TRIBHUVAN UNIVERSITY

INSTITUTE OF SCIENCE AND TECHNOLOGY

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BACHELOR OF SCIENCE IN COMPUTER SCIENCE AND INFORMATION TECHNOLOGY

(COURSE OF STUDY)

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EFFECTIVE FROM ACADEMIC YEAR – 2074

Tribhuvan University

Institute of Science and Technology

Course of Study

Bachelor of Science in Computer Science and Information Technology

(B.Sc. CSIT)

2017

Prepared by

Computer Science and Information Technology Subject Committee

Introduction:

The Bachelor of Science in Computer Science and Information Technology (B.Sc.CSIT) curriculum is designed by closely following the courses practiced in accredited international universities, subject to the condition that the intake students are twelve years of schooling in the science stream or equivalent from any university recognized by Tribhuvan University (TU). In addition to the foundation and core Computer Science and Information Technology courses, the program offers several elective courses to fulfill the demand of high technology applications development. The foundation and core courses are designed to meet the undergraduate academic program requirement, and the service courses are designed to meet the need of fast changing computer technology and application. Students enrolled in the four year B.Sc.CSIT program are required to take courses in design and implementation of computer software systems, foundation in the theoretical model of computer science, and a functional background of computer hardware. All undergraduate students are required to complete 126 credit hours of computer science course and allied courses.

Objective:

The main objective of B.Sc.CSIT program is to provide students intensive knowledge and skill on different areas of computer science and information technology including design, theory, programming and application of computer system. It is envisaged that graduate of this program will be equipped with necessary knowledge of computer software and hardware system.

Eligibility Criteria for Admission

A student who seeks admission to B.Sc.CSIT program:

- Should have successfully completed twelve years of schooling in the science stream or equivalent form any university, board or institution.
- Should have secured a minimum of second division.
- Should have successfully passed the entrance examination conducted by Institute of Science and Technology (IOST), TU.
- Complied with all the application procedures.

Course Duration:

The entire course is of eight semesters (four academic years). There is a separate semester examination after the end of each semester.

Hours of Instruction:

a) **1Working days:** 90 days in a semester

b) **Class hours:**

- 3 credit hour courses with theory and lab is equivalent to 3 hours theory and 3 hours lab = 6 working hours per week.
- 3 credit hours theory-only course is equivalent 3 hours theory and 2 hours tutorial = 5 working hours per week.

Evaluation

Theory course should have internal weightage of 20% and external weightage of 80%. For the course having lab work, the internal weightage is 20%, lab work weightage is 20% and external weightage is 60%. A student should secure minimum of 40% in each category to pass a course. The final score in each course will be the sum of overall weightage of in all categories. There will be a separate practical examination for the 20% weightage of lab work conducted by concerned college in the presence of an external examiner.

The project work and internship are evaluated by different evaluators. To pass project work and internship, students should secure at least 40% marks in the evaluation of each evaluator and final score will be the sum of all the evaluations. For the evaluation of final presentation, an external examiner will be assigned from the IOST.

The Grading System

A student having passed his/her 8 semesters (4 years) of study will be graded as follows

- **Distinction:** 80 % and above (8 semester's average)
- **First Division:** 70 % and above (8 semester's average)
- **Second Division:** 55 % and above (8 semester's average)
- **Pass Division:** 40 % and above (8 semester's average)

Attendance Requirement:

Students are required to attend regularly all theory and practical classes and should maintain 80 percent attendance in each course separately.

Final Examination:

Institute of science and technology, Tribhuvan University, will conduct the final examination at the end of each semester. 80% weightage will be given to the final examination for theory course and 60% will be given for the course having both theory and practical.

Course Structure:

Semester I

Course Code	Course Title	Credit Hours	Full Marks
CSC109	Introduction to Information Technology	3	100
CSC110	C Programming	3	100
CSC111	Digital Logic	3	100
MTH112	Mathematics I	3	100
PHY113	Physics	3	100
Total		**15**	**500**

Semester II

Course Code	Course Title	Credit Hours	Full Marks
CSC160	Discrete Structure	3	100
CSC161	Object Oriented Programming	3	100
CSC162	Microprocessor	3	100
MTH163	Mathematics II	3	100
STA164	Statistics I	3	100
Total		**15**	**500**

Semester III

Course Code	Course Title	Credit Hours	Full Marks
CSC206	Data Structure and Algorithms	3	100
CSC207	Numerical Method	3	100
CSC208	Computer Architecture	3	100
CSC209	Computer Graphics	3	100
STA210	Statistics II	3	100
Total		**15**	**500**

Semester IV

Course Code	Course Title	Credit Hours	Full Marks
CSC257	Theory of Computation	3	100
CSC258	Computer Networks	3	100
CSC259	Operating Systems	3	100
CSC260	Database Management System	3	100
CSC261	Artificial Intelligence	3	100
Total		**15**	**500**

Semester V

Course Code	Course Title	Credit Hours	Full Marks
CSC314	Design and Analysis of Algorithms	3	100
CSC315	System Analysis and Design	3	100
CSC316	Cryptography	3	100
CSC317	Simulation and Modeling	3	100
CSC318	Web Technology	3	100
	Elective I	3	100
Total		**18**	**600**

List of Electives:

1. Multimedia Computing (CSC319)
2. Wireless Networking (CSC320)
3. Image Processing (CSC321)
4. Knowledge Management (CSC322)
5. Society and Ethics in Information Technology (CSC323)
6. Microprocessor Based Design (CSC324)

Semester VI

Course Code	Course Title	Credit Hours	Full Marks
CSC364	Software Engineering	3	100
CSC365	Complier Design and Construction	3	100
CSC366	E-Governance	3	100
CSC367	NET Centric Computing	3	100
CSC368	Technical Writing	3	100
	Elective II	3	100
Total		**18**	**600**

List of Electives:
1. Applied Logic (CSC369)
2. E-commerce (CSC370)
3. Automation and Robotics (CSC371)
4. Neural Networks (CSC372)
5. Computer Hardware Design (CSC373)
6. Cognitive Science (CSC374)

Semester VII

Course Code	Course Title	Credit Hours	Full Marks
CSC409	Advanced Java Programming	3	100
CSC410	Data Warehousing and Data Mining	3	100
MGT411	Principles of Management	3	100
CSC412	Project Work	3	100
	Elective III	3	100
Total		**15**	**500**

List of Electives:
1. Information Retrieval (CSC413)
2. Database Administration (CSC414)
3. Software Project Management (CSC415)
4. Network Security (CSC416)
5. Digital System Design (CSC417)
6. International Marketing (MGT418)

Semester VIII

Course Code	Course Title	Credit Hours	Full Marks
CSC461	Advanced Database	3	100
CSC462	Internship	6	200
	Elective IV	3	100
	Elective V	3	100
Total		**15**	**500**

List of Electives:

1. Advanced Networking with IPV6 (CSC463)
2. Distributed Networking (CSC464)
3. Game Technology (CSC465)
4. Distributed and Object Oriented Database (CSC466)
5. Introduction to Cloud Computing (CSC467)
6. Geographical Information System (CSC468)
7. Decision Support System and Expert System (CSC469)
8. Mobile Application Development (CSC470)
9. Real Time Systems (CSC471)
10. Network and System Administration (CSC472)
11. Embedded Systems Programming (CSC473)
12. International Business Management (MGT474)

Introduction to Information Technology

Course Title: Introduction to Information Technology
Course No: CSC109
Nature of the Course: Theory + Lab
Semester: I

Full Marks: 60 + 20 + 20
Pass Marks: 24 + 8 + 8
Credit Hrs: 3

Course Description: This course covers the basic concepts of computers and information technology including introduction, hardware, software, memory, input/output, data representation, database, networks and data communication, Internet, multimedia, and computer security.

Course Objectives: The main objective of this course is to provide students knowledge of fundamental concepts of computers and information technology.

