Curriculum for Undergraduate Degree (B.Tech.) in Computer Science and Engineering (Data Science) (w.e.f. AY: 2020-21)

Part III: Detailed Curriculum

Second Semester

Course Name:	**Physics**		
Course Code:	BS-PH201	**Category:**	Basic Science Courses
Semester:	Second	**Credit:**	4.0
L-T-P:	3-1-0	**Pre-Requisites:**	Mathematics Course with Vector Calculus
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	Understand the basic concepts of Electricity and Magnetism and comprehend their uses in real life situations.
2	Understand the formulations of Quantum Mechanics and its applications to modern technologies.
3	Describe the working principle of LASER and their applications to communication systems such as Optical Fiber.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Module-1: Foundations of Quantum Mechanics**	**(8L)**
	Introduction to Quantum Physics: Brief idea about the historical development of quantum mechanics.	1
	Black Body Radiation: Planck's Hypothesis and derivation of Planck's Radiation formula, Limiting case of Planck's radiation law: Wien's Radiation Law & Rayleigh Jean's law, Stefan's Boltzmann law & Wien's Displacement law (no derivation), Numerical problems with applications of radiation laws.	2
	Compton Effect: Experimental observation of Compton effect, Derivation of the Compton shift, Modified and Unmodified lines, Estimation of the energy of the scattered radiation and energy of recoiled electron, Numerical problems.	2
	Wave-Particle Duality: de Broglie hypothesis, Wave-particle duality, Calculation of de Broglie wavelength, Verification of matter waves by Davisson and Germer experiment, Concept of phase velocity and group velocity and their inter-relation.	2
	Uncertainty Principle: Heisenberg's uncertainty principles (no derivation) for motion of microscopic particles, Nonexistence of electrons within nucleus, Zero point energy, Numerical problems.	1

2	**Module-2: Schrödinger Wave Equation and Its Applications** ***Formulation of Quantum Mechanics:*** Postulates of Quantum Mechanics, Concept of operators and their Eigen values, Wave function and its physical significance, Expectation value of an observable quantity, Discussion of associated problems. ***Schrödinger Wave Equation:*** Time independent Schrödinger's equation from time dependent one by the separation of variable method. ***Applications of Quantum Mechanics:*** Solution of Schrödinger's time-independent equation for a free particle in an infinite potential well (1D & 3D box), Associated theoretical and numerical problems, Concept of degeneracy and non-degeneracy of a particle enclosed in a 3D box, Concept of quantum mechanical tunneling and quantum harmonic oscillator	**(8L)** 3 1 4
3	**Module-3: Dielectric Materials and their Applications** ***Concept of Dielectric and Polarization:*** Electric field inside a Dielectric, Electric dipole and dipole moment, Polar and non-polar dielectrics, Influence of electric field on non-polar and polar molecules, Atomic polarizability and polarization vector. ***Inter Relationship among Dielectric Parameters:*** Concept of surface and volume bound charges, Gauss' law in presence of dielectric, Derivation of relation among electric field, polarization and displacement vector, Concept of susceptibility, permittivity and dielectric constant in linear dielectrics, Problems on relation between polarizability, susceptibility and dielectric constant. ***Types of Polarization:*** Electronic polarization and derivation of electronic polarizability, Concept of ionic and orientational polarization (no derivation). ***Applications of Dielectric:*** Dielectric breakdown and dielectric strength, Concept of Dielectric loss, Few applications of dielectrics in different fields.	**(5L)** 1 2 1 1
4	**Module-4: Time Varying Fields** ***Electromagnetic Induction:*** Faraday's law of electromagnetic induction, Integral & differential form of Faraday's law, Application of Faraday's law in Motors and Generators, Calculation of Induced EMF. ***Displacement Current:*** Ampere's law: integral & differential forms, Inconsistency of Ampere's law, Maxwell's modification, Concept and characteristics of displacement current.	**(3L)** 2 1
5	**Module-5: Electromagnetic Waves** ***Maxwell's Electromagnetic Field Equations:*** Maxwell's equations in differential & integral forms, Physical significances, Maxwell's equations under different conditions (free space, good conductor, perfect insulators etc.). ***Plane Electromagnetic Wave in Free Space:*** Wave equations in free space, Estimation of velocity of the EM wave in free space, Concept of transverse nature of electromagnetic waves. ***Plane Electromagnetic Wave in Medium:*** Wave equations in non-conducting and conducting media, Calculation of skin depth, Estimation of magnitude and direction of electric/magnetic field. ***Energy in an Electromagnetic Field:*** Flow of energy associated to electromagnetic field and Poynting vector.	**(6L)** 2 1 2 1

6	**Module-6: Laser and Fiber Optics** ***Introduction to Laser:*** Properties of light sources, Need of suitable light source in communication, Invention of laser, Characteristics and applications of laser. ***Interaction of Light with Matter:*** Stimulated absorption, spontaneous emission and stimulated emission of radiation, Transitions probabilities, Einstein's A and B coefficients and the inter-relationship among them. ***Components and Working of Laser Systems:*** Necessary conditions for lasing action, Metastable energy state, Population inversion, Amplification by optical cavity resonator, Design of resonator to ensure single longitudinal mode operation, Working principle of solid-state lasers (ruby laser and Nd:YAG laser) and gas lasers (He-Ne laser & CO_2 laser). ***Optical Communication:*** Introduction, Need for optical communication, Salient features of optical fibers, Amplitude and digital modulation, Estimation of number of speech signals to be sent simultaneously through specific bandwidth analog/digital communication system ***Light Guidance in Fibers:*** Ray theory of light guidance, Relative refractive index difference and numerical aperture, Concept of modes of a fiber, Single and multimode fibers, Step-index and graded-index fibers. ***Transmission characteristics of optical fibers:*** Attenuation, Rayleigh scattering, Pulse broadening mechanism, Estimation of intermodal dispersion, bit rate - length product, Minimization of intermodal dispersion.	**(9L)** 1 1 2 2 1 2
Total		**39L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Differentiate between different dielectric materials depending on their dielectric strength, breakdown voltage, losses and apply them to real life problems.
2	Apply the concepts of Faraday's law to analyze mechanisms of electromagnetic breaking and solve problems on induced EMF for motors, generators etc.
3	Solve for electric field, magnetic field & power flow using Maxwell's equations and analyze various medium of propagations.
4	Understand the concept of black body radiation and predict its temperature from the spectrum, and comprehend the particle nature of light using Compton Effect, existence of matter waves.
5	Describe the basic formulations of Quantum Mechanics such as the concept of operators, wave function and their evolution using Schrödinger equation and apply them to understand the workings of devices like Tunnel Diode, Scanning Tunnelling Microscopy etc.
6	Explain the workings of various LASERs and their uses especially in optical fiber communication. Illustrate the concept of modes of an optical fiber and estimate the dispersion leading to calculation of Bit Rate of a communication channel..

Learning Resources:	
1	'Introduction to Quantum Mechanics' by David J. Griffiths
2	'Quantum Mechanics' by Leonard I. Schiff
3	'Quantum Physics' by A. N. Konar
4	'Perspectives of Modern Physics' by Aurther Beiser

5	'Introduction to Electrodynamics' by David J. Griffiths
6	'Electrical Engineering Materials' by A. J. Dekker
7	'Fundamentals of Optics' by Jenkins and White
8	'Lasers, theory and applications' by K. Thyagrajan and A. Ghatak
9	'Understanding Lasers' by Jeff Hecht
10	'An Introduction to Fiber Optics' by Ajoy Ghatak and K. Thyagrajan

Course Name:	**Mathematics-II**		
Course Code:	BS-M201	**Category:**	Basic Science Courses
Semester:	Second	**Credit:**	04
L-T-P:	3-1-0	**Pre-Requisites:**	Nil
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To learn how to solve different types of differential equation
2	To know the different types of improper integral
3	To know the Laplace transform
4	Basic concept of graph, digraph, walk, Hamiltonian graph, Euler circuit,
5	Basic concept of tree, binary tree

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Ordinary Differential Equations of First order:** ❖ Formation of ordinary differential equation, order and degree. ❖ Equations of first order and first degree (i) Method of separation of variables; Homogeneous equations (ii) Exact equations and their solution, In-exact equations, Integrating Factors (iii) Linear and Bernoulli's equations ❖ Equations of first order and higher degree Equations solvable for p, solvable for x, solvable for y; Clairaut's equations,	**8L**
2	**Higher Order Ordinary Differential Equations:** (i) Equations with constant coefficients, D-operator, Complementary Function (CF) and Particular Integral (PI) (ii) Cauchy-Euler's homogeneous equations (iii) Method of variation of parameters (iv) Solution of simultaneous first order ordinary differential equations	**8L**
3	**Improper Integrals:** (i) Improper integrals, their types, convergence criterion of some standard improper integrals (ii) Gamma and Beta functions, their relation (no proof) and applications	**3L**
4	**Laplace Transforms and Inverse Laplace Transforms:** (i) Definition of LT, LT of some standard functions; Properties of LT: Linearity, Change of scale property, First and Second Shifting property;	**8L**

	LT of a function multiplied by t^n and divided by t; LT of unit step and periodic functions; LT of derivatives. (ii) Inverse LT: Method of partial fractions, Convolution theorem (iii) Solutions of initial and boundary value problems by LT	
5	**Graph Theory:** (i) Introduction: Vertices, edges, loops, parallel edges, walk, trail, path, circuit; Euler and Hamiltonian circuits (ii) Connected and disconnected graph, directed and non-directed graph, simple graph, complete and bi-partite graph; Theorems on graph. (iii) Incidence and adjacency matrix; Graph isomorphism (iv) Shortest path: Dijkstra's algorithm	**8L**
6	**Tree:** (i) Definition of tree, binary tree; Theorems. (ii) Spanning tree: BFS and DFS algorithms (iii) Minimal spanning tree: Kruskal's and Prim's algorithms	**5L**
Total		**40L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand different techniques to solve first and second order ordinary differential equations with its formulation to address the modelling of systems and problems of engineering sciences.
2	Apply different types of transformations between two 2-dimensional planes for analysis of physical or engineering problems
3	Use tree and graph algorithms for different problems
4	evaluation of different types of improper integrals

