporting authoring
Building reports with relational vs Multidimensional data models; Types of Reports – List, crosstabs, Statistics, Chart, map, financial etc; Data Grouping & Sorting, Filtering Reports, Adding Calculations to Reports, Conditional formatting, Adding Summary Lines to Reports. Drill up, drill- down, drill-through capabilities. Run or schedule report, different output forms – PDF, excel, csv, xml etc.

Unit 5: BI Deployment, Administration & Security
Centralized Versus Decentralized Architecture, BI Architecture Alternatives, phased & incremental BI roadmap, System Sizing, Measurements and Dependencies, System Sizing, Measurements, and Dependencies. Setting Early Expectations and Measuring the Results. End-User Provisos. OLAP Implementations. Expanding BI Authentication Authorization, Access Permissions, Groups and Roles, Single-sign on Server Administration, Manage Status & Monitoring, Audit, Mail server & Portal integration, Back Up and Restore.

Course outcome:	On completion of this course, the students will be able to 1. gain knowledge of Business Intelligence 2. build business projects 3. generate and manage BI reports 4. do BI Deployment, Administration & Security.

Text Book:	1. Business Intelligence (IBM ICE Publication). 2. K.P.Soman, Shyam Diwakar and V. Ajay, "Insight into data mining Theory and Practice", Prentice Hall of India, 2006.
Reference Book:	1.Yanchang Zhao, "R and Data Mining", Elsevier, 2013 2. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn and TensorFlow, O'Reilly Media, 2017 3.Http://www.cio.com/article/40296/Business_Intelligence_Definition_and_Solutions.