Third Semester					
Theory					
Sl. No.	**Category**	**Subject Code**	**Subject Name**	**L-T-P**	**Credit**
1	BSC	19CM3BS01T	Mathematics-III	3-0-0	3
2	HSMC	19CM3HS01T/ 19CM3HS02T	Humanities-1 Organizational Behavior/ Management-1 Engineering Economics & Costing	3-0-0	3
4	ESC	19CM3ES01T	Data Structure using C	3-0-0	3
3	ESC	19CS3ES02T/ 19CS3ES03T	Analog Electronics Circuits/ Digital Electronics Circuits	3-0-0	3
5	PCC	19CS3PC01T	**PCC-1:** Database Engineering	3-0-0	3
6	PCC	19CS3PC02T	**PCC-2:** Computer Network And Data Communication	3-0-0	3
7	MC	19CM3MC01T	**Mandatory Course:** Environmental Science & Engineering	3-0-0	0
Total Credit (Theory)					**18**
Practical					
1	ESC	19CM3ES01L	Data Structure using C Lab	0-0-2	1
2	ESC	19CS3ES02L/ 19CS3ES03L/	Analog Electronics Lab/ Digital Electronics Lab (ICT)	0-0-2	1
3	PCC	19CS3PC01L	**PCC Lab-1:** Database Engineering Lab	0-0-2	1
4	PCC	19CS3PC02L	**PCC Lab-2:**Computer Network & Data Communication Lab	0-0-2	1
5	PSI	19CM3PS01L	Summer Internship/Training	0-0-2	1
Total Credit (Practical)					**5**
Total Semester Credit					**23**

19CM3BS01T	Mathematics-III (3-0-0)	Credit :3

Course Objectives:

1. The course should enable the students to: Enrich the knowledge of probability on single random variables and probability distributions.
2. Apply the concept of correlation and regression to find covariance.
3. Analyse the given data for appropriate test of hypothesis Understand the foundations for classical inference involving confidence intervals and hypothesis testing.
4. Knowledge of Numerical method for solving mathematical problems.

Module-I: **[8 hrs]**

Random variables: discrete and continuous random variables, probability distribution of a random variable. Some characteristic of probability distribution. Probability mass function and probability density functions; Mathematical expectation: Mean, Variance and standard deviation of a probability distribution.

Module-II: **[8 hrs]**

Binomial distribution; Mean and variances of Binomial distribution, Recurrence formula for the Binomial distribution; Poisson distribution: Poisson distribution as a limiting case of Binomial distribution, mean and variance of Poisson distribution, Recurrence formula for the Poisson distribution; Normal distribution; Mean, Variance, Characteristics of normal distribution.

Module-III: **[10hrs]**

Methods of Sampling. Estimation, point and interval estimation, Basic data analysis, setting of hypothesis, null hypothesis and alternate hypothesis, testing of hypothesis, type I and type II errors, critical region, confidence interval, level of significance. One sided test, two sided test. Chi-square test: Goodness of fit and test of association. Correlation: Coefficient of correlation, Computation of correlation coefficient, Regression: Lines of regression and their properties.

Module-IV: **[8 hrs]**

Root Finding: Introduction, Numerical solution by Bisection Method, Newton Raphson method, Secant method, Fixed point method. Interpolation: Lagrange, Newton forward, Backward, Divided Difference Method.

Module-V: **[10 hrs]**

Numerical Integration; Trapezoidal Method ,Simpson's 1/3 rule, Gauss-quadrature 2 & 3 points method, Solution of First Order Differential equation by Euler's method, Modified Euler's method, Runge-Kutta 4th order and Predicator & Corrector methods(Adams-Bashforth Method).

Course Outcomes:

On completion of this course, students are able to:

CO-1: Use the basic probability rules, discrete and continuous probability distributions, including requirements of mean and variance and making decisions.

CO-2: Identify the characteristics of different discrete and continuous distributions. Identify the type of statistical situation to which different distributions can be applied.

CO-3: Use of continuous distribution various hypothesis of testing, Employee the principles of linear regression and correlation and significance of the correlation coefficient.

CO-4: Use of the Numerical method for finding roots, fitting the data into a polynomial equation, integrating any integration and solve any first order ode with initial condition.

TEXT BOOKS:

1. E. Kreyszig,Advanced Engineering Mathematics, Tenth Edition, Willey.
2. Richards A Johnson, Irvin Miller and Johnson E Freund,Probability and Statistics for Engineering, 9th Edition, PHI.
3. M. K. Jain, S.R.K. Iyenger and R.K. Jain, Numerical Methods for Scientific and engineering Computations, New age International Publication (P) Ltd.

REFERENCE BOOKS:

1. S. C. Gupta , V. K. Kapur, Fundamental of Mathematical Statistics.
2. RohitKhurana, Kanti B. Datta, Engineering Mathematics, Cengage Publications.
3. Jay l. Devore, Probability and Statistics for Engineering and the Sciences. 8th edition, Cengage.
4. S Arora, SumeetArora, P N Arora. Comprehensive Statistical Methods, Schaum Series.
5. B.V. Raman, Higher Engineering Mathematics, Mc-Graw Hills Education.

19CM3HS01T	Humanities-1 : Organizational Behavior (3-0-0)	Credit :3

Course Objectives:

Developing an understanding of the behavior of individuals and groups inside organizations by enhancing the skills in appreciating individuals, interpersonal, and group process for increased effectiveness both within and outside of organizations is the goal of any organization. Through this course students will develop theoretical and practical insights and problem-solving capabilities for effectively managing the organizational processes.

Module-I : Fundamentals of OB: **[6 Hrs]**

Definition, scope and importance of OB, Relationship between OB and the individual, Evolution of OB, Models of OB. Learning; Theories and their applications

Module II : Foundations of Individual Behavior: **[12 Hrs]**

Personality and values: Definition and importance of Personality for performance, The Myers-Briggs Type Indicator and The Big Five personality model, Significant personality traits suitable to the workplace (personality and job – fit theory), Personality Tests and their practical applications. Attitude; ABC Model. Perception: Meaning and concept of perception, Factors influencing perception, Selective perception, Perceptual errors.

Motivation: Definition & Concept of Motive & Motivation, The Content Theories of Motivation (Maslow's Need Hierarchy & Herzberg's Two Factor model Theory), The Process Theories (Vroom's expectancy Theory & Porter Lawler model), Contemporary Theories – Equity Theory of Work Motivation.

Module- III: Foundations of Group Behavior: **[8 Hrs]**

Group Dynamics, Types of Groups, The Five – Stage Model of Group Development. Developing Work Teams, Team Effectiveness & Team Building.

Leadership: Concept, Types & Styles of Leadership, Traditional & Contemporary theories of leadership Success stories of today's Global and Indian leaders.

Module- IV: Foundations of Organisational Behavior: **[10 Hrs]**

Organisational Culture; creating and maintenance. Organisational Change; concept and technique and theories of change. Organisational Development; concept and methods of doing development.

Course Outcomes:

1. Students will understand the essential of maintaining the inter-personal relationships in organisations.
2. Personality factors will be effectively used to understand the communication among groups.
3. The reasons for conflict will be known and prescriptive methods can be devised to enhance higher productivity in organisations.
4. Being an employee in an organisation the importance of organisational change and culture can be known to all.

Text Book:

1. Organizational Behaviour, Robbins, Judge, Sanghi, Pearson.

Reference Books:

2. Organizational Behaviour, K. Awathappa, HPH.
3. Organizational Behaviour, VSP Rao, Excel

4. Introduction to Organizational Behaviour, Moorhead, Griffin, Cengage.
5. Organizational Behaviour,Hitt, Miller, Colella, Wiley
6. Organizational Behaviour, Suba Rao,Mishra, Himalaya
7. Organisational Behaviour – Uma Sekharan

19CM3HS02T	**Management-1:** Engineering Economics & Costing **(3-0-0)**	**Credit :3**

Module-I: **[8 Hrs]**
Introduction to Economics: Definition, scope and nature of economics, consumption laws, demand & supply analysis, elasticity of demand& supply, indifference curve analysis.

Module-II: **[10 Hrs]**
Production : factors of production, production function, law of variable proportion, laws of return to scale, elasticity of factor-substitution, optimal combination of factor-inputs, production efficiency, economies of scales,Cost of Production: types of costs, economic costs: fixed cost and variable costs, short-run and long-run cost functions.

Module-III: **[10 Hrs]**
Market Structure: pure competition, perfect competition, imperfect market, monopoly andoligopoly.Indian Banking System, Functions and Roles of Commercial Banks and ReserveBank of India.

Module-IV: **[12 Hrs]**
Time value of money and interest formulae,Nominal and effective rate of interest, Present, Annual and Future worth analysis, Rate ofReturn Analysis, Cost-Benefit analysis in Public sector projects.

Module- V: (as per choice of faculty) **[8 Hrs]**
Portion covered can be tested through Internal evaluation only not to be included in University examination.

Text Books:

1. Koutsoyiannis, A., 'Modern Microeconomics', English Language Book Society, Macmillan.
2. Pindyck, R S, Rubinfeld, D L &Mehta , 'Microeconomics', 6 th Edition, Pearson Education India.

