# Mathematics

4 Yrs. B.Tech In Mathematics and Computing

Effective from 2025-26


# भारतीय सूचना प्रौद्योगिकी संस्थान राँची

**INDIAN INSTITUTE OF INFORMATION TECHNOLOGY, RANCHI**

(An Institution of National importance under act of Parliament)

Ranchi - 834010, Jharkhand

# I. Proposed Course Structure of B.Tech in Mathematics and Computing

| **Proposed course structure** |
|---|
| • Bachelor degree is classified into B.Tech and B.Tech (Hon.).<br><br>Condition for B.Tech (Hons.)= CGPA ≥ 8.0 (at the end of fourth semester) |
| • Total credits<br>B.Tech = 162-170 credits<br>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=44 | 24=44 |
| III | 25=69 | 25=69 |
| IV | 20=89 | 20=89 |
| V | 24=113 | 20=109 |
| VI | 25=138 | 21=130 |
| VII | 24=162 | 20=150 |
| VIII | 20=182 | 20=170 |
| Total | 182 | 170 |

## Semester wise courses

| Semester I – Common for B Tech (Hons.) & B Tech. | | | | |
|---|---|---|---|---|
| **S.No.** | **Course Code** | **Course Title** | **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.No.** | **Course Code** | **Course Title** | **L-T-P** | **Credits** |
| **1.** | **MA-1002** | Mathematics-II (Probability and Statistics) | 3-1-0 | 4 |
| **2.** | **EC-1002** | Digital Logic & Design | 3-0-0 | 3 |
| **3.** | **CS-1002** | Data Structures and Programming Languages | 3-0-0 | 3 |
| **4.** | **EC-1003/PH-1001** | Electrical Technology/ Engineering Physics | 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 - B Tech (Hons.) & B Tech. | | | | |
|---|---|---|---|---|
| **S. No.** | **Course Code** | **Course Title** | **L-T-P** | **Credits** |
| **1.** | **MA-2001** | Mathematics-III (Complex Variable, Real analysis &Linear Algebra) | 3-1-0 | 4 |
| **2.** | CS-2001 | Python Programming | 3-0-0 | 3 |
| **3.** | CS-2003 | Computer Organization and Architecture | 3-0-0 | 3 |
| **4.** | CS-2005 | Theory of Computation | 3-0-0 | 3 |
| **5.** | CS-2007 | Fundamentals of Algorithm | 3-0-0 | 3 |
| **6.** | HS-2001 | Management Concepts and Organizational Behavior | 3-0-0 | 3 |
| **7.** | CS-2101 | Python Programming Lab | 0-0-3 | 2 |
| **8.** | CS-2103 | Computer Organization and Architecture Lab | 0-0-3 | 2 |
| **9.** | CS-2107 | Algorithms Lab | 0-0-3 | 2 |
| | **Total Credits** | | | **25** |

| Semester IV- B Tech (Hons.) & B Tech. | | | | |
|---|---|---|---|---|
| **S. No.** | **Course Code** | **Course Title** | **L-T-P** | **Credits** |
| **1.** | MA-2002 | Mathematics-IV: Combinatorics and Graph Theory | 3-1-0 | 4 |
| **3.** | CS-2002 | Compiler Design | 3-0-0 | 3 |
| **4.** | CS-2004 | Numerical Methods and Scientific Computing | 3-0-0 | 3 |
| **5.** | CS-2006 | Object Oriented Programming with Python | 3-0-0 | 3 |
| **6.** | CS-2008 | Artificial Intelligence and Machine Learning | 3-0-0 | 3 |
| **7.** | CS-2104 | Numerical Methods and Scientific Computing Lab | 0-0-3 | 2 |
| **8.** | CS-2108 | Artificial Intelligence and Machine Learning Lab | 0-0-3 | 2 |
| | **Total Credits** | | | **20** |

| Semester V- B Tech (Hons.) & B Tech. | | | | |
|---|---|---|---|---|
| **S. No.** | **Course Code** | **Course Title** | **L-T-P** | **Credits** |
| **1.** | MA-3001 | Mathematical Modelling & Simulation | 3-1-0 | 4 |
| **2.** | MA-3003 | Optimization Techniques | 3-0-0 | 3 |
| **3.** | CS-3001 | Database Management System | 3-0-0 | 3 |
| **4.** | CS-3003 | Operating System | 3-0-0 | 3 |
| **5.** | ----- | **Hons. Elective-I** | **3-1-0** | **4** |
| **6.** | CS-3101 | Database Management System Lab | 0-0-3 | 2 |
| **7.** | CS-3103 | Operating System Lab | 0-0-3 | 2 |
| **8.** | CS-3005 | Computer System Performance Analysis | 3-0-0 | 3 |
| | **Total Credits** | | | **20 (24)** |

| Hons. Elective-I | | |
|---|---|---|
| **S. No.** | **Course Code** | **Course Title** |
| **1.** | **ME-3001** | Modern Algebra |
| **2.** | **ME-3003** | Functional Analysis |
| **3.** | **ME-3005** | Computational Topology: Theory and Applications |

| Semester VI-B Tech (Hons.) & B Tech. | | | | |
|---|---|---|---|---|
| **S. No.** | **Course Code** | **Course Title** | **L-T-P** | **Credits** |
| **1.** | MA-3002 | Numerical Solution of PDE | 3-1-0 | 4 |
| **2.** | MA-3004 | Stochastic Process and Queuing Theory | 3-1-0 | 4 |
| **3.** | CS-3002 | Computer Network | 3-0-0 | 3 |
| **4.** | MA-3006 | Number Theory and Crypotography | 3-1-0 | 4 |
| **5.** | **---** | **Hons Elective-II** | **3-1-0** | **4** |
| **6.** | CS-3004 | Software Engineering | 3-0-0 | 3 |
| **8.** | | Open Elective Course-I | 3-0-0 | 3 |
| | **Total credits** | | | **21(25)** |

| Open Elective-I | | | Hons. Elective-II | | |
|---|---|---|---|---|---|
| **S. No.** | **Course Code** | **Course Title** | **S. No.** | **Course Code** | **Course Title** |
| **1.** | | Mathematical Finance | **1.** | **ME-3002** | Game Theory |
| **2.** | | Advanced Data Structures and Algorithms | **2.** | **ME-3004** | Operation Research |
| **3.** | | Intellectual Property Rights | **3.** | **ME-3006** | Fuzzy set & Fuzzy logic |

| Semester VII- B Tech (Hons.) & B Tech. | | | | |
|---|---|---|---|---|
| **S. No.** | **Course Code** | **Course Title** | **L-T-P** | **Credits** |
| **1.** | CS-4001 | Cloud Computing | 3-1-0 | 4 |
| **2.** | CS-4003 | Big Data Analytics and Data Science | 3-1-0 | 4 |
| **3.** | **---** | Open Elective-II | 3-0-0 | 3 |
| **4.** | **---** | Open Elective-III | 3-0-0 | 3 |
| **5.** | **---** | **Hons Elective-III** | **3-1-0** | **4** |
| **6.** | PR-4101 | Minor Project | 0-0-3 | 4 |

| | | | | |
|---|---|---|---|---|
| **7.** | **PR-4103** | Industrial / Internship Seminar | --- | 2 |
| | **Total Credits** | | | **20(24)** |

| **Hons. Elective-III** | | |
|---|---|---|
| **S. No.** | **Course Code** | **Course Title** |
| **1.** | **ME-4001** | Actuarial Mathematics |
| **2.** | **ME-4003** | Mathematical Methods |
| **3.** | **ME-4005** | Quality Control & Decision Making |

| **Open Elective-II & III** | | |
|---|---|---|
| **S. No.** | **Course Code** | **Course Title** |
| **1.** | | Orbital Mechanics |
| **2.** | | Industrial Engineering |
| **3..** | | Internet and Web Programming |
| **4.** | | Cluster and Grid Computing |
| **5.** | | Data Warehousing & Data Mining |
| **6.** | | Introduction to Deep Learning |
| **7.** | | Dynamical System |
| **8.** | | Computer Graphics |
| **9.** | | Information Theory and Coding |

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

| **Semester VIII - Common forB Tech (Hons.) & B Tech.** | | | | |
|---|---|---|---|---|
| **S. No.** | **Course Code** | **Course Title** | **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

**Note:**

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

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## II. Format of Subject codes

**1) Course code AA-XYZZ is explained as**

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**X=** 1

**3) For open electives:**

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## Breakup of the credits semester wise

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

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## Semester wise courses

| Semester I – Common for B Tech (Hons.) & B Tech. | | | | |
|---|---|---|---|---|
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| **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** |

| **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.

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

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

Unit-III: BJT: Bipolar Junction Transistor (BJT types, operation, configurations, characteristics), Cutoff and saturation operations, Q point, BJT switching times, Applications of BJT. FET: Field Effect Transistor (FET types, operation, configurations, characteristics), MOS structure, CV characteristics, Metal-Oxide Semiconductor FET, Complimentary MOSFET (CMOS).

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

**Course outcome:**

• 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.

**Course Content**

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

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

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

**Course Outcome**

• 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

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

**Course objective**

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

**Course content**

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

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

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

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

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

**Course outcome**

• 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. 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.)

| **CS-1001** | Computer Programming: Concepts and Practices | L-T-P-C:3-0-2-5 |
|---|---|---|

**Course objective:**

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

**Course content:**

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

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

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

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

Unit-V: 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.

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

**Course objective:** The course aims to:

• Enhance the Employability and Career Skills of students

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

**Module I**

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

**Module II**

**Interviewing Principles and Skills:** Fundamental principles of interviewing, Interview etiquette: dress code, body language, attending job interviews, telephone/skype interview, one to one interview &panel interview, Success in an interview, Types of Interviews, Improving self- expression Important Non-verbal aspects.

**Module III**

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

**Module IV**

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

**Module V**

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

**Course outcome:**

At the end of the course Learners will be able to

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

**Text Book:**


1. Barun K. Mitra, Effective Technical Communication, Oxford University Press, Delhi.2006.
2. Fundamentals of Business Communication, Paperback – 1 January 2019 by Kumkum Bhardwaj (Wiley Publication)
3. Business Communication Today by Bovee & Thill 15th Edition, Prenhall.

**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
6. Business Communication Today | Fortheenth Edition | By Pearson
7. Effective Technical Communication by Rizvi, Tata McGraw Hill.
8. Communication Skills by Sanjay Kumar & Pushp Lata, Oxford University Press

| **Semester II - Common for B Tech (Hons.) & B Tech.** | | | | |
|---|---|---|---|---|
| **S.No.** | **Course Code** | **Course Title** | **L-T-P** | **Credits** |
| **1.** | **MA-1002** | Mathematics-II (Probability and Statistics) | 3-1-0 | 4 |
| **2.** | **EC-1002** | Digital Logic & Design | 3-0-0 | 3 |
| **3.** | **CS-1002** | Data Structures and Programming Languages | 3-0-0 | 3 |
| **4.** | **EC-1003/PH-1001** | Electrical Technology/ Engineering Physics | 3-0-0 | 3 |
| **5.** | **MA-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** |

| **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

Mathematical Expectation, Moments, Baye's Theorem and independence; Random Variables: Discrete, continuous and mixed random variable, probability mass, probability density and cumulative distribution functions, Moment generating function, Chebyshev's inequality.

Unit 2

Special Distribution: Uniform, Binomial, Poisson, Exponential, Gamma, Normal, Beta distribution, correlation, regression, independence of random variables, Bivariate normal distribution, simple, multiple and partial correlation Coefficient; Sampling Distribution: Chi-Square distribution, Goodness of Fit Test, Student's t-Distribution, Fisher's t- distribution, F-Distribution.

Unit 3

Estimation: Criterions of a good estimator, related theorems and results, uniformly minimum variance unbiased estimation, Rao-Blackwell theorem, Cramer-Rao inequality, Methods of estimation, Interval estimation.

Unit 4

Test of hypotheses: Definition of various terms, Neyman-Pearson's lemma, likelihood ratio test, Tests for mean and variance in normal distribution (one and two population case), Paired t-test, chi- square test for goodness of fit, contingency tables, large sample tests through normal approximations, test of independence, Sequential Analysis, Non-Parametric tests.

Unit 5

Analysis of Variance: One-way and two way classifications.