Learning Resources:	
1	'Introduction to Quantum Mechanics' by David J. Griffiths
2	'Quantum Mechanics' by Leonard I. Schiff
3	'Quantum Physics' by A. N. Konar
4	'Perspectives of Modern Physics' by Aurther Beiser
5	'Introduction to Electrodynamics' by David J. Griffiths
6	'Electrical Engineering Materials' by A. J. Dekker
7	'Fundamentals of Optics' by Jenkins and White
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Course Name:	**Basic Electrical and Electronics Engineering**		
Course Code:	ES-EE201	**Category:**	Engineering Sciences Courses
Semester:	Second	**Credit:**	4
L-T-P:	4-0-0	**Pre-Requisites:**	Knowledge of Class XII level Physics & Mathematics
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Group A: Basic Electrical Engineering

Course Objectives:	
1	To provide comprehensive idea about AC and DC circuit analysis
2	To make the students understand about working principals and applications of electric machines
3	To make the students understand the components of low voltage electrical installations
4	To provide basic idea about general structure of electrical power system.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
Module 1	**DC Circuits** Kirchoff current and voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton theorems, maximum power transfer theorem.	**5**
Module 2	**AC Circuits** Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel),	4
Module 3	**Three phase system** Generation of three-phase AC power, Three-phase balanced circuits, voltage and current relations in star and delta connections. Relationship between line and phase quantities.	2
Module 4	**DC Machines** Construction, EMF equation, Principle of operation of DC generator, Principle of operation of DC motor, speed-torque characteristics of shunt and series machine, starting of DC motor	5
Module 5	**AC Machines** **Transformers** Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency **Three-phase induction motor**	4

	Generation of rotating magnetic fields, Construction and working of a three-phase induction motor.	
Module 6	**Electrical Installations** Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries.	3
Module 7	**General structure of electrical power system**: Power generation to distribution through overhead lines and underground cables with single line diagram	1
Total		**24**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Apply the concepts of KVL/KCL and network theorems in solving DC circuits.
2	Analyze the steady state behavior of single phase and three phase AC circuits.
3	Illustrate the working principles of DC machines, transformer as well as induction motor and employ them in different area of applications.
4	Describe the components of low voltage electrical installations.
5	Describe the general structure of electrical power system.

Learning Resources:	
1	D. P. Kothari and I. J. Nagrath, Basic Electrical Engineering, Tata McGraw Hill, 2010.
2	C.L. Wadhwa, Basic Electrical Engineering, New Age, 2007.
3	S K Bhattacharya, Basic Electrical and Electronics Engineering, Pearson, 2011
4	Ashfaq Husain and Haroon Ashfaq, Fundamentals of Electrical Engineering, Dhanpat Rai & Co., Delhi, 2007.
5	J.B. Gupta, Basic Electrical Engineering, Kataria& Sons, 2015.
6	L. S. Bobrow, Fundamentals of Electrical Engineering, Oxford University Press, 2011.
7	E. Hughes, Electrical and Electronics Technology, Pearson, 2010.

Group B: Basic Electronics Engineering

Course Objectives:	
1	To make the students understand about the semiconductor.
2	To make the students understand about Diode and its circuit.
3	To make the students understand about different Transistors.
4	To make the students understand about the basics of OPAMP and digital electronics.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1.	***Introduction to Semiconductors:*** Energy band theory, Fermi levels: Conductors, Semiconductors and Insulators: electrical properties, band diagrams, intrinsic and extrinsic,	5

	energy band diagram, electrical conduction phenomenon, P-type and N-type semiconductors, drift and diffusion carriers, mass action law.	
2	***Diode and Diode Circuits:*** Formation of P-N junction,depletion region, built-in-potential, forward and reverse biased P-N junction, energy band diagrams,V-I characteristics, Zener diode forward and reverse characteristics, Avalanche breakdown andzener breakdown., junction capacitance and varactor diode**.** Simple diode circuits, load line, linear piecewise model; rectifiers: half wave, full wave, PIV, ripple factor, efficiency**.**	4 3
3	***Introduction to Bipolar Junction Transistor(BJT) and Field Effect Transistor (FET):*** Formation of PNP / NPN junctions, schematic symbols, current components in BJT, energy band diagram, transistor mechanism and principle of operation, CE, CB, CC configuration and characteristics, cut-off, active and saturation mode, early effect. Qualitative discussion on BJT as an amplifier**.** JFET (N channel only)structure, Drain and Transfer characteristics.	4 2
4	***Introduction to OPAMP and Digital Electronics:*** Introduction to Operational Amplifiers: Characteristics, Inverting and Non-Inverting mode of operation, summing amplifier, difference amplifier. Introduction to binary number; Basic Boolean algebra; Introduction to integrated circuits, Logic gates and truth tables for different logic operations and simple digital circuits using the basic gates.	3 3
Total		**24**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Identify semiconductor materials, draw band-diagrams, distinguish between intrinsic and extrinsic semiconductors, n- and p- type semiconductors, calculate drift and diffusion current components
2	Explain the junction properties and the phenomenon of rectification, draw the I-V characteristics and identify operating points; Calculate ripple factors, efficiency of power supplies.
3	Draw and explain the I-V characteristics of BJTs and FET – both input and output;
4	Understand basics of OPAMP and learn the use of it as amplifier.
5	Explain binary numbers and identify different logic gates and circuit implementation.

Learning Resources:	
1	Rakshit and Chattopadhyay: Introduction to Electronics Principle
2	Malvino: Electronic Principle.
3	Millman &Halkias: Integrated Electronics.
4	Boyelstad &Nashelsky: Electronic Devices & Circuit Theory.

Course Name:	**English**		
Course Code:	HM-HU201	**Category:**	Humanities and Social Sciences including Management Courses
Semester:	Second	**Credit:**	2
L-T-P:	2-0-0	**Pre-Requisites:**	1. Students must have basic command of English to talk about day-to-day events and experiences of life. 2. Comprehend Lectures delivered in English. 3. Read and understand relevant materials written in English.
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To develop Technical Communication Skills (speaking, reading and writing).

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1.	**TECHNICAL COMMUNICATION**: Theory of Communication – Definition, Scope & Barriers of Communication. Different Communication Models Effective Communication (Verbal / Non-verbal) Presentation / Public Speaking Skills	1L
2	**VOCABULARY BUILDING**: Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives. Synonyms, antonyms, homonyms and standard abbreviations: Acronyms	1L
3.	**BASIC WRITING SKILLS**. Arranging paragraphs & Sentences in logical order Creating Cohesion. Organizing principles of paragraphs in documents. Techniques for writing precisely. Importance of proper punctuation. Creating coherence: Arranging paragraphs & Sentences in logical order.	1 L
4	**GRAMMAR**: Sentence Structures & Types: Simple, Compound, Complex. Use of phrases and clauses in sentences. Transformation of sentences. Articles, Prepositions, Tense, Voice, Narration. Identifying Common Errors in Writing. Subject-verb agreement. Noun-pronoun agreement. Misplaced modifiers. Redundancies. Clichés.	9 L
5	**WRITING PRACTICES**: Teaching all varieties of Technical Reports, Précis Writing, Essay Writing, Business Letters, Cover Letter & CV; E-mail, Memo, Notice, Agenda, Minutes.	10 L

6.	**READING COMPREHENSION**: Strategies for Reading Comprehension, Practicing Technical & Non-Technical Texts, both Seen (3 texts) and Unseen.	2L
Total		**24L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Acquire basic proficiency in English including reading comprehension, writing and speaking skills. Write grammatically correct English.
2	Acquire basic language skills (listening, speaking, reading and writing) in order to communicate in English.
3	Acquire linguistic competence necessarily required in various life situations.
4	Develop intellectual, personal and professional abilities.

Learning Resources:	
1.	Practical English Usage. Michael Swan. OUP. 1995.
2.	Remedial English Grammar. F.T. Wood. Macmillan.2007
3.	On Writing Well. William Zinsser. Harper Resource Book. 2001
4.	Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
5.	Universal English. Prof. Prasad Kataria Publications, 2019.
6.	"Communication Skills for Professionals"-Nira Konar, Prentice Hall of India 2nd edition, New Delhi, 2011
7.	Gajendra Singh Chauhan, Smita Kashiramka and L. Thimmesha. Functional English. Cengage, 2019. Course Outcomes The student will acquire basic proficiency in English including reading and listening comprehension, writing and speaking skills.

Course Name:	**Physics Laboratory**		
Course Code:	BS-PH291	**Category:**	Basic Science Courses
Semester:	Second	**Credit:**	1.5
L-T-P:	0-0-3	**Pre-Requisites:**	Nil
Full Marks:	100		
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05

Course Objectives:	
1	Apply the concepts of physics to carry out experiments on Quantum physics, EMT, Optics and General properties of matter and interpret the same for deduction of results.

Course Contents: (Choose 10 experiments from the following)		
Module No.	**Description of Topic**	**Contact Hrs.**
1	Determination of Dispersive Power of the Material of a Prism	**3P/ week**
2	Determination of wavelength of a monochromatic light by Newton's ring	
3	Determination of Wavelength of the Given LASER Light by Diffraction Method	
4	Determination of Thermo-electric Power of a given Thermocouple	
5	Determination of Specific Charge (e/m) of Electron by J. J. Thompson's Method	
6	Determination of Hall Coefficient of a Semiconductor	
7	Study of Current Voltage Characteristic, Load Response, Areal Characteristic and Spectral Response of a Photovoltaic Solar Cell	
8	Determination of Unknown Resistance using Carey Foster's Bridge	
9	Determination of Planck Constant using Photocell	
10	Verification of Bohr's Atomic Orbital Theory Through Frank-Hertz Experiment	
11	Determination of Rydberg Constant by Studying Hydrogen Spectrum	
12	Determination of Band Gap of a Semiconductor by Four Probe Method	
13	Determination of Young's Modulus of Elasticity of the Material of a Bar by the Method of Flexure	
14	Determination of Rigidity Modulus of the Material of a Wire by Dynamic Method	
15	Determination of Coefficient of Viscosity by Poiseulle's Capillary Flow Method	
Total		**39P**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Examine various semiconductor properties (Hall coefficient, Band gap) and relate the same to the theoretical laws they have learnt.
2	Analyze various solar cell properties to get an idea of optimized performance.
3	Verify quantization of energy in atoms and calculate the least action.
4	Apply the concept of thermo-emf for thermometric calibration and calculate specific charge for charge characterization and unknown resistances using Wheatstone bridge principle.
5	Compute different fundamental elastic constants & general properties of matter.
6	Apply the concept of interference and diffraction to calculate wavelength of light sources and use lasers in fiber optic communications.

Learning Resources:	
1	An Advanced Course in Practical Physics, by D. Chattopadhyay, P. C. Rakshit
2	A Manual of Practical Engineering Physics and Material Science, by A S Vasudeva
3	A Textbook of Engineering Physics Practical, by Dr. R Das, Dr. R Kumar, C S Robinson & P K Sahu

Course Name:	**Basic Electrical and Electronics Engineering Lab**		
Course Code:	ES-EE291	**Category:**	Engineering Sciences Courses
Semester:	Second	**Credit:**	2
L-T-P:	0-0-4	**Pre-Requisites:**	Knowledge of Class XII level Electronics, Physics & Mathematics
Full Marks:	100		
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05

Group A: Basic Electrical Engineering Laboratory

Course Objectives:	
1	Provide working knowledge for the analysis of basic DC and AC circuits
2	Measurement of power in three phase system
3	Provide working knowledge on Electric machines.

Course Contents:		
Module No.	**Description of Topic/ Experiment**	**Contact Hrs.**
1	Verification of Circuit Theorem, (a) Thevenin's Theorem (with DC sources only) (b) Norton's Theorem (with DC sources only)	3
2	Calibration of ammeter and Wattmeter.	3
3	Measurement of current, voltage and power in RLC series circuit excited by (single-phase) AC supply.	3
4	Measurement of power in a three phase unbalanced circuit by Two Wattmeter Method	3
5	(a) Open circuit and short circuit test of a single-phase transformer (b) Load test of the transformer and determination of efficiency and regulation	3
6	Determination of Torque –Speed characteristics of separately excited DC motor.	3
Total		**18 P**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Illustrate Thevenin's and Norton's theorems
2	Explain the concept of single phase and three phase AC supply.
3	Identify the parameters of a single phase transformer by open circuit and short circuit test.
4	Demonstrate the different characteristics of separately excited DC motor.

Learning Resources:	
1	Laboratory Manual

Group B: Basic Electronics Engineering Laboratory

Course Objectives:	
1	To make the students familiarize with the electronic tools and components.
2	To make the students understand about p-n junction diode and zener diode characteristics and half wave and full wave rectifiers' performances.
3	To make the students understand about the characteristics of BJT and JFET in different modes of operation of it.
4	To make the students understand about the basics of OPAMP and logic gates.

Course Contents:		
Exp. No.	**Description of Topic**	**Contact Hrs.**
1.	Familiarisation with passive and active electronic components such as Resistors, Inductors, Capacitors, Diodes, Transistors (BJT) and electronic equipment like DC power supplies, multimeters etc. Familiarisation with measuring and testing equipment like CRO, Signal generators etc.	3
2	a) Study of I-V characteristics of Junction diodes. b) Study of I-V characteristics of Zener diodes.	3
3	Study of Half and Full wave rectifiers with Regulation and Ripple factors.	3
4	a) Study of I-V characteristics of BJTs. for CB configurations b) Study of I-V characteristics of BJTs. for CE configurations	3
5	a) Study of drain characteristics of n-channel Junction Field Effect Transistors. b) Study of OPAMP as inverting and non-inverting amplifiers and determination of gain.	3
6	Study of Logic Gates and realization of Boolean functions using Logic Gates.	3
Total		**18P**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Identify different electronic components and can select appropriate tools and/or equipments for performing specific operation.
2	Realize the I-V characteristics of a p-n junction diode and a zener diode and will be able to understand the applicability of them in relation to their characteristics.
3	Implement half wave and full wave rectifier circuits and can analyse the performance of them.
4	Realize the I-V characteristics of BJT in CB and CE configurations and will be able to identify different operating regions of it.
5	Realize the I-V characteristics of JFET and will be able to identify different operating regions of it.
6	Use OPAMP as amplifier and verify the truth tables of different logic gates.

Learning Resources:	
1	Laboratory Manual

Course Name:	**Engineering Graphics & Design**		
Course Code:	ES-ME291	**Category:**	Engineering Sciences Courses
Semester:	Second	**Credit:**	3
L-T-P:	1-0-4	**Pre-Requisites:**	Nil
Full Marks:	100		
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05

Course Objectives:	
1	To make students aware of importance of engineering drawing and to familiar with the drawing tools and standards.
2	To improve the technical communication skill in the form of communicative drawing for solution of science & engineering problems.
3	To develop ability to apply modern CAD tools in engineering practice

Course Contents:

Module No.	Description of Topic/ Experiment	Contact Hrs.
1	**Introduction to Engineering Drawing**: Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Different types of lines and their use; Drawing standards and codes.	1L+4P
2	**Lettering, Dimensioning, Scales:** Plain scale, Diagonal scale and Vernier Scales.	1L+4P
3	**Geometrical Construction and Curves:** Construction of polygons, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid, Involute, Archimedean Spiral.	1L+4P
4	**Projection of Points, Lines, Surfaces**: Principles of Orthographic Projections-Conventions - 1st and 3rd angle projection, Projections of Points and lines inclined to both planes; Projections of planes (Rectangle, pentagon, Hexagon etc.) inclined Planes - Auxiliary Planes.	1L+4P
5	**Projection of Regular Solids:** Regular solids inclined to both the Planes- Auxiliary Views; Draw simple annotation, dimensioning and scale (Cube, Pyramid, Prism, Cylinder, Cone).	1L+4P
6	**Combination of Regular Solids, Floor Plans:** Regular solids in mutual contact with each other like Spheres in contact with cones standing on their base. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc.	1L+4P
7	**Isometric Projections:** Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions;	1L+4P
8	**Sections and Sectional Views Of Right Angular Solids:** Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw the	1L+4P

	sectional orthographic views of geometrical solids, objects from industry and dwellings (foundation to slab only)	
9	**Overview of Computer Graphics, Customisation& CAD Drawing:** listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.; Isometric Views of lines, Planes, Simple and compound Solids]; Set up of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerancing; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles;	1L+4P
10	**Annotations, Layering & Other Functions:** applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation, Computer- aided design (CAD) software modelling of parts and assemblies. Parametric and non-parametric solid, surface, and wireframe models. Part editing and two-dimensional documentation of models. Planar projection theory, including sketching of perspective, isometric, multiview, auxiliary, and section views. Spatial visualization exercises. Dimensioning guidelines, tolerancing techniques; dimensioning and scale multi views of dwelling;	2L+8P
11	**Demonstration of A Simple Team Design Project:** Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; meshed topologies for engineering analysis and tool-path generation for component manufacture; geometric dimensioning and tolerancing; Use of solid- modelling software for creating associative models at the component and assembly levels; floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Applying colour coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling; Introduction to Building Information Modelling (BIM).	2L+8P
Total		**13L+52P**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Familiarize with basics of drawing, dimensioning, scales, curves
2	Comprehend the theory of orthographic projection and its applications
3	Prepare and interpret isometric projection
4	Create and modify 2D drawing using AutoCAD software

Learning Resources:	
1	Pradeep Jain, Ankita Maheswari, A.P. Gautam, Engineering Graphics & Design, Khanna Publishing House
2	Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House
3	Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication
4	Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education
5	Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers
6	Corresponding set of CAD Software Theory and User Manuals

Third Semester

Course Name:	**Communication Engineering**		
Course Code:	ES-EC301(D)	**Category:**	Engineering Science Courses
Semester:	3rd Semester	**Credit:**	2
L-T-P:	2-0-0	**Pre-Requisites:**	Digital Electronics
Full Marks:	100		
Examination Scheme:	Semester Examination: 70 Continuous	Assessment: 25	Attendance: 05

Course Objectives:	
1	To analyze Base band signal to different Analog (continuous & discrete) and Digital modulation technique along with it's functionality.
2	Analyze the efficiency of the system by considering Bit rate, Baud rate, Channel capacity and Channel efficiency with different encoding technique and their limitations and applications.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	***Elements of Communication system, Analog Modulation & Demodulation:*** Elements of Communication systems (mention of transmitter, receiver and channel, Introduction to Base Band transmission & Modulation and its needs***;*** Basic principles of Linear Modulation, Amplitude Modulation, Spectrum of AM Signal, The Balanced Modulator, The Square law Demodulator, DSB-SC, SSB-SC, their Methods of Generation and Demodulation, Phase-locked Loop (PLL). Basic principles of Non-linear modulation (Angle Modulation - FM, PM) Frequency Modulation Systems, Frequency Deviation, Spectrum of FM Signal with Sinusoidal Modulation, Bandwidth of FM Signal Narrowband and wideband FM, Generation of FM Signal, FM Demodulator.	6
2	***Noise, SNR Analog-to-Digital Conversion*****:** Noise in Communication systems - Internal & External noise, Signal-to-Noise ratio, White noise, thermal noise, Figure of Merit. Importance of SNR in system design.Sampling theorem, Sampling rate, Reconstruction from samples, Aliasing, Application of Sampling Theorem, PAM, PWM and PPM Signal Generation and Detection. Basic concept of Pulse Code Modulation, Block diagram of PCM; Multiplexing - TDM, FDM.	6
3	**Digital Transmission, Modulation & Demodulation Techniques:** Concept of Quantisation & Quantisation error, Uniform Quantiser, Non-uniform Quantiser, A-law & μ law, companding***;*** Encoding, Coding efficiency, Line coding & properties, NRZ & RZ, AMI, Manchester coding PCM, DPCM***;***. Bit rate, Baud rate, Information capacity, Shanon's limit***;*** M-ary encoding, Introduction to the different digital modulation techniques - ASK, FSK, PSK, BPSK, QPSK, Introduction to	6

	QAM, mention of 8QAM, 16 QAM without elaboration; Delta modulation, Adaptive delta modulation..	
4	**Information Theory & Coding**: Introduction, News value & Information content , Entropy, Mutual information , Information rate, Shanon-Fano algorithm for encoding, Shannon's Theorem - Source Coding Theorem, Channel Coding Theorem, Information Capacity Theorem, Error Control & Coding – basic principle only;	5
Total		**24**

Course Outcomes:	
After completion of the course, students will be able to:	
1	The need for modulation and its requirements.
2	Concept of different analog and digital modulation techniques, their principles.generation and detection.
3	Know the different types of noise and its importance in system design.
4	Compute the coding efficiency of the systems and its relative merits and demerits of the different line coding techniques.
5	Calculate the information content, entropy, information rate and error correcting techniques for given situations.

Learning Resources:	
1	Principles of Communication Systems by Taub & Schilling, 2nd Edition. Tata Mc Graw Hill.
2	Communication Systems by Siman Haykin,4th Edition, John Wiley and Sons Inc.
3	Modern digital and analog communication system, by B. P. Lathi, 3rd Edition, Oxford University Press.
4	Communication Systems by V. Chandra Sekar, 1st edition, Oxford University Press.

Course Name:	**Digital Electronics**		
Course Code:	ES-EC302	**Category:**	Engineering Science Courses
Semester:	Third	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Basic Electronics
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To acquire the basic knowledge of digital logic gates and apply it to understand digital electronics circuits.
2	To prepare students to perform the analysis and design of various digital electronic circuits
3	To know different logic family, A/D Converter, D/A Converter.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**Introduction to Number System and code:** Number System and Number Base Conversion, BCD, ASCII, EBDIC, Gray codes and their conversions; Signed binary number representation with 1's and 2's complement methods, Binary arithmetic.	4
2	**Boolean algebra and Logic Gates:** Venn diagram, Boolean operations and functions, algebraic manipulation, minterms and maxterms, sum-of-products and product-of-sum representations, Digital Logic gates	4
3	**Simplification of Boolean functions:** K-map method, don't care conditions, prime implicants, Quine-McCluskey method	5
4	**Combinational logic circuits:** Adders and subtractors, comparator, multiplexer, demultiplexer, decoder, encoder, parity generator etc.	5
5	**Sequential Circuits:** Basic Flip-flop & Latch, Clocking and timing issues, Monostable and Astable Circuit using 555 Timer. Flip-flops -SR, JK, D, T and JK Master-slave Flip Flops, Registers (SISO, SIPO, PIPO, PISO) Ring counter, Johnson counter Basic concept of Synchronous and Asynchronous counter, General counter design methodology.	12
6	**Logic families:** TTL, ECL, MOS and CMOS - basic concepts	2
7	**A/D and D/A conversion techniques:** Basic concepts D/A: R-2-R only A/D: Successive Approximation	4
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Realize number systems, basic gate operations and laws Boolean algebra.
2	Understand basic structure of different combinational circuits- multiplexer, decoder, encoder etc.
3	Perform different operations with sequential circuits.
4	Design A/D and D/A conversion techniques and articulate the basic concepts of Logic families.

Learning Resources:	
1	Morris Mano- Digital Logic and Computer Design- PHI
2	Leach & Malvino—Digital Principles & Application, 5/e, McGraw H
3	Floyed & Jain- Digital Fundamentals-Pearson.

4	S. Salivahanan, S. Arivazhagan – Digital Circuits and Design
5	D. Ray Chaudhuri- Digital Circuits-Vol-I & II, 2/e- Platinum Publisher
6	Tocci, Widmer, Moss- Digital Systems,9/e- Pearson

Course Name:	**Mathematics III**		
Course Code:	BS-M 301	**Category:**	Basic Science Course
Semester:	3rd	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	High school mathematics and BSM-101
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To understand probability theory and its applications.
2	To know about Bivariate distribution and Marginal distribution.
3	To learn Fourier series & transform.
4	To use the concept of generating function in solving recurrence relation.
5	To know about sampling distribution and hypothesis

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Module-1: Basic Probability:** • **Probability** (i) Definition of random experiment, sample space, events and probability. (ii) Basic theorems (Statement only) of probability and related problems. (iii) Conditional probability and independent events; Multiplication theorem; Baye's theorem (statement only) and related problems. • **Probability Distribution** (i) Definition of random variable; Discrete and continuous random variable; Probability mass function (p.m.f.) and probability density function (p.d.f.) of single random variable; Cumulative distribution function (c.d.f.); Applications. (ii) Expectation and variance of random variable; Properties and applications. (iii) **Some special types of distributions** ➢ **Discrete probability distribution:** Binomial and Poisson distributions; Mean and variance (no proof) and examples. ➢ **Continuous probability distribution:** Uniform, Exponential and Normal distributions; Mean and variance (no proof) and examples	8
2	**Module-2: Bivariate Probability Distribution:**	6

	• **Discrete bivariate distribution** (i) Joint probability distribution of two discrete random variables, marginal distribution. (ii) Expectation, variance, covariance; Independent random variables. • **Continuous bivariate distribution** (i) Joint probability distribution of two continuous random variables, marginal distribution. (ii) Expectation, variance, covariance; Independent random variables.	
3	**Module-3: Statistics:** • **Sampling distribution** (i) Population and sampling distribution; statistic, standard error and confidence interval. (ii) Point and interval estimation; unbiased and consistent estimator; maximum likelihood estimate. (iii) Chebyshev's inequality. • **Test of hypothesis** (i) Simple and composite hypothesis. Critical region. Level of significance. (ii) Type I and Type II errors. (iii) One sample and two sample tests for means and proportions. χ^2 - test for goodness of fit.	8
4	**Module-4: Fourier Series and Fourier Transforms:** • **Fourier Series** (i) Periodic function and periodic extension of a function; Odd and even functions. (ii) **Special wave forms:** square wave, half wave rectifier, full wave rectifier, saw-toothed wave, triangular wave (graphical illustration only). (iii) Euler's formulae for Fourier series; Fourier series of functions of period 2π; Fourier series of functions of period $2l$; Dirichlet's conditions and related problems. (iv) Half range Sine and Cosine series and related problems. (v) Parseval's identity (statement only) and related problems. • **Fourier Transforms** (i) Definition of Fourier transforms; Properties of Fourier transforms: Linearity, Shifting, change of scale property; Fourier transforms of some elementary functions; Fourier transforms of derivatives. (ii) Fourier sine and cosine transforms and related problems. (iii) Inverse Fourier transforms and convolution theorem; related problems.	10
5	**Module-5: Recurrence Relation & Generating Function** • **Generating Function** (i) Introduction to generating function (ii) Some standard generating functions	5

	(iii) Solution of recurrence relations by generating functions	
Total		**37**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Learn the ideas of probability and random variables, various discrete and continuous probability distributions with their properties and their applications in physical and engineering environment
2	Understand the basic ideas of statistics with different characterisation of a univariate and bivariate data set.
3	Apply statistical tools for analysing data samples.
4	Learn the tools of Fourier transform to analyze engineering problems and apply the concept of convergence of infinite series in many approximation techniques in engineering disciplines.
5	To solve engineering problems using z transform and probability theory.

Learning Resources:	
1	Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.
2	Michael Greenberg, Advanced Engineering Mathematics, Pearson.
3	B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers.
4	Kanti B. Dutta, Mathematical Methods of Science and Engineering, Cenage Learning
5	Reena Garg, Chandrika Prasad, Advanced Engineering Mathematics, Khanna Publishers.
6	N.G. Das, Statistical Methods (Combined Volume), Tata-McGraw Hill
7	S. Ross, A First Course in Probability, Pearson Education India
8	W. Feller, An Introduction to Probability Theory and its Applications, Vol. 1, Wiley

Course Name:	**Data Structures and Algorithms**		
Course Code:	PC-CS301	**Category:**	Professional Core Courses
Semester:	Third	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Programming Concept, Basic Mathematics
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To familiarize the students with the basic concepts of linear data structures and operations on it.
2	To acquaint the students with nonlinear data structures and its application areas.
3	To develop the ability to compare complexity of different sorting and searching algorithms.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Introduction: Basic Terminologies: Elementary Data Organizations, Array, Data Structure Operations: insertion, deletion, traversal etc. Analysis of an Algorithm: Asymptotic Notations, Time-Space trade off. Searching: Linear Search and Binary Search algorithms and their complexity analysis, Interpolation Search algorithm. Recursion: Definition and Types with examples of each types, Tower of Hanoi problem and its complexity analysis.	6
2	Stacks and Queues: Stack as an ADT and its operations, Applications of Stacks: Expression Conversion and Evaluation – corresponding algorithms. Queue as an ADT: Types of Queue: Linear Queue, Circular Queue, Priority Queue; Operations on each types and their algorithms. Dequeue: Basic concept and associated algorithms.	6
3	Linked Lists: Singly linked lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from linked list; Linked representation of Stack and Queue, Application of Linked list: representation of Polynomial and addition of two polynomials. Doubly linked list and Circular Linked List: Basic Concept and Operations.	6
4	Trees: Basic Tree Terminologies, Different types of Trees: Binary Tree, its properties, Complete and Strictly Binary Tree, Threaded Binary Tree, Binary Search Tree: insertion, deletion & traversal algorithms, AVL tree, Applications of Binary Trees. B Tree, B+ Tree: definitions and construction algorithms. Graph: Basic terminologies and Representations, Graph traversal algorithms (BFS and DFS), Minimal Spanning Tree algorithms (Prim's and Kruskal's).	12
5	Sorting and Hashing: Objective and properties of different sorting algorithms: Bubble Sort, Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort; Performance analysis and comparison among all the methods; Hashing: Definition, Hash functions, Collision resolution techniques.	6
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand the basic concepts of Data structures and complexity of algorithms.
2	Comprehend the concepts of linear and nonlinear data structures and operations on them.
3	Apply the knowledge of linear and nonlinear data structures in solving problems.
4	Analyze complexity of different Sorting and Searching algorithms.

Learning Resources:	
1	"Data Structures with C" by Seymour Lipschutz, McGrawHill
2	"Data Structures Using C" by Reema Thareja, Oxford
3	"Fundamentals of Data Structures of C" by Ellis Horowitz, Sartaj Sahni
4	"Data Structures using C" by A N Tenenbaum, Y Langsam, M J Augenstein, Pearson

Course Name:	**Introduction to Industrial Management**		
Course Code:	HM-HU 301	**Category:**	Management Science and

			Humanities Courses
Semester:	Third	**Credit:**	2
L-T-P:	2-0-0	**Pre-Requisites:**	Nil
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	Contribute to the success of companies through effective problem solving.
2	Design, develop, implement, and improve integrated systems that include people, materials, information, equipment, and environments.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction** System- concept, definition, types, parameters, variables and behavior. Management – definition and functions. Organization structure: i. Definition. ii. Goals. iii. Factors considered in formulating structure. iv. Types. v. Advantages and disadvantages. vi. Applications. Concept, meaning and importance of division of labor, scalar & functional processes, span of control, delegation of authority, centralization and decentralization in industrial management. Organizational culture and climate – meaning, differences and factors affecting them. Moral-factors affecting moral. Relationship between moral and productivity. Job satisfaction- factors influencing job satisfaction. Important provisions of factory act and labor laws.	4
2	**Critical Path Method (CPM) and Programme Evaluation Review Technique (PERT):** CPM & PERT-meaning, features, difference, applications. Understand different terms used in network diagram. Draw network diagram for a real life project containing 10-15 activities, computation of LPO and EPO.(Take minimum three examples). Determination of critical path on network. Floats, its types and determination of floats. Crashing of network, updating and its applications	6
3	**Materials Management:** Material management-definition, functions, importance, relationship with other departments. Purchase - objectives, purchasing systems, purchase procedure, terms and forms used in purchase department. Storekeeping-functions, classification of stores as centralized and decentralized with their advantages, disadvantages and application in actual practice. Functions of store, types of records maintained by store, various types and applications of storage equipment, need and general methods for codification of stores. Inventory control: i. Definition. ii. Objectives. iii. Derivation for expression for Economic Order Quantity (EOQ) and numeric examples. iv. ABC analysis and other modern methods of	4

	analysis. v. Various types of inventory models such as Wilson's inventory model, replenishment model and two bin model. (Only sketch and understanding, no derivation.). Material Requirement Planning (MRP)-concept, applications and brief details about software packages available in market.	
4	**Production planning and Control (PPC):** Types and examples of production. PPC :i. Need and importance. ii. Functions. iii. Forms used and their importance. iv. General approach for each type of production. Scheduling- meaning and need for productivity and utilisation. Gantt chart- Format and method to prepare. Critical ratio scheduling-method and numeric examples. Scheduling using Gantt Chart (for at least 5-7 components having 5-6 machining operations, with processes, setting and operation time for each component and process, resources available, quantity and other necessary data), At least two examples. Bottlenecking- meaning, effect and ways to reduce.	6
5	**Value Analysis (VA) and Cost Control:** VA-definition, terms used, process and importance. VA flow diagram. DARSIRI method of VA. Case study of VA-at least two. Waste-types, sources and ways to reduce them. Cost control-methods and important guide lines.	3
6	**Recent Trends in IM:** ERP (Enterprise resource planning) - concept, features and applications. Important features of MS Project. Logistics- concept, need and benefits. Just in Time (JIT)-concept and benefits. Supply chain management-concept and benefits	3
Total		**36**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Interpret given organization structure, culture, climate and major provisions offactory acts and laws.
2	Explain material requirement planning and store keeping procedure.
3	Plot and analyze inventory control models and techniques.
4	Prepare and analyze CPM and PERT for given activities.
5	List and explain PPC functions.

Learning Resources:	
1	*L.S. Srinath– "CPM & PERT principles and Applications".*
2	*Buffa – "Modern Production Management".*
3	*N. Nair – "Materials Management".*
4	*O. P. Khanna – "Industrial Engineering & Management".*
5	*Mikes – "Value Analysis".*
6	*S.C. Sharma, "Engineering Management – Industrial Engineering & Management", Khanna Book Publishing Company, New Delhi*

Course Name:	**Biology**		
Course Code:	BS-BIO301	**Category:**	Basic Science Course
Semester:	3rd	**Credit:**	2
L-T-P:	2-0-0	**Pre-Requisites:**	Basic knowledge of Physics, Chemistry and Mathematics
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	Bring out the fundamental differences between science and engineering
2	Discuss how biological observations of 18th Century that lead to major discoveries

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**Module 1- Introduction to Biology:** To convey that Biology is as important a scientific discipline as Mathematics, Physics and Chemistry Bring out the fundamental differences between science and engineering by drawing a comparison between eye and camera, Bird flying and aircraft. Mention the most exciting aspect of biology as an independent scientific discipline. Why we need to study biology? Discuss how biological observations of 18th Century that lead to major discoveries. Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor. These examples will highlight the fundamental importance of observations in any scientific inquiry.	2
2	**Module2-Classification System in Biology:** The underlying criterion, such as morphological, biochemical or ecological be highlighted. Hierarchy of life forms at phenomenological level. A given organism can come under different category based on classification. Model organisms for the study of biology come from different groups. *E. coli, S. cerevisiae, D. melanogaster, C. elegance, A. thaliana, M. musculus.*	2
3	**Module 3: Genetics:** To convey that "Genetics is to biology what Newton's laws are to Physical Sciences" Mendel's laws, Concept of segregation and independent assortment. Concept of allele. Gene mapping, Gene interaction, Epistasis. Meiosis and Mitosis be taught as a part of genetics. Emphasis to be given not to the mechanics of cell division nor the phases but how genetic material passes from parent to offspring. Importance of stem cell research.	2
4	**Module 4: Biomolecules**: To convey that all forms of life have the same building blocks and yet the manifestations are as diverse as one can imagine Molecules of life. In this context discuss monomeric units and polymeric structures. Discuss about sugars, starch and cellulose. Amino acids and proteins. Nucleotides and DNA/RNA.	4

5	**Module 5: Enzymes:** To convey that without catalysis life would not have existed on earth Enzymology: How to monitor enzyme catalysed reactions. How does an enzyme catalyse reactions? Discuss at least two examples.	2
6	**Module 6: Information Transfer:** The molecular basis of coding and decoding genetic information is universal Molecular basis of information transfer. DNA as a genetic material. Hierarchy of DNA structure- from single stranded to double helix to nucleosomes. Concept of genetic code. Universality and degeneracy of genetic code. Define gene in terms of complementation and recombination.	4
7	**Module 7: Macromolecular analysis:** How to analyse biological processes at the reductionist level Proteins- structure and function. Hierarch in protein structure. Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements.	4
8	**Module 8: Metabolism:** ATP as an energy currency. This should include the breakdown of glucose to CO2 + H2O (Glycolysis and Krebs cycle) and synthesis of glucose from CO2 and H2O (Photosynthesis). Energy yielding and energy consuming reactions. Concept of Energy charge.	2
9	**Module 9: Microbiology:** Concept of microscopic organisms. Concept of species and strains. Identification and classification of microorganisms. Sterilization and media compositions. Growth kinetics. Microscopy: simple, compound, phase-contrast, SEM, TEM, Confocal: principle and applications.	2
Total		**24**

Course Outcomes:	
After completion of the course, students will be able to:	
1	State different engineering applications from biological perspective.
2	Classify biological systems and identify different organisms and microorganisms depending on their morphological, biochemical and ecological criterion.
3	Explain the concept of recessiveness and dominance during the passage of genetic material from parent to offspring and describe DNA as a genetic material in the molecular basis of information transfer.
4	Discuss structures of different biomolecules starting from basic units and hence understand different biological processes at the reductionistic level.
5	Describe protein structures and enzymology and also compare different mechanisms of enzyme action.
6	Describe energy transformation processes in biological systems.

Learning Resources:	
1	Biology for Engineers. Arthur T. Johnson. CRC Press.
2	Biology and Engineering of Stem Cell Niches. A K Vishwakarma and Jefferey Karp, Elsevier.
3	Environmental Biology for Engineers and Scientists. David A. Vaccari, P. P. Storm and J. F Alleman. ELBS

4	Biology for Engineers. G. K. Suraishkumar. Oxford

Course Name:	**Digital Electronics Laboratory**		
Course Code:	ES-EC392	**Category:**	Engineering Science Courses
Semester:	3rd	**Credit:**	1.5
L-T-P:	0-0-3	**Pre-Requisites:**	Basic Electronics
Full Marks:	100		
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05

Course Objectives:	
1	To acquire the basic knowledge of digital logic gates and application it to understand digital electronics circuits.
2	To prepare students to design various combinational and sequential circuits.
3	To know the working principle of A/D and D/A Converter.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Realization of Basic gates (AND,OR,NOT) from Universal Gates(NAND & NOR).	3
2	Implementation of the given Boolean function using logic gates in both sop and pos forms.	3
3	Design and Verify adder, subtractor Circuit	3
4	Implementation and Verification of Decoder, Encoder, Multiplexer, Demultiplexer Circuit	6
5	Verification of state tables of RS, JK, T and D flip-flops	3
6	Design of Shift Register	3
7	Design of Asynchronous Counter	3
8	Design of Synchronous Counter	3
9	Design of Ring/Johnson Counter	3
10.	Study of D/A Converter and A/D Converter Circuit	6
Total		**36P**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Realize basic gate operations and laws Boolean algebra.
2	Design of different combinational circuits.
3	Design of different sequential circuits.
4	Study of A/D converter and D/A converter circuits.

Learning Resources:	
1	Morris Mano- Digital Logic and Computer Design- PHI

2	Leach & Malvino—Digital Principles & Application, 5/e, McGraw H
3	Floyed & Jain- Digital Fundamentals-Pearson.
4	S. Salivahanan, S. Arivazhagan – Digital Circuits and Design
5	D. Ray Chaudhuri- Digital Circuits-Vol-I & II, 2/e- Platinum Publisher
6	Tocci, Widmer, Moss- Digital Systems,9/e- Pearson

Course Name:	**Data Structures and Algorithms Lab**		
Course Code:	PC-CS391	**Category:**	Professional Core Courses
Semester:	Third	**Credit:**	1.5
L-T-P:	0-0-3	**Pre-Requisites:**	Programming knowledge
Full Marks:	100		
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05

Course Objectives:	
1	To familiarize the students with programming concepts required for implementing linear data structures and operations on it.
2	To acquaint the students with dynamic memory allocation concepts required for implementing linear & nonlinear data structures.
3	To develop the ability to write menu driven programs that compares different sorting and searching techniques.

Course Contents: The course should cover (but may not limited to) C program implementation of the following topics

Module No.	Description of Topic	Contact Hrs.
1	**Linear Data Structure:** a) Basic data structure operations using Array b) Implementation of Stack operations using array c) Implementation of Linear Queue operations using array d) Implementation of Circular Queue operations using array	4×3
2	**Application of Stack:** a) Program to convert an infix expression to Postfix Expression b) Program for Evaluating a Postfix Expression. (optional)	1×3
3	**Programs using Dynamic Memory Allocation:** Implementation of Single Linked List and associated operations (menu driven) Application of Single Linked List : a) Implementation of Stack and Queue using Single Linked List. b) Program to add two Polynomials using Single Linked List (SLL).	3×3
4	Implementation of various Sorting algorithms (Menu driven) Implementation of various Searching algorithms (Menu driven)	3×3

5	**Implementation of Non-Linear Data Structure** a) Binary Search Tree: Construction and Traversal b) AVL tree: Construction and Traversal (optional)	1×3
Total		**36P**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Write the basic codes on linear Data structures and operations performed on it
2	Apply dynamic memory allocation concept to implement linear and nonlinear data structures programs
3	Apply the knowledge of linear data structures to solve expression conversion programs.
4	Compare different Sorting and Searching techniques by writing menu driven programs.

Learning Resources:	
1	"Data Structures with C" by Seymour Lipschutz, McGrawHill
2	"Data Structures Using C" by Reema Thareja, Oxford
3	"Fundamentals of Data Structures of C" by Ellis Horowitz, Sartaj Sahni
4	"Data Structures using C" by A N Tenenbaum, Y Langsam, M J Augenstein, Pearson

Course Name:	**IT Workshop (Using Python) Lab**		
Course Code:	PC-CS392	**Category:**	Professional Core Course
Semester:	Fourth	**Credit:**	1.5
L-T-P:	0-0-3	**Pre-Requisites:**	Familiar with any Basic computer language
Full Marks:	100		
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05

Course Objectives:	
1	a) Master the fundamentals of writing Python scripts b)Learn core Python scripting elements such as variables and flow control structures
2	a) Use Python to read and write files b) Make their code robust by handling errors and exceptions properly
3	a) Explore Python's object-oriented features b) Search text using regular expressions
4	Understand the Exception Handling and Object-oriented concept of Python.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**

1	**Introduction** History, Features, Setting up path, Working with Python, Basic Syntax, Variable and Data Types, Operator	3
2	**Conditional Statements** If , If- else, Nested if-else, Looping, For, While, Nested loops	3
3	**Control Statements** Break, Continue, Pass **String Manipulation** Accessing Strings, Basic Operations, String slices, Function and Methods	3
4	**Lists** Introduction, Accessing list, Operations, Working with lists, Function and Methods **Tuple** Introduction, Accessing tuples, Operations, Working, Functions and Methods **Dictionaries** Introduction, Accessing values in dictionaries, Working with dictionaries, Properties	6
5	**Functions** Defining a function, Calling a function, Types of functions, Function Arguments, Anonymous functions, Global and local variables **Modules** Importing module, Math module, Implementation of Array using numpy module, Random module, Packages, Composition, Input-Output	6
6	**Exception Handling** Exception, Exception Handling, Except clause, Try- finally clause, User Defined Exceptions	3
7	**The Object-Oriented Approach: Classes, Methods, Objects** Basic concepts of object programming, Implementation of Properties of Object-oriented Programming, Inheritance.	3
8	**File Handling** Introduction to File Handling, Data Files, Opening and Closing Files, Reading and Writing Files	3
9	**Data Visualization using Python** Concept of Data Visualization, Using Pyplot of Matplotlib library, Creating Line chart, Bar chart and Pie chart using pyplot interface, Customizing the Plot	3
Total		**36P**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand and develop Computational Thinking concepts.
2	Express a problem-solving strategy to breakdown a complex problem into a series of simpler tasks.

3	Describe python programs that appropriately utilize built-in functions and control flow statements.
4	Use functions for structuring Python programs
5	Represent compound data using Python lists, tuples, dictionaries
6	Knowledge of different Charts along with the comparison of different charts.

Learning Resources:	
1	"Core Python Programming" by R.Nageswar Rao
2	"Python:the complete reference" by Martin C.Brown
3	"Let us Python" by Yashvant Kanetkar
4	"Programming and Problem Solving With Python" by Ashok Namdev Kamthane and Amit Ashok Kamthane
5	"Python Programming" by Anurag Gupta and G. P. Biswas

Course Name:	**Environmental Science**		
Course Code:	MC371	**Category:**	Mandatory Course
Semester:	Third	**Credit:**	0
L-T-P:	2-0-0	**Pre-Requisites:**	Basic concepts of Environmental Science
Full Marks:	100		
Examination Scheme:	Semester Examination of 100 marks		

Course Objectives:	
1	Purpose: We as human being are not an entity separate from the environment around us rather we are a constituent seamlessly integrated and co-exist with the environment around us. We are not an entity so separate from the environment that we can think of mastering and controlling it rather we must understand that each and every action of ours reflects on the environment and vice versa. Ancient wisdom drawn from Vedas about environment and its sustenance reflects these ethos. There is a direct application of this wisdom even in modern times.
2	Idea of an activity based course on environment protection is to sensitize the students on the above issues through following two type of activities.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**(a) Awareness Activities:** i) Small group meetings about any of the topic. ii) Slogan making event iii) Poster making event iv) Seminar on any of the topic. v) Preparation of a report on any of the topic regarding current scenario.	 4 2 5 4 4
2	**(b) Actual Activities:** i) Plantation ii) Gifting a tree to see its full growth iii) Cleanliness drive	 1 1 1

	iv) Drive for segregation of waste v) Shutting down the fans and ACs of the campus for an hour or so	1 1
		24

Course Outcomes:	
After completion of the course, students will be able to:	
1	Explain basic concepts, man, society & environment, their interrelationship, mathematics of population growth and associated problems, steady state conservation system.
2	Demonstrate natural environmental hazards like flood, earthquake, landslide-causes, effects and control/management.
3	Classify air pollution, water pollution, land pollution, noise pollution and their controls.
4	Study Elements of ecology and environmental management.

Learning Resources:	
1	M.P. Poonia & S.C. Sharma, Environmental Studies, Khanna Publishing House, New Delhi, 2019
2	Environmental science by Gillbert G. Master

Fourth Semester

Course Name:	**Numerical Methods**		
Course Code:	BS-M 404	**Category:**	Basic Science Course
Semester:	4th	**Credit:**	2
L-T-P:	2-0-0	**Pre-Requisites:**	Some concepts from basic math – algebra, geometry, pre-calculus and statistics
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To compute different numerical errors in computations.
2	To learn interpolation techniques.
3	To apply the techniques for solving integrations, ODEs.
4	Solve linear and non-linear equations.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Approximation in numerical computation:** Truncation and rounding errors, Fixed and floating-point arithmetic, Propagation of errors.	2
2	**Interpolation:** Newton's Forward Interpolation, Newton's Backward Interpolation, Lagrange's Interpolation, Newton's Divided Difference Interpolation	4
3	**Numerical integration:** General Quadrature Formula, Trapezoidal Rule, Simpson's 1/3 Rule, Expression for corresponding error terms	3
4	**Numerical solution of a system of linear equations:** Gauss Elimination Method, Matrix Inversion, LU Factorization Method, Gauss-Seidel Iterative Method	6
5	**Numerical solution of Non-Linear equation:** Bisection Method, Regula-Falsi Method, Newton-Raphson Method	4
6	**Numerical solution of ordinary differential equation:** Euler's Method, Runge-Kutta Methods, Predictor-Corrector Methods, Finite Difference Method	5
7	**Measure of Central Tendency and Dispersion:** Mean, median, mode and S.D.	3
8	**Curve Fitting by Method of Least Square:** Fitting a straight line of the form $y = a + bx$, Fitting a curve of the form $y = ax + bx^2$, $y = ab^x, y = ae^{bx}, y = ax^b$.	3
Total		**30**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems.
2	Apply numerical methods to obtain approximate solutions to mathematical problems.
3	Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.
4	Analyse and evaluate the accuracy of common numerical methods.

Learning Resources:	
1	C.Xavier: C Language and Numerical Methods.
2	A. K. Jalan and Utpal Sarkar, Numerical Methods-A Programming Based Approach, Orient Blackswan Private Ltd.
3	Dutta & Jana: Introductory Numerical Analysis.
4	J.B.Scarborough: Numerical Mathematical Analysis.
5	Jain, Iyengar , & Jain: Numerical Methods (Problems and Solution).
6	Balagurusamy: Numerical Methods, Scitech.
7	Baburam: Numerical Methods, Pearson Education.
8	N. Dutta: Computer Programming & Numerical Analysis, Universities Press.
9	Soumen Guha & Rajesh Srivastava: Numerical Methods, OUP.
10	Srimanta Pal: Numerical Methods, OUP.

Course Name:	**Computer Organization and Architecture**		
Course Code:	PC-CS(D)401	**Category:**	Professional Core

			Course
Semester:	Fourth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Digital Electronics
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To introduce students how Computer Systems work & basics involved in data representation.
2	This course will also expose students to the basic organization of Processor and Memory System.
3	The students will be able to know how I/O devices are being accessed.
4	To learn the principles of pipelining
5	To distinguish between the concepts of serial, parallel, pipeline architecture.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Basic Computer Organization and Data Representation** Basic organization of the stored program computer and operation sequence for execution of a program. Role of operating systems and compiler/assembler. Fetch, decode and execute cycle, Commonly used number systems. Fixed- and floating-point representation of numbers Floating point - IEEE 754 standard, Overflow, Underflow	3
2	**Microoperation and Computer Arithmetic:** Arithmetic Microoperations, Logic Microoperations, Shift Microoperation Design of adders - Ripple carry adder, Serial Adder and Carry Look Ahead Adder, Arithmetic Circuit Fixed point multiplication -Booth's algorithm.	4
3	**Central Processing Unit** General Register Organization, Stack Organization Instruction Formats, Addressing Modes, Instruction Set, CISC Characteristics, RISC Characteristics Design of control unit - hardwired and microprogrammed control.	3
4	**Memory Organization** Static and dynamic memory, Memory hierarchy, Associative memory. Cache memory, Associative Mapping, Direct Mapping, Set Associative Mapping, Virtual memory, Paging, Segmentation, Page Replacement Algorithm, Memory unit design with special emphasis on implementation of CPU-memory interfacing. Data path design for read/write access.	8
5	**Input-Output Organization** Peripheral Devices, Input-Output Interface, Asynchronous Data Transfer, Mode of Transfer, Priority Interrupt, Direct Memory Access	3

6	**Pipelining** Basic concepts, instruction and arithmetic pipeline, data hazards, control hazards and structural hazards, techniques for handling hazards. Exception handling. Pipeline optimization techniques; Compiler techniques for improving performance.	6
7	**Instruction-level parallelism** Basic concepts, techniques for increasing ILP, superscalar, super pipelined and VLIW processor architectures. Array and vector processors.	4
8	**Multiprocessor architecture** Taxonomy of parallel architectures; Centralized shared- memory architecture: synchronization, memory consistency, interconnection networks. Distributed shared memory architecture. Cluster computers. Non von Neumann architectures: data flow computers, reduction computer architectures, systolic architectures.	5
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Describe Computer hardware, System, Instruction sets and Addressing Mode.
2	Design memory organization that uses banks for different word size operations.
3	Learn pipelining concepts with a prior knowledge of stored program methods
4	Study of parallel architecture and interconnection network

Learning Resources:	
1	Mano, M.M., "Computer System Architecture", PHI.
2	Hayes J. P., "Computer Architecture & Organisation", McGraw Hill,
3	Hamacher, "Computer Organisation", McGraw Hill,
4	William Stallings "Computer Organization and Architecture Designing for Performance", Pearson
5	J. L. Hennessy and D. A. Patterson, "Computer Architecture A Quantitative Approach", Morgan Kauffman, 2011.
6	Hwang & Briggs—Computer Architecture & Parallel Processing, TMH
7	B.Ram – "Computer Organization & Architecture", Newage Publications
8	Rajaraman – "Computer Organization & Architecture", PHI
9	Hwang, K. "Advanced Computer architecture with parallel programming", McGraw Hill, 1993

Course Name:	**Operating System**		
Course Code:	PC-CS 402	**Category:**	Professional Core Course
Semester:	Fourth	**Credit:**	3

L-T-P:	3-0-0	**Pre-Requisites:**	Computer Organization
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To Learn Operating System concepts and algorithms
2	To gain the knowledge about the application and analysis of algorithms

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Introduction: Types of Operating Systems, OS Services, System Calls, Structure of an OS - Layered, Monolithic, Microkernel Operating Systems, Concept of Virtual Machine.	3
2	Processes: Definition, Process Relationship, Different states of a Process, Process State transitions, Process Control Block (PCB), Context switching Thread: Definition, Various states, Benefits of threads, Types of threads, Concept of multithreads, Process Scheduling: Foundation and Scheduling objectives, Types of Schedulers, Scheduling criteria: CPU utilization, Throughput, Turnaround Time, Waiting Time, Response Time; Scheduling algorithms: Pre-emptive and Non pre-emptive, FCFS, SJF, RR	6
3	Deadlocks: Definition, Necessary and sufficient conditions for Deadlock, RAG, Deadlock Prevention, Deadlock Avoidance: Banker's algorithm, Deadlock detection and Recovery.	4
4	Inter-process Communication: Critical Section, Race Conditions, Mutual Exclusion, Hardware Solution, The Producer Consumer Problem, Semaphores, Event Counters, Message Passing, Classical IPC Problems: Reader's & Writer Problem, Dinning Philosopher Problem etc.	6
5	Memory Management: Basic concept, Logical and Physical address map, Memory allocation: Contiguous Memory allocation– Fixed and variable partition– Internal and External fragmentation and Compaction; Paging, Protection and sharing, Disadvantages of paging, segmentation	6
6	Virtual Memory: Basics of Virtual Memory – Hardware and control structures – Locality of reference, Page fault, Working Set, Dirty page/Dirty bit – Demand paging, Page Replacement algorithms: Optimal, First in First Out (FIFO), Not recently used (NRU) and Least Recently used (LRU).	4
7	Disk Management: Disk structure, Disk scheduling - FCFS, SSTF, SCAN, C-SCAN, Boot-block, Bad blocks	4
8	File Management: Concept of File, Access methods, File types, File operation, Directory structure, File System structure, Allocation methods (contiguous, linked, indexed), Free-space management (bit vector, linked list, grouping), directory implementation (linear list, hash table).	3
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Recall and understand introductory concepts of operating system
2	Apply and analyze process scheduling methods and deadlock handling schemes
3	Understand inter process communication
4	Understand, apply and analyze memory management and disk management procedures

Learning Resources:	
1	Operating System Concepts, Silberschatz, Galvin and Gagne, Wiley
2	Principles of Operating System, Naresh Chauhan, Oxford
3	Operating System, Deitel, Deitel, Pearson

Course Name:	Design and Analysis of Algorithm		
Course Code:	PC-CS403	Category:	Mandatory Course
Semester:	Fourth	Credit:	3
L-T-P:	3-0-0	Pre-Requisites:	Data Structure, Discrete Mathematics, Basic Programming Ability
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	The aim of this course is to learn how to develop efficient algorithms for simple computational tasks and reasoning about the correctness of them
2	Through the complexity measures, different range of behaviors of algorithms and the notion of tractable and intractable problems will be understood.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction:** Characteristics of algorithm. Analysis of algorithm: Asymptotic analysis of complexity bounds – best, average and worst-case behavior; Performance measurements of Algorithm, Time and space trade-offs, Analysis of recursive algorithms through recurrence relations: Substitution method, Method of Iteration, Recursion Tree method and Masters' theorem (Examples: Analysis of Binary Search, Merge Sort and Quick Sort using Recurrence)	6
2	**Fundamental Algorithmic Strategies:** **Divide and Conquer Method:** Basic method, use, Example – Max-Min Problems and its complexity analysis. **Greedy Method:** Basic method, use, Examples – Fractional Knapsack Problem, Job sequencing with deadlines, Activity Scheduling Problem,	10

	Travelling Salesperson Problem and their complexity analysis **Dynamic Programming:** Basic method, use, Examples – Matrix Chain Manipulation, 0/1 Knapsack Problem and their complexity analysis **Branch and Bound and Backtracking:** Basic method, use, Examples – 15 Puzzles Problem, N queens' problem, Graph Coloring problem, Hamiltonian Cycle Problem	
3	**Graph and Tree Algorithms:** Traversal algorithms: Recapitulation of Depth First Search (DFS) and Breadth First Search (BFS); Shortest path Algorithms (Single Source and All Pairs with their Complexity Analysis), Transitive Closure, Minimum Spanning Tree (Prim's and Kruskal's Algorithms with their Complexity Analysis), Topological Sorting, Ford Fulkerson algorithm, Max-Flow Min-Cut theorem (Statement and Illustration).	10
4	**Tractable and Intractable Problems:** Computability of Algorithms, Computability classes – P, NP, NP- complete and NP-hard. Satisfiability Problem, Cook's theorem, Clique decision problem	6
5	**Advanced Topics:** Approximation Algorithms: Introduction and Example - Vertex Cover Problem, Randomized Algorithms: Introduction and Example - Quick Sort	4
Total		**36**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Recall the fundamental concepts of Asymptotic Notations and identify their mathematical significance and analyze worst-case running times of algorithms based on asymptotic analysis and justify the correctness of algorithms. Derive and solve recurrence relation.
2	Describe different algorithm design techniques like D&C, Greedy Method, DP, Backtracking, Branch and Bound, Graph Algorithms, NP etc and their implementations.
3	Apply appropriate algorithms and required Data Structure to construct the solution of a given problem.
4	Explain Randomized algorithms (expected running time, probability of error), and Approximation algorithm to compute approximation factors.
5	Analyze algorithms and determine the correctness.

Learning Resources:	
1	Introduction to Algorithms, 4TH Edition, Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, MIT Press/McGraw-Hill.
2	Fundamentals of Algorithms – E. Horowitz et al.
3	Algorithm Design, 1ST Edition, Jon Kleinberg and ÉvaTardos, Pearson.
4	Algorithm Design: Foundations, Analysis, and Internet Examples, Second Edition, Michael T Goodrich and Roberto Tamassia, Wiley.
5	Algorithms -- A Creative Approach, 3RD Edition, UdiManber, Addison-Wesley, Reading, MA

6	Design & Analysis of Algorithms, Gajendra Sharma, Khanna Publishing House (AICTE Recommended Textbook – 2018)
7	Algorithms Design and Analysis, Udit Agarwal, Dhanpat Rai

Course Name:	**Discrete Mathematics**		
Course Code:	PC-CS 404	**Category:**	Basic Science Course
Semester:	4th	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Some concepts from basic math – algebra, geometry, pre-calculus
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To use mathematical logics and Boolean algebra in the field of computer applications.
2	To know about Set-Relation-Function and Group theory.
3	To learn counting techniques and number theory.
4	To use the concept of graph theory in engineering problems.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Module-1: **Sets-Relation-Function** • Operations and Laws of Sets • Cartesian Products, Binary Relation, Equivalence Relation, Partial Ordering Relation, Lattice **Number Theory** • Proofs by Mathematical Induction • The Division Algorithm, Prime Numbers, The Greatest Common Divisor, Euclidean Algorithm, The Fundamental Theorem of Arithmetic	10
2	**Module-2:** **Combinatorics** • Basic Counting Techniques, Inclusion and Exclusion Theorem • Permutation and Combination • Pigeon-Hole Principle	6
3	**Module-3:** **Propositional Logic and Proofs** • Basic Connectives and Truth Tables of propositional logics, Disjuntive and Conjuntive Normal Form using truth table, Argument • Quantifiers and their uses	8

	• Proofs; Forward Proof, Proof by Contradiction, Proof by Contraposition, Proof by Mathematical Induction • The Laws of Logic, Logical Implication, Rules of Inference	
4	**Module-4:** **Algebraic Structures and Boolean Algebra** • Algebraic Structures with one Binary Operator • Group, Subgroup, Cyclic group, Permutation group, Symmetric group. • Coset, Lagrange's Theorem, Normal Subgroup, Quotient group • Homomorphism and Isomorphism of groups **Algebraic Structures with two Binary Operators** • Rings, Integral Domain and Fields **Boolean Algebra** • Identities of Boolean Algebra, Duality, Representation of Boolean Function, Disjuntive and Conjuntive Normal Form • Switching network from Boolean expression using Logic Gates • Karnaugh Map	10
5	**Module-5:** **Advanced Graph Theory** • Planar and Dual graph: Kuratowski's graphs, Euler's formulae for connected and disconnected planar graphs, Detection of planarity • Graph Coloring: Vertex coloring, Chromatic number of complete graphs, circuit and bipartite graph, Chromatic polynomial • Connectivity and matching	6
Total		**40**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Express a logic sentence in terms of predicates, quantifiers, and logical connectives
2	Derive the solution for a given problem using deductive logic and prove the solution based on logical inference
3	Classify its algebraic structure for a given a mathematical problem,
4	Evaluate Boolean functions and simplify expressions using the properties of Boolean algebra
5	Develop the given problem as graph networks and solve with techniques of graph theory

Learning Resources:	
1	Russell Merris, Combinatorics, Wiley-Interscience series in Discrete Mathematics and Optimisation
2	N. Chandrasekaran and M. Umaparvathi, Discrete Mathematics, PHI
3	Gary Haggard, John Schlipf and Sue Whitesides, Discrete Mathematics for Computer Science, CENGAGE Learning
4	Gary Chartrand and Ping Zhang – Introduction to Graph Theory, TMH
5	J.K. Sharma, Discrete Mathematics, Macmillan

6	Winfried Karl Grassmann and Jean-Paul Tremblay, Logic and Discrete Mathematics, PRSEAON.
7	S. K. Chakraborty and B. K. Sarkar, Discrete Mathematics, OXFORD University Press.
8	Douglas B. West, Introduction to graph Theory, PHI
9	C. L. Liu, Elements of Discrete Mathematics, 2nd Ed., Tata McGraw-Hill, 2000.
10	R. C. Penner, Discrete Mathematics: Proof Techniques and Mathematical Structures, World Scientific, 1999.
11	R. L. Graham, D. E. Knuth, and O. Patashnik, Concrete Mathematics, 2nd Ed., Addison-Wesley, 1994.
12	N. Deo, Graph Theory, Prentice Hall of India, 1974.
13	S. Lipschutz and M. L. Lipson, Schaum's Outline of Theory and Problems of Discrete Mathematics, 2nd Ed., Tata McGraw-Hill, 1999.
14	J. P. Tremblay and R. P. Manohar, Discrete Mathematics with Applications to Computer Science, Tata McGraw-Hill, 1997.
15	Higher Algebra- S.K. Mapa
16	N. Chandrasekaran and M. Umaparvathi, Discrete Mathematics, PHI
17	S.B. Singh, Discrete Structures – Khanna Publishing House (AICTE Recommended Textbook – 2018)
18	S.B. Singh, Combinatorics and Graph Theory, Khanna Publishing House (AICTE Recommended Textbook – 2018)

Course Name:	**Numerical Methods Lab**		
Course Code:	BS-M 494	**Category:**	Basic Science Course
Semester:	4th	**Credit:**	1
L-T-P:	0-0-2	**Pre-Requisites:**	
Full Marks:	100		
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05

Course Objectives:	
1	To compute different numerical errors in computations.
2	To learn interpolation techniques.
3	To apply the techniques for solving integrations, ODEs.
4	Solve linear and non-linear equations.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Assignments on Interpolation:** Newton's Forward Interpolation, Newton's Backward Interpolation, Lagrange's Interpolation	4
2	**Assignments on Numerical Integration:** Trapezoidal Rule, Simpson's 1/3 Rule	4
3	**Assignments on Solution of Transcendental Equations:** Bisection Method, Regula-Falsi Method, Newton-Raphson Method	4
4	**Assignments on ODEs:** Euler's Method, Runge-Kutta Method of Order Four	4

5	**Curve Fitting by the Method of Least Squares:** Fitting a straight line of the form $y = a + bx$, Fitting a curve of the form $y = ax + bx^2$, $y = ab^x, y = ae^{bx}, y = ax^b$	4
6	**Measure of Central Tendency:** Mean and Standard Deviation, Median and Mode	2
7	**Assignments on Numerical Solution of a system of Linear Equations:** Gauss Elimination Method, Gauss-Seidel Method	2
Total		**24**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems.
2	Apply numerical methods to obtain approximate solutions to mathematical problems.
3	Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.
4	Analyse and evaluate the accuracy of common numerical methods.

Learning Resources:	
1	C.Xavier: C Language and Numerical Methods.
2	A. K. Jalan and Utpal Sarkar, Numerical Methods-A Programming Based Approach, Orient Blackswan Private Ltd.
3	Dutta & Jana: Introductory Numerical Analysis.
4	J.B.Scarborough: Numerical Mathematical Analysis.
5	Jain, Iyengar , & Jain: Numerical Methods (Problems and Solution).
6	Balagurusamy: Numerical Methods, Scitech.
7	Baburam: Numerical Methods, Pearson Education.
8	N. Dutta: Computer Programming & Numerical Analysis, Universities Press.
9	Soumen Guha & Rajesh Srivastava: Numerical Methods, OUP.
10	Srimanta Pal: Numerical Methods, OUP.

Course Name:	**Computer Organization and Architecture Laboratory**		
Course Code:	PC-CS(D)491	**Category:**	Professional Core Course
Semester:	Fourth	**Credit:**	1.5
L-T-P:	0-0-3	**Pre-Requisites:**	Digital Electronics, Basic Programming Concept
Full Marks:	100		
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05

Course Objectives:	
1	To Familiar with different type of IC-chips
2	To Design different arithmetic and Logic Circuits

3	To know the working principle of RAM IC.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1.	Familiarity with IC-chips: a) Multiplexer, b) Decoder, c) Encoder d) Comparator Truth Table verification and clarification from Data-book.	6
2	Design an Adder/Subtractor composite unit.	3
3	Use a multiplexer unit to design a composite ALU	3
4	Use ALU chip for multibit arithmetic operation	3
5	Implement read write operation using RAM IC	3
6	Cascade two RAM ICs for vertical and horizontal expansion.	3
7	HDL introduction. Basic digital logic base programming with HDL	3
8	8-bit Addition, Multiplication, Division	3
9	8-bit Register design, Memory unit design and perform memory operations.	3
10	8-bit simple ALU design, 8-bit simple CPU design	3
11	Interfacing of CPU and Memory- Simulation only	3
Total		**36P**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Familiar with different ICs and their Application
2	Design different circuits with RAM ICs and perform read-write operation.
3	Design various hardware circuits using VHDL software.
4	Integrate components to present independent circuitry.

Course Name:	**Operating System Lab**		
Course Code:	PC-CS 492	**Category:**	PC
Semester:	4th	**Credit:**	1.5
L-T-P:	0-0-3	**Pre-Requisites:**	Computer organization
Full Marks:	100		
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05

Course Objectives:	
1	To learn UNIX commands and shell script
2	To gain the knowledge about process, thread, signal, semaphore and IPC

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	UNIX Commands and Permissions	3

2	Creating a bash shell script, making a script executable, shell syntax (variables, conditions, control structures, functions, CLA, String)	9
3	C programs for parent process, child process, orphan process, sleeping process, running process, zombie process.	6
4	Multithreaded C program using PThread API and Win32 API	6
5	C programs for signal handling, sending signals and signal interface.	3
6	C programs regarding Semaphore	3
7	Inter-process communication through shared memory segment, message queues, pipes and named pipes	6
Total		**36P**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Recall and understand UNIX commands and applications of shell script
2	Apply and Analyze Process and Thread execution
3	Apply and Analyze Signal and Semaphore
4	Apply and Analyze IPC related concepts

Learning Resources:	
1	UNIX Concepts and Applications, Sumitabha Das, McGrawhill
2	Vijay Mukhi's The C Odyssey UNIX – The Open Boundless C, BPB Publications

Course Name:	**Design and Analysis of Algorithm lab**		
Course Code:	PC-CS493	**Category:**	Professional Core Courses
Semester:	Fourth	**Credit:**	1.5
L-T-P:	0-0-3	**Pre-Requisites:**	Data Structure, Basic Programming Ability
Full Marks:	100		
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05

Course Objectives:	
1	The aim of this course is to study about various designing paradigms of algorithms for solving real world problems.
2	Through this course one can apply appropriate algorithms and methods of analysis.
3	To pick an appropriate data structure for a design situation is also under consideration.

Course Contents:		
Module No.	**Description of Topic/ Experiment**	**Contact Hrs.**
The contents should include about 10 assignments with the focus given as outlined below:		
UNIT - I Divide and Conquer, Greedy Method, Dynamic Programming		

1	Implement Binary Search, Merge Sort, Implement Quick Sort, Find Maximum and Minimum Element from an Array of Elements Implement Knapsack Problem, Job sequencing with deadlines, Traveling Salesman Problem Find the minimum number of scalar multiplication needed for Chain of Matrix	15
UNIT - II Graph Traversal Algorithm, Minimum Cost Spanning Tree Generation Algorithms, Shortest Path Algorithms		
2	Implement Breadth First Search (BFS), Depth First Search (DFS) Implement Minimum Cost Spanning Tree by Prim's and Kruskal's Algorithm Implement Single Source shortest Path for a graph (Dijkstra, Bellman Ford Algorithm) and All pair of Shortest path for a graph (Floyd- Warshall Algorithm)	15
UNIT - III Backtracking and Branch and Bound		
3	Implement N Queen problem Implement Graph Coloring Problem Implement Hamiltonian Problem Implement 15-Puzzle Problem	6
Total		**36**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Demonstrate and implement Binary Search, Merge Sort, Quick Sort, and Max-min Problem using D&C Algorithm Design Techniques.
2	Implement Fractional Knapsack, Job Sequencing with Deadline, TSP, Matrix Chain, Graph Traversals, MST problems, Shortest Path, N- Queens, Graph Coloring, Hamiltonian Cycle, and 15 Puzzles using proper Algorithm Design Techniques.
3	Apply suitable algorithm for solving a particular problem.
4	Analyze the complexities and memory usages of different algorithms.

Learning Resources:	
1	Introduction to Algorithms, 4TH Edition, Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, MIT Press/McGraw-Hill.
2	Fundamentals of Algorithms – E. Horowitz et al.
3	Algorithms Design and Analysis, Udit Agarwal, Dhanpat Rai
4	Design and Analysis of Algorithm, Biswas and Dey, JBBL

Course Name:	**Constitution of India**		
Course Code:	MC472	**Category:**	Mandatory Course
Semester:	Fourth	**Credit:**	Zero
L-T-P:	2-0-0	**Pre-Requisites:**	
Full Marks:	100		
Examination	Semester Examination of 100 marks		

Scheme:	

Course Objectives:	
1	**Develop an understanding of the nation's constitution.**
2	**Develop knowledge about the various levels of governance in the country.**

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction:** : Sources and Constitutional history. Preamble, Fundamental Rights and Duties, Directive Principles of State Policy.	3
2	**Union Government and its Administration:** Structure of the Indian Union: Federalism, Centre- State relationship, President: Role, power and position, PM and Council of ministers, Lok Sabha, Rajya Sabha, Supreme Court	6
3	**State Government and its Administration** Governor.Role and Position, CM and Council of ministers High Court	6
4	**Local Administration District's Administration head:** Role and Importance, Municipalities: Introduction, Mayor, and role of Elected Representative. Pachayati raj: Introduction, Zila Pachayat, Elected officials and their roles. Importance of grass root democracy	6
5	**Election Commission Election Commission:** Role and Functioning, Chief Election Commissioner	2
Total		

Course Outcomes:	
After completion of the course, students will be able to:	
1	Gain an understanding of the constitution of India.
2	Become aware of the various levels of governance in the country.

Learning Resources:	
1	'Indian Polity' by Laxmikanth
2	'Indian Administration' by Subhash Kashyap
3	'Indian Constitution' by D.D. Basu
4	'Indian Administration' by Avasti and Avasti