Reference Books:

3. Varian, H R, 'Intermediate Microeconomics', 7th edition, East West Press India.
4. Samuelson, Paul A, 'Economics', 5th edition, McGraw Hill New York.
5. Basics of Engineering Economy; Leland Blank and Anthony Tarquin, TMH
6. Contemporary Engineering Economics, Chan. S Park, Pearson
7. Engineering Economics, Paneerselvam, PHI
8. Engineering Economics; Sasmita Mishra, PHI

19CM3ES01T	Data Structures using C (3-0-0)	Credit :3

Course Objective:

1. Implementation of different linear data structure.
2. Implementation of non-linear data structures like trees and graphs.
3. Applying different sorting and searching algorithms.

Module-I: **[10 Hrs]**

Abstract Data Types – Definition and Representation, ADT of rational number, ADT of Stack, Data Structure and ADT. Stack and its usages: reversing string, matching parentheses, in fix to postfix, decimal to binary number. Queue: linear & circular queue, Deque & Applications. Matrix – sparse and dense. Representation of sparse matrix, Transpose & addition of sparse matrices.

Module-II: **[8 Hrs]**

Linked list and its representation: using array, using self referential structure. Singly, circular and double linked lists. Operations on linked list – Insertion, Deletion, Traversals. Usages of Linked list – insertion sort, Addition/multiplication of polynomials. Addition/Multiplication of large numbers.

Module-III: **[12 Hrs]**

Tree: Definition and Terminologies, child and parent nodes, Sub tree, root, leaf node, internal node, height of a tree. Binary, ternary, quad tree. Binary tree traversals. Reconstruction of binary tree from traversals. Binary search tree – inserting a new key, deleting a key, searching a key. AVL tree – inserting a new key into an AVL tree using rotations. B- tree : insertion and deletion using node splitting and merging.

Module-IV: **[6 Hrs]**

Sorting and Searching: Bubble sort, selection sort quick sort and merge sort. Linear and binary search, Fibonacci search.

Module-V: **[6 Hrs]**

Basic Graph Algorithm: Graph representation – adjacency matrix and list – pros and cons. Graph traversals – Depth First Search and Breadth First Search.

Course Outcome:

1. Apply the basic data structure like stack, queue, linked list, tree and graph on different problems.
2. Compare and differentiate different implementation of data structure.
3. Analyzing the time complexity and space complexity of different sorting and searching algorithms and data structures implementation.

Text Books:

1. Data Structures: A Pseudocode Approach with C – Gilberg & Forouzan, 2nd Edition, Cengage, Indian Reprint 2016
2. Data Structures and Program Design in C – Kruse, Leung, 2nd Edition, Pearson,2008.

Reference Books:

3. Data Structures Using C - Yedidyah Langsam & Moshe J. Augenstein Aaron M. Tanenbaum, 3rd Edition, Pearson, 2009
4. Algorithms and Data Structures: The basic toolbox, Kurt Mehlhorn and Peter Sanders, Springer, 2010
5. Programming and Data Structures (NPTEL) – (Vodeo lectures by Dr. Naveen Garg, IIT Delhi,new course available from July 2019)

19CS3ES02T	Analog Electronics (3-0-0)	Credit :3

Course Objectives:

1. Understand the basics of construction, operation and characteristics of different transistors and its biasing techniques
2. Develop small-signal model to analyze the performance of different amplifier both for low frequency and high frequency operation.
3. Analyze the performance parameters of large signal amplifiers and feedback topologies; extend the concept of feedback in different amplifier and oscillator circuits.

Module – I **[8 Hrs]**

Biasing of BJTs: Load lines (AC and DC); Operating Points; Different Biasing Techniques; Bias Stabilization; Bias design Examples.

Biasing of FETs and MOSFETs: Operating point, Load line, Biasing techniques of FETs and design, Bias design: Graphical and analytical Method, Complimentary MOS (Principal of oeration).

Module – II **[12 Hrs]**

Small Signal Analysis of BJTs: Small-Signal Equivalent-Circuit Models; r_e model, Small Signal Analysis of CE, CC, CB amplifiers using r_e model, Hybrid equivalent Model, Graphical determination of hybrid parameter.

Small Signal Analysis of FETs: Small-Signal Equivalent-Circuit Model, Small Signal Analysis of CS, CD, CG Amplifiers.; Source Follower and Cascaded System.

Two port system approach: Effects of R_S and R_L on CE amplifier operation, Effects of R_{SIG} and R_L on CS Amplifier, Small signal analysis of Cascade and Cascode configurations, Darlington Connection and Current Mirror Circuits.

Module – III **[6 Hrs]**

Frequency Response of BJT and FET Amplifiers: General Frequency Considerations, Low and High Frequency Analysis of Single Stage Amplifiers, Square Wave Testing of amplifier.

Module – IV **[4 Hrs]**

Operational Amplifier: Ideal Op-Amp, Op-Amp Parameters, Open-loop and Closed-loop Gains, OP-AMP application as weighted summer, Differentiator and Integrator, Instrumentationamplifier.

Module – V **[6 Hrs]**

Feedback amplifier and Oscillators: Concepts of negative and positive feedback, Four Basic Feedback Topologies, Advantage of Negative feedback, Principle of oscillation, OP-AMP based sinusoidal Oscillator Circuits: Wien Bridge oscillator and R-C Phase shift oscillator; CrystalOscillators.

Course Outcome

After completion of the course, the student will be able to

1. Analyze and understand the different biasing techniques to have excellent stabilization against internal and external parameter variation.
2. Develop small-signal model to analyze the performance of different amplifier both for low frequency and high frequency operation.

3. Apply the concept of different feedback and feedback topologies in designing various circuits used for amplification and frequency generation.
4. Analyze and design operational amplifier based amplifier and oscillator circuits by understanding its characteristics and configuration details.

Text Books:

1. Electronic Devices and Circuits theory, R.L. Boylestad and L. Nashelsky, 10th Edition, Pearson Education.

Reference Books:

2. Microelectronics Circuits, A. Sedra and K.C Smith, Oxford University press
3. Electronic Circuits: Analysis and Design(SIE), Donald Neamen, Mc-Graw Hills
4. Milliman's Electronics Devices and Circuits, J. Milliman, C. Halkias, 2nd Edition, TMH

19CS3ES03T	Digital Electronics (3-0-0)	Credit :3

Course Objectives:

1. To provide insight about the requirement of designing low cost and high speed Digital systems.
2. To gain inclusive knowledge about combinational and sequential logic blocks.
3. To get the idea of designing complex digital circuits.
4. To understand the different types of memory and their working principles.
5. To familiarize with various technologies used for Integrated Circuit design.

Module – I **[6 Hrs]**

Digital Fundamentals and Binary Codes: Introduction to Digital System, Binary Data Representation, Codes: BCD, Excess-3, Gray Code, One-Hot Code, ASCII Code, Logic Levels, Logic gates, Boolean Operators and Expressions.
Simplification of Boolean Functions: Representation of min-terms and max-terms, Simplification of Boolean Functions using K-Map up to 5 variables, K-Map with don't care inputs.
Function Implementations: AND-OR, OR-AND, NAND-NAND, NOR-NOR, AOI, OAI.

Module – II **[8 Hrs]**

Arithmetic Circuits: Introduction to Combinational Circuit, Half Adder, Full Adder, Half Subtractor, Full Subtractor, Adder-Subtractor, Binary Parallel Adder, BCD Adder, CLA Adder, Multiplier, Square circuit, Magnitude Comparator.
Combinational Circuits: Gray –to- Binary and Binary –to- Gray Code Converter, Encoder, Priority encoder, Decoder, Cascading of Decoders, Multiplexer, Cascading of Multiplexer, Function Implementations using Multiplexer, De-Multiplexer, Decoder.

Module – III **[6 Hrs]**

Sequential Components: Latches, Flip-Flops, Analysis of Flip-Flops: Functional Table, Characteristic Table, Characteristic Equation, State Diagram, Excitation Table, Timing Diagram, Positive-Edge-Triggered D Flip-Flop, Master-Slave JK-FF, Flip-Flop conversions.

Module – IV **[10 Hrs]**

Sequential Circuits: Design Procedure, Counter: Asynchronous and Synchronous Counter, Shift Registers: Shift of Binary Bits, SISO, SIPO, PISO, PIPO, Ring Counter, Johnson Counter, Design and Analysis of Clocked Sequential Circuits, FSM Fundamentals: Melay and Moore Machines.

Module – V **[6 Hrs]**

Memory Blocks: Types of Memory, Memory Decoding, Read-Only Memory (ROM), Random Access Memory (RAM). Logic Families: Characteristics of DTL, RTL, TTL and CMOS Logic.

Course Outcomes:

1. Acquire basic knowledge about binary codes and the simplification of logic function using Boolean laws and mapping methods.

2. Understand the behavior of combinational and sequential circuits and use them for development of complex digital systems.
3. Acquire fundamental knowledge about the operation of memory and their application towards synchronous circuits.
4. Illustrate the operation of different logic families and their application in designing integrated circuits for serving the mankind in day to day life.