**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. Fundamentals of Mathematical Statistics by S. C. Gupta and V. K. Kapoor. 12 th Edition, 2020. Sultan Chand and Sons.
2. Applied Statistics and Probability for Engineers by Douglas C. Montgomery & George C. Runger. 7 th Edition, 2018. Willey.

**Reference Book:**

1. Fundamentals of Statistics by Goon A.M., Gupta M.K. and Dasgupta B. 2013. World Press
2. Statistical inference by H C Saxena and P U Surendran. Sultan Chand and Sons
3. Applied Probability and Statistics by Mario Lefebvre. 2006. Springer
4. Probability and Statistics by Morris H. DeGroot and Mark J. Schervish. 4 th Edition. 2010. Pearson.

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

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

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

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

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

**Course outcome:**

• 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 Structures and Programming Languages** | **L-T-P-C:3-0-0-3** |
|---|---|---|
| **Course objective:**<br>• Understand and remember algorithms and its analysis procedure.<br>• Introduce the concept of data structures through ADT including List, Stack, Queues.<br>• To design and implement various data structure algorithms.<br>• To introduce various techniques for representation of the data in the real world.<br>• To develop application using data structure algorithms.<br>• Compute the complexity of various algorithms. | | |
| **Course content:**<br>Unit-I: 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.<br><br>Unit-II: I/O Operations, Conditional execution, Loops, Logical and bit wise operations, Lists and list processing, Dictionaries and Data processing, Modules, Packages.<br><br>Unit-III: String and List methods, Trees, binary trees, binary tree traversals, Threaded trees, Applications of trees.<br><br>Unit-IV: Graphs, Graphs representations, Depth first and Breadth first search algorithms, minimum spanning trees, Shortest path algorithms, Application of Graphs.<br><br>Unit-V: Sorting and Searching, Merge-sort, Quick-sort, Heap-sort, Binary search, External search, Hashing, String algorithms. | | |
| **Course outcome:**<br>• Select appropriate data structures as applied to specified problem definition.<br>• Implement operations like searching, insertion, and deletion, traversing mechanism etc. On various data structures.<br>• Students will be able to implement Linear and Non-Linear data structures. | | |

| |
|---|
| • Implement appropriate sorting/searching technique for given problem.<br>• Design advance data structure using Non-Linear data structure.<br>• Determine and analyze the complexity of given Algorithms. |
| **Text Book:**<br>1. Jon Kleinberg and Eva Tardos; Algorithm Design, Pearson education Inc. 2006.<br>2. A.M. Tenenbaum, Y. langsum and M.J. Augenstein; Data Structures using C, Prentice Hall of India private. Limited, 2015. |
| **Reference Books:**<br>1. G. Shanker Rao; Mathematical Foundations of Computer Science, I.K. International Publishing House Private Limited, 2006.<br>2. Robert Sedgewick; Algorithms in C, Addition-Wesley, 1998. |

| **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. | | |

| **MA-1004** | **Discrete Mathematics** | **L-T-P-C: 3-0-0-3** |
|---|---|---|

**Course objective:**

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

**Course content:**

**Unit 1**

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

**Unit 2**

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

**Unit 3**

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

**Unit 4**

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

**Unit 5**

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

**Unit 6**

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

**Course outcome:**

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

**Text Book:**


1. C Liu, D. Mohapatra. Elements of Discrete Mathematics: A Computer Oriented Approach.
2. NarsinghDeo. 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:**

**Module I**

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

**Module II**

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

**Module III**

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

**Module IV**

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

**Module V**

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

**Course outcome:**

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

**Text Book:**


1. Mike W Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003
2. Govindarajan M, Natarajan S, Senthil Kumar V S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004
3. A Textbook on Professional Ethics and Human Values Paperback – 23 May 2022 by R.S. Naagarazan
4. Understanding Business Ethics by Stanwick, 1st Edition, Pearson education.
5. Business Ethics and Corporate Governance by Fernando, 2nd Edition, Pearson Education.


**Reference Book:**

1. Charles B Fleddermann, “Engineering Ethics”, Pearson Prentice Hall, New Jersey, 2004
2. Charles E Harris, Michael S Pritchard and Michael J Rabins, “Engineering Ethics-Concepts and Cases”, Cengage learning, 2009.
3. John R Boatright, “Ethics and the Conduct of Business”, Pearson education, New Delhi, 2003
4. Edmund G Seebauer and Robert L Barry, “Fundamentals of Ethics for scientists and engineers”, Oxford university press, 2001
5. Laura P Hartman and Joe Desjardins, “Business Ethics: Decision making for personal integrity and social responsibility”, McGraw Hill education, India Pvt, New Delhi, 2013
6. A Review Handbook Of Human Values And Professional Ethics Paperback – 12 October 2020, By M. Nagendra
7. Ethical insights on awakening the soul by Pramod Pathak, 1st Edition, Ocean Publishing.
8. Reinventing the society- The search for a paradigm by Pathak, Sharma and Singh, 1st Edition,McMillan


| **Semester III - B Tech (Hons.) & B Tech.** | | | | |
|---|---|---|---|---|
| **S. No.** | **Course Code** | **Course Title** | **L-T-P** | **Credits** |
| **1.** | **MA-2001** | Mathematics-III (Complex Variable, Real analysis &Linear Algebra) | 3-1-0 | 4 |
| **2.** | CS-2001 | Python Programming | 3-0-0 | 3 |
| **3.** | CS-2003 | Computer Organization and Architecture | 3-0-0 | 3 |
| **4.** | CS-2005 | Theory of Computation | 3-0-0 | 3 |
| **5.** | CS-2007 | Fundamentals of Algorithm | 3-0-0 | 3 |
| **6.** | HS-2001 | Management Concepts and Organizational Behavior | 3-0-0 | 3 |
| **7.** | CS-2101 | Python Programming Lab | 0-0-3 | 2 |
| **8.** | CS-2103 | Computer Organization and Architecture Lab | 0-0-3 | 2 |
| **9.** | CS-2107 | Algorithms Lab | 0-0-3 | 2 |
| | **Total Credits** | | | **25** |

| **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 I

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

Unit II

Matrices and Linear Algebra: Matrices and its properties, rank of matrices. Characteristic and minimal polynomials of matrices. Eigen values and eigen vectors of matrices, Caylay- Hamilton Theorem. System of linear equations. 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.

Unit III

Set theory and Riemann integral: 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 IV

Sequence and Series of Functions: Bolzano-Weierstrass Theorem. Heine-Borel Theorem. Sequence and Series of Function, point wise 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 V

Function of several variables and Lebesgue integral: 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. Monotone functions, types of discontinuity, functions of bounded variation, Lebesgue measure and Lebesgue integral.

**Course outcome:**

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

- Find regions that are mapped under certain Transformations.

**Text Book:**

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

**Reference Book:**

1. Real Analysis- R. R. Goldberg
2. Linear Algebra-J. H. Kwak & S. Hong

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

**Course content:**

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

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

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

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

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

**Course outcome:**

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

**Text Book:**

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

**Reference Book:**

| 1. Python Programming Fundamentals- A Beginner's Handbook, Nischay kumar Hegde. | | |
|---|---|---|
| **CS-2101** | **Python Programming Lab** | **L-T-P-C:0-0-3-2** |
| Control structures, list and tuples, conditional statements and loops, functions, Import a module, plot data, MicroPython and NodeMCU. Configure NodeMCU for MicroPython. MicroPython to send digital data on GPIO pins of NodeMCU and glow LED connected with NodeMCU or any other MicroPython supported board. Connect Digital/Analog I/O module with NodeMCU, Display temperature in MicroPython, Connect NodeMCU with withWiFi Access Point and transmit data from NodeMCU to Cloud. Connect Digital/Analog I/O module with NodeMCU and send temperature and light data on cloud (Thingspeak, Firebase or any other cloud service). | | |

| **CS-2003** | **Computer Organization and Architecture** | **L-T-P-C:3-0-0-3** |
|---|---|---|
| **Course content:**<br>Unit-I: Introduction: Organization and Architecture, Block diagram of digital computer, Structure and function, Register Transfer language, Register transfer Bus and Memory transfer.<br><br>Unit-II: Computer Arithmetic: Arithmetic micro operations, Logic micro operations, Shift micro operations and Arithmetic logic shift unit, Addition and Subtraction, Multiplication Algorithms and Division Algorithms, Floating Point representation and its Operations<br><br>Unit-III: Computer Organization and Design: Instruction codes, Computer Registers, Computer instructions, Instruction cycle, Memory-reference Instructions, Register reference instructions, Input-output and Interrupt, Stack organization, Instruction formats, Addressing modes, Data Transfer and manipulation, Program control, Reduced Instruction set computer.<br><br>Unit-IV: 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.<br><br>Unit-V: Input – Output Organization: Peripheral Devices, Input-Output Interface, Asynchronous Data Transfer, Modes of Transfer, Priority Interrupt Direct memory Access, Input-Output Processor, Serial Communication. | | |
| **Course outcome:**<br>• Identify functional units, bus structure and addressing modes<br>• Design the hardwired and micro-programmed control units<br>• Identify memory hierarchy and performance.<br>• Design Arithmetic Logic Unit • Interface I/O devices<br>• Understand pipelined execution and instruction scheduling | | |
| **Text Book:** | | |

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

**Reference Book:**

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

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

List of Lab Assignments / Experiments:

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

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

**Course content:**

Unit-I: 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-II: 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, MyhillNerode theorem.

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

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

| **CS-2007** | **Fundamentals of Algorithm** | **L-T-P-C:3-0-0- 3** |
|---|---|---|
| **Course objective:**<br>• Understand concept of computer algorithms and learn techniques of problem solving<br>• Design algorithms for solving practical problems<br>• Learn analysis of algorithms in terms of complexity theory | | |
| **Course content:**<br>Unit-I: Preliminaries: Problem vs. Solutions. Algorithms vs. Programs. Properties of Algorithm. Complexity Measures. Model of Computation – RAM model (Architecture, instruction set, usage). Examples.<br><br>Unit-II: 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.<br><br>Unit-III: 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.<br><br>Unit-IV: 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.<br><br>Unit-V: 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-VI: Limit of Computation: Reducibility. Classes of Problems: P, NP, NP completeness, NP hard problems. Examples. Incomputability

**Course outcome:**

• Learn when to use which algorithm techniques and for which kind of problems
• Understand lower bound of problems
• Design efficient computer algorithm for solving practical problems

**Text Book:**

1. Introduction to Algorithms – Cormen, Leiserson, Rivest and Stein
2. Fundamentals of Computer Algorithms – Horowitz and Sahni

**Reference Books:**

1. The Design and Analysis of Computer Algorithms -- Aho, Hopcroft and Ullman
2. The Art of Computer Programming (Vol 1 & 3) – Donald E Knuth

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

Study of time requirements of searching and sorting algorithms; Tally the experimental time requirement with the theoretical time complexity; Understanding of problem size and growth of functions; Understanding best case, worst case and average case analysis.
Text file compression using Huffman coding, Implementation of graph algorithms; Study of data structures' roles in developing efficient algorithms (in connection with graph algorithms), Role of randomness in computing.

| HS-2001 | Management Concepts and Organizational Behavior | L-T-P-C:3-0-0-3 |
|---|---|---|

**Course objective:**

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

**Module I**

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

**Module II**

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

**Module III**

**Interpersonal Processes**- **Teams and Groups**- Definition of Group, Stages of group development, Types of groups, meaning of team, merits and demerits of team; difference between team and

group, **Conflict-** Concept, sources, types, management of conflict; **Leadership:** Concept, function, styles & qualities of leadership. **Communication –** Meaning, process, channels of communication, importance and barriers of communication.