Course Contents:

Unit 1: Introduction to Computer (3 Hrs.)
Introduction; Digital and Analog Computers; Characteristics of Computer; History of Computer; Generations of Computer; Classification of Computer; The Computer System; Application of Computers

Unit 2: The Computer System Hardware (3 Hrs.)
Introduction; Central Processing Unit; Memory Unit; Instruction Format; Instruction Set; Instruction Cycle; Microprocessor; Interconnecting the Units of a Computer; Inside a Computer Cabinet

Unit 3: Computer Memory (4 Hrs.)
Introduction; Memory Representation; Memory Hierarchy; CPU Registers; Cache Memory; Primary Memory; Secondary Memory; Access Types of Storage Devices; Magnetic Tape; Magnetic Disk; Optical Disk; Magneto-Optical Disk; How the Computer uses its memory

Unit 4: Input and Output Devices (4 Hrs.)
Introduction; Input-Output Unit; Input Devices; Human Data Entry Devices; Source Data Entry Devices; Output Devices; I/O Port; Working of I/O System

Unit 5: Data Representation (6 Hrs.)
Introduction; Number System; Conversion from Decimal to Binary, Octal, Hexadecimal; Conversion of Binary, Octal, Hexadecimal to Decimal; Conversion of Binary to Octal, Hexadecimal; Conversion of Octal, Hexadecimal to Binary; Binary Arithmetic; Signed and Unsigned Numbers; Binary Data Representation; Binary Coding Schemes; Logic Gates

Unit 6: Computer Software (6 Hrs.)
Introduction; Types of Software; System Software; Application Software; Software Acquisition; Operating System (Introduction, Objectives of Operating System, Types of OS, Functions of OS, Process Management, Memory Management, File Management, Device Management, Protection and Security, User Interface, Examples of Operating Systems)

Unit 7: Data Communication and Computer Network (5 Hrs.)
Introduction; Importance of Networking; Data Transmission Media; Data Transmission across Media; Data Transmission and Data Networking; Computer Network; Network Types; Network Topology; Communication Protocol; Network Devices; Wireless Networking

Unit 8: The Internet and Internet Services (4 Hrs.)
Introduction; History of Internet; Internetworking Protocol; The Internet Architecture; Managing the Internet; Connecting to Internet; Internet Connections; Internet Address; Internet Services; Uses of Internet; Introduction to Internet of Things (IoT), Wearable Computing, and Cloud Computing, Introduction to E-commerce, E-governance, and Smart City, and GIS

Unit 9: Fundamentals of Database (4 Hrs.)
Introduction; Database; Database System; Database Management System; Database System Architectures; Database Applications; Introduction to Data Warehousing, Data mining, and BigData

Unit 10: Multimedia (3 Hrs.)
Introduction; Multimedia - Definition; Characteristics of Multimedia; Elements of Multimedia; Multimedia Applications

Unit 11: Computer Security (3 Hrs.)
Introduction; Security Threat and Security Attack; Malicious Software; Security Services; Security Mechanisms (Cryptography, Digital Signature, Firewall, Users Identification and Authentication, Intrusion Detection Systems); Security Awareness; Security Policy

Laboratory Works:
After completing this course, students should have practical knowledge of different hardware components of computer, operating systems, Word Processors, Spreadsheets, Presentation Graphics, Database Management Systems, and Internet and its services.

Text Books:
1. Computer Fundamentals, Anita Goel, Pearson Education India

Reference Books:
1. Introduction to Computers, Peter Norton, 7th Edition, McGraw Hill Education
2. Computer Fundamental, Pradeep K. Sinha and Priti Sinha
3. Data Mining Concepts and Techniques, Third Edition, Jiawei Han, Micheline Kamber and Jian Pei
4. Cloud Computing Bible, Barrie Sosinsky, Wiley

C Programming

Course Title: C Programming
Course No: CSC110
Nature of the course: Theory + Lab
Semester: I

Full Marks: 60 + 20 + 20
Pass Marks: 24 + 8 + 8
Credit Hrs.: 3

Course Description: This course covers the concepts of structured programming using C programming language.

Course Objective: This course is designed to familiarize students to the techniques of programming in C.

Course Contents:

Unit 1: Problem Solving with Computer (2 Hrs.)
Problem analysis, Algorithms and Flowchart, Coding, Compilation and Execution, History of C, Structure of C program, Debugging, Testing and Documentation

Unit 2: Elements of C (4 Hrs.)
C Standards(ANSI C and C99), C Character Set, C Tokens, Escape sequence, Delimiters, Variables, Data types (Basic, Derived, and User Defined), Structure of a C program, Executing a C program, Constants/ Literals, Expressions, Statements and Comments.

Unit 3: Input and Output (2 Hrs.)
Conversion specification, Reading a character, Writing a character, I/O operations, Formatted I/O

Unit 4: Operators and Expression (4 Hrs.)
Arithmetic operator, Relational operator, Logical or Boolean operator, Assignment Operator, Ternary operator, Bitwise operator, Increment or Decrement operator, Conditional operator, Special Operators(sizeof and comma), Evaluation of Expression, Operator Precedence and Associativity.

Unit 5: Control Statement (4 Hrs.)
Conditional Statements, Decision Making and Branching, Decision Making and Looping, Exit function, Break and Continue.

Unit 6: Arrays (6 Hrs.)
Introduction to Array, Types of Array (Single Dimensional and Multidimensional), Declaration and Memory Representation of Array, Initialization of array, Character Array and Strings, Reading and Writing Strings, Null Character, String Library Functions(string length, string copy, string concatenation, string compare)

Unit 7: Functions (5 Hrs.)
Library Functions, User defined functions, Funciton prototype, Function call, and Function Definition, Nested and Recursive Function, Function Arguments and Return Types, Passing

Arrays to Function, Passing Strings to Function, Passing Arguments by Value, Passing Arguments by Address, Scope visibility and lifetime of a variable, Local and Global Variable,

Unit 8: Structure and Union (5 Hrs.)
Introduction, Array of structure, Passing structure to function, Passing array of structure to function, Structure within structure (Nested Structure), Union, Pointer to structure

Unit 9: Pointers (6 Hrs.)
Introduction, The & and * operator, Declaration of pointer, Chain of Pointers, Pointer Arithmetic, Pointers and Arrays, Pointers and Character Strings, Array of Pointers, Pointers as Function Arguments, Function Returning pointers, Pointers and Structures, Dynamic Memory Allocation

Unit 10: File Handling in C (4 Hrs.)
Concept of File, Opening and closing of File, Input Output Operations in File, Random access in File, Error Handling in Files

Unit 11: Introduction to Graphics (3 Hrs.)
Concepts of Graphics, Graphics Initialization and Modes, Graphics Function

Laboratory Works:
This course requires a lot of programming practices. Each topic must be followed by a practical session. Some practical sessions include programming to:

- Create, compile and run simple C programs, handle different data types available in C, perform arithmetic operations in C, perform formatted input and output operations, perform character input and output operations.
- Perform logical operations, create decision making programs, create loops to repeat task.
- Create user-defined functions, create recursive functions, work with automatic, global and static variables, create, manipulate arrays and matrices (single and multi-dimensional), work with pointes, dynamically allocate de-allocate storage space during runtime, manipulate strings (character arrays) using various string handling functions.
- Create and use structures and files to keep record of students, employees etc.

Text Books:

1. Byron Gottfried: "Programming with C," , Second Edition, McGraw Hill Education.
2. Herbert Schildt, C The Complete Reference, Fourth Edition, Osborne/McGraw-Hill Publication.

Reference Books:

1. Paul Deitel, Harvey Deitel, C: How to Program, Eighth Edition, Pearson Publication.
2. Al Kelley, Ira Pohl: "A Book on C", Fourth Edition, Pearson Education.
3. Brian W. Keringhan, Dennis M. Ritchiem, The C programming Language, Second Edition, PHI Publication.
4. Ajay Mittal, Programming in C: A Practical Approach, Pearson Publication

5. Stephen G. Kochan, Programming in C, CBS publishers & distributors.
6. E. Balagurusamy, Programming in ANSI C, Third Edition, TMH publishing

Digital Logic

Course Title: Digital Logic
Course No: CSC111
Nature of the Course: Theory + Lab
Semester: I

Full Marks: 60 + 20 + 20
Pass Marks: 24 + 8 + 8
Credit Hrs: 3

Course Description: This course covers the concepts of digital logic and switching networks. The course includes the fundamental concepts of boolean algebra and its application for circuit analysis, multilevel gates networks, flip-lops, counters logic devices and synchronous and asynchronous sequential logic and digital integrated circuits.