Text Books:

1. Digital Design, 3rd Edition, M. Morris Mano, Pearson Education.

Reference Books:

1. Digital Principles And Applications, Seventh Edition , Donald P Leach, Albert Paul Malvino, Goutam Saha, ,Tata McGraw Hill Education Private limited

2. Fundamentals of digital circuits, 8th edition, A. Anand Kumar, PHI

3. Digital Fundamentals, 5th Edition, T.L. Floyd and R.P. Jain, Pearson Education, New Delhi.

4. Digital Logic Design Principles, 2nd edition, Norman Balabanian & Bradley Carlson, Wiley 2004.

19CS3PC01T	Database Engineering (3-0-0)	3 Credit

Course Objective:

1. Introducing basic database concepts like ERDiagram, Relational Algebra,
2. Designing Normalized databases
3. Advantages, disadvantages and implementation of NoSQL database design in contrast to SQL based database.
4. Introducing database transactions

Module-I: **[7 Hrs]**

Introductory concepts of DBMS: Introduction and applications of DBMS, Purpose of data base, Data, Independence, Database System architecture- levels, Mappings.

Entity-Relationship model: Basic concepts, Design process, constraints, Keys, Design issues, E-R diagrams, weak entity sets. Reduction to E-R database schema.

Module-II: **[7 Hrs]**

Database Programming: Relational Algebra and calculus (Domain and Tuple relational calculus) Basics of SQL, DDL,DML,creation, alteration, defining constraints – Primary key, foreign key, unique, not null, check, IN operator, Functions - aggregate functions, Built-in functions –numeric, date, string functions, set operations, sub-queries, correlated sub-queries, Use of group by, having, order by, join and its types, Exist, Any, All , view and its types. Transaction control commands – Commit, Rollback, save point. Concepts, Cursors, Stored Procedures, Stored Function, and Database Triggers.

Module-III: **[13 Hrs]**

Normalization of **Databases**:

Functional Dependency – definition, trivial and non-trivial FD, closure of FD set, closure of attributes, irreducible set of FD, Normalization – 1NF, 2NF, 3NF, Decomposition using FD-dependency preservation, BCNF, Multi- valued dependency, 4NF, Join dependency and 5NF.

Module-IV: **7 Hours**

Transaction Management: Transaction concepts, properties of transactions, serializ-ability of transactions, testing for serializability, System recovery, Two- Phase Commit protocol, Recovery and Atomicity, Log-based recovery, concurrent executions of transactions and related problems, Locking mechanism, solution to concurrency related problems, deadlock, two-phase locking protocol.

User security, grants, privileges, roles, access control.

Module-V: **[10 Hrs]**

Performance tuning and introduction to NOSQl

Overview of NOSQL databases, measures of query cost, selection operation, sorting, join.

Performance Tuning Overview, Basic Tuning Tools, Using Statspack, Identifying Problem SQL **Statements**, Query Optimization

Influencing the Optimizer (Indexes (B-tree, Bitmap, Function Based indexes and reverse key indexes).

Course Outcome:

1. Designing database solutions for different real life problems
2. Write efficient and optimised SQL queries
3. Designing and differentiating solutions using schema based database and NoSQL database methods.

Text Books:

1. Elmasari &Navathe, Fundamentals of Database System, Seventh Edition, Pearson Education Book .
2. Sudarshan, Korth, Database System Concepts, 6th edition, McGraw-Hill Education Book .
3. Prof. Partha Pratim Das, Department of Computer Science & Engineering, IIT Kharagpur https://onlinecourses.nptel.ac.in/noc18_cs15/preview
4. Prof. Arnab Bhattacharya, IIT Kanpur https://nptel.ac.in/courses/106104135/
5. Dr. Leo Mark, Georgia Institute of Technology, https://in.udacity.com/course/database-systems-concepts-design--ud150

19CS3PC02T	Computer Network & Data Communication (3-0-0)	3 Credit

Course Objective:

1. Understand the concepts of data communication, layered model, wireless devices in computer networks.
2. Explain the various techniques used to access a shared channel in the network and IEEE specifications for LANs.
3. List types of networking devices, backbone networks and Internet Protocol (IP)addressing.
4. Explain the responsibilities of network, transport and application layers.

Module – I **[12 Hrs]**

Overview of Data Communication Networks, Protocols and standards, OSI Reference model, TCP/IP Protocol.

Physical Layer: Analog Signals, Digital Signals, Data Rate Limits, Transmission Impairment, Data rate limit, Digital Transmission: Digital-to-Digital conversion, Analog-to-Digital conversion, Transmission modes, Analog Transmission: Digital-to-Analog conversion, Analog-to-Analog conversion, Multiplexing: Frequency Division Multiplexing (FDM), Wave Division Multiplexing (WDM), Time Division Multiplexing (TDM), Transmission Media: Guided Media (Twisted-Pair Cable, Coaxial Cable and Fiber-Optic Cable) and unguided media (wireless), Switching: Circuit Switched Network, Datagram Network, Virtual-Circuit Network , Telephone Network, Dial-up Modems and Digital Subscriber Lines.

Module – II **[12 Hrs]**

Error Detection and correction: Types of Errors, Error Detection mechanism (Linear codes, CRC, Checksum), Error Correction mechanism: Hamming Encoding. Data Link Control and Protocols: Flow and Error Control, Stop-and-Wait ARQ. Go-Back-N ARQ, Selective Repeat ARQ, HDLC and Point-to-Point Protocol Multiple Access: Random Access (ALOHA, CSMA, CSMA/CD, CSMA/CA), Controlled Access (Polling, Reservation, Token Passing), Channelization (FDMA, TDMA, CDMA). Wired LANs (Ethernet): Traditional Ethernet, Fast Ethernet, Gigabit Ethernet.

Module – III **[6 Hrs]**

Wireless LANs: IEEE 802.11 and Bluetooth.

Connecting Devices: Passive Hub, Repeater, Active Hub, Bridge, Two layers Switch, Router, Three layers Switch, Gateway.

Virtual Circuit Networks: Frame Relay, Architecture & layers, ATM: Design goals, Architecture & layers.

Module – IV **[6 Hrs]**

Network Layer: IPV4 addresses, IPV6 addresses, Internet Protocol: Internetworking, IPV4 datagram, IPV6 packet format and advantages. Network Layer Protocols: ARP, RARP, IGMP and ICMP. Routing: Unicast Routing Protocols and Multicast Routing Protocols.

Transport Layer: Process to Process Delivery, User Datagram Protocol (UDP) and Transmission Control Protocol (TCP).

Module – V **[4 Hrs]**

Domain Name System (DNS): Name Space, Domain Name Space, DNS in Internet, Resolution and Dynamic Domain Name System (DDNS), Remote logging, Electronic Mail (SMTP) and file transfer

(FTP), WWW: Architecture & Web document, HTTP: Transaction & Persistent vs. Non-persistent connection. Introduction to Wi-Fi and Li-Fi Technology.

Course Outcome:

1. Explain computer network reference models, networking devices and different transmission techniques.
2. Reason the need for flow and error control at the data link layer and explain the associated protocols; enumerate the shared channel access methods, associated protocols and Wired LAN standards and implementations.
3. Explain how network layer, transport layer and application layer facilitates the transfer of message from one node to another in a global network.

Text Books and Online Resources:

1. Data Communications and Networking, Behrouz A. Forouzan, Tata McGraw-Hill, 5th Edition(2013).
2. Computer Networks, A. S. Tannenbum, D. Wetherall, Pearson Education, 5th Edition(2014).
3. Data and Computer Communications, William Stallings, Pearson Education, 10th Edition(2018).
4. Computer Networking, A Top-Down Approach, James F. Kurose, Keith W. Ross, Pearson publication, 6th Edition(2017).
5. http://www.nptelvideos.in/2012/11/computer-networks.html, Prof. Sujoy Ghosh, IIT, Kharagpur.
6. https://nptel.ac.in/courses/106105183/, Prof. SoumyaKantiGhosh, IIT, Kharagpur.
7. https://www.classcentral.com/course/stanford-openedx-introduction-to-computer-networking-1578, Prof. Philip Levis and Professor Nick McKeown, Stanford University.

19CS3MC01T	Environmental Science (3-0-0)	3 Credit

Course Objectives

1. To provide insight about impact of the humans activities on environment and impact of environment on the humans & its health.
2. To understand the basic problem of anthropogenic environmental pollution
3. To gain comprehensive knowledge about the social problem arising out of industrialization.
4. To familiarize with the environmental ethics and act related to environment

Module – I:

Ecosystem Ecological Concepts and Natural Resources:

Ecological perspective and value of environment. Ecosystem: Concept, structure & Function of ecosystem; Energy cycle, Food Chain, & Food Web; Ecological pyramid, types; Biodiversity; Ecological Succession: Type of ecosystems: Forest, Grassland, Desert and Aquatic. Geochemical Cycles: Water, Carbon, Oxygen and Nitrogen cycles. Environmental gradients, Tolerance levels of environment factor, Indian Environmental Law; Environmental Auditing; Environment Impact Assessment (EIA): Origin and procedure, Project Screening.

Module – II

Water pollution and Treatment Water quality standards and parameters:

Assessment of water quality. Types, sources and consequences of water pollution. Ground water Contamination. Water table and Aquifer, Ground water recharge. Water Treatment Processes: Pre-treatment, Conventional and Advanced processes. Waste Water Treatment: DO and BOD of waste water, pretreatment, primary and secondary treatment. Activated sludge treatment (preliminary idea only).

Module – III

Air Pollution Air pollution and pollutants, criteria & non-criteria pollutants. Acid rain, Green house gases, Ozone layer depletion, Smog. Industrial Air Emission Control: Flue gas desulphurization, NOx removal. Methods for control of particulate matters (Mechanical device, Fabric Filtration, scrubber, Electrostatic precipitator). Noise Pollution: Physical Properties of sound, Noise criteria, Noise Standards, Noise measurement, Noise control.