**Module IV**

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

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

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

**Text Book:**


1. Robbins, S.P. and Decenzo, D.A. Fundamentals of Management, Pearson.
2. Stoner, J et. al, Management, Prentice Hall of India
3. Moorhead, Griffin, Introduction to Organizational Behaviour, Cengage.
4. Hitt, Miller, Colella, Organizational Behaviour, Wiley
5. Robbins, S.P. & Judge, T.A., Organisational Behaviour, Prentice Hall of India
6. Organizational Behaviour by Stephen P Robbins, 16th Edition, Pearson
7. Organizational Behaviour by Fred Luthans, 12th Edition, McGraw Hill
8. Mamoria: Personel Management
9. Dessler and Varkkney: Human Resource Management


**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- B Tech (Hons.) & B Tech. | | | | |
|---|---|---|---|---|
| **S. No.** | **Course Code** | **Course Title** | **L-T-P** | **Credits** |
| **1.** | MA-2002 | Mathematics-IV: Combinatorics and Graph Theory | 3-1-0 | 4 |
| **2.** | CS-2002 | Compiler Design | 3-0-0 | 3 |
| **3.** | CS-2004 | Numerical Methods and Scientific Computing | 3-0-0 | 3 |
| **4.** | CS-2006 | Object Oriented Programming | 3-0-0 | 3 |
| **5.** | CS-2008 | Artificial Intelligence and Machine Learning | 3-0-0 | 3 |
| **6.** | CS-2104 | Numerical Methods and Scientific Computing Lab | 0-0-3 | 2 |
| **7.** | CS-2108 | Artificial Intelligence and Machine Learning Lab | 0-0-3 | 2 |
| | **Total Credits** | | | **20** |

| **MA-2002** | **Mathematics-IV: Combinatorics and Graph Theory** | **L-T-P-C:3-0-0-3** |
|---|---|---|
| **Course objective:** | • Students will learn core ideas in combinatorial mathematics.<br>• Define how graphs serve as models for many standard problems<br>• Discuss the concept of graph, tree, cut set, flow and networks<br>• 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.

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| **Course outcome:** | • Learning how to apply combinatorial ideas to practical problems.<br>• Understanding the use of graphs as models.<br>• Understanding of various types of trees and methods for traversing trees.<br>• Solving some real time problems using concepts of graph theory<br>• 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.<br>2. C Liu, D. Mohapatra. Elements of Discrete Mathematics: A Computer Oriented Approach.<br>3. Narsingh Deo. Graph Theory With Applications To Engineering And Computer Science |
| **Reference Book:** | 1. Lovasz, Pelikan, and Vesztergombi. Discrete Mathematics: elementary and beyond.<br>2. D. West. Introduction to graph theory, Prentice Hall, 1996<br>3. Harris, Hirst, & Mossinghoff. Combinatorics and Graph Theory, 2008<br>4. Michel Townsend. Discrete Mathematics: Applied Combinatorics and graph theory. |

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

Course Objective:

The main objective of this course is to introduce the major concept areas of language translation and compiler design and to develop an awareness of the function and complexity of modern compilers. This course is a study of the theory and practice required for the design and implementation of interpreters and compilers for programming languages.

Course content:

Unit-I: 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-II: Syntax Analysis: Role of Parser, Writing Grammars, Context-Free Grammars: Top-Down parsingRecursive 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-III: 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-IV: 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-V: 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 Outcomes:

- To realize basics of compiler design and apply for real time applications.
- To introduce different translation languages.
- To understand the importance of code optimization.
- To know about compiler generation tools and techniques.
- To learn working of compiler and non compiler applications.
- Design a compiler for a simple programming language.

Text Book:

1. O.G. Kakde, Compiler design, Laxmi Publications

Reference Book:

1. Aho, Ravi Sethi, Monica S Lam, Ullman, Compilers -Principles, Techniques and Tools, Pearson
2. Randy Allen, Ken Kennedy, Optimizing Compilers for Modern Architectures, Morgan Kauffmann, 2001.
3. John R Levine, Tony Mason, Doug Brown, Lex and Yacc, Orielly

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

- Study the iterative and direct methods to solve system of linear equations.
- Explain the convergence/error analysis of iterative methods.
- Discuss the interpolating polynomials, difference operators and difference equations.
- Study the Numerical techniques to solve ODEs.

- Discuss the Quadrature and equispaced formulas to evaluate definite integrals.

Course content:

Unit-I: 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-II: 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-III: 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.

Unit-IV: 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-V: 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-VI: 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 Outcomes:

- Find the solution of transcendental and algebraic equations.
- Understand the convergence of an iterative method.
- Find the interpolating polynomial for any given data set.
- Apply the numerical techniques to solve definite integrals.
- Find the approximate solution of an ODE.

Text Book:

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| 1. Numerical Methods For Scientific And Engineering Computation M. K. Jain, S. R. K. Iyengar And R. K. Jain |
| Reference Book:<br>1. An Introduction to Numerical Analysis, Kendall Atkinson |

| CS-2006 | Object Oriented Programming with Python | L-T-P-C: 3-0-0-3 |
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Unit-I: Principles of OOPs, Basics of Python, Functions in Python: Basic Concepts of OOP, Benefits of OOP, OOP Languages, Applications of OOP. Python program basics, data types, operators in Python, scope resolution, type cast operators, operator overloading, operator precedence. Main function, function prototyping, call by reference, inline functions, default arguments, constant arguments, function overloading, friend and virtual functions, maths library functions.

Unit-II: Classes, objects, constructors and destructors – C structures revisited, specifying a class, defining a member function, private member functions, memory allocation for objects, static data members and member functions, array of objects, objects as function arguments, friendly functions, returning objects, pointers to members, constructors, Parametrized constructors, Multiple constructors, Copy constructor, Destructors.

Unit-III: Operator overloading, inheritance, virtual functions and polymorphism – Overloading unary operators, overloading binary operators, rules for overloading operators, type conversions. Derived classes, single inheritance, multilevel inheritance, multiple inheritance, hierarchical inheritance, hybrid inheritance, virtual base classes, abstract classes, nesting of classes. Pointers, pointer to objects, this pointer, pointer to derived classes, virtual functions, pure virtual functions.

Unit-IV: Console I/O operations, working with files and templates – Python streams and stream classes, unformatted I/O operations, formatted console I/O operations, managing output with manipulators. Classes for file stream operations, opening/closing of file, file pointers and their manipulation, error handling during file operation, command line arguments. Class templates, class template with multiple parameters, function templates, overloading template functions, member function templates, non-type template arguments.

Unit-V: Exception handling and Standard template library – Basics of exception handling, exception handling mechanism, throwing mechanism, catching mechanism, rethrowing exception, specifying exception. Components of STL, Containers, Algorithms, Iterators, Application of Container classes, Functions objects.

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| Text Book |

1. Steven F. Lott and Dusty Phillips, Python Object-Oriented Programming: Build robust and maintainable object-oriented Python applications.

Reference Book

1. Steven F. Lott, Mastering Object-Oriented Python.
2. Rohan Chopra, Aaron England and Mohamed Noordeen Alaudeen, Data Science with Python: Combine Python with machine learning principles to discover hidden patterns in raw data.

| CS-2008 | Artificial Intelligence and Machine Learning | L-T-P-C: 3-1-0-4 |
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**Course Content**

Unit-I: Fundamental issues in intelligent systems: History of artificial intelligence; philosophical questions; fundamental definitions; philosophical questions; modeling the world; the role of heuristics. Search and constraint satisfaction: Problem spaces; brute-force search; best-first search; two-player games; constraint satisfaction.

Unit-II: AI planning systems: Definition and examples of planning systems; planning as search; operator-based planning; propositional planning. Sequential decision making: Achieving behaviour by specifying rewards, Markov Decision Problems.

Unit-III: Introduction to Machine Learning, classification using Bayes rule, introduction to Bayes decision theory. Learning as optimization, linear regression. Probabilistic view: ML and MAP estimates. Logistic Regression: Gradient Descent, Stochastic Gradient methods. Hyperplane based classifiers, Perceptron, and Perceptron Convergence Theorem. Support vector machine and kernel methods.

Unit-IV: Feedforward neural networks, backpropagation algorithm. Autoencoders, Convolutional neural networks, and application to computer vision. The sequence to sequence models, recurrent NN and LSTM and applications to NLP.

Unit-V: Undirected Graphical Models, Markov Random Fields, Introduction to MCMC and Gibbs Sampling. Restricted Boltzmann Machine. EM algorithm, Mixture models and K-means, Bayesian Networks, Introduction to HMMs. Generative models: GANs and VAEs.

**Text Books**

1. Stuart Russell and Peter Norvig: Artifical Intelligence: A Modern Approach, Pearson; Third edition (2013).
2. Elaine Rich, Kevin Knight and Shivashankar B Nair, Artificial Intelligence, Tata McGraw Hill, 3rd Edition 2009.
3. Bishop. C M, Pattern Recognition and Machine Learning, Springer, 2006.

**Reference Books**

1. N. J. Nilsson, "Principles of Artificial Intelligence", Narosa Publishing House, 1980.
2. Clocksin & Mellish, Programming in PROLOG, Narosa Publ. House.

3. Hastie T, Tibshirani R and Friedman J, The Elements of Statistical Learning: Data Mining, Inference and Prediction, Springer, 2nd Edition, 2009
4. Haykin. S, Neural Networks and Learning Systems, Prentice Hall, 3rd Edition, 2009
5. Goodfellow, Bengio, Courville, Deep Learning, MIT Press, 2017

| CS-2108 | Artificial Intelligence and Machine Learning Lab | L-T-P-C: 0-0-3-2 |
|---|---|---|

The lab focuses on recent developments in branches of machine learning and artificial intelligence (AI and ML). Image and video content analysis, computer vision, neural architecture search, medical image computing, and probabilistic machine learning are the main focus areas now under investigation at this lab. In addition to conducting research, the lab offers courses and labs in machine learning and related fields to students and professionals in the industry. Also, the lab gives the students a complete overview of the most recent developments in computer vision, deep learning, and statistical computing.

- RGB-D Video Content Analysis
- Human Activity and Event Recognition and Prediction
- Image/ Video Quality Assessment and Enhancement
- Video Summarization
- Segmentation and Tracking
- Affective Computing
- 3D Image Reconstruction
- Manifold / Representation Learning

| **Semester V- B Tech (Hons.) & B Tech.** | | | | |
|---|---|---|---|---|
| **S. No.** | **Course Code** | **Course Title** | **L-T-P** | **Credits** |
| **1.** | MA-3001 | Mathematical Modeling& Simulation | 3-1-0 | 4 |
| **2.** | MA-3003 | Optimization Techniques | 3-0-0 | 3 |
| **3.** | CS-3001 | Database Management System | 3-0-0 | 3 |
| **4.** | CS-3003 | Operating System | 3-0-0 | 3 |
| **5.** | **-----** | **Hons. Elective-I** | **3-1-0** | **4** |
| **6.** | CS-3101 | Database Management System Lab | 0-0-3 | 2 |
| **7.** | CS-3103 | Operating System Lab | 0-0-3 | 2 |
| **8.** | CS-3005 | Computer System Performance Analysis | 3-0-0 | 3 |
| | **Total Credits** | | | **20 (24)** |

| **Hons. Elective-I** | | |
|---|---|---|
| **S. No.** | **Course Code** | **Course Title** |
| **1.** | **ME-3001** | Modern Algebra |
| **2.** | **ME-3003** | Functional Analysis |
| **3.** | **ME-3005** | Computational Topology: Theory and Applications |

| MA-3001 | Mathematical Modeling & Simulation | L-T-P-C: 3-1-0-4 |
|---|---|---|

Course Objectives:

- Development of mathematical models.
- Discuss the merits and demerits of any model.
- Explain the convergence of any mathematical model.
- Analyze the mathematical model.

Course Content

Unit-I: History of Mathematical Modeling, latest development in Mathematical Modeling, Merits and Demerits of Mathematical Modeling, Quantitative and Qualitative approach of modeling, Conceptual and Physical models, stationary and in stationary models, distributed and lumped models, models in real world problem.

Unit-II: Introduction to difference equations, Non-linear Difference equations, Steady state solution and linear stability analysis. Discrete dynamical systems: equilibrium and long term behavior, Linear Models, Growth models, Decay models, Drug Delivery Problem, Linear Prey-Predator models, Volterra's principle, Lanchester combat model.

Unit-III: Introduction to Continuous Models, Drug Distribution in the Body, Epidemic Models (SI, SIR, SIRS, SIS, SEIR), Steady State solutions, Linearization and Local Stability Analysis, logistic, prey predator model, Competition models

Unit-IV: Spline, Random numbers, Generating discrete and continuous random variables, Multiple Regression, Variance reduction techniques, Statistical validation techniques, Markov chain, Monte Carlo methods and applications.

Course Outcomes:

- Formulate the mathematical models for given problem.
- Identify the merits and demerits of mathematical models.
- Find the convergence analysis of any model.
- Use the Markov chain and Monte Carlo methods.