Course Objectives: The main objective of this course is to introduce the basic tools for the design of digital circuits and introducing methods and procedures suitable for a variety of digital design applications.

Course Contents:

Unit 1: Binary Systems (6 Hrs.)

Digital Systems, Binary numbers, Number base conversion, Octal and hexadecimal numbers, compliments, Signed Binary numbers, Decimal codes (BCD, 2 4 2 1,8 4 -2 -1,Excess 3, Gray Code), Binary Storage and Registers, Binary logic

Unit 2: Boolean algebra and Logic Gates (5 Hrs.)

Basic and Axiomatic definitions of Boolean algebra, Basic Theorems and properties of Boolean Algebra, Boolean Functions, Logic Operations, Logic Gates, Integrated Circuits

Unit 3: Simplification of Boolean Functions (5 Hrs.)

K-map, Two and Three variable maps, Four variable maps, product of sum simplification, NAND and NOR implementation, Don't Care conditions, Determinant and selection of Prime Implicants

Unit 4: Combinational Logic (5 Hrs.)

Design Procedure, Adders, Subtractors, Code Conversions, Analysis Procedure, Multilevel NAND and NOR Circuits, Exclusive-OR Circuits

Unit 5: Combinational Logic with MSI and LSI (8 Hrs.)

Binary Parallel Adder and Subtractor, Decimal Adder, Magnitude Comparator, Decoders and Encoders, Multiplexers, Read-only-Memory (ROM), Programmable Logic Array (PLA), Programmable Array Logic (PAL)

Unit 6: Synchronous and Asynchronous Sequential Logic (10 Hrs.)

Flip-Flops, Triggering of flip-flops, Analysis of clocked sequential circuits, Design with state equations and state reduction table, Introduction to Asynchronous circuits, Circuits with latches.

Unit 7: Registers and Counters (6 Hrs.)
Registers, Shift registers, Ripple Counters, Synchronous Counters, Timing Sequences, The memory

Laboratory Works:
Students should be able to realize following digital logic circuits as a part of laboratory work.

- Familiarizations with logic gates
- Combinatorial Circuits
- Code Converters
- Design with Multiplexers
- Adders and Subtractors
- Flip-Flops
- Sequential Circuits
- Counters
- Clock Pulse Generator

Text Books:
1. M. Morris Mano, “Digital Logic & Computer Design”

Reference Books:

1. Brain Holdsworth, “Digital Logic Design”, Elsevier Science.
2. John Patrick Hayes, “Introduction to Digital Logic Design”, Addison-Wesley.
3. M. Morris Mano and Charles Kime, “Logic and Computer Design Fundamentals”, Pearson New International.

Mathematics I

Course Title: Mathematics I
Course No: MTH112
Nature of the Course: Theory
Semester: I

Full Marks: 80 + 20
Pass Marks: 32 + 8
Credit Hrs: 3

Course Description: The course covers the concepts of functions, limits, continuity, differentiation, integration of function of one variable; logarithmic, exponential, applications of derivative and antiderivatives, differential equations, vectors and applications, partial derivatives and Multiple Integrals.

Course Objectives: The objective of this course is to make students able to

- understand and formulate real world problems into mathematical statements.
- develop solutions to mathematical problems at the level appropriate to the course.
- describe or demonstrate mathematical solutions either numerically or graphically.

Course Contents:

Unit 1: Function of One Variable (5 Hrs.)

Four ways of representing a function, Linear mathematical model**,** Polynomial, Rational, Trigonometric, Exponential and Logarithmic functions, Combination of functions, Range and domain of functions and their Graphs

Unit 2: Limits and Continuity (4 Hrs.)

Precise definition of Limit, Limits at infinity, Continuity, Horizontal asymptotes, Vertical and Slant asymptotes

Unit 3: Derivatives (4 Hrs.)

Tangents and velocity, Rate of change, Review of derivative, Differentiability of a function, Mean value theorem, Indeterminate forms and L'Hospital rule

Unit 4: Applications of Derivatives (4 Hrs.)

Curve sketching, Review of maxima and minima of one variable, Optimization problems, Newton's method

Unit 5: Antiderivatives (5 Hrs.)

Review of antiderivatives, Rectilinear motion, Indefinite integrals and Net change, Definite integral, The Fundamental theorem of calculus, Improper integrals

Unit 6: Applications of Antiderivatives (5 Hrs.)

Areas between the curves, Volumes of cylindrical cells, Approximate Integrations, Arc length, Area of surface of revolution

Unit 7: Ordinary Differential Equations (6 Hrs.)
Introduction, Introduction to first order equations Separable equations, Linear equations, Second order linear differential equations, Non homogeneous linear equations, Method of undetermined coefficients

Unit 8: Infinite Sequence and Series (5 Hrs.)
Infinite sequence and series, Convergence tests and power series, Taylor's and Maclaurin's series

Unit 9: Plane and Space Vectors (4 Hrs.)
Introduction, Applications, Dot product and cross Product, Equations of lines and Planes, Derivative and integrals of vector functions, Arc length and curvature, Normal and binormal vectors, Motion in space

Unit 10: Partial Derivatives and Multiple Integrals (3 Hrs.)
Limit and continuity, Partial derivatives, Tangent planes, Maximum and minimum values, Multiple integrals

Text Book

1. Calculus Early Transcendentals, James Stewart, 7E, CENGAGE Learning.

Reference Book

1. Calculus Early Transcendentals, Thomas, 12th Editions, Addision Wesley.

Physics

Course Title: Physics
Course No.: PHY113
Nature of the Course: Theory + Lab
Semester: I

Full Marks: 60 + 20 + 20
Pass Marks: 24 + 8 + 8
Credit Hour: 3

Course Description: This course covers the fundamentals of physics including oscillations, electromagnetic theory, and basics of quantum mechanics, band theory, semiconductors and universal logic gates and finally physics of manufacturing integrated circuits.

Course Objectives: The main objective of this course is to provide knowledge in physics and apply this knowledge for computer science and information technology.

Course Contents:

Unit 1: Rotational Dynamics and Oscillatory Motion (5 Hrs.)
Moment of inertia and torque, Rotational kinetic energy, Conservation of angular momentum, Oscillation of spring: frequency, period, amplitude, phase angle and energy

Unit 2: Electric and Magnetic Field (5 Hrs.)
Electric and magnetic field and potential, Force on current carrying wire, magnetic dipole moment, Force on a moving charge, Hall effect, Electromagnetic waves

Unit 3: Fundamentals of Atomic Theory (8 Hrs.)
Blackbody radiation, Bohr atom, Spectrum of Hydrogen, Franck-Hertz experiment, de Broglie's hypothesis and its experimental verification, Uncertainty principle and its origin, matter waves and the uncertainty principle, group velocity.

Unit 4: Methods of Quantum Mechanics (5 Hrs.)
Schrodinger theory of quantum mechanics and its application, Outline of the solution of Schrodinger equation for H-atom, space quantization and spin, Atomic wave functions

Unit 5: Fundamentals of Solid State Physics (6 Hrs.)
Crystal structure, Crystal bonding, Classical and quantum mechanical free electron model, Bloch theorem, Kronig-Penny model, Tight-binding approximation, conductors, insulators and semiconductors, effective mass and holes.

Unit 6: Semiconductor and Semiconductor devices (8 Hrs.)
Intrinsic and extrinsic semiconductors, Electrical conductivity of semiconductors, Photoconductivity, Metal-metal junction: The contact potential, The semiconductor diode, Bipolar junction transistor (BJT), Field effect transistor (FET).

Unit 7: Universal Gates and Physics of Integrated Circuits (8 Hrs.)
Universal gates, RTL and TTL gates, Memory circuits, Clock circuits, Semiconductor purification: Zone refining, Single crystal growth, Processes of IC production, Electronic component fabrication on a chip.

Laboratory Works:
Students should able to perform at least one experiment from units 1, 2 and 5, 6, 7. The details of the experiment will be provided in the manual.