Module – IV

Solid Waste Management Municipal Solid Waste (MSW):

Source, classification and Composition. MSW Management : Properties, separation, storage and transportation. Waste minimization of MSW, Reuse and Recycling. Hazardous Waste Management (HWM): Generation and Transportation. Treatment of hazardous waste: Incinerators, Inorganic treatment, Handling of treatment plant residue. Waste minimization techniques.

Module – V

Occupational Safety and Health Acts Safety procedures, Type of Accidents, Chemical and Heat Burns, Prevention of Accidents involving Hazardous substances, Human error and Hazard Analysis. Hazard Control Measures in integrated steel industry, Petroleum Refinery, L.P.G. Bottling, Pharmaceutical industry. Fire Prevention: Detection, Extinguishing Fire. Electrical Safety, Product Safety. Personal Protective Equipment.

Course Outcomes

1. Able to understand the concept of environmental pollution and its effect on society Understand.
2. Able to understand the root of the environmental problem and adopted for its remedial.
3. Able to understand the environmental ethics and act related to environment
4. Able to understand the problem of population growth and its effect on social issue and environment

19CM3ES01L	Data Structure using C Lab (0-0-2)	1 credit

Prerequisites Programs:

1. Create a structure that stores a point in 2D. Accept 3 such points and find out the area of the triangle enclosed by these three points.
2. One array of numbers to be sorted. The no of element of the array is an user input. Create the array dynamically, accept its members and sort the array.

Programs for Evaluation Lab:

1. **(Integer stack simulation)** Write a structure for an integer stack, implement function push, pop, and pick, IsEmpty and IsFull function. Write a main function and call the functions based on an option entered.

2. **(Palindrome checking using stack)** Implement a stack of characters and create mystack.h. Write a program to check whether an entered string is a palindrome or not. One need to include mystack.h for calling the functions of character stack.

3. **(Simulating circular queue)** Defining structure of a circular queue (with a counter), write functions for inserting, deleting and counting no of elements present in the queue. Write functions IsFull and IsEmpty also. Write main function to call them.

4. **(Infix to Postfix)** Write a program to convert an infix expression into its corresponding postfix expression. The expression contains alphabets, operators and parentheses. During the conversion all possible checks for the correctness should be checked. [(a+b)/(c-d) would output ab+cd-/, ((a+b)^c-d would give error as “unmatched parenthesis]

5. **(Insertion sort)** A singly linked list gives a better way to implement insertion sort. A flat file contains some unknown number of integers. Implement insertion sort using a singly linked list that reads the next integer from the file and insert it into a linked list in its proper position. Write a function that prints the list after all elements is properly inserted into the linked list.

6. **(Polynomial addition)** Represent a polynomial of a single variable using a singly linked list. Write functions createPolynomial that stores one polynomial in a singly linked list. Write a function to add two such linked lists.

7. **(BST simulation)** Declare a binary search tree where information at each node would be a single integer. Write functions for inserting a key, deleting a key from the tree. Write recursive traversal routines. After each insertion/deletion find all traversal results.

8. **(Bubble sort)** One array of numbers to be sorted. The no of element of the array is a user input. Create the array dynamically, accept its members and sort the array using bubblesort algorithm. Also count the total number of swaps.

9. **(Quick sort)** Write a function to implement recursive quick sort algorithm and using this function sort an array of integers. Write another function to search for a key in this sorted array using binary search.

10. **(Merge Sort)** Implement recursive merge sort using an array of fixed size and hence sort an array of double numbers using this function.

11. **(Heap sort)** Implement heapify, build heap and heap sort routines. Apply heapsort to sort an array of numbers. Write a function to search for a given key in this sorted array using sequential search.

12. **(BFS traversal)** Clearly declaring data structure of a graph, Write functions to read a directed graph from a flat file and to implement BFS routine in a directed graph. Show the result of BFS traversal in distance and previous arrays.

19CS3ES02L	Analog Electronics Lab(0-0-2)	1 Credit

Course Objective

1. To illustrate the students different electronic circuit and their application in practice.
2. To impart knowledge on assessing performance of electronic circuit through monitoring of sensitive design and modeling parameters.

List of Experiments

(At least 10 out of 13 experiments should be done)

1. Determination of cut- off and saturation voltage of a BJT and its application as a switch.
2. Assemble and test of BJT bias circuits: Fixed bias and feedback bias.
3. Design, assemble and test of BJT bias circuits: Voltage divider bias
4. Design, assemble and test of JEET bias circuits: fixed bias and self bias.
5. Design, assemble and test of BJT common-emitter circuit – D.C and A.C performance: Voltage gain, input impedance and output impedance with bypassed and un-bypassed emitterresistor.
6. Design, assemble and test of BJT emitter-follower – D.C and A.C performance: A.C. voltage gain, input impedance and outputimpedance.
7. Design, assemble and Test of JFET/MOSFET common-source amplifiers – D.C and A.C performance: Voltage gain, input impedance and outputimpedance.
8. Determination of Bandwidth of a common-emitter amplifier from its frequency response.
9. Determination of Bandwidth of a BJT CE amplifier using Square wave testing.
10. Design and test of Differential amplifier circuits with its DC and AC performance.
11. Design and test of Darlington connection/ current mirrorcircuits.
12. Graphical determination of h-parameters of a CE amplifier.
13. Design Wien Bridge/R-C phase shift oscillator.

Course Outcome

After completion of the course, the student will be able to

1. Test and experiment different types of BJT/JFET based electronic circuit and analyze their operation under different operating conditions.
2. Evaluate possible causes of discrepancy in experimental observations in comparison to theoretical outcome.
3. Practice different types of wiring and instruments connections keeping in mind technical, Economical, safety issues.
4. Prepare professional quality textual and graphical presentations of laboratory data and Computational results.

19CS3ES03L	Digital Electronics Lab (0-0-2)	1 Credit

Course Objectives:

To understand the procedure for designing fundamental building blocks and observes their outputs.

List of Experiments:

[1]. Digital Logic Gates: Investigate logic behavior of AND, OR, NAND, NOR, EX-OR, and Inverter gates.
[2]. Gate-level minimization: Two level and multi-level implementation of Boolean functions.
[3]. Design and Testing of combinational circuits: Half-Adder, Half-Subtraction, and Full Adder.
[4]. Design of binary to Gray, Gray to Binary Code Converter, and Seven Segment Display Decoder.
[5]. Design and implementation of 2-bit Binary Multiplier
[6]. Testing of Multiplexer and function implementation using suitable Multiplexer.
[7]. Testing of Decoder and function implementation using suitable Decoder.
[8]. Testing of basic SR Latch and FFs: D-FF, JK-FF
[9]. Design and Testing of SISO, SIPO Shift Registers
[10]. Design and testing of 3-bit binary Asynchronous UP-Counter and Modulo-6 counter.

Course Outcomes:

1. Test the different digital ICs and use them for designing different combinational and sequential circuits.
2. Verify and debug the outputs for developing an error free circuit.

19CS3PC01L	Database Engineering Lab (0-0-2)	1 Credit

List of Experiments:

1. Retrieving Data Using the SQL SELECT Statement.
2. Restricting and Sorting Data.
3. Manipulating Data.
4. Using DDL Statements to Create and Manage Tables.
5. Using Single-Row Functions to Customize Output.
6. Reporting Aggregated Data Using the Group Functions.
7. Displaying Data from Multiple Tables.
8. Using Sub queries to Solve Queries.
9. Creating Other Schema Objects (indexes, views).
10. User security (privileges, roles).
11. Cursors and composite data types...
12. Functions and procedures.
13. Packages.
14. Triggers.
15. Mini project (Application Development)

Text Books:

Murach's MySQL: Joel Murach , 2nd Edition.

19CS3PC02L	Computer Network & Data Communication Lab (3-0-0)	3 credit

Experiment-1. Introduction to LAN hardware and IP addresses configuration
Experiment-2. Understanding and use of networking tools: ifconfig, ping, traceroute, arp, dig and nslookup
Experiment-3. Configuration of CISCO Switches and Routers.
Experiment-4. Study of network traffic using Wireshark filters.
Experiment-5. Controlling of network scenario using Netam and tc.
Experiments- 6 to 8 are based on the following experiments:

1. Simulate a three node point to point network with duplex links between them. Set queue size and vary the bandwidth and find number of packets dropped.
2. Simulate a four node point to point network with the links connected as follows: n0 – n2, n1 – n2 and n2 – n3. Apply TCP agent between n0 – n3 and UDP agent between n1 – n3. Apply relevant applications over TCP and UDP agents changing the parameter and determine the number of packets sent by TCP / UDP.
3. Simulate the transmission of ping messages over a network topology consisting of 6 nodes and find the number of packets dropped due to congestion.
4. Simulate an Ethernet LAN using 'n' nodes, change error rate and data rate and compare throughput.
5. Simulate an Ethernet LAN using 'n' nodes and set multiple traffic nodes and plot congestion window for different source / destination.