Textbooks:

1 Zeigler B.P. Praehofer. H. and Kim I.G. "Theory of modeling and simulation", 2nd Edition. Academic press 2000

2 Willy, Kai Velten; Mathematical modelling and simulation: introduction for scientist and engineers

Reference Book:

1. Shannon, R. E., "System Simulation: the Art and Science", Prentice Hall Inc. 1990

2. Pratab.R " Getting started with MATLAB" Oxford university Press 2009

| MA-3003 | Optimization Techniques | |
|---|---|---|

Course Objective:

- Formulate the problem.
- Optimize the linear and non linear functions with/without restrictions.
- Explain the Primal problem with its dual.
- Discuss the methods to solve Assignment and Transportation problems
- Discuss the Dynamic programming.

Unit-I: Objective function; Constraints and Constraint surface; Formulation of design problems as mathematical programming problems, Classification of optimization problems, Optimization techniques –classical and advanced techniques.Stationary points; Functions of single and two variables; Global Optimum, Optimization of function of one variable and multiple variables; Gradient vectors; Examples, Optimization of function of multiple variables subject to equality constraints; Lagrangian function Optimization of function of multiple variables subject to equality constraints; Hessian matrix formulation; Eigen values, Kuhn-Tucker Conditions; Examples

Unit-II: Convex Sets, Polyhedron, Convex and Affine functions, Standard form of linear programming(LP) problem; Canonical form of LP problem; Basic Feasible Solution, Graphical method, Simplex algorithm and construction of simplex tableau; Simplex criterion; Minimization versus maximization problems, Revised simplex method; Duality in LP; Primal-dual relations; Dual Simplex, method; Sensitivity or post optimality analysis, Other algorithms for solving LP problems –Karmarkar's projective scaling method

Unit-III: Transportation and assignment problems, zero sum games

Unit-IV: Unimodal function, Unrestricted search, Exhaustive search, Dichotomous search, Interval halving method, Fibonacci method, Golden section method, Direct root methods.

Unit-V: Sequential optimization; Representation of multistage decision process; Types of multistage decision problems; Concept of sub optimization and the principle of optimality, Recursive equations –Forward and backward recursions; Computational procedure in dynamic programming(DP), Discrete versus continuous dynamic programming; Multiple state variables; curse of dimensionality in DP

Course outcomes:

- Formulate and solve the optimization problem.
- Solve the Assignment and Transportation problems.
- Compare the dual and primal solutions of any problem.
- Use the dynamic programming.
- Use the Revised simplex mothod.

**Text**

1. U. Faigle, W. Kern, and G. Still, Algorithmic Principles of Mathematical Programming, Kluwe, 2002.
2. D.P. Bertsekas, Nonlinear Programming, 2nd Ed., Athena Scientific, 1999.

**Reference**

1. N. S. Kambo, Mathematical Programming Techniques, East West Press, 1997
2. M. S. Bazarra, J.J. Jarvis, and H.D. Sherali, Linear Programming and Network Flows, 4th Ed., 2010. (3nd ed. Wiley India 2008).
3. K. Deb, "Optimization for Engineering Design-Algorithms and Examples", Prentice-Hall of India Pvt. Ltd., New Delhi, 1995

| CS-3001 | Database Management System | |
|---|---|---|

Course Objective:

The objective of the course is to present an introduction to database management systems, with an emphasis on how to organize, maintain and retrieve - efficiently, and effectively - information from a DBMS.

Course Content

Unit-I: Introduction to database management, data abstraction and system structure. Entity relational model, entity set, relationship sets, mapping cardinalities, keys, E-R diagrams.

Unit-II: Relational model, database schema, relational algebra, outer join and manipulation of databases.

Unit-III: Tuple relational calculus: Example queries, formal definitions and safety of expressions; SQL: Query processing and optimization, set operations, aggregate functions, data definition language and views, comparison of queries in relational algebra, SQL, tuple relation calculus and domain relation calculus.

Unit-IV: Relational database design, various normal forms, functional dependencies, canonical cover, lossless join, dependency preservation, multi value dependency and higher normal forms, transaction management, ACID property.

Unit-V: Serializability and testing for serializability, concurrency control schemes, lock-based protocols, two-phase locking protocols, graph-based protocols, time stamp-based protocols, deadlocks. Recovery systems, log-based recovery, deferred and immediate database modification, object oriented database design.

Course Outcomes:

- Describe the fundamental elements of relational database management systems
- Explain the basic concepts of relational data model, entity-relationship model, relational database design, relational algebra and SQL.
- Design ER-models to represent simple database application scenarios.

- Convert the ER-model to relational tables, populate relational database and formulate SQL queries on data.
- Improve the database design by normalization.

Text Book

1. Database System Concepts; Abraham Silberschatz, Henry F Korth; 6th, McGraw Hill Education (India) Pvt. Limited; 2013.
2. An Introduction to Database Systems; C J Date, A Kannan, S Swamynathan; 8th, Dorling Kindersley (India) Pvt. Ltd.; 2013.

Reference Book

1. Abraham, H. and Sudershan, S., "Database System Concepts", 4th Ed., McGraw-Hill, 2002
2. Elmasi, R. and Navathe, S.B., "Fundamentals of Database Systems", 4thEd., Pearson Education., 2005

| CS-3003 | Operating System | L-T-P-C: 3-1-0-4 |
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Course content

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

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

Unit-III: Memory management, Contiguous and Noncontiguous schemes, Paging and virtual memory and Memory related system calls.

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

Unit-V: Unix and Windows 2000 as case studies.

Text Book:

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

Reference Book:

1. Milan Milenkovich; Operating Systems: Concepts and Design McGraw-Hill international edition, Computer Science Series, 2001.
2. Per Brinch Hansen; Operating System Principles, Prentice-Hall Publication, New Delhi,2015.

| CS-3103 | Operating System Lab | L-T-P-C: 0-0-3-2 |
|---|---|---|

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|---|
| Familiarization with UNIX system calls for process management and inter-process communication. process management (creation, synchronization, and communication); processor scheduling; deadlock prevention, avoidance, and recovery; main-memory management; virtual memory management (swapping, paging, segmentation and page replacement algorithms); control of disks and other input/output devices; file-system structure and implementation; and protection and security. |

| CS-3005 | Computer System Performance Analysis | |
|---|---|---|
| | | |

Course Content

Unit-I: Introduction: The Art Of Performance Evaluation, Common Mistakes In Performance Evaluation, A Systematic Approach To Performance Evaluation, Selecting An Evaluation Technique, Selecting Performance Metrics, Commonly Used Performance Metrics, Utility Classification Of Performance Metrics, Setting Performance Requirements.

Unit-II: Workloads, Workload Selection and Characterization: Types of Work Loads, Addition Instructions, Instruction Mixes, Kernels; Synthetic Programs, Application Benchmarks, Popular Benchmarks. Work Load Selection: Services Exercised, Level Of Detail; Representativeness; Timeliness, Other Considerations In Workload Selection. Work Load Characterization Techniques: Terminology, Averaging, Specifying Dispersion, Single Parameter Histograms, Multi Parameter Histograms, Principle Component Analysis, Markov Models, Clustering.

Unit-III: Monitors, Program Execution Monitors and Accounting Logs: Monitors: Terminology and classification; Software and hardware monitors, Software versus hardware monitors, Firmware and hybrid monitors, Distributed System Monitors, Program Execution Monitors and Accounting Logs, Program Execution Monitors, Techniques for Improving Program Performance, Accounting Logs, Analysis and Interpretation of Accounting log data, Using accounting logs to answer commonly asked questions.

Unit-IV: Capacity Planning and Benchmarking: Steps in capacity planning and management; Problems in Capacity Planning; Common Mistakes in Benchmarking; Benchmarking Games; Load Drivers; Remote-Terminal Emulation; Components of an RTE; Limitations of RTEs, Experimental Design and Analysis: Introduction: Terminology, Common mistakes in experiments, Types of experimental designs, 2k Factorial Designs, Concepts, Computation of effects, Sign table method for computing effects; Allocation of variance; General 2k Factorial Designs, General full factorial designs with k factors: Model, Analysis of a General Design, Informal Methods

Unit-V: Queuing Models: Introduction: Queuing Notation; Rules for all Queues; Little‟s Law, Types of Stochastic Process. Analysis of Single Queue: BirthDeath Processes; M/M/1

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| Queue; M/M/m Queue; M/M/m/B Queue with finite buffers; Results for other M/M/1 Queuing Systems. Queuing Networks: Open and Closed Queuing Networks; Product form networks, queuing Network models of Computer Systems. Operational Laws: Utilization Law; Forced Flow Law; Little‟s Law; General Response Time Law; Interactive Response Time Law; Bottleneck Analysis; Mean Value Analysis and Related Techniques; Analysis of Open Queuing Networks; Mean Value Analysis; |
| |
| Text Book<br>1. Raj Jain: The Art of Computer Systems Performance Analysis, 1st edition, John Wiley and Sons, 2012 |
| Reference Book<br>1. Paul J Fortier, Howard E Michel: computer Systems Performance Evaluation and prediction, 1st edition, Elsevier, 2009<br>2. Trivedi K S: Probability and Statistics with Reliability, Queuing and Computer Science Applications, 1st edition, PHI, 2011. |

## Honours Elective-I

| **ME-3001** | Modern Algebra | L-T-P-C: 3-1-0-4 |
|---|---|---|
| Course Objective:<br>• Explain the Group and its properties.<br>• Discuss the abelian groups and Sylow theorems.<br>• Study the Isomorphism and its properties.<br>• Understand the Rings and Fields.<br>• Explain the Finite field and its extension. | | |
| Course Content<br>Unit-I: Groups - elementary properties including cancellation laws, uniqueness of the identity and inverses; unique solvability of linear equations; subgroups and subgroup tests; orders of elements; cyclic groups; modular systems; abelian groups; permutation groups, including the alternating and symmetric groups, cycle notation, and transpositions; dihedral groups and applications to symmetry.<br><br>Unit-II: Direct products, Finitely generated abelian groups, invariants of a finite abelian group, Group actions, Sylow theorems<br><br>Unit-III: Normal Subgroups and quotient groups, Isomorphism theorems, Auto orphisms, Conjugacy and G-sets, Normal series, Solvable groups, Nilpotent groups.<br><br>Unit-IV: Rings, ideals and quotient rings, Homomorphism, Sum and direct sum of ideals, Maximal and prime ideals, Nilpotent and Nil ideals, Zorn’s lemma. Unit IV: Unique factorization domain, Principle ideal domain, Euclidean domain, Polynomial rings over | | |

UFD.Definition and examples, Sub modules and direct sums, R-homomorphism and quotient modules, completely reducible modules, free modules.

Unit-V: Field extensions, Finite fields.

Course Outcomes:

- Identify the group and its type.
- Compare two or more group structures.
- Find the order of an element in a algebraic structure.
- Find irreducible and reducible elements of a ring and field.

Text Book:

1. J. Fraleigh, A First Course in Abstract Algebra, Pearson, 2003.
2. D. Dummit and R. Foote, Abstract Algebra, Wiley, 2004.

Reference Book

1. I. N. Herstein, Topics in Algebra, Wiley, 2008.
2. P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul, Basic Abstract Algebra, Cambridge University Press, 1995.

| ME-3003 | Functional Analysis | L-T-P-C: 3-1-0-4 |
|---|---|---|

Course objective:

- Study different types of norms and mappings.
- Explain the spaces of continuous functions, dual, Banach and Hilbert spaces.
- Study the applications of Fourier and wavelet analysis.
- Study the compact and self-adjoint operators.
- Study the Hardy spaces and Toeplitz operators.

Course Contents

Unit-I: Normed Spaces,Norms. Banach spaces and Completeness. Examples, including the spaces Lp [0,1].Linear Maps and ContinuityBounded linear maps. Normed spaces of linear maps. The open mapping and closed graph theorems.

Unit-II: Spaces of Continuous Functions Dual Spaces. Zorn's Lemma. The Hahn-Banach theorem. The space of continuous functions on a compact metric space and the Stone-Weierstrass theorem.Hilbert SpacesInner product spaces. Associated norms, and the Cauchy-Schwarz inequality. Orthogonal complements and direct sums. Representation of functionals on Hilbert spaces, and adjoints of operators.