Text Books:

1. Garcia Narciso, Damask Arthur, Physics for Computer Science Students, Springer-Verlag

Reference Books:

1. Heliday David, Resnick Robert and Walker Gearl, Fundamentals of Physics, 9th ed., John-Wiley and Sons, Inc.
2. Francis W. Sears, Hugh D. Young, Roger Freedman, Mark Zemansky, University Physics, Volume 1 & 2, 14th ed., Pearson Publication
3. Knight Randall D., Physics for Scientists and Engineers: A Strategic Approach, 3rd ed., Pearson Publication

Discrete Structures

Course Title: Discrete Structures
Course No: CSC160
Nature of the Course: Theory + Lab
Semester: II

Full Marks: 60 + 20 + 20
Pass Marks: 24 + 8 + 8
Credit Hrs: 3

Course Description: The course covers fundamental concepts of discrete structure like introduce logic, proofs, sets, relations, functions, counting, and probability, with an emphasis on applications in computer science.

Course Objectives: The main objective of the course is to introduce basic discrete structures, explore applications of discrete structures in computer science, understand concepts of Counting, Probability, Relations and Graphs respectively.

Course Contents:

Unit 1: Basic Discrete Structures (7 Hrs.)

1.1. Sets: Sets and Subsets, Power Set, Cartesian Product, Set Operations, Venn Diagram, Inclusion-Exclusion Principle, Computer Representation of Sets
1.2. Functions: Basic Concept, Injective and Bijective Functions, Inverse and Composite Functions, Graph of Functions, Functions for Computer Science (Ceiling Function, Floor Function, Boolean Function, Exponential Function), Fuzzy Sets and Membership Functions, Fuzzy Set Operations
1.3. Sequences and Summations: Basic Concept of Sequences, Geometric and Arithmetic Progression, Single and Double Summation

Unit 2: Integers and Matrices (6 Hrs.)

2.1. Integers: Integers and Division, Primes and Greatest Common Divisor, Extended Euclidean Algorithm, Integers and Algorithms, Applications of Number Theory (Linear Congruencies, Chinese Remainder Theorem, Computer Arithmetic with Large Integers)
2.2. Matrices: Zero-One Matrices, Boolean Matrix Operations

Unit 3: Logic and Proof Methods (6 Hrs.)

3.1. Logic: Propositional Logic, Propositional Equivalences, Predicates and Quantifiers, Negation of Quantified Statements, Proof of quantified statements, Nested Quantifiers, Rules of Inferences
3.2. Proof Methods: Basic Terminologies, Proof Methods (Direct Proof, Indirect Proof, Proof by Contradiction, Proof By Contraposition, Exhaustive Proofs and Proof by Cases), Mistakes in Proof

Unit 4: Induction and Recursion (5 Hrs.)

4.1. Induction: mathematical Induction, Strong Induction and Well Ordering, Induction in General
4.2. Recursive Definitions and Structural Induction, Recursive Algorithms, Proving Correctness of Recursive Algorithms

Unit 5: Counting and Discrete Probability (9 Hrs.)

5.1. Counting: Basics of Counting, Pigeonhole Principle, Permutations and Combinations, Two Element Subsets, Counting Subsets of a Set, Binomial Coefficients, Generalized Permutations and Combinations, Generating Permutations and Combinations

5.2. Discrete Probability: Introduction to Discrete Probability, Probability Theory, Probability Calculation in Hashing, Expected Value and Variance, Randomized Algorithms

5.3. Advanced Counting: Recurrence Relations, Solving Recurrence Relations (Homogeneous and Non-Homogeneous equations), Introduction to Divide and Conquer Recurrence Relations

Unit 6: Relations and Graphs (12 Hrs.)

6.1. Relations: Relations and their Properties, N-ary Relations with Applications, Representing Relations, Closure of Relations, Equivalence Relations, Partial Ordering

6.2. Graphs: Graphs Basics, Graph Types, Graph Models, Graph Representation, Graph Isomorphism, Connectivity in Graphs, Euler and Hamiltonian Path and Circuits, Matching Theory, Shortest Path Algorithm (Dijkstra's Algorithm), Travelling Salesman Problem, Graph Coloring

6.3. Trees: Introduction and Applications, Tree Traversals, Spanning Trees, Minimum Spanning Trees (Kruskal's Algorithm)

6.4. Network Flows: Graph as Models of Flow of Comodities, Flows, Maximal Flows and Minimal Cuts, The Max Flow-Min Cut Theorem

Laboratory Works:

The laboratory work consists of implementing the algorithms and concepts discussed in the class. Student should implement problems with following concepts;

- Set Operations and Boolean Matrix Operations
- Primility Testing, Number Theory Algorithms, and Operations on Integers
- Counting and Some Recursive Algorithms
- Algorithms for Relations, Graphs

Text Books:

1. Kenneth H. Rosen, Discrete mathematics and its applications, Seventh Edition McGraw Hill Publication, 2012.
2. Bernard Kolman, Robert Busby, Sharon C. Ross, Discrete Mathematical Structures, Sixth Edition Pearson Publications, 2015
3. Joe L Mott, Abraham Kandel, Theodore P Baker, Discrete Mathematics for Computer Scientists and Mathematicians, Printice Hall of India, Second Edition, 2008

Reference Books:

1. Ken Bogart, Scot Drysdale, Cliff Stein, Discrete Mathematics for Computer Scientists, First Edition Addison-Wesley, 2010

Object Oriented Programming

Course Title: Object Oriented Programming
Course No: CSC161
Nature of Course: Theory + Lab
Semester: II

Full Marks: 60 + 20 + 20
Pass Marks: 24 + 8 + 8
Credit Hrs: 3

Course Description: The course covers the basic concepts of object oriented programming using C++ programming language.

Course Objectives: The main objective of this course is to understand object oriented programming and advanced C++ concepts such as composition of objects, operator overloads, inheritance and polymorphism, file I/O, exception handling and templates.

Course Contents:

Unit 1: Introduction to Object Oriented Programming (3 Hrs.)
Overview of structured programming approach, Object oriented programming approach, Characteristics of object oriented languages

Unit 2: Basics of C++ programming (5 Hrs.)
C++ Program Structure, Character Set and Tokens, Data Type, Type Conversion, Preprocessor Directives, Namespace, Input/Output Streams and Manipulators, Dynamic Memory Allocation with new and delete, Control Statements.

Functions: Function Overloading, Inline Functions, Default Argument, Pass by Reference, Return by Reference, Scope and Storage Class.

Pointers: Pointer variables declaration & initialization, Operators in pointers, Pointers and Arrays, Pointer and Function.

Unit 3: Classes & Objects (8 Hrs.)
A Simple Class and Object, Accessing members of class, Initialization of class objects: (Constructor, Destructor), Default Constructor, Parameterized Constructor, Copy Constructor, The Default Copy Constructor, Objects as Function Arguments, Returning Objects from Functions, Structures and Classes, Memory allocation for Objects, Static members, Member functions defined outside the class.

Unit 4: Operator Overloading (7 Hrs.)
Fundamental of operator overloading, Restriction on operator overloading, Operator functions as a class members, Overloading unary and binary operator, Data Conversion (basic to basic, basic to user-defined, user-defined to basic, user-defined to user-defined)

Unit 5: Inheritance (7 Hrs.)
Introduction to inheritance, Derived Class and Base Class, Access Specifiers (private, protected, and public), Types of inheritance, Public and Private Inheritance, Constructor and Destructor in derived classes, Aggregation

Unit 6: Virtual Function, Polymorphism, and miscellaneous C++ Features (5 Hrs.)
Concept of Virtual functions, Late Binding, Abstract class and pure virtual functions, Virtual Destructors, Virtual base class, Friend function and Static function, Assignment and copy initialization, Copy constructor, This pointer, Concrete classes, Polymorphism and its roles.

Unit 7: Function Templates and Exception Handling (4 Hrs.)
Function templates, Function templates with multiple arguments, Class templates, templates and inheritance, Exceptional Handling (Try, throw and catch), Use of exceptional handling.