Experiments- 9 to 10 are based on the following experiments to be implemented in C/Java:

1. Implementation of Distance Vector Algorithm to find suitable path for transmission.
2. Program for ERROR detecting code using CRC-CCITT (16bit).
3. Using TCP/IP Sockets, write a client-server program to make client sending the file name and the server to send back the contents of the requested file if present.
4. Program for CLIENT SERVER communication using message Queues or FIFOs as IPC channels that client sends the file name and the server to send back the contents of the requested file if present.
5. Program for Congestion control using Leaky Bucket Algorithm.

Fourth Semester					
Theory					
Sl. No.	**Category**	**Subject Code**	**Subject Name**	**L-T-P**	**Credit**
1	HSMC	19CM4HS01T/ 19CM4HS02T	Humanities-1 Organizational Behavior/ Management-1 Engineering Economics & Costing	3-0-0	3
2	PCC	19CS4PC01T	**PCC-3**: Computer Organization and Architecture	3-0-0	3
3	PCC	19CS4PC02T	**PCC-4**: Object Oriented Programming using JAVA	3-0-0	3
4	PCC	19CS4PC03T	**PCC-5:** Design & Analysis of Algorithms	3-1-0	4
5	PCC	19CS4PC04T	**PCC-6:** Discrete Structure	3-0-0	3
6	PEC	19CS4PE01T/ 19CS4PE02T/ 19CS4PE03T/ 19CS4PE04T /	**Prof Elective-1:** Computer Graphics/ Data Science for Engineers / Cryptography and Network Security/ Digital Signal Processing	3-0-0	3
Total Credit (Theory)					**19**
Practical					
1	PCC	19CS4PC01L	**PCC Lab-3**: Computer Organization and Architecture Lab	0-0-2	1
2	PCC	19CS4PC02L	**PCC Lab-4**: Object Oriented Programming using JAVA Lab	0-0-2	1
4	PCC	19CS4PC03L	**PCC Lab-5:** Design & Analysis of Algorithms Lab	0-0-2	1
Total Credit (Practical)					**3**
Total Semester Credit					**22**

19CM4HS01T	Humanities-1 :OB (3-0-0)	Credit :3

Course Objectives:

Developing an understanding of the behaviour of individuals and groups inside organizations by enhancing the skills in appreciating individuals, interpersonal, and group process for increased effectiveness both within and outside of organizations is the goal of any organisation. Through this course students will develop theoretical and practical insights and problem-solving capabilities for effectively managing the organizational processes.

Module-I : Fundamentals of OB: **[6 Hrs]**
Definition, scope and importance of OB, Relationship between OB and the individual, Evolution of OB, Models of OB. Learning; Theories and their applications

Module II : Foundations of Individual Behavior: **[12 Hrs]**
Personality and values: Definition and importance of Personality for performance, The Myers-Briggs Type Indicator and The Big Five personality model, Significant personality traits suitable to the workplace (personality and job – fit theory), Personality Tests and their practical applications. Attitude; ABC Model. Perception: Meaning and concept of perception, Factors influencing perception, Selective perception, Perceptual errors.

Motivation: Definition & Concept of Motive & Motivation, The Content Theories of Motivation (Maslow's Need Hierarchy & Herzberg's Two Factor model Theory), The Process Theories (Vroom's expectancy Theory & Porter Lawler model), Contemporary Theories – Equity Theory of Work Motivation.

Module- III: Foundations of Group Behavior: **[8 Hrs]**
Group Dynamics, Types of Groups, The Five – Stage Model of Group Development. Developing Work Teams, Team Effectiveness & Team Building.

Leadership: Concept, Types & Styles of Leadership, Traditional & Contemporary theories of leadership Success stories of today's Global and Indian leaders.

Module- IV: Foundations of Organisational Behavior: **[10 Hrs]**
Organisational Culture; creating and maintenance. Organisational Change; concept and technique and theories of change. Organisational Development; concept and methods of doing development.

Course Outcomes:

1. Students will understand the essential of maintaining the inter-personal relationships in organisations.
2. Personality factors will be effectively used to understand the communication among groups.
3. The reasons for conflict will be known and prescriptive methods can be devised to enhance higher productivity in organisations.
4. Being an employee in an organisation the importance of organisational change and culture can be known to all.

Text Book:

1. Organizational Behaviour, Robbins, Judge, Sanghi, Pearson.

Reference Books:

1. Organizational Behaviour, K. Awathappa, HPH.
2. Organizational Behaviour, VSP Rao, Excel
3. Introduction to Organizational Behaviour, Moorhead, Griffin, Cengage.
4. Organizational Behaviour,Hitt, Miller, Colella, Wiley
5. Organizational Behaviour, Suba Rao,Mishra, Himalaya
6. Organisational Behaviour – Uma Sekharan

19CM3HS02T	Management-1: EEC (3-0-0)	Credit :3

Module-I: **[8 Hrs]**

Introduction to Economics: Definition, scope and nature of economics, consumption laws, demand & supply analysis, elasticity of demand& supply, indifference curve analysis.

Module-II: **[10 Hrs]**

Production : factors of production, production function, law of variable proportion, laws of return to scale, elasticity of factor-substitution, optimal combination of factor-inputs, production efficiency, economies of scales,Cost of Production: types of costs, economic costs: fixed cost and variable costs, short-run and long-run cost functions.

Module-III: **[10 Hrs]**

Market Structure: pure competition, perfect competition, imperfect market, monopoly andoligopoly.Indian Banking System, Functions and Roles of Commercial Banks and ReserveBank of India.

Module-IV: **[12 Hrs]**

Time value of money and interest formulae,Nominal and effective rate of interest, Present, Annual and Future worth analysis, Rate ofReturn Analysis, Cost-Benefit analysis in Public sector projects.

Module- V: (as per choice of faculty) **[8 Hrs]**

Portion covered can be tested through Internal evaluation only not to be included in University examination.

Text Books:

1. Koutsoyiannis, A., 'Modern Microeconomics', English Language Book Society, Macmillan.
2. Pindyck, R S, Rubinfeld, D L &Mehta , 'Microeconomics', 6 th Edition, Pearson Education India.
3. Varian, H R, 'Intermediate Microeconomics', 7th edition, East West Press India.

Reference Books:

4. Samuelson, Paul A, 'Economics', 5th edition, McGraw Hill New York.
5. Basics of Engineering Economy; Leland Blank and Anthony Tarquin, TMH
6. Contemporary Engineering Economics, Chan. S Park, Pearson
7. Engineering Economics, Paneerselvam, PHI
8. Engineering Economics; Sasmita Mishra, PHI

19CS4PC01T	Computer Organization & Architecture (3-0-0)	3 Credits

Course Objectives:

1. Able to understand the basic organizational structure of computer system along with the operational concepts, the concepts of ALU, CU and Memory design, the concept of cache memory, virtual memory and principle of pipelining.
2. Able to solve the problems related to cache memory and performance, page replacement algorithms, memory construction, arithmetic operations, and pipelining.
3. Able to analyze the performance differences of computing evolution on basic operation like addition, multiplication and division, page replacement algorithms and cache memory mappings.

Module-I: **[8 Hrs]**

Functional blocks of a computer: CPU, memory, input-output subsystems, Von-Neuman vs Harvard Architecture, Instruction set architecture of a CPU–registers, instruction execution cycle, Basic Operational Concepts, addressing modes, instruction set. Case study – instruction sets of some common CPUs.

Module-II: **[10 Hrs]**

Computer arithmetic – integer addition and subtraction, ripple carry adder, carry look-ahead adder, etc. multiplication – shift-and add, Booth multiplier, carry save multiplier, etc. Division restoring and non-restoring techniques, signed number representation, fixed and floating point representations, floating point arithmetic.

CPU control unit design: hardwired and micro-programmed design approaches, Case study – design of a simple hypothetical CPU.

Module-III: **[10 Hrs]**

Memory system design: semiconductor memory technologies, memory organization.

Memory organization: Memory interleaving, concept of hierarchical memory organization, cache memory, cache size vs. block size, mapping functions, replacement algorithms, write policies.

Module-IV: **[6 Hrs]**

Peripheral devices and their characteristics: Input-output subsystems, I/O device interface, I/O transfers–program controlled, interrupt driven and DMA, privileged and non-privileged instructions, software interrupts and exceptions. Programs and processes–role of interrupts in process state transitions, I/O device interfaces – SCII, USB

Module-V: **[6 Hrs]**

Pipelining: Basic concepts of pipelining, throughput, speedup and efficiency, pipeline hazards: Structural hazards, data hazards, control hazards.

Course Outcome:

1. Understand the theory and architecture of central processing unit.
2. Analyze some of the design issues in terms of speed, technology, cost, performance.
3. Design a simple CPU with applying the theory concepts.
4. Understand the architecture and functionality of central processing unit.
5. Exemplify in a better way the I/O and memory organization.
6. Define different number systems, binary addition and subtraction, 2's complement representation and operations with this representation.

Text Books:

1. "Computer Organization" 5th edition Carl Hamacher, Zvonkovranesic, Safwat Zaky, McGraw Hill.
2. "Computer Organization and Design: The Hardware/Software Interface", 5th Edition by David A. Patterson and John L. Hennessy, Elsevier.

Reference Books:

1. "Computer Architecture and Organization", 3rd Edition by John P. Hayes, WCB/McGraw-Hill.
2. "Computer Organization and Architecture: Designing for Performance", 10th Edition by William Stallings, Pearson Education.
3. "Computer System Design and Architecture", 2nd Edition by Vincent P. Heuring and Harry F. Jordan, Pearson Education.

19CS4PC02T	OBJECT-ORIENTED PROGRAMMING USING JAVA(3-0-0)	Credit: 3

Course Objective:

1. Learn the syntax, semantics and idioms of the Java programming language.
2. Gain confidence in object oriented programming principles through lots of practical exercises that provide useful exposure to the core Java class libraries.

Module- I : **[8 Hrs]**

Introduction to Java and Java programming Environment. Object Oriented Programming Concepts: Encapsulation, Abstraction ,Inheritance ,Polymorphism.

Fundamental Programming Structure: Data Types, variable, keywords, typecasting, Arrays, Operators and their precedence.

Control Flow: Java's Control Statements (if, switch, iteration, statement, while, do-while, for, Nested loop).
Concept of Objects and Classes, Using Existing Classes building your own classes, constructor overloading, static , final, this keyword.

Module - II : **[8 Hrs]**

Inheritance: Introduction, types of inheritance. Use of super keyword. Method overriding, Dynamic method Dispatch, Using Abstract Classes, Using final with inheritance. The Object Class.

Packages & Interfaces: Packages, Access Protection, Importing package, Interface, Implementing Interfaces, variables in Interfaces, Interfaces can be extended.

Exception Handling: Fundamentals, Types Checked , Unchecked exceptions, Using try & catch, Multiple catch, throw , throws, finally, Java's Built in exceptions, user defined exception.

Module –III : **[8 Hrs]**

Multi Threading: Java Thread Life Cycle, Thread Priorities, Synchronization, Creating a thread, Runnable interface, Creating Multiple threads, Using isAlive () and join (), wait () & notiCS().

String Handling: String constructors, String length, Character Extraction, String Comparison, Modifying a string.

Java I/O: Classes & Interfaces, Stream classes, Byte streams, Character streams, Serialization.

Module IV : **[6 Hrs]**

Wrapper Classes : Wrapper classes and its methods.
Collection Framework: Introduction, interfaces, List, Set, Map etc, List interfaces and its classes.
Introduction to Database: Introduction to DataBase. Driver Types, Registering Driver, Creating Connection, Executing SQL query using Statement, PreparedStatment. ResultSet methods.

Module-V: **[6 Hrs]**

Event Handing: Event Delegation Model, Event Classes, Event Listener Interfaces, Adapter classes.

AWT: AWT Classes window fundamentals, component, container, panel, Window, Frame, working with Graphics , Control Fundamentals , Layout managers, Handling Events by Extending AWT components.
Swing: Icons & Labels, Text fields, Buttons, Combo boxes, Tabbed panes, Scroll panes, Trees, Tables.

Course Outcome:

1. Implement and apply various Object Oriented programming concepts.
2. Applying Collection Classes and Files, Multiple Threads & handle Exceptions in developing a java applications.
3. Developing a Java standalone application having front end design and back end.

Text Books:

1. Java: One Step Ahead by Anita Seth (Author), B.L. Juneja (Author) Oxford University Press.
2. Head First Java 2nd edition Kathy Sierra & Bert Bates

Reference Books:

3. JAVA Complete Reference (9th Edition) Herbert Schildt.
4. https://www.udemy.com/java-the-complete-java-developer-course/
   Java Programming Masterclass for Software Developers Created by Tim Buchalka, Tim Buchalka's Learn Programming Academy, Goran Lochert

19CS4PC03T	Design and Analysis of Algorithm(3-1-0)	4 Credit

Course Objective:

1. Translating a plain text problems to convert into an algorithm
2. Calculate best case, worst case time complexity and space complexities of different algorithm and choosing the best solution from the available options
3. Applying different design paradigm to solve different problems and comparing their best case, worst case scenarios.
4. Designing and applying different data structures over different algorithms for solving different problems.
5. Understand different P-class, NP class problems.

Module-I: **[12 Hrs]**

Introduction to problems and algorithms , Mathematics for algorithm analysis , Insertion sort Analysing algorithms, Designing of algorithms, Asymptotic notation Standard notations and common functions, Recurrence relations, The substitution method, The recursion-tree method, The master method, Divide and conquer: Min-Max Heap, Priority queue,Heapsort , Quicksort, Merge Sort, Sorting in Linear Time: Lower bounds for sorting: Counting sort, Radix sort, Bucket sort, Fast Fourier transform , Finding the convex hull : Graham Scan, Finding the closest pair of points

Module-II: **[8 Hrs]**

Greedy method: Elements of the greedy strategy, Huffman codes, task-scheduling problem, Fractional Knapsack problem, Coin change problem, Dynamic programming: Assembly-line Scheduling, Matrix-Chain Multiplication, Longest Common Subsequence(LCS), 0/1 Knapsack problem, Rod Cutting problem

Module-III: **[6 Hrs]**

Graph algorithms: Basic Definitions and Application, Representations of graphs, Breadth-first search and Depth-first search, Data Structures for Disjoint Sets, Strongly connected components, Minimum Spanning Trees: The algorithms of Kruskal and Prim

Module-IV: **[6 Hrs]**

Single-Source Shortest Paths: The Bellman-Ford algorithm, Dijkstra's algorithm, All-Pairs Shortest Paths-Shortest paths and matrix multiplication, The Floyd-Warshall algorithm
String Matching: The naive string-matching algorithm, The Rabin-Karp algorithm, The Knuth-Morris-Pratt algorithm.

Module-V: **[8 Hrs]**

Network Flow: Flow networks, The Ford-Fulkerson method, Maximum bipartite matching.
Backtracking – n-Queen problem – Hamiltonian Circuit Problem – Subset Sum Problem.
Branch and Bound – LIFO Search and FIFO search – Assignment problem – Knapsack Problem, NP-Completeness: Classes P and NP, NP-complete problems.: Reduction of 3SAT to Subset Sum, Approximation Algorithm for TSP

Course Outcome:

1. Given a English language problem description define the problem precisely with input/output requirements, examine its inherent complexity and develop a generic or set of initial solutions and justify their correctness.
2. Given an algorithm descriptions, analyse the time and space complexity of the algorithm in the worst case, average case, and amortized scenario as needed in terms of asymptotic order of complexity.
3. Given a problem definition explore different alternative algorithmic solutions, compare them with respect to time and space complexity and choose the design scheme and /or design parameter and data structure appropriately to obtain the best possible choice(s) that can be converted to an executable programs.
4. Examine and prove whether a problem is of polynomial complexity, hard(np complete) or otherwise and develop optimal and approximate algorithm for them as applicable.

Text Books:

1. Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, Introduction to Algorithms, Third Edition, MIT Press/McGraw-Hill, 2009.
2. Ellis Horowitz, SartajSahni and SanguthevarRajasekaran, Computer Algorithms/ C++, Second Edition, Universities Press, 2007.

Reference Books:

3. SanjoyDasgupta, Christos H. Papadimitriou and Umesh V. Vazirani, Algorithms, McGraw-Hill, 2008.
4. Jon Kleinberg and ÉvaTardos, Algorithm Design, Addison-Wesley/PEARSON EDUCATION-2006.
5. S. Sridhar, —Design and Analysis of Algorithms‖, Oxford university press, First Edition, 2015.

MOOC:

1. Prof.Abhiram G Ranade, Prof.Ajit A Diwan, Prof.SundarViswanathan,IIT Bombay, https://nptel.ac.in/courses/106101060/
2. Prof.MadhavanMukund,Chennai Mathematical Institute, https://nptel.ac.in/ courses/106106131/
3. Reyna Hulett, CS161, Stanford School of Engineering, https://online.stanford.edu/courses/cs161-design-and-analysis-algorithms

19CS4PC04T	Discrete Structure (3-0-0)	3 Credit

Course Objective:

1. To develop logical thinking and its application to computer science
2. How to count some different types of discrete structures;
3. Reason mathematically about basic data types and structures(such as numbers, sets, graphs, and trees) used in computer algorithms and systems; distinguish rigorous definitions and conclusions from merely plausible ones; synthesize elementary proofs, especially proofs by induction.
4. Model and analyze computational processes using analytic and combinatorial methods.

Module-I. **[10 Hrs]**

Set Theory: Definition of Sets, Venn Diagrams, complements, cartesian products, power sets, counting principle, cardinality and countability (Countable and Uncountable sets). Propositional logic: Proposition logic, basic logic, logical connectives, truth tables, tautologies, contradiction , normal forms(conjunctive and disjunctive), modus ponens and modus tollens, validity, predicate logic, universal and existential quantification. Theory of inference, Methods of proof: proof by implication, converse, inverse, contrapositive, negation, and contradiction, direct proof, proof by using truth table, proof by counter example.,proof by induction.

Module-II. **[8 Hrs]**

Sequences and Summations counting: basic counting rules. permutations, combinations. Numeric Functions and Generating Functions: Discrete Numeric functions, Generating Functions, Recurrence Relations and Recursive Algorithms: Recurrence relations, Linear recurrence relations with constant coefficients, Solution of recurrence relations by the method of generating functions, Divide and conquer algorithms,

Module-III. **[10 Hrs]**

Relations: representation of relations by graphs; properties of relations; equivalence relations and partitions; Closure of relations, Warshall's algorithm, Partial orderings; Posets; Linear and well-ordered sets;

Definition and elementary properties of groups, semigroups, monoids, rings, fields, vectorspaces and lattices; Boolean Algebras: Lattices and algebraic systems, Principle of duality, Distributive and complemented lattices, Boolean functions and Boolean expressions.

Module-IV. **[8 Hrs]**

Graphs and Trees: Basic terminology, Diagraphs and relations, representation of Graphs, operations on graphs, paths and circuits, graph traversals, shortest path in weighted graphs, Eulerian paths and circuits, Hamiltonian paths and circuits, Traveling sales person's problem, Planar graphs, Graph Coloring.

Module-V. **[4 Hrs]**

Trees: Trees, Rooted trees, Binary search trees, Spanning trees, Minimum spanning trees, Kruskal's Algorithm, Prim's Algorithm.

Course Outcome:

1. Applying set theory and logic for solving problems
2. Apply number theory and linear algebra to solve problems
3. Solving different problems using graph theory and trees

Text Books:

1. Kenneth H. Rosen, "Discrete Mathematics and its Applications", Mc.Graw Hill, 2002.
2. C. L. Liu, D. P. Mohapatra, Elements of Discrete Mathematics: A computer OrientedApproach, McGraw Hill Education (India) Private Limited, 4th Edition, 2013.

Reference Books:

3. Joe L. Mott, A. Kandel, and T. P. Baker, Discrete Mathematics for Computer Scientists &Mathematics, Prentice Hall of India, 2nd Edition, 2006
4. N. Deo, Graph Theory with applications to Engineering & Computer Science, PrenticeHall of India, 2006.
5. S. Lipschutz, Discrete Mathematics, Tata McGraw Hill, 2005.
6. https://nptel.ac.in/syllabus/106106094/ course coordinated by : IIT Madras course available from : 31-december-2009, by Coordinator: Prof. Kamala Krithivasan, IIT Madras

19CS4PE01T	Computer Graphics (3-0-0)	3 Credit

Course Objective:

1. To explain basic principles for representation of the geometric objects in the 2D and 3D coordinates. Utilize the computer system and methods
2. To demonstrate the implementation of the algorithms and techniques necessary to produce geometric objects in 2D and 3D space illustrations.
3. To elaborate the clipping and projection technique and curve tracing methods.
4. To elaborate the geometric optics necessary to determine how light bounces off surfaces. Shading algorithms to determine how a surface should be shaded to produce realistic illustrations. Curves and surfaces methods for rendering and shading curved objects.

Module-I: **[8 Hrs]**

Overview of Graphics System: Video Display Units, Raster-Scan and Random Scan Systems, Graphics Input and Output Devices. Output Primitives: Line drawing Algorithms: DDA and Bresenham's Line Algorithm, Circle drawing Algorithms: Midpoint Circle Algorithm and Bresenham's Circle drawing Algorithm.

Module-II: **[6 Hrs]**

Two Dimensional Geometric Transformation: Basic Transformation (Translation, Rotation, Scaling) Matrix Representation, Composite transformations, Reflection, Shear, Transformation between coordinate systems. Two Dimensional Viewing: Window-to- View Port Coordinate Transformation.

Module-III: **[10 Hrs]**

Clipping: Line Clipping (Cohen-Sutherland Algorithm) and Polygon Clipping (Sutherland-Hodgeman Algorithm), Aliasing and Antialiasing, Half Toning, Thresholding, Dithering. Polygon Filling: Seed Fill Algorithm, Scan line Algorithm. Two Dimensional Object Representations: Spline Representation, Bezier Curves, B-Spline Curves. Fractal Geometry: Fractal Classification and Fractal Dimension.

Module-IV: **[8 Hrs]**

3D Geometric and Modelling Transformations: Translation, Rotation, Scaling, Reflections, shear, Composite Transformation. Projections: Parallel Projection, Perspective Projection.

Visible Surface Detection Methods: Back-Face Detection, Depth Buffer, A- Buffer, Scan- Line Algorithm, Painters Algorithm.

Module-V: **[8 Hrs]**

Illumination Models: Basic Models, Displaying Light Intensities. Color models: properties of light, XYZ, RGB, YIQ and CMY color models, Surface Rendering Methods: Polygon Rendering Methods: Gouraud Shading, Phong Shading.

Computer Animation: Types of Animation, Key frame Vs. Procedural Animation, Methods of Controlling Animation, Morphing. Introduction to Virtual Reality and Augmented Reality.

Course Outcome:

1. Student will illustrate the basic principles for representation of the geometric objects in the 2D and 3D coordinates with clipping, projection and shading.
2. Student will implement the algorithms for producing geometric objects in 2D and 3D space using C language.

3. Develop a standalone graphics project using visual animation and rendering

Text Books:

1. Computer Graphics, C version; D. Hearn and M. P. Baker; Pearson Education, 2nd Edition, 2002
2. Computer Graphics Principle and Practice, J.D. Foley, A. Dam, S.K. Feiner, Addison Wesley, 4th Edition, 2014.

Reference Books:

3. Procedural Elements of Computer Graphics, David Rogers, TMH. 1998
4. https://www.coursera.org/learn/interactive-computer-graphics by Takeo Igarashi (Professor) Department of Computer Science, Graduate School of Information Science and Technology, University of Tokyo.

19CS4PE02T	Data Science for Engineers(3-0-0)	3 Credit

Course Objectives :

1. Introduce R as a programming language
2. Introduce the mathematical foundations required for datascience
3. Introduce the first level data science algorithms
4. Introduce a data analytics problem solving framework
5. Introduce a practical capstone case study

MODULE -I **[8 Hrs]**

Introduction: Introduction to Data Science, Data Science Venn Diagram, Relation to data mining, machine learning, big data and statistics, Business Intelligence (BI) vs. Data Science. Types of Data: Structured v/s unstructured data, Examples of data pre-processing, Quantitative vs qualitative data, Four levels of data. Stages of a data science project: Defining the goal, Data collection and management, Explore the data, Modeling, Model evaluation and critique, Presentation and documentation.

MODULE -II **[8 Hrs]**

Introduction to Linear algebra for data science: Vectors and matrices.
Introduction to Probability: Bayesian versus Frequentist, Frequentist approach, The law of large numbers, Compound events, Conditional probability, Bayesian ideas revisited, Bayes theorem , More applications of Bayes theorem, Random variables, Discrete random variables.
Basic Statistics: Obtaining data (Observational, Experimental), Sampling data, Probability sampling, Random sampling, Unequal probability sampling, measurement of statistics , Measures of center (Mean, Median, Mode, Skewness, Quantile, Percentile), Measures of variation, Measures of relative standing, Correlations in data, The Empirical rule.

MODULE -III **[12 Hrs]**

Data Visualization: Basic principles, ideas and tools for data visualization, Identify effective and ineffective visualization (Scatter plots, Line graphs, Bar charts, Histograms, Box plots), Correlation versus causation, Simpson's paradox, Verbal communication.
Machine Learning Essentials: Machine learning, Working principles, Types of machine learning (Supervised learning, Unsupervised learning, Reinforcement learning), How does statistical modeling fit. Some Basic Algorithms like Linear Regression, k-Nearest Neighbors (k-NN), k-Means, Decision Tree. Feature Extraction, Eigen vectors and Eigen values, Principal Component Analysis (PCA).

MODULE -IV **[6 Hrs]**
Beyond the Essentials: The bias variance tradeoff (Error due to bias, Error due to variance, Two extreme cases of bias/variance tradeoff, How bias/variance play into error functions), K folds cross-validation, Grid searching (Visualizing training error versus cross-validation error), Ensembling techniques (Random forests, Comparing Random forests with decision trees), Introduction to structure of Neural networks.

MODULE -V **[6 Hrs]**

Hands on laboratory using R Language for example like Data Visualization (Scatter plots, Line graphs, Bar charts, Histograms, Box plots), Some Basic Algorithms like Linear Regression, k-Nearest Neighbors (k-NN), k-Means, Decision Tree. Principal Component Analysis (PCA), Random Forests, Neural Networks.

Course Outcomes:

1. Describe a flow process for data science problems (Remembering)
2. Classify data science problems into standard typology (Comprehension)
3. Develop R codes for data science solutions (Application)
4. Correlate results to the solution approach followed (Analysis)
5. Assess the solution approach (Evaluation)
6. Construct use cases to validate approach and identify modifications required

Text Books:

1. Principles of Data Science, Sinan Ozdemir, Packt Publishing Ltd 2016.
2. Doing Data Science, Straight Talk From The Frontline, Cathy O'Neil and Rachel Schutt., O'Reilly. 2014.
3. An Introduction to Statistical Learning with Applications in R. James G, Witten D, Hastie Tibshirani R, Springer, 2013.
4. Hands-On Data Science with R: Techniques to perform data manipulation and ...,Vitor Bianchi Lanzetta, Nataraj Dasgupta, Ricardo Anjoleto Farias, Packt publishing ltd, 2018.
5. Data Science for Engineers : https://swayam.gov.in/nd1_noc19_cs60/preview (Prof. Raghunathan Rengasamy & Prof. Shankar Narasimhan, IIT Madras).
6. https://www.udemy.com/course/data-science-and-machine-learning-bootcamp-with-r/ (Created by Jose Portilla)
7. https://www.udemy.com/machinelearning/ Machine Learning A-Z™: Hands-On Python & R In Data Science By: Kirill Eremenko, Hadelin de Ponteves

19CS4PE03T	Cryptography and Network Security(3-0-0)	3 Credit

Course Objective:

1. Understand OSI security architecture and classical encryption techniques.
2. Acquire fundamental knowledge on the concepts of finite fields and number theory.
3. Understand various block cipher and stream cipher models.
4. Describe the principles of public key cryptosystems, hash functions and digital signature.

Module I: **[8 Hrs]**

Introduction & Number Theory: Services, Mechanisms and attacks, the OSI security architecture, Network security model

Classical Encryption techniques: Symmetric cipher model, substitution techniques, transposition techniques, steganography.

FINITE FIELDS AND NUMBER THEORY: Groups, Rings, Fields, Modular arithmetic, Euclidean's algorithm Finite fields, Polynomial Arithmetic, Prime numbers: Fermat's and Euler's theorem, testing for primality, The Chinese remainder theorem, discrete logarithms.

Module II: **[8 Hrs]**

Block Ciphers and Public Key Cryptography: Block cipher principles, Data Encryption Standard, strength of DES, Block cipher design principles, block cipher modes of operation, Advanced Encryption Standard (AES), Triple DES

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

Module III: **[8 Hrs]**

Hash Functions and Digital Signatures: Authentication requirement, Authentication function, MAC, Hash function, Security of hash function and MAC, MD5, SHA, HMAC , CMAC, Digital signature and authentication protocols

Module IV: **[8 Hrs]**

System Security: Authentication applications, Kerberos, X.509 Authentication services, Intruders, Intrusion detection, password management, viruses and related threats, Firewall, Types of Firewalls, Internet Firewalls for Trusted system,

Module V: **[8 Hrs]**

Network Security:

E-mail Security: Security Services for E-mail-attacks possible through E-mail: Pretty Good Privacy, S/MIME. IPSecurity: Overview of IPSec, IP and IPv6-Authentication Header-Encapsulation, Web Security: SSL/TLS Basic Protocol, computing the keys, client authentication, Encoding-Secure Electronic Transaction (SET).

Course Outcome:

1. Explain how different Hash Functions and Digital Signatures algorithms and Public Key Cryptography techniques applied for developing cryptographic and digital signature systems.
2. Designing and solving block cyphering and public key cryptography algorithms
3. Explain and compare different Network security system and system security.

Text Books:

1. William Stallings, Cryptography and Network Security, 6th Edition, Pearson Education,2013.
2. Charlie Kaufman, Radia Perlman and Mike Speciner, "Network Security: Private Communication in a Public World", 2nd Edition, Prentice-Hall, 2002.

Reference Books:

3. Behrouz A. Ferouzan, "Cryptography & Network Security", 2nd Edition, Tata McGraw Hill, 2010.
4. Man Young Rhee, "Internet Security: Cryptographic Principles, Algorithms andProtocols", 1st Edition, Wiley Publications, 2003.
5. NPTEL Course by Dr.DebdeepMukhopadhyay, IIT, Kharagpur, https://nptel.ac.in/courses/106105031

19CS4PE04T	Digital Signal Processing (3-0-0)	3 Credit

Course Objective:

1. Represent signals mathematically in discrete-time.
2. Analyze discrete-time systems using z-transform.
3. Understand the Discrete-Fourier Transform (DFT) and the FFT algorithms.
4. Design digital filters for various applications.

Module I: **[8 Hrs]**

Discrete-time signals and systems: Discrete-time signals, Discrete-time systems, LTI systems, Discrete-time systems described by difference equations;Implementation of Discrete-time systems,Correlation of Discrete-time signals.

Module II: **[8 Hrs]**

z-transform: z-transform, Region of Convergence, Analysis of Linear Time Invariant systems using z-transform,Properties of z-transform for causal signals, Interpretation of stability in z-domain, Inverse z-transforms, the one-sided z-transform.

Module III: **[8 Hrs]**

Discrete Fourier Transform : Frequency Domain Analysis, Discrete Fourier Transform (DFT), Properties of DFT, Convolutions ofsignals, Fast Fourier Transform Algorithm, Linear filtering methods based on the DFT, Implementation of Discrete Time Systems.

Module IV: **[8 Hrs]**

Designof Digital filters: Designof FIR Digital filters: Windowmethod,Park-McClellan's method. Effect of finite register length in FIR filter design.
Design of IIR Digital Filters:Butterworth, Chebyshev and Elliptic Approximations,Low-pass, Band-pass, Band-stop and High-passfilters.

Module V: **[8 Hrs]**

Designof Adaptive Digital filters : Adaptive Direct-form FIR filter, LMS and RLS algorithms, Adaptive lattice-ladder filter, Kalman Filter

Course Outcome:

1. Represent signals and systems mathematically in discrete-time
2. Analyzeand apply discrete-time systems using different transform functions.
3. Design digital filters for various applications.

Text Books:

1. J. G. Proakis and D.G. Manolakis, “Digital Signal Processing: Principles, Algorithms and Applications”,4th Edition, Pearson, 2007.
2. S. K. Mitra, “Digital Signal Processing: A computer based approach”, 4th Edition, McGraw Hill, 2013.

Reference Books:

3. A.V. Oppenheim and R. W. Schafer, "Discrete Time Signal Processing", 3rd Edition, Pearson/Prentice-Hall, 2010.
4. L. R. Rabiner and B. Gold, "Theory and Application of Digital Signal Processing", Prentice Hall, 1992.
5. NPTEL Course by Prof. S.C. Dutta Roy, IIT Delhi https://nptel.ac.in/courses/117102060/

19CS4PC01L	Computer Organization & Architecture Lab (0-0-2)	1 Credits

Course Objective:

1. Understanding the behavior of Logic Gates, Adders, Decoders, Multiplexers and Flip-Flops.
2. Understanding the behavior of ALU, RAM, STACK and PROCESSOR from working modules and the modules designed by the student as part of the experiment

Laboratory Experiments

1. Study of Computer Components

(a) Identification of different components of a PC.

(b) Assembling & disassembling of a PC.

2. Study of different troubleshooting of a dot matrix printer using LX 1050+ Printer Trainer Module.

3. Study of the functions of SMPS using SMPS Trainer Kit.

(a) Study of SMPS with Single Output under Line Regulation.

(b) Study of SMPS with Multi Output under Line Regulation.

(c) Study of SMPS with Single Output under Load Regulation.

4. Study of different troubleshooting of CPU using CPU Trainer Module.

5. Familiarization of different types of byte addressing instruction using 8085 simulator.

6. Study of assembly Language program in PC using 8086 architecture.

7. Design of digital circuits (H/A, F/A, Decoder & Encoder) in VHDL using Active VHDL.

8. Design of digital circuits (MUX, DEMUX & ALU) in VHDL using Active VHDL.

9. Write a C/C++ program to perform signed bit multiplication using Booth's algorithm.

10. Write a C/C++ program for IEEE-754 floating point representation and perform Addition/Subtraction.

Course Outcome:

1. Analyze the behavior of logic gates
2. Design combinational circuits for basic components of computer system and applications.
3. Analyze the operational behavior and applications of various flip-flop
4. Design Arithmetic logic units and different types of memory blocks.

19CS4PC02L	Object-Oriented Programming Using Java Lab (0-0-2)	1 Credit

Course Objective:

1. Learn and implement Programs with the syntax, semantics and idioms of the Java programming language.
2. Implement practical exercises
3. Develop a standalone application.

List of Experiments:

1. Data types & variables, decision control structures: if, nested if etc Loop control structures: do, while, for etc.
2. Classes and objects.
3. Data Abstraction & Data hiding, Inheritance.
4. Interfaces and inner classes, wrapper classes.
5. Exception handlings
6. Threads
7. IO Files
8. Collections
9. Database Connectivity.
10. Applets AWT and Swing.

Course Outcome:

1. Understand and implement various Object Oriented Concepts like inheritance, abstraction and polymorphism.
2. Work with Collection Classes and Files, Multiple Threads, & handle Exceptions.
3. Develop applications to interact with a Database.
4. Design and implement Graphical User Interface(GUI) Applications in Java using AWT and Swing.

Text Books and Reading Materials :

1. Java: One Step Ahead by Anita Seth (Author), B.L. Juneja (Author) Oxford University Press.
2. Head First Java 2nd edition Kathy Sierra & Bert Bates
3. JAVA Complete Reference (9th Edition) Herbert Schildt.
4. https://www.udemy.com/java-the-complete-java-developer-course/
5. Java Programming Masterclass for Software Developers Created by Tim Buchalka, Tim Buchalka's Learn Programming Academy, Goran Lochert

19CS4PC03L	Design & Analysis of Algorithm Lab (0-0-2)	1 Credit

List of Experiments:

1. Insertion Sort/ Selection Sort
2. Divide and Conquer: Fibonacci search/Binary search
3. Divide and Conquer: Merge Sort/Quicksort/Heap Sort
4. Divide and Conquer: Convex hull/Finding closet pair
5. Dynamic Programming: MCM/LCS
6. Dynamic Programming: Rod Cutting problem /Assembly line Scheduling
7. Greedy method: Activity Selection/Huffman Coding
8. Graph Search: BFS/DFS
9. Graph Greedy MST: Kruskal/Prim's
10. Graph Greedy Shortest Path: Bellman ford/Dijkstra
11. Rabin Karp string matching algorithm/Subset Sum problem using Branch and Bound

Prerequisite: Each student should have a good knowledge on basic data structures like Stack, Queue, List, Heap, Matrix.