Unit-III: Orthonormal Sets,Orthonormal sets and sequences, and related results. Application to Fourier series and Legendre polynomials.Spectral Theory
The spectrum of an operator. Complex analysis on Banach spaces. Non-emptiness and compactness of the spectrum. Self-adjoint and unitary operators. The spectral radius formula, and the spectral mapping theorem for polynomials.

Unit-IV: Compact Operators, Definition and basic properties of compact operators. The spectral theorem for compact self-adjoint operators. Application to differential equations.The Fredholm Index Definition of a Fredholm operator and its index. Atkinson's theorem. Invariance properties of the index. Hardy spaces and Toeplitz operators. The Toeplitz index theorem.

Unit-V: Fourier and Wavelets Analysis The Fourier transform as and its properties. View of the Fourier transform as a unitary operator. Concept of a wavelet. The wavelet series. The integral wavelet transform. Inversion formula.

Course outcomes:

- Explain different type of norms and mapping.
- Understand orthogonality of sets and sequences.
- Apply the operators to differential equations.
- Able to apply the Fourier and Wavelet analysis.
- Understand the applications of Fourier transforms.

Text Book:

1. B. V. Limaye, Functional Analysis, 2nd edition, Wiley Eastern, 1996.
2. E. Kreyszig, Introduction to Functional Analysis with Applications, John Wiley and Sons, 1978.

Reference Book:

1. Debnath and Mikusinski; Introduction to Hilbert Spaces with Applications, Academic Press; 3rd edition (2005)
2. J.B. Conway, A Course in Functional Analysis, Springer, 1990.

| **ME-3005** | **Computational Topology: Theory and Applications** | L-T-P-C: 3-1-0-4 |
|---|---|---|

Course Objective: Discuss the relations b/w different topological space and their applications.

Course Content

Unit-I: Introduction to topological data analysis via recent applications.Mathematical preliminaries from group theory and linear algebra: group homomorphism and isomorphism, quotient group, classification of finitely generated Abelian groups, linear transformations, matrix representations.

Unit-II: Complexes: Clique, Delaunay, Cech, Rips, random complexes, algorithms for constructingcomplexes

Unit-III: Simplicial homology: chains, cycles, the boundary operator, the homology group, simplicial maps, Betti numbers, Euler-Poincare characteristic, nerve theorem, matrix

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| reduction algorithms, Persistent Homology: filtrations, persistence diagrams, barcodes, spanning acycles, algorithms<br><br>Unit-IV: Morse functions: Morse Lemma, Morse-Smale complex, contour tree, Reeb graph, algorithms for construction and simplification, hierarchical representation<br><br>Unit-V: Random topology: Random complexes, Morse inequalities, Limiting distribution of Bettinumbers and persistence diagrams<br><br>Software: TDA on R, Gudhi, Ripser, Javaplex, TTK |
| Course Outcomes: Understand the different topological spaces and also find their applications. |
| Text Book<br>1. Edelsbrunner, Herbert, and John Harer. Computational topology: an introduction. American Mathematical Soc., 2010. |
| Reference Book<br>1. Hatcher, Allen. Algebraic topology., (2001). |

| **Semester VI-B Tech (Hons.) & B Tech.** | | | | |
|---|---|---|---|---|
| **S. No.** | **Course Code** | **Course Title** | **L-T-P** | **Credits** |
| **1.** | MA-3002 | Numerical Solution of PDE | 3-1-0 | 4 |
| **2.** | MA-3004 | Stochastic Process and Queuing Theory | 3-1-0 | 4 |
| **3.** | CS-3002 | Computer Network | 3-0-0 | 3 |
| **4.** | MA-3006 | Number Theory and Crypotography | 3-1-0 | 4 |
| **5.** | **---** | **Hons Elective-II** | **3-1-0** | **4** |
| **6.** | CS-3004 | Software Engineering | 3-0-0 | 3 |
| **8.** | | Open Elective Course-I | 3-0-0 | 3 |
| | **Total credits** | | | **21(25)** |

| **Open Elective-I** | | | **Hons. Elective-II** | | |
|---|---|---|---|---|---|
| **S. No.** | **Course Code** | **Course Title** | **S. No.** | **Course Code** | **Course Title** |
| **1.** | | Mathematical Finance | **1.** | **ME-3002** | Game Theory |
| **2.** | | Advanced Data Structures and Algorithms | **2.** | **ME-3004** | Operation Research |
| **3.** | | Intellectual Property Rights | **3.** | **ME-3006** | Fuzzy set & Fuzzy logic |

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|---|---|---|
| MA-3002 | Numerical Solution of PDE | L-T-P-C: 3-1-0-4 |

Course Objective:

- Study the implicit and explicit methods to solve PDEs.
- Discus the numerical solution of Parabolic PDEs.
- Explain the numerical solution of Elliptic PDEs.
- Know the numerical solution of Hyperbolic PDEs.
- Study the Convergence of difference schemes.

Course Content

Unit-I: Overview of PDEs: Classification of multidimensional PDEs: Elliptic, Hyperbolic, Parabolic, Implicit Vs Explicit Methods to Solve PDEs, Well-posed and ill-posed PDEs.

Unit-II: Numerical solution of parabolic equations: Explicit methods for 1-D heat or diffusion equation, Difference Approximations for Derivative Terms in PDEs, Numerical solution of 1-D heat equation using the finite difference method, Explicit Forward Euler method, Stability analysis for forward Euler method, Method of lines, Implicit methods for 1-D heat equation, Finite Difference for 2D Heat (or Diffusion) Problems, Alternating Direct Implicit method, Crank Nicolson implicit method.

Unit-III: Numerical Solution of Elliptic and hyperbolic equations: The 5-points and nine points stencil for the Laplacian, Some finite difference methods for 1-D hyperbolic equations and their convergence and stabilities.

Course Outcomes:

- Distinguish the implicit and explicit difference schemes.
- Find the numerical solution of PDEs.
- Minimize the error occurred in difference schemes.
- Find the convergence and stability of difference schemes.

Text Book

1. J.W. Thomas; Numerical partial differential equations: finite difference methods.
2. A. Iserles; A first course in the Numerical analysis of differential equations

Reference Book

1. K. W. Morton and D. F. Mayers, Numerical Solution of Partial Differential Equations: An Introduction

| MA-3004 | Stochastic Process and Queuing Theory | L-T-P-C: 3-1-0-4 |
|---|---|---|

Course Objectives:

- Explain the Morkov models and Markov processes and their applications.
- Study the different Queuing models and their applications.

Course Content

Unit-I: Review of random variables, expectations, conditional probabilities, conditional expectations, convergence of a sequence of random variables and limit theorems.

Minimum mean square error estimation and the orthogonality principle, building blocks of estimation theory.

Unit-II: Markov models. Classification and convergence of both discrete-time and continuous-time Markov chains, Martingales.

Unit-III: Markov processes, orthogonal increment processes, and Brownian motion.

Unit-IV: Linear stochastic systems and estimation theory. Expectation Maximization (EM) algoritME-maximum likelihood parameter,Innovation sequences and linear stochastic equations are introduced. Kalman Filter.

Unit-V: State and parameter estimation and applications to queues, communications, finance, biology and manufacturing.

Course Outcomes:

- Find the applications of Morkov models and Markov processes
- Apply the applications of Queuing models.
- Use the linear stochastic system and estimation theory.

Text Book

1. A. Goswami and B.V. Rao, A Course in Applied Stochastic Processes, Hindustan Book Agency, 2006.
2. U. N. Bhat and G. K. Miller, Elements of Applied Stochastic Processes, 3rd edition, Wiley, 2002.

Reference Book

1. S. M. Ross, Stochastic Processes, 2nd edition, Wiley, 1995

| CS-3002 | Computer Network | L-T-P-C: 3-1-0-4 |
|---|---|---|
| | | |

Course Content

Unit-I: Introduction: Use of computer networks, Network hardware, Network software, Reference models, Example networks.

Unit-II: 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-III: 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-IV: Transport Layer: The transport layer services, Elements of transport layer protocols, The internet transport protocols-UDP and TCP.

Unit-V: Application Layer: DNS-Domain name system, E-mail, The World Wide Web, Streaming audio and video, Content delivery networks.

Text Book

1. Larry Peterson and Bruce S Davis “Computer Networks :A System Approach” 5th Edition , Elsevier -2014.
2. Douglas E Comer, “Internetworking with TCP/IP, Principles, Protocols and Architecture” 6th Edition, PHI – 2014

Reference Book

1. Uyless Black, “Computer Networks, Protocols , Standards and Inte rfaces” 2 nd Edition - PHI.
2. Behrouz A Forouzan, “TCP /IP Protocol Suite” 4 th Edition – Tata McGraw-Hill.

| MA-3006 | Number Theory and Crypotography | L-T-P-C: 3-1-0-4 |
|---|---|---|

Course Objective:

- Discuss the congruence theory of number system.
- Study the Primitive roots of any positive integer.
- Explain different crypto algorithms to encrypt and decrypt the message.
- Discuss the applications in cryptography and factorization, Known attacks.

Course Content

Unit-I: The number system and the Well-Ordering Principle, Mathematical InductionDivisibility and Factorization, Divisibility, Greatest Common Divisors, Euclidean Algorithm, Least Common Multiple, Representations of integers (Decimal Representation and Binary Representation of integers). Solving Linear Diophantine Equations, Primes, Prime Numbers, Unique Prime Factorization, Test of Primality by Trial Division

Unit-II: The concept of congruences, Congruence Classes, applications of Congruences: Check digits. Solving (single) linear congruenceSolving system of linear congruences, the Chinese Remainder Theorem.

Unit-III: Fermat's Little Theorem, general case: Euler's theorem, Primitive Roots. The multiplicative order Primitive Roots (mod n), The modulus n which does not have primitive roots, The Existence Theorems, The use of primitive roots. Euler's Criterion, The Legendre Symbol and its properties, Examples of computing the Legendre symbol, Jacobi Symbol, Quadratic Residues and Primitive Roots.

Unit-IV: Continued fractions, Continued fraction method Hash Functions, Public Key cryptography, Diffie-Hellmann key exchange, Discrete logarithm-based crypto-systems, RSA crypto-system, Signature Schemes, Digital signature standard, RSA Signature schemes.

Unit-V: Knapsack problem. Introduction to elliptic curves, Group structure, Rational points on elliptic curves, Elliptic Curve Cryptography. Applications in cryptography and factorization, Known attacks.

Course Outcomes:

- Able to apply the Format's little theorem and Euler's theorems.
- Find the solution of congruence systems using Chinese Remainder Theorem.
- Make the encryption and decryption of any message.
- Use the Crypto-system and RSA signature schemes.

Text Book

1. N. Koblitz, A Course in Number Theory and Cryptography, Springer 2006.
2. I. Niven, H.S. Zuckerman, H.L. Montgomery, An Introduction to theory of numbers, Wiley, 2006.

Reference Book

1. L. C. Washington, Elliptic curves: number theory and cryptography, Chapman & Hall/CRC, 2003.
2. J. Silverman and J. Tate, Rational Points on Elliptic Curves, Springer-Verlag, 2005.

| CS-3004 | Software Engineering | L-T-P-C: 3-0-0-3 |
|---|---|---|

Course objective:

- To discuss the software engineering discipline, its evolution, impact and emergence of software engineering and explain the development and use of different software life cycle models for real-life industrial applications.
- To discuss different aspects of software project management, risk management and configuration management and explain various requirement elicitation, analysis and specification techniques.
- To discuss various software design methodologies, the impact of cohesion and coupling measures on the goodness of the software design.
- To discuss the importance of practicing different coding standards, guidelines and different testing strategies along with software reliability metrics and software quality management techniques & Standards

Course content:

Unit 1 Software development life cycle and Project Management Software development life cycle (SDLC) models, software project management, project planning, project estimation, Halstead's Software Science, project scheduling, staffing, Organization and team structure, risk management, configuration management

Unit 2 Requirements analysis and specification Requirements gathering and analysis, software requirements specification, formal systems specification, axiomatic specification, algebraic specification.

Unit 3 Software Design Outcome of a design process, cohesion and coupling, layered arrangement of modules, approaches to software design, function-oriented software design overview of SA/SD methodology, structured analysis, DFDs, structured design, detailed design, design review, objectoriented 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

Hons Elective:II

| **ME-3002** | Game Theory | |
|---|---|---|

Course Objective: This course is intended to provide students with a comprehensive treatment of game theory with specific emphasis on applications in Economics and Engineering. The aim of this course is to introduce students to the novel concepts of Game
Theory with special emphasis on its applications in diverse fields and current research.

Course Content:

Unit-I: Two-Person Zero Sum Games Maximin and minimax criterion of optimality, Saddle point, Pure and mixed strategies, Dominance property.

Unit-II: Solution Methods for Matrix Games Algebraic method, Graphical method for solving 2×n and n×2 games, Invertible matrix games, Symmetric games, Matrix Games and Linear Programming

Unit-III: Two-Person Non-zero sum Games 2×2 Bimatrix Games, Interior Mixed Nash Points by Calculus, Non linear Programming Method for Nonzero Sum Two-Person Games.

Unit-IV: N-Person Non-zero sum Games with a Continuum of Strategies Economic Applications of Nash Equilibrium, Duels, Auctions – Complete Information

Course Outcomes:

- Apply the maximin and minimax criterion of optimality.
- Solve 2×n and n×2 games, Invertible matrix games, Symmetric games, Matrix Games and Linear Programming.
- Solve Non linear programming method for nonzero sum.
- Identify the applications of Nash Equilibrium, Duels, Auctions-Complete Information.

Text Book

1. E.N. Barron, Game Theory: An Introduction, John Wiley & Sons
2. Osborne M.J., An Introduction to Game Theory, Oxford University Press

Reference Book

1. A. Mas-Colell, M.D. Whinston and J.R. Green, Microeconomic Theory, Oxford University Press
2. R.A. Gibbons, Primer in Game Theory,Pearson Education

| **ME-3004** | Operation Research | |
|---|---|---|

Course Objective: The Objective of the paper is to introduce the basic concepts of Operational Research and linear programming to the students

Course Content:

Unit-I: Basics of Operational Research: Origin & Development of Operational Research, Definition and Meaning of Operational Research, Different Phases of an Operational Research Study, Scope and Limitations of Operational Research, Mathematical Modeling of Real Life Problems.

Unit-II: Linear Programming: Introduction to Linear algebra. Solution of a system of Linear Equations, Linear independence and dependence of vectors, Concept of Basis, Basic Feasible solution, Convex sets. Extreme points, Hyperplanes and Halfspaces, Convex cones, Polyhedral sets and cones.

Unit-III: Linear Programming Problem Formulation, solution by Graphical Method, Theory of Simplex Method, Simplex Algorithm, Two phase Method, Charnes-M Method, Degeneracy, Theory of Duality, Dual-simplex method.

Course Outcomes:

- Analyze any real life system with limited constraints and depict it in a model form.
- Convert the problem into a mathematical model.

- Solve the mathematical model manually as well as using soft resources/software such as solver, TORA etc.
- Understand variety of problems such as assignment, transportation, travelling salesman etc.

Text Book

1. G. Hadley: Linear Programming. Narosa, Reprint, 2002.
2. F.S. Hillier. G.J. Lieberman: Introduction to Operations Research- Concepts and Cases, 9th Edition, Tata Mc-Graw Hill, 2010.

Reference Book

1. Joseph S. Martinich (2000) Production and Operations Management: An Applied Modern Approach, John Wiley & Sons.

| **ME-3006** | Fuzzy Sets and Fuzzy Logic | |
|---|---|---|

Course Content

Unit-I: Fuzzy Sets: Basic concepts, fuzzy sets versus crisp sets, fuzzy sets versus rough sets, operations on fuzzy sets, complements, intersections, unions and their combinations, fuzzy numbers, fuzzy equations.

Unit-II: Fuzzy Relation: Crisp versus fuzzy relations, binary fuzzy relations, equivalence relations, compatibility relations, ordering relations, fuzzy morphisms.

Unit-III: Fuzzy Logic: Classical logic, multivalued logics, fuzzy propositions, fuzzy quantifiers, Linguistic Hedges, influence from conditional fuzzy propositions, conditional and qualified propositions, quantified propositions.

Unit-IV: Fuzzy expert systems: Fuzzy implications, Multiconditional approximate reasoning, interval-valued approximate reasoning.

Unit-V: Fuzzy controllers: Fuzzy systems and neural networks, fuzzy automata, applications in economics, computer engineering and reliability theory

Text Book

1. George J. Klir, Bo Yuan, Fuzzy Sets and Fuzzy Logic Theory and Applications, Prentice Hall of India Pvt. Ltd
2. H. J. Zimmerman, Fuzzy Set Theory and its Applications, Fourth edition, Springer

Reference Book

1. Timothy J. Ross, Fuzzy Logic with Engineering applications, Third edition, Wiley

Open Elective-I

| | Mathematical Finance | |
|---|---|---|
| | | |
| Course Content:<br>Unit-I: Introduction to Financial Markets: Bonds, Stocks, Futures & Forwards, Swaps, Options. Interest,Present & Future Values, Annuities, Amortization and Bond Yield, Price Yield Curve and Term Structure of Interest Rates. Markowitz Theory, Return & Risk and Two Asset PortfolioMinimum Variance Portfolio and Feasible Set, Multi Asset Portfolio, Minimum Variance Portfolio, Efficient Frontier and Minimum Variance Line. Market Portfolio, Market Line, Capital Asset Pricing Model.<br><br>Unit-II: No-Arbitrage Principle and Pricing of Forward Contracts, Futures, Options and Put-Call-Parity, Bounds on Options. Derivative Pricing in a Single Period Binomial ModelDerivative Pricing in Multiperiod Binomial ModelDerivative Pricing in Binomial Model and Path Dependent Options.<br><br>Unit-III: Discrete Probability SpacesFiltrations and Conditional Expectations, Properties of Conditional Expectations. Examples of Conditional Expectations, Martingales-Neutral Pricing of European Derivatives in Binomial Model, Actual and Risk-Neutral Probabilities, Markov Process, American Options.<br><br>Unit-IV: Stochastic Calculus: General Probability Spaces, Expectations, Change of Measure, Filtrations, Independence, Conditional Expectations, Brownian Motion and its Properties, Ito's Integral and its Properties, Ito's Formula, Ito's Processes, Multivariable Stochastic Calculus, Stochastic Differential Equations.<br><br>Unit-V: Black-Scholes-Merton (BSM) Model, BSM Equation, BSM Formula, Greeks, Put-Call Parity, Change of Measure, Girsanov Theorem, Risk-Neutral Pricing of Derivatives, BSM Formula. MRT and Hedging, Multidimensional Girsanov and MRTMultidimensional BSM Model, Fundamental Theorems of Asset PricingModel with Dividend-Paying Stocks. | | |
| Text Book:<br>1. Chandra, Dharmaraja, Mehra, Khemchandani; Financial Mathematics: An Introduction, Narosa Publishing House.<br>2. Fred Espen Benth, Option Theory with Stochastic Analysis: An introduction to mathematical finance, Springer. | | |
| Reference Book:<br>1. S. E. Shreve , Stochastic Calculus for Finance, Vol. I & Vol. II, Springer.<br>2. Thomas Mikosh, Elementry Stochastic Calculus with Finance in view, World Scientific. | | |
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| | Advanced Data Structures and Algorithms | |
|---|---|---|

Course Content

Unit-I: Review of design techniques: greedy method, divide-and-conquer, dynamic programming with advanced applications and/or emphasis on their theoretical foundations

Unit-II: Review of amortized analysis;Data structure: B-trees, Fibonacci heaps with application to Prim's MST algorithm, interval trees, data structures for disjoint sets;

Unit-III: Algorithms for maximum flow and its applications; String matching; Approximation Algorithms: Set cover, max-SAT, knapsack, bin packing, scheduling, traveling salesman tour

Unit-IV: Introduction to Randomized Algorithms; Geometric Algorithms: convex hull algorithms, and its lower bound, line segment intersection, closest pair points.

Text Book

1. J Kleinberg and E Tardos, *Algorithm Design,* Addison-Wesley, 2005.
2. TH Cormen, CF Leiserson, RL Rivest, and C Stein, *Introduction to Algorithms*, 3rd Ed., MIT Press, 2009.

Reference Book

1. AV Aho, J Hopcroft, and JD Ullman, *The Design and Analysis of Algorithms*, Addison-Wesley, 1974.

| | Intellectual Property Rights | |
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Course Content

Unit-I: Introduction: Concept of IPR, Historical development , kinds of IPR, brief description of patent, trademark, copyright ,industrial design, importance of IPR, IPR authorities.

Unit-II: PATENTS :Introduction, Indian Patent Act 1970 &2002, Protectable subject matter--patentable invention, Procedure for obtaining patent, Provisional and complete specification Rights conferred on a patentee, transfer of patent, Revocation and surrender of patents, Infringement of patents, Action for infringement, Patent agents, Patent in computer programs

Unit-III: Trademark: Introduction, Statutory authorities, principles of registration of trademarks, rights conferred by registration of trademarks, Infringement of trademarks and action against infringement, procedure of registration and duration, licensing in trademark

Unit-IV: Copyright: Introduction, Author and ownership of copyright, rights conferred by copyright, term of copyright, assignment/licence of copyright, Infringement of copyright

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| ,remedies against infringement of copyright, registration of copyright, copyright enforcement and societies.<br><br>Unit-V: Industrial design: The design act-2000, registerability of a design, procedure of registration of a design, piracy of a registered design, Case law on designs. International IPR & case laws: World intellectual property organization, WCT, WPPT, TRIPS, Copyright societies, international IPR dispute resolution mechanism. Case laws |
| |
| Text Book<br>1. Law Relating to Intellectual property, fourth edition by B.L.Wadehra .Universal law publishing co. pvt. Ltd , 2007 |
| Reference Book<br>1. Intellectual property: Patents, copyright ,trademarks and allied rights. Fifth edition by W.R. Cornish. Sweet & Maxwell publisher, 2003<br>2. Law and practice of intellectual property in India by VikasVashishth, 2006<br>3. Dr. B. L. Wadhera, "Intellectual Property Law Handbook". Universal Law Publishing, 2002<br>4. Patents ,copyrights, trade marks and design by B L Wadhera, 2014 |

| **Semester VII- B Tech (Hons.) & B Tech.** | | | | |
|---|---|---|---|---|
| **S. No.** | **Course Code** | **Course Title** | **L-T-P** | **Credits** |
| **1.** | CS-4001 | Cloud Computing | 3-1-0 | 4 |
| **2.** | CS-4003 | Big Data Analytics and Data Science | 3-1-0 | 4 |
| **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.** | PR-4101 | Minor Project | 0-0-3 | 4 |
| **7.** | **PR-4103** | Industrial / Internship Seminar | --- | 2 |
| | **Total Credits** | | | **20(24)** |

| **Hons. Elective-III** | | |
|---|---|---|
| **S. No.** | **Course Code** | **Course Title** |
| **1.** | **ME-4001** | Actuarial Mathematics |
| **2.** | **ME-4003** | Mathematical Methods |

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|---|---|---|
| **3.** | **ME-4005** | Quality Control & Decision Making |

| **Open Elective-II & III** | | |
|---|---|---|
| **S. No.** | **Course Code** | **Course Title** |
| **1.** | | Orbital Mechanics |
| **2.** | | Industrial Engineering |
| **3..** | | Internet and Web Programming |
| **4.** | | Cluster and Grid Computing |
| **5.** | | Data Warehousing & Data Mining |
| **6.** | | Introduction to Deep Learning |
| **7.** | | Dynamical System |
| **8.** | | Computer Graphics |
| **9.** | | Information Theory and Coding |

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

| MA-4001 | Cloud Computing | |
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Course Content

Unit-I: Introduction: Network centric computing and network centric content, Peerto-peer systems, Cloud Computing: an old idea whose time has come, Cloud Computing delivery models & Services, Ethical issues, Cloud vulnerabilities, Challenges, Cloud Infrastructure: Amazon, Google, Azure & online services, open source private clouds. Storage diversity and vendor lock-in, intercloud, Energy use & ecological impact of data centers, service level and compliance level agreement, Responsibility sharing, user experience, Software licensing.

Unit-II: Cloud Computing: Applications & Paradigms, Challenges, existing and new application opportunities, Architectural styles of cloud applications: single , multi ,hybrid cloud site, redundant, non redundant , 3 tier, multi tier architectures, Workflows coordination of multiple activities, Coordination based on a state machine model -the Zoo Keeper, The Map Reduce programming model, Apache Hadoop, A case study: the GrepTheWeb application, Applications: Healthcare, Energy systems, transportation, manufacturing, Education, Government, mobile communication, application development.

Unit-III: Cloud Resource Virtualization: Definition, merits and demerits, types & Techniques, Layering, Virtual machine monitors, Hardware support for virtualization Case study: Xen -a VMM based on paravirtualization, Optimization of network virtualization in Xen 2.0, vBlades -paravirtualization targeting a x86-64 Itanium processor, A performance comparison of virtual machines, The darker side of virtualization, Software fault isolation.

Unit-IV: Cloud Resource Management and Scheduling: Policies and mechanisms for resource management, Applications of control theory to task scheduling on a cloud, Stability of a two-level resource allocation architecture, Feedback control based on dynamic thresholds, Coordination of specialized autonomic performance managers, A utility-based model for cloud-based web services, Resource bundling, combinatorial auctions, fair queuing, Start time fair queuing, borrowed virtual time, Cloud scheduling subject to deadlines, Scheduling mapreduce applications subject to deadlines, Resource management and application scaling.

Unit-V: Storage systems: Evolution, Storage models, file systems, databases, DFS, General parallel File system, GFS, Hadoop, Locks & Chubby, TPS, NOSQL, BigTable, Mega store. Cloud security: Risks, Security, privacy, Trust. Security of OS,VM, VMM, shared image, management OS, Xoar.

Text Book

1. Cloud Computing Theory and Practice – DAN C. Marinescu – Elsevier
2. Cloud Computing: A hands on Approach, by Bagha Madisetti

Reference Book

1. Distributed and Cloud Computing, From Parallel Processing to the Internet of Things, Kai Hwang, Jack Dongarra, Geoffrey Fox. MK Publishers
2. Cloud Computing: A Practical Approach, Anthony T. Velte, Toby J. Velte, Robert Elsenpeter, McGraw Fill, 2010.

| CS-4001 | Big Data Analytics and Data Science | L-T-P-C: 3-1-0-4 |
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Course Content:

Unit-I: Big data- Concepts, Needs and Challenges of big data. Types and source of big data. Components of Hadoop Eco System- Data Access and storage, Data Intelligence, Data Integration, Data Serialization, Monitoring, Indexing

Unit-II: Introduction, Parallel processing using Pig, Pig Architecture, Grunt, Pig Data Model-scalar and complex types. Pig Latin- Input and output, Relational operators, User defined functions. Working with scripts
Introduction-Hive modules, Data types and file formats, Hive QL-Data Definition and Data Manipulation.

Unit-III: Hive QL queries, Hive QL views- reduce query complexity. Hive scripts. Hive QL Indexes-create, show, drop. Aggregate functions. Bucketing vs Partitioning, Relational

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| database management in Hadoop: Bi directional data transfer between Hadoop and external database. Import data- Transfer an entire table, import subset data, use different file format. Incremental import import new data, incrementally import data, preserving the value<br><br>Unit-IV: Export transfer data from Hadoop, update the data, update at the same time, export subset of columns. Hadoop ecosystem integration- import data to hive, using partitioned hive tables, replace special delimiters<br><br>Unit-V: Introduction. Information retrieval search engine, categories of data, inverted index. Design- field attributes and types. Indexing- indexing tool. Indexing operations using csv documents. Searching data- parameters, default query |
| Text Book<br>1. AlanGates,Programming PigDataflowScriptingwithHadoop,O'ReillyMedia,Inc,2011.<br>2.Jason Rutherglen, Dean Wampler, Edward Caprialo, Programming Hive, O'ReillyMedia Inc,2012<br>3.KathleenTing,JarekJarcecCecho,ApacheSqoopCookbook,O'ReillyMediaInc,2013.<br>4.Dikshant Shahi, Apache Solr: A Practical approach to enterprise search, Apress, 2015.<br>5.Chuck Lam, Hadoop in Action, Manning Publications,2010.<br>6.Andrea Gazzarini, Apache Solr Essentials, PACKT Publications, 2015 |

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**Hons Elective-III**

| **MA-4001** | **Actuarial Mathematics** | |
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| Course Content<br>Unit-I: Basics of time value of money, Interest rates, Annuities<br><br>Unit-II: Mortality theory, Survival time, Actuarial functions of mortality, Mortality tables<br><br>Unit-III: Life insurance and annuities, Cash flows, Endowments, Life annuities<br><br>Unit-IV: Premiums, Net and Gross premiums. | | |
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| Text Book<br>1. Arjun K. Gupta and Tamas Varga, An Introduction to Actuarial Mathematics, Vol. 14. Springer Science & Business Media, 2013 | | |
| Reference Book<br>1. S. David Promislow, Fundamentals of Actuarial Mathematics, Wiley, 2015. | | |

| **ME-4003** | Mathematical Methods | |
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Course Content

Unit-I: Power series solutions, recurrence relations, Bessel functions, Modified Bessel functions, Legendre polynomial, Laguerre polynomial, Chebyshev polynomial, Hermite polynomials

Unit-II: Concept and calculation of Green's function, Properties, Green's function method for ordinary and partial differential equations.

Unit-III: Fourier Series, Fourier Cosine series, Fourier Sine series, Fourier integrals. Fourier transform, Laplace transform, Hankel transform, finite Hankel transform, Mellin transform.

Unit-IV: Solution of differential equations by integral transform methods. Construction of the kernels of integral transforms on a finite interval through Sturm-Liouville problem. Occurrence of integral equations.

Unit-V: Regular and singular integral equations: Volterra integral equations, Fredholm integral equations, Volterra and Fredholm equations with different types of kernels

Text Book

1. A. D. Poularikas, The Transforms and Applications Handbook, CRC Press, 1996.
2. L. Debnath and D.D. Bhatta, Integral Transforms and Their Applications, Chapman and Hall/CRC, 2011

Reference Book

1. G. F. Roach, Green's Functions, Cambridge University Press, 1995.
2. Larry C. Andrews, Special Functions of Mathematics for Engineers, Oxford University Press, 1997

| **ME-4005** | Quality Control & Decision Making | |
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Course Content

Unit-I: Introduction to Statistical Quality Control, Process control and product control. Tools for SQC. Control charts for variables. Control charts for attributes. Natural tolerance limits and specification limits.

Unit-II: Acceptance sampling inspection plans. Single Sampling plan. Double sampling plan and their comparison. Sequential sampling plan.

Unit-III: Components and analysis of time series. Measurement of trend, seasonal variations and cyclic variations. Auto-regression series. Autocorrelation and correlogram. Choosing an appropriate forecasting model. Time series forecasting of seasonal data.

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| Unit-IV: Decision making. Pay off tables. Decision trees. Maximax payoff, Maxmin payoff. Expected monetary value. Expected opportunity loss. Return-to-risk ratio. Decision making with sample information. Utility. |
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| Text Book<br>1. Statistics for Managers (7th Edition) by David M.Levine, David F. Stephan, and Kathryn A. Szabat. PHI Learning Delhi.<br>2. Probability and Statistics for Engineers & Scientists by Walpole, Myers, Myers, and Ye. Prentice Hall, NJ. |
| Reference Book<br>1. Introduction to Statistical Quality Control by Montgomery, D.C. John Wiley and Sons |

**Open Electives-II and III**

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| | Orbital Mechanics | |
| Course Objective:<br>Introduce students to spacecraft orbital dynamics and the issues associated with orbital control and station keeping. Primary focus in regimes where two-body analysis and conics are a valid model. Computation and implementation of impulsive maneuvers in three dimensions; transfer orbits and Lambert's theorem to support discussions of mission trajectory design. Impact of the trajectory on other subsystems. | | |
| Course Content<br>Unit-I: Introduction to the laws of Kepler and Newton; universal gravitation and integrals of motion.<br><br>Unit-II: Fundamental concepts associated with the two-body problem and conics; orbital elements.<br><br>Unit-III: Orbital maneuvers: (1) orbit establishment; (2) single impulse adjustments; (3) multiple impulse transfers including Hohmann transfers, local gravity fields and flybys, Hoelker and Silber transfers, Lambert time-of-flight theorem, three-dimensional transfers; (4) mission design issues<br><br>Unit-IV: Orbital perturbations including Euler-Hill equations for two-close orbiters and some navigational issues. | | |
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**Text Books**

1. Curtis, H. D., Orbital Mechanics for Engineering Students , 2 nd ed., Elsevier (2009).
2. Chobotov, V. A., Orbital Mechanics , 3 rd ed., AIAA Edu. Series (2002).

**References**

1. Wiesel, W. E., Spaceflight Dynamics , 2 nd ed., McGraw-Hill (1996).
2. Brown, C. D., Spacecraft Mission Design , 2 nd ed., AIAA Edu. Series (1998).
3. Escobal, P. R., Methods of Orbit Determination , 2 nd ed., Krieger Pub. Co. (1976).
4. Tewari, A., Atmospheric and Space Flight Dynamics: Modeling and Simulation with MAT- LAB and Simulink , Birkhuser (2007).

| | Industrial Engineering | |
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Course Content

Unit-I: Introduction, Definition and objectives of Industrial Engineering, Scope of Industrial Engineering, Production systems and their classifications; Productivity-Total and partial productivity, Reasons and remedy for poor productivity.

Unit-II: Job analysis and Work Measurement Systems: Work System Design: Taylor's scientific management, Gilbreth's contributions; method study, micro-motion study, principles of motion economy; work measurement - stop watch time study, micro motion and memo motion, work sampling, standard data, PMTS; ergonomics; job evaluation, merit rating, incentive schemes, and wage administration; business process reengineering.

Unit-III: Production Planning and Control Types and characteristics of production systems Objective and functions of Production, Planning & Control, Routing, Scheduling and Operations scheduling, production scheduling, job shop scheduling problems, sequencing problems, scheduling tools and techniques, Loading, Dispatching and its sheets & Gantt charts.

Unit-IV: Quality Engineering Quality concept and costs; statistical quality control, Concept of specification limits, statistical control limits, process capability, Process control and control charts for both attributes and variable data. Acceptance Sampling- Single and double sampling.

Unit-V: Reliability and Maintenance Reliability, availability and maintainability; distribution of failure and repair times; determination of MTBF and MTTR, reliability models; system reliability determination; Maintenance management and its objectives, Various types of Maintenance Planning, House Keeping, 5S concepts.

Unit-VI: Material Handling Principles, functions, and objectives of Material Handling; Selection and classification of Material Handling Equipments; Relation of material handling with plant layout

Text Book

1. Industrial Engineering and Management; B. Kumar, Khanna Publication, ISBN8174091963, 2011.
2. Introduction to work Study, International Labour Office, Geneva, 3rd edition, Oxford and IBH publishing Co. Pvt. Ltd, New Delhi, ISBN- 8120406028, 2008.

Reference Book

1. Industrial Engineering and Management, Pravin Kumar, Pearson Education, 1st edition, ISBN- 9789332543560, 2015

| | Internet and Web Programming | |
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Course Content

Unit-I: Internet and WWW: Internet basic, Introduction to internet and its applications, E- mail, telnet, FTP, e-commerce, video conferencing, e-business. Internet service providers, domain name server, internet address World Wide Web (WWW): World Wide Web and its evolution, uniform resource locator (URL), browsers - internet explorer, netscape navigator, opera, firefox, chrome, mozilla. Search engine, web saver - apache, IIS, proxy server, HTTP protocol.

Unit-II: WEBSITES BASIC ANDWEB 2.0: Web 2.0: Basics-RIA Rich Internet Applications - Collaborations tools - Understanding websites and web servers: Understanding Internet – Difference between websites and web server- Internet technologies Overview – Understanding the difference between internet and intranet; HTML and CSS: HTML 5.0 , XHTML, CSS 3.

Unit-III: E-MAIL SECURITY & FIREWALLS : PGP - S/MIME - Internet Firewalls for Trusted System: Roles of Firewalls - Firewall related terminologyTypes of Firewalls - Firewall designs - SET for E-Commerce Transactions, intellectual property: copyright, patents, trademarks, cyber laws

Unit-IV: SERVELETS AND JSP: JSP Technology Introduction-JSP and Servelets- Running JSP Applications Basic JSP- JavaBeans Classes and JSP-Tag Libraries and Files- Support for the Model- View- Controller Paradigm- Case Study- Related Technologies.

Unit-V: XML: Introduction to XML, uses of XML, simple XML, XML key components, DTD and Schemas, Well formed, using XML with application.XML, XSL and XSLT. Introduction to XSL, XML transformed simple example, XSL elements, transforming with XSLT

Unit-VI: PHP: Starting to script on server side, Arrays, function and forms, advance PHP, Basic command with PHP examples, Connection to server, creating database, selecting a database, listing database, listing table names creating a table, inserting data, altering tables, queries, deleting database, deleting data and tables, PHP my admin and database bugs.

Text Book

1. Internet and Web Technologies by Raj Kamal, Tata McGraw Hill
2. An Introduction to Search Engines and Web Navigation, Mark Levene, Pearson Education
3. Modeling the Internet and the Web, PierreBaldi, PaoloFrasconi, Padhraic Smyth, John Wiley and Sons Ltd.

Reference Book

1. HTML: A Beginner's Guide by Wendy Willard, Tata McGraw-Hill
2. PHP and MySQL for Dynamic Web Sites, Ullman, Larry, Peachpit Press

| | Introduction to Deep Learning | |
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Course Content

Unit-I: Introduction: Human brain, neuron models, neural nets as directed graphs, feedback, neural architectures, knowledge representation, connection to artificial intelligence, Pytorch and Tensorflow.

Unit-II: Learning Process: Error-correction learning, memory based learning, Hebbian learning, competitive learning, Boltzmann learning, credit assignment, learning with and without a teacher, learning tasks, memory, statistical learning theory, Backpropagation using MNSIT.

Unit-III: Modern practical deep neural networks: Deep feedforward networks, regularization for deep learning, optimization for training deep models, convolutional Networks, Classification using Tensorflow and Pytorch.

Unit-IV: Sequence Modelling: Recurrent and recursive nets, practical Methodology, applications. Reinforcement learning.

Unit-V: Deep Learning Research: Linear factor models, auto encoders, variational auto encoders, restricted Boltzmann machine, generative adversarial networks, Transfer learning.

Text Book

1. Simon Haykin, Neural networks: A comprehensive foundation, Second Edition, Prentice Hall, New Delhi, 1999
2. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 2016.

| | Data Warehousing & Data Mining | |
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Course Content

Unit-I: Data Warehousing: - Basic concepts in data warehousing, Collecting the requirements of data warehouse, Data Warehouse Architecture, Design, Implementation& Maintenance, OLAP in data warehouse, Data warehousing and the web, Data Cube Technology, From Data Warehousing to Data Mining.

Unit-II: Data Mining Concepts: Data mining primitives, Basics of data mining, Query language, Architectures of data mining systems.

Unit-III: Mining Association Rules in Large Databases: Association Rule Mining, Mining Single Dimensional Boolean Association Rules from Transactional Databases, Mining Multilevel Association Rules from Transaction Databases, Mining Multidimensional Association Rules from Relational Databases and Data Warehouses, From Association Mining to Correlation Analysis, Constraint Based Association Mining.

Unit-IV: Classification and Prediction: Issues Regarding Classification and Prediction, Classification by Decision Tree Induction, Bayesian Classification, Classification by Back propagation, Classification Based on Concepts from Association Rule Mining, Other Classification Methods, Prediction, Classifier Accuracy.

Unit-V: Cluster Analysis in Data Mining: Types of Data in Cluster Analysis. A Categorization of Major Clustering Methods, Partitioning Methods, Density Based Methods, Grid Based Methods, Model Based Clustering Methods, Outlier Analysis.

Unit-VI: Mining Complex Types of Data: Multidimensional Analysis and Descriptive Mining of Complex Data Objects, Mining Spatial Databases, Mining Multimedia Databases, Mining Time Series and Sequence Data, Mining Text Databases. Applications and trends in Data Mining: - Applications, Systems products and research prototypes, Additional themes in data mining, Trends in Data mining, spatial mining, and Web Mining

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| Text Book<br>1. Data Warehousing Fundamentals, P. Ponnian, John Weliey<br>2. Data Mining Introductory & Advanced Topics, M.H. Dunham, Pearson Education.<br>3. Data Mining Concepts & Techniques, Han, Kamber, M. Kaufman. |
| Reference Book<br>1. The Data Warehouse Lifecycle Tool Kit, Ralph Kimball, John Wiley<br>2. Master in Data Mining, M.Berry , G.Linoff, John Wiley<br>3. Building the Data Ware houses, W.H.Inmon, WielyDreamtech. |

| | Cluster and Grid Computing | |
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| Course Content<br>Unit-I: Cluster Computing Introduction to concepts in Cluster based distributed computing Hardware technologies for cluster computing and software for cluster computing, and different Software Architecture for Cluster Computing.<br><br>Unit-II: Programming Models and Paradigms, features and performance of standard MPI variants, Derived data types, communicators.<br><br>Unit-III: Resource management and scheduling Managing, cluster resources: single system images, system level middleware, distributed task scheduling, monitoring and administering system resources Parallel I/O and Parallel Virtual File System. Scheduling: Condor, Maui Scheduler, Portable Batch System (PBS).<br><br>Unit-IV: Grid Computing: Grids and Grid Technologies, Programming models and Parallelization Techniques, Grid Security Infrastructure, Setting up Grid, deployment of Grid software and tools, and application execution.<br><br>Unit-V: Standard application development tools and paradigms Performance evaluation tools, HINT, netperf, netpipe, ttcp, Iperf.message.<br><br>Unit-VI: Data Management Application Case Study: Molecular Modeling for Drug Design and Brain Activity Analysis, Resource management and scheduling. | | |
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| Text Book<br>1. Beowulf Cluster Computing with Linux, 2nd edition, William Gropp, Ewing Lusk, Thomas Sterling, MIT Press.<br>2. Introduction to grid computing - Bart Jacob, Michael Brown<br>3. In Search of Clusters: The ongoing battle in lowly parallel computing, Second Edition, by Gregory F. Pfister, Prentice Hall Publishing Company | | |
| Reference Book<br>1. Parallel Programming with MPI by Peter Pacheco, Morgan Kaufmann | | |

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| 2. How to Build a Beowulf – A Guide to the Implementation and Application of PC Clusters, by Thomas Sterling, John Salmon, Donald J. Becker and Daniel F. Savarese, MIT Press |

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| | Dynamical System | |
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| Course Content<br>Unit-I: Linearization of Non-linear Systems, Limitations, Hartman–Grobman Theorem, Local Stability, Global Stability, Lyapunov Function, Lyapunov Theorem on Stability, LaSalle Invariance Principle,<br><br>Unit-II: Oscillations: Limit Set, Attractors, Periodic Orbits, Limit Cycle, Poincare-Bendixson Theorem, Bendixson-Dulac Criterion.<br><br>Unit-III: Discrete Dynamical Systems: Maps and Flows, Composition of Maps, Orbits, Phase Portrait, Fixed Points, Stable and Unstable Fixed Points, Basin of Attraction and Basin Boundary, Linear Stability Analysis, Cobweb Diagram, Periodic Points, Periodic Cycles, Stability of Periodic Point and Periodic Cycle, Hyperbolic Points, Non-Hyperbolic Points, Schwarzian Derivative.<br><br>Unit-IV: Bifurcations in One-Dimensional Systems: Saddle-Node Bifurcation, Pitchfork Bifurcation, Transcritical Bifurcation. Bifurcations in Two-Dimensional Systems: Saddle-Node Bifurcation, Pitchfork Bifurcation, Transcritical Bifurcation, Hopf-Bifurcation, Homoclinic and Heteroclinic Bifurcations. Period Doubling Bifurcation, Neimark-Sacker Bifurcation.<br><br>Unit-V: Sensitive Dependence on Initial Conditions (SDIC), Sarkovskii's Theorem, Period-Three Implies Chaos for 1-D Maps. Some Chaotic Maps, Universal Sequence, Feigenbaum Number, Poincaré Section, Lyapunov Exponents, Routes of Chaos, Some Examples of Chaos. | | |
| Text Book<br>1. 1. G C Layek - An Introduction to Dynamical Systems, Springer<br>2. S. H. Strogatz, Nonlinear dynamics and chaos with applications to Physics, Biology, Chemistry, and Engineering (Westview Press)<br>3. Lawrence Perko, Differential Equations and Dynamical Systems, Springer<br>4. J Hale and H Koack - Dynamics and Bifurcations, Springer. | | |
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| | Computer Graphics | |
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| Course Content: | | |

Unit-I: Overview of Computer Graphics: Usage of Graphics and their applications, Over view of Graphics systems: Refreshing display devices, Random and raster scan display devices, Colour Models: RGB, HSV etc., Tablets, Joysticks, Track balls, Mouse and light pens, plotters, printers, digitizers.

Unit-II: Output primitives: DDA Line drawing algorithm, Bresenham's Line Drawing Algorithm, Mid-point circle algorithm, Mid-point Ellipse algorithms, filling algorithms, boundary fill and flood fill algorithms, scan-line filling, character generation, line attributes, fill styles, antialiasing.

Unit-III: Transformations: Basic 2D Transformations, Matrix representations & Homogeneous Coordinates, Matrix Representations for basic 2D and 3D transformations, Composite Transformations, reflection and shear transformations, affine transformation, transformations between coordinate systems.

Unit-IV: Two dimensional viewing: The viewing Pipeline, Viewing Coordinate Reference Frame, Window-to-Viewport Coordinate Transformation, Two Dimensional Viewing Functions, Barky line clipping algorithm, Algorithm for polygon clipping, Sutherland-Hodgeman polygon clipping, Wailer-Atherton polygon clipping, curve clipping, Text clipping.

Unit-V: Curves and Surfaces: Representation of surfaces, polygon meshes, plane equations, parametric cubic curves, Hermite Curves, Bezier Curves, 4 point and 5 point Bezier curves using Bernstein Polynomials, Conditions for smoothly joining curve segments, Bezier bi- cubic surface patch, B-Spline Curves, Cubic B-Spline curves using uniform knot vectors, Testing for first and second order continuities.

Text Book:

1. D. Hearn and P. Baker, "Computer Graphics", Prentice Hall.
2. R. Plastock and G. Kalley, "Theory and Problems of Computer Graphics", Schaum's Series, McGraw Hill.
3. Foley et al., "Computer Graphics Principles & practice", Addison Wesley.

| | Information Theory and Coding | |
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Course Content:

Unit-I: Discrete information sources, entropy, joint and conditional entropy, chain rule. Source coding, mapping functions and efficiency, mutual information, prefix codes, instantaneous decoding, construction of Huffman codes. Lempel-Ziv coding.

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| Unit-II: Discrete memoryless channel model, transition probability matrix, channel capacity, symmetric channels. Block coding, equivocation. Entropy rate, channel-coding theorem. Markov chains and data processing.<br><br>Unit-III: Data translation coding, prefix codes and block codes, fixed and variable length block codes, the Kraft inequality. Channel coding for error correction. Error rates and error distribution for the binary symmetric channel, Error detection and correction, maximum likelihood decoding principle, Hamming distance code capability. Linear block codes, Hamming weight, Hamming distance, and the Hamming cube. Syndrome decoders and the parity-check theorem.<br><br>Unit-IV: Cyclic codes, polynomial representation of cyclic codes, polynomial modulo arithmetic. Generator, parity-check, and syndrome polynomials. Systematic cyclic codes, the Hamming codes. BCH codes, Burst-correcting codes. |
| Text Book:<br>1. G.A. Jones and J.M. Jones, Information and Coding Theory, Springer Undergraduate Mathematics Series.<br>2. W.C. Huffman and V. Pless, Fundamental of Error Correcting Codes, Cambridge University Press |
| Reference Book:<br>1. R.B. Wells, Applied Coding and Information Theory for Engineers, Pearson Education.<br>2. T.M. Cover and J.M. Thomas, Elements of Information Theory, Wiley Student Edition. |
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| **Semester VIII - Common forB Tech (Hons.) & B Tech.** | | | | |
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| **S. No.** | **Course Code** | **Course Title** | **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

**Note:**

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