Unit 8: File handling (6 Hrs.)
Stream Class Hierarchy for Console Input /Output, Unformatted Input /Output, Formatted Input /Output with ios Member functions, Formatting with Manipulators, Stream Operator Overloading, File Input/output with Streams, Opening and Closing files, Read/Write from File, File Access Pointers and their Manipulators, Sequential and Random Access to File, Testing Errors during File Operations

Laboratory Works:
Students should be able to implement the concepts of Object Oriented Programming using C++ language.

Text Book:

1. Robert Lafore, Object Oriented Programming in C++, Fourth Edition, SAMS publications.
2. Herbert Schildt, C++ The Complete Reference, Fourth Edition, Tata McGraw Hill Publication.

Reference Books:

1. Deitel and Deitel, C++ How to Program, Third Edition, Pearson Publication.
2. Joyce Farrell, Object-oriented programming using C++, Fourth Edition, Cengage Learning.

Microprocessor

Course Title: Microprocessor
Course No: CSC162
Nature of the Course: Theory + Lab
Semester: II

Full Marks: 60 + 20 + 20
Pass Marks: 24 + 8 + 8
Credit Hrs: 3

Course Description: This course contains of fundamental concepts of computer organization, basic I/O interfaces and Interrupts operations.

Course Objectives: The course objective is to introduce the operation, programming and application of microprocessor.

Course Contents:

Unit1: Introduction (4 Hrs.)
Introduction to Microprocessor, Components of a Microprocessor: Registers, ALU and control & timing, System bus (data, address and control bus), Microprocessor systems with bus organization

Unit 2: Basic Architecture (7 Hrs.)
Microprocessor Architecture and Operations, Memory, I/O devices, Memory and I/O operations, 8085 Microprocessor Architecture, Address, Data And Control Buses, 8085 Pin Functions, Demultiplexing of Buses, Generation Of Control Signals

Unit 3: Instruction Cycle (3 Hrs.)
Fetch Operation and Timing Diagram; Execute Operation and Timing Diagram, Instruction Cycle, Machine Cycle, T-States, T-States, Memory Interfacing

Unit 4: Assembly Language Programming (10 Hrs.)
Assembly instruction format, Instruction Types, Mnemonics, Operands, Macro assemblers, Linking, Assembler directives, Addressing Modes, Simple sequence programs, Flags, Branch, Jumps, While-Do, Repeat-Until, If-Then-Else and Multiple If-then Programs, Debugging

Unit 5: Basic I/O, Memory R/W and Interrupt Operations (6 Hrs.)
Memory Read, Memory Write, I/O Read, I/O Write, Direct Memory Access, Interrupt, Types, Interrupt Masking

Unit 6: Input/ Output Interfaces (6 Hrs.)
Interfacing Concepts, Ports, Interfacing Of I/O Devices, Interrupts In 8085, Programmable Interrupt Controller 8259A, Programmable Peripheral Interface 8255A

Unit 7: Advanced Microprocessors (9 Hrs.)
8086: logical block diagram and segments, 80286: Architecture, Registers, (Real/Protected mode), Privilege levels, descriptor cache, Memory access in GDT and LDT, multitasking, addressing modes, flag register 80386: Architecture, Register organization, Memory access in protected mode, Paging

Laboratory Works:

The laboratory work includes Assembly language programming using 8085/8086/8088 trainer kit. The programming should include: Arithmetic operation, base conversion, conditional branching etc. The lab work list may include following concepts:

1. Assembly language program using 8085 microprocessor kit.
2. Use of all types of instructions and addressing modes.
3. Arrays and the concept of Multiplications and Division operations on Microprocessor.
4. Assembly language programming, using any types of Assembler, including the different functions of Int 10h, and 12h

Text Books:

1. Ramesh S.Gaonkar, Microprocessor Architecture, Programming, and Applications with 8085, Prentice Hall

Reference Books:

1. A.P.Malvino and J.A.Brown, Digital Computer Electronics, 3rd Edition, Tata McGraw Hill D.V.Hall, Microprocessors and Interfacingv – Programming and Hardware, McGraw Hill
2. 8000 to 8085 Introduction to 8085 Microprocessor for Engineers and Scientists, A.K.Gosh, Prentice Hall

Mathematics II

Course Title: Mathematics II
Course No: MTH163
Nature of the Course: Theory
Semester: II

Full Marks: 80 + 20
Pass Marks: 32 + 8
Credit Hrs: 3

Course Description: The course contains concepts and techniques of linear algebra. The course topics include systems of linear equations, determinants, vectors and vector spaces, eigen values and eigenvectors, and singular value decomposition of a matrix.

Course Objectives: The main objective of the course is to make familiarize with the concepts and techniques of linear algebra, solve system of linear equation with Gauss-Jordon method, to impart knowledge of vector space and subspace, eigenvalues and eigenvectors of a matrix and get the idea of diagonalization of a matrix, linear programming, Group, Ring, and Field.

Course Contents:

Unit 1: Linear Equations in Linear Algebra (5 Hrs.)

System of linear equations, Row reduction and Echelon forms, Vector equations, The matrix equations $A\mathbf{x} = \mathbf{b}$, Applications of linear system, Linear independence

Unit 2:Transformation (4 Hrs.)

Introduction to linear transformations, the matrix of a linear Transformation, Linear models in business, science, and engineering

Unit 3: Matrix Algebra (5 Hrs)

Matrix operations, The inverse of a matrix, Characterizations of invertible matrices, Partitioned matrices, Matrix factorization, The Leontief input output model, Subspace of R^n, Dimension and rank

Unit 4: Determinants (4 Hrs.)

Introduction, Properties, Cramer’s rule, Volume and linear transformations

Unit 5: Vector Spaces (5 Hrs.)

Vector spaces and subspaces, Null spaces, Column spaces, and Linear transformations, Linearly independent sets: Bases, Coordinate systems

Unit 6: Vector Space Continued (4 Hrs.)

Dimension of vector space and Rank, Change of basis, Applications to difference equations, Applications to Markov Chains

Unit 7: Eigenvalues and Eigen Vectors (5 Hrs.)

Eigenvectors and Eigenvalues, The characteristic equations, Diagonalization, Eigenvectors and linear transformations, Complex eigenvalues, Discrete dynamical systems, Applications to differential equations

Unit 8: Orthogonality and Least Squares (5 Hrs.)
Inner product, Length, and orthoganility, Orthogonal sets, Orthogonal projections, The Gram-Schmidt process, Least squares problems, Application to linear models, Inner product spaces, Applications of inner product spaces

Unit 9: Groups and Subgroups (5 Hrs.)
Binary Operations, Groups, Subgroups, Cyclic Groups

Unit 10: Rings and Fields (4 Hrs.)
Rings and Fields, Integral domains

Text Books:
1. Linear Algebra and Its Applications, David C. Lay, 4^{th} Edition, Pearson Addison Wesley.
2. Linear Algebra and Its Applications, Gilbert Strang, 4^{th} Edition, Addison, CENGAGE Learning.

Statistics I

Course Title: Statistics I
Course No: STA164
Nature of the Course: Theory + Lab
Semester: II

Full Marks: 60 + 20 + 20
Pass Marks: 24 + 8 + 8
Credit Hrs: 3

Course Description: This course contains basics of statistics, descriptive statistics, probability, sampling, random variables and mathematical expectations, probability distribution, correlation and regression.

Course Objectives: The main objective of this course is to impart the knowledge of descriptive statistics, correlation, regression, sampling, theoretical as well as applied knowledge of probability and some probability distributions.

Course Contents:

Unit 1: Introduction (4 Hrs.)

Basic concept of statistics; Application of Statistics in the field of Computer Science & Information technology; Scales of measurement; Variables; Types of Data; Notion of a statistical population

Unit 2: Descriptive Statistics (6 Hrs.)

Measures of central tendency; Measures of dispersion; Measures of skewness; Measures of kurtosis; Moments; Steam and leaf display; five number summary; box plot

Problems and illustrative examples related to computer Science and IT

Unit 3: Introduction to Probability (8 Hrs.)

Concepts of probability; Definitions of probability; Laws of probability; Bayes theorem; prior and posterior probabilities

Problems and illustrative examples related to computer Science and IT

Unit 4: Sampling (3 Hrs.)

Definitions of population; sample survey vs. census survey; sampling error and non sampling error; Types of sampling

5. Random Variables and Mathematical Expectation (5 Hrs.)

Concept of a random variable; Types of random variables; Probability distribution of a random variable; Mathematical expectation of a random variable; Addition and multiplicative theorems of expectation

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Unit 6: **Probability Distributions (12 Hrs.)**
Probability distribution function**,** Joint probability distribution of two random variables; Discrete distributions: Bernoulli trial, Binomial and Poisson distributions; Continuous distribution: Normal distributions; Standardization of normal distribution; Normal distribution as an approximation of Binomial and Poisson distribution; Exponential, Gamma distribution

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Unit 7: Correlation and Linear Regression (7 Hrs.)
Bivariate data; Bivariate frequency distribution; Correlation between two variables; Karl Pearson's coefficient of correlation(r); Spearman's rank correlation; Regression Analysis: Fitting of lines of regression by the least squares method; coefficient of determination

Problems and illustrative examples related to computer Science and IT

Laboratory Works:
The laboratory work includes using any statistical software such as Microsoft Excel, SPSS, STATA etc. whichever convenient using Practical problems to be covered in the Computerized Statistics laboratory

Practical problems

S. No.	Title of the practical problems	No. of practical problems
1	Computation of measures of central tendency (ungrouped and grouped data) Use of an appropriate measure and interpretation of results and computation of partition Values	1
2	Computation measures of dispersion (ungrouped and grouped data) and computation of coefficient of variation.	1
3	Measures of skewness and kurtosis using method of moments, Measures of Skewness using Box and whisker plot.	2
4	Scatter diagram, correlation coefficient (ungrouped data) and interpretation. Compute manually and check with computer output.	1
5	Fitting of lines of regression (Results to be verified with computer output)	1
6	Fitting of lines of regression and computation of correlation coefficient, Mean residual sum of squares, residual plot.	1
7	Conditional probability and Bayes theorem	3
8	Obtaining descriptive statistics of probability distributions	2
9	Fitting probability distributions in real data (Binomial, Poisson and Normal)	3
	Total number of practical problems	**15**

Text Books:

1. Michael Baron (2013). Probability and Statistics for Computer Scientists. 2nd Ed., CRC Press, Taylor & Francis Group, A Chapman & Hall Book.
2. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, & Keying Ye (2012). Probability & Statistics for Engineers & Scientists. 9th Ed., Printice Hall.

Reference Books:

1. Douglas C. Montgomery & George C. Ranger (2003). Applied Statistics and Probability for Engineers. 3rd Ed., John Willey and Sons, Inc.
2. Richard A. Johnson (2001). Probability and Statistics for Engineers. 6th Ed., Pearson Education, India

Data Structures and Algorithms

Course Title: Data Structures and Algorithms
Course No: CSC206
Nature of the Course: Theory + Lab
Semester: III

Full Marks: 60 + 20 + 20
Pass Marks: 24 + 8 + 8
Credit Hrs: 3

Course Description: This course includes the basic foundations in of data structures and algorithms. This course covers concepts of various data structures like stack, queue, list, tree and graph. Additionally, the course includes idea of sorting and searching.

Course Objectives:

- To introduce data abstraction and data representation in memory
- To describe, design and use of elementary data structures such as stack, queue, linked list, tree and graph
- To discuss decomposition of complex programming problems into manageable sub-problems
- To introduce algorithms and their complexity

Course Contents:

Unit 1: Introduction to Data Structures & Algorithms (4 Hrs.)

1.1 Data types, Data structure and Abstract date type
1.2 Dynamic memory allocation in C
1.3 Introduction to Algorithms
1.4 Asymptotic notations and common functions

Unit 2: Stack (4 Hrs.)

2.1 Basic Concept of Stack, Stack as an ADT, Stack Operations, Stack Applications
2.2 Conversion from infix to postfix/prefix expression, Evaluation of postfix/ prefix expressions

Unit 3: Queue (4 Hrs.)

3.1 Basic Concept of Queue, Queue as an ADT, Primitive Operations in Queue
3.2 Linear Queue, Circular Queue, Priority Queue, Queue Applications

Unit 4: Recursion (3 Hrs.)

4.1 Principle of Recursion, Comparison between Recursion and Iteration, Tail Recursion
4.2 Factorial, Fibonacci Sequence, GCD, Tower of Hanoi(TOH)
4.3 Applications and Efficiency of Recursion

Unit 5: Lists (8 Hrs.)

5.1 Basic Concept, List and ADT, Array Implementation of Lists, Linked List
5.2 Types of Linked List: Singly Linked List, Doubly Linked List, Circular Linked List.
5.3 Basic operations in Linked List: Node Creation, Node Insertion and Deletion from Beginning, End and Specified Position
5.4 Stack and Queue as Linked List

Unit 6: Sorting (8 Hrs.)

6.1 Introduction and Types of sorting: Internal and External sort
6.2 Comparison Sorting Algorithms: Bubble, Selection and Insertion Sort, Shell Sort
6.3 Divide and Conquer Sorting: Merge, Quick and Heap Sort
6.4 Efficiency of Sorting Algorithms

Unit 7: Searching and Hashing (6 Hrs.)

7.1 Introduction to Searching, Search Algorithms: Sequential Search, Binary Search
7.2 Efficiency of Search Algorithms
7.3 Hashing : Hash Function and Hash Tables, Collision Resolution Techniques

Unit 8: Trees and Graphs (8 Hrs.)

8.1 Concept and Definitions, Basic Operations in Binary Tree, Tree Height, Level and Depth
8.2 Binary Search Tree, Insertion, Deletion, Traversals, Search in BST
8.3 AVL tree and Balancing algorithm, Applications of Trees
8.4 Definition and Representation of Graphs, Graph Traversal, Minimum Spanning Trees: Kruskal and Prims Algorithm
8.5 Shortest Path Algorithms: Dijksrtra Algorithm

Laboratory Works:

The laboratory work consists of implementing the algorithms and data structures studied in the course. Student should implement at least following concepts;

- Dynamic memory allocation and deallocation strategies
- Stack operations and Queue operations
- Array and Linked List implementation of List
- Linked List implementation of Stack and Queues
- Sorting, Searching and Hashing algorithms
- Binary Search Trees and AVL Tress
- Graph Representation, Spanning Tree and Shortest Path Algorithms

Text Books:

1. Y Langsam , MJ Augenstein and A.M , Tanenbaum Data Structures using C and C++ , Prentice Hall India, Second Edition 2015

Reference Books:

1. Leen Ammeral, Programmes and Data Structures in C, Wiley Professional Computting
2. G.W Rowe, Introduction to Data Structure and Algroithms with C and C++ , prentice Hall India
3. R.L Kruse, B.P. Leung, C.L. Tondo, Data Structure and Program Design in C Prentice-Hall India

Numerical Method

Course Title: Numerical Method
Course No.: CSC207
Nature of the Course: Theory + Lab
Semester: III

Full Marks: 60 + 20 + 20
Pass Marks: 24 + 8 + 8
Credit Hrs: 3

Course Description: This course contains the concepts of numerical method techniques for solving linear and nonlinear equations, interpolation and regression, differentiation and integration, and partial differential equations.

Course Objectives: The main objective of the course is to provide the knowledge of numerical method techniques for mathematical modeling.

Course Content:

Unit 1: Solution of Nonlinear Equations (8 Hrs.)

1.1 Errors in Numerical Calculations, Sources of Errors, Propagation of Errors, Review of Taylor's Theorem

1.2 Solving Non-linear Equations by Trial and Error method, Half-Interval method and Convergence, Newton's method and Convergence, Secant method and Convergence, Fixed point iteration and its convergence, Newton's method for calculating multiple roots, Horner's method

Unit 2: Interpolation and Regression (8 Hrs.)

2.1 Interpolation vs Extrapolation, Lagrange's Interpolation, Newton's Interpolation using divided differences, forward differences and backward differences, Cubic spline interpolation

2.2 Introduction of Regression, Regression vs Interpolation, Least squares method, Linear Regression, Non-linear Regression by fitting Exponential and Polynomial

Unit 3: Numerical Differentiation and Integration (8 Hrs.)

3.1 Differentiating Continuous Functions (Two-Point and Three-Point Formula), Differentiating Tabulated Functions by using Newton's Differences, Maxima and minima of Tabulated Functions

3.2 Newton-Cote's Quadrature Formulas, Trapezoidal rule, Multi-Segment Trapezoidal rule, Simpson's 1/3 rule, Multi-Segment Simpson's 1/3 rule, Simpson's 3/8 rule, Multi-Segment Simpson's 3/8 rule, Gaussian integration algorithm, Romberg integration

Unit 4: Solving System of Linear Equations (8 Hrs.)

4.1 Review of the existence of solutions and properties of matrices, Gaussian elimination method, pivoting, Gauss-Jordan method, Inverse of matrix using Gauss-Jordan method

4.2 Matrix factorization and Solving System of Linear Equations by using Dolittle and Cholesky's algorithm

4.3 Iterative Solutions of System of Linear Equations, Jacobi Iteration Method, Gauss-Seidal Method

4.4 Eigen values and eigen vectors problems, Solving eigen value problems using power method.

Unit 5: Solution of Ordinary Differential Equations (8 Hrs.)

5.1 Review of differential equations, Initial value problem, Taylor series method, Picard's method, Euler's method and its accuracy, Heun's method, Runge-Kutta methods

5.2 Solving System of ordinary differential equations, Solution of the higher order equations, Boundary value problems, Shooting method and its algorithm

Unit 6: Solution of Partial Differential Equations (5 Hrs.)

6.1 Review of partial differential equations, Classification of partial differential equation, Deriving difference equations, Laplacian equation and Poisson's equation, engineering examples

Laboratory Works:

The laboratory exercise should consist program development and testing of non-linear equations, system of linear equations, interpolation, numerical integration and differentation, linear algebraic equations, ordinary and partial differential equations.Numerical solutions using C or Matlab.

Text Books:

1. W. Chency and D. Kincaid, "*Numerical Mathematics and Computing*", 7thEdition, Brooks/Cole Publishing Co, 2012
2. C.F. Gerald and P.O. Wheatley, "*Applied Numerical Analysis*", 9thEdition, Addison Wesley Publishing Company, New York, 2011

Reference Books:

1. E. Balagurusamy, “Numerical Methods”, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1999
2. W.H. Press, B.P. Flannery et al., "*Numerical Recipes: Art of Scientific Computing*", 3rd Edition, Cambridge Press, 2007.
3. J. M. Mathews and K. Fink, “Numerical Methods using MATLAB “, 4rd Edition, Prentice Hall Publication, 2004

Computer Architecture

Course Title: Computer Architecture
Course No: CSC208
Nature of the Course: Theory + Lab
Semester: III

Full Marks: 60 + 20 + 20
Pass Marks: 24 + 8 + 8
Credit Hrs: 3

Course Description: This course includes concepts of instruction set architecture, organization or micro-architecture, and system architecture. The instruction set architecture includes programmer's abstraction of computer. The micro-architecture consist internal representation of computers at register and functional unit level. The system architecture includes organization of computers at the cache and bus level.

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Course Objectives:

- Discuss representation of data and algorithms used to perform operations on data
- Demonstrate different operations in terms of Micro-operations
- Explain architecture of basic computer and micro-programmed control unit
- Understand and memory and I/O organization of a typical computer system
- Demonstrate benefits of pipelined systems

Course Contents:

Unit 1: Data Representation (4 Hrs.)

1.1. Data Representation: Binary Representation, BCD, Alphanumeric Representation, Complements, Fixed Point representation, Representing Negative Numbers, Floating Point Representation, Arithmetic with Complements, Overflow, Detecting Overflow
1.2. Other Binary Codes: Gray Code, self Complementing Code, Weighted Code, Excess-3 Code, EBCDIC
1.3. Error Detection Codes: Parity Bit, Odd Parity, Even parity, Parity Generator & Checker

Unit 2: Register Transfer and Microoperations (5 Hrs.)

2.1. Microoperation, Register Transfer Language, Register Transfer, Control Function
2.2. Arithmetic Microoperations: Binary Adder, Binary Adder-subtractor, Binary Incrementer, Arithmetic Circuit
2.3. Logic Microoperations, Hardware Implementation, Applications of Logic Microoperations.
2.4. Shift Microoperations: Logical Shift, Circular shift, Arithmetic Shift, Hardware Implementation of Shifter.

Unit 3: Basic Computer Organization and Design (8 Hrs.)

3.1. Instruction Code, Operation Code, Stored Program Concept
3.2. Registers and memory of Basic Computer, Common Bus System for Basic Computer.
3.3. Instruction Format, Instruction Set Completeness, Control Unit of Basic Computer, Control Timing Signals

3.4. Instruction Cycle of Basic computer, Determining Type of Instruction, Memory Reference Instructions, Input-Output Instructions, Program Interrupt & Interrupt Cycle.
3.5. Description and Flowchart of Basic Computer

Unit 4: Microprogrammed Control (4 Hrs.)

4.1. Control Word, Microprogram, Control Memory, Control Address Register, Sequencer
4.2. Address Sequencing, Conditional Branch, Mapping of Instructions, Subroutines, Microinstruction Format, Symbolic Microinstructions
4.3. Design of Control Unit

Unit 5: Central Processing Unit (4 Hrs.)

5.1. Major Components of CPU, CPU Organization
5.2. Instruction Formats, Addressing Modes, Data Transfer and manipulation, Program Control, Subroutine Call and Return, Types of Interrupt
5.3. RISC vs CISC, Pros and Cons of RISC and CISC, Overlapped Register Windows

Unit 6: Pipelining (6 Hrs.)

6.1. Parallel Processing, Multiple Functional Units, Flynn's Classification
6.2. Pipelining: Concept and Demonstration with Example, Speedup Equation, Floating Point addition and Subtraction with Pipelining
6.3. Instruction Level Pipelining: Instruction Cycle, Three & Four-Segment Instruction Pipeline, Pipeline Conflicts and Solutions
6.4. Vector Processing, Applications, Vector Operations, Matrix Multiplication

Unit 7: Computer Arithmetic (6 Hrs.)

7.1. Addition and Subtraction with Signed Magnitude Data, Addition and Subtraction with Signed 2's Complement Data
7.2. Multiplication of Signed Magnitude Data, Booth Multiplication, Division of Signed magnitude Data, Divide Overflow

Unit 8: Input Output Organization (4 Hrs.)

8.1. Input-Output Interface: I/O Bus and Interface Modules, I/O vs. Memory Bus, Isolated vs. Memory-Mapped I/O
8.2. Asynchronous Data Transfer: Strobe, Handshaking
8.3. Modes of Transfer: Programmed I/O, Interrupt-Initiated I/O, Direct memory Access
8.4. Priority Interrupt: Polling, Daisy-Chaining, Parallel Priority Interrupt
8.5. Direct Memory Access, Input-Output Processor, DMA vs. IOP

Unit 9: Memory Organization (4 Hrs.)

9.1 Memory Hierarchy, Main Memory, RAM and ROM Chips, Memory address Map, Memory Connection to CPU, Auxiliary Memory (magnetic Disk, Magnetic Tape)
9.1 Associative Memory: Hardware Organization, Match Logic, Read Operation, Write Operation
9.1 Cache Memory: Locality of Reference, Hit & Miss Ratio, Mapping, Write Policies

Laboratory Works:

The laboratory work includes implementing and simulating the algorithms, studied in the course, by using high level languages like C or VHDL. The laboratory works should include at least following concepts;

- Simulate features like overflow, data representation by using VHDL
- Simulate design of different units by using VHDL
- Simulate pipelining by using VHDL
- Implement algorithms for computer arithmetic using high level language like C or C++

Text Books:

1. M. Morris Mano, “Computer System Architecture”, Prentice-Hall of India, Pvt. Ltd., Third edition, 2007

References Books:

1. William Stallings, “Computer Organization and Architecture”, Prentice-Hall of India, Pvt. Ltd., Seventh edition, 2005.
2. Vincent P. Heuring and Harry F. Jordan, “Computer System Design and Architecture”, Prentice-Hall of India, Pvt. Ltd., Second edition, 2003.

Computer Graphics

Course Title: Computer Graphics
Course no: CSC209
Nature of the Course: Theory + Lab
Semester: III

Full Marks: 60 + 20 + 20
Pass Marks: 24 + 8 + 8
Credit Hrs: 3

Course Description: The course covers concepts of graphics hardware, software, and applications, data structures for representing 2D and 3D geometric objects, drawing algorithms for graphical objects, techniques for representing and manipulating geometric objects, illumination and lighting models, and concept of virtual reality.

Course Objectives: The objective of this course is to understand the theoretical foundation as well as the practical applications of 2D and 3D graphics.

Course Contents:

Unit 1: Introduction of Computer Graphics (3 Hrs.)

1.1 A Brief Overview of Computer Graphics, Areas of Applications.
1.2 Graphics Hardware: Display Technology, Architecture of Raster-Scan Displays,Vector Displays, Display Processors, Hard copy device. Input Devices**.**
1.3 Graphics Software: Software standards, Need of machine independent graphics language.

Unit 2: Scan Conversion Algorithm (6 Hrs.)

2.1 Scan Converting a Point and a straight Line: DDA Line Algorithm, Bresenham's Line Algorithm
2.2 Scan Converting Circle and Ellipse :Mid Point Circle and Ellipse Algorithm
2.3 Area Filling: Scan Line Polygon fill Algorithm, Inside-outside Test, Scan line fill of Curved Boundary area, Boundary-fill and Flood-fill algorithm

Unit 3: Two-Dimensional Geometric Transformations (5 Hrs.)

3.1 Two-Dimensional translation, Rotation, Scaling, Reflection and Shearing
3.2 Homogeneous Coordinate and 2D Composite Transformations. Transformation between Co-ordinate Systems.
3.3 Two Dimensional Viewing: Viewing pipeline, Window to viewport coordinate transformation
3.4 Clipping: Point, Lines(Cohen Sutherland line clipping, Liang-Barsky Line Clipping) , Polygon Clipping(Sutherland Hodgeman polygon clipping)

Unit 4: Three-Dimensional Geometric Transformation (5 Hrs.)

4.1 Three-Dimensional translation, Rotation, Scaling, Reflection and Shearing
4.2 Three-Dimensional Composite Transformations
4.3 Three-Dimensional Viewing: Viewing pipeline, world to screen viewing transformation, Projection concepts(Orthographic, parallel, perspective projections)

Unit 5: 3D Objects Representation (7 Hrs.)

5.1 Representing Surfaces: Boundary and Space partitioning

- 5.1.1 Polygon Surface: Polygon tables , Surface normal and Spatial orientation of surfaces, Plane equations, Polygon meshes
- 5.1.2 Wireframe Representation
- 5.1.3 Blobby Objects

5.2 Representing Curves: Parametric Cubic Curves, Spline Representation, Cubic spline interpolation, Hermite Curves, Bezier and B-spline Curve and surface

5.3 Quadric Surface: Sphere and Ellipsoid

Unit 6: Solid Modeling (4 Hrs.)

6.1 Sweep ,Boundary and Spatial-Partitioning Representation

6.2 Binary Space Partition Trees (BSP)

6.3 Octree Representation

Unit 7: Visible Surface Detections (5 Hrs.)

7.1 Image Space and Object Space Techniques

7.2 Back Face Detection, Depth Buffer (Z-buffer), A-Buffer and Scan-Line Algorithms.

7.3 Depth Sorting Method (Painter's Algorithm)

7.4 BSP tree Method, Octree and Ray Tracing

Unit 8: Illumination Models and Surface Rendering Techniques (5 Hrs.)

8.1 Basic Illumination Models: Ambient light, Diffuse reflection, Specular reflection and Phong model

8.2 Intensity attenuation and Color consideration ,Transparency, Shadows

8.3 Polygon Rendering Methods : Constant intensity shading, Gouraud shading , Phong Shading and Fast Phong Shading

Unit 9: Introduction to Virtual Reality (2 Hrs.)

9.1 Concept of Virtual reality

9.2 Virtual Reality Components of VR System, Types of VR System, 3D Position Trackers, Navigation and Manipulation Interfaces

9.3 Application of VR

Unit 10: Introduction to OpenGL (3 Hrs.)

1.1 Introduction, Callback functions, Color commands, Drawings pixels, lines, polygons using OpenGL, Viewing and Lighting

Laboratory Works:

The laboratory course consists of implementing following algorithms using high level languages and OpenGL.

1. DDA Line Algorithm
2. Bresenham's line drawing algorithm
3. Mid Point Circle Algorithm
4. Mid Point Ellipse Algorithm
5. Basic transformation on 2D including Translation, Rotation and Scaling
6. Simple 3D Object with basic transformations including Translation, Rotation and Scaling

7. Clipping
8. Hidden surface removal
9. Basic Drawing Techniques in OpenGL

Text Books:

1. Donald Hearne and M. Pauline Baker, “Computer Graphics, C Versions.” Prentice Hall

Reference Books:

1. J.D. Foley, S.K. Feiner and J.F. Hughes, “Computer Graphics – Principles and Practises” (Second Edition in C)
2. R.K. Maurya, “Computer Graphics with Virtual Reality”, Wiley India
3. F.S. Hill, Stephen M.Kelley, “Computer Graphics using Open GL” Prentice Hall

Statistics II

Course Title: Statistics II
Course No: STA210
Nature of Course: Theory + Lab
Semester: III

Full Marks: 60 + 20 + 20
Pass Marks: 24 + 8 + 8
Credit Hrs: 3

Course Description: The course consists of concepts of sampling, testing hypothesis, parametric and non parametric tests, correlation and regression, experimental designs and stochastic processes.

Course Objectives: The main objective of the course is to acquire the theoretical as well as practical knowledge of estimation, testing of hypothesis, application of parametric and non-parametric statistical tests, design of experiments, multiple regression analysis, and basic concept of stochastic process with special focus to data/problems related with computer science and information technology

Course Contents:

Unit 1: Sampling Distribution and Estimation (6 Hrs.)

Sampling distribution; sampling distribution of mean and proportion; Central Limit Theorem; Concept of inferential Statistics; Estimation; Methods of estimation; Properties of good estimator; Determination of sample size; Relationship of sample size with desired level of error

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Unit 2: Testing of hypothesis (8 Hrs.)

Types of statistical hypotheses; Power of the test, concept of p-value and use of p -value in decision making, steps used in testing of hypothesis, one sample tests for mean of normal population (for known and unknown variance), test for single proportion, test for difference between two means and two proportions, paired sample t-test; Linkage between confidence interval and testing of hypothesis

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Unit 3: Non parametric test (8 Hrs.)

Parametric vs. non-parametric test; Needs of applying non-parametric tests; One-sample test: Run test, Binomial test**,** Kolmogorov–Smirnov test; Two independent sample test: Median test, Kolmogorov-Smirnov test, Wilcoxon Mann Whitney test, Chi-square test; Paired-sample test: Wilcoxon signed rank test; Cochran’s Q test; Friedman two way analysis of variance test; Kruskal Wallis test

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Unit 4: Multiple correlation and regression (6 Hrs.)

Multiple and partial correlation; Introduction of multiple linear regression; Hypothesis testing of multiple regression; Test of significance of regression; Test of individual regression coefficient; Model adequacy tests

Problems and illustrative examples related to computer Science and IT

Unit 5: **Design of experiment (10 Hrs.)**
Experimental design; Basic principles of experimental designs; Completely Randomized Design (CRD); Randomized Block Design (RBD); ANOVA table, Efficiency of RBD relative to CRD, Estimations of missing value (one observation only), Advantages and disadvantages; Latin Square Design (LSD): Statistical analysis of $m \times m$ LSD for one observation per experimental unit, ANOVA table, Estimation of missing value in LSD (one observation only), Efficiency of LSD relative to RBD, Advantage and disadvantages.

Problems and illustrative examples related to computer Science and IT

Unit 6: Stochastic Process (7 Hrs.)
Definition and classification; Markov Process: Markov chain, Matrix approach, Steady- State distribution; Counting process: Binomial process, Poisson process; Simulation of stochastic process; Queuing system: Main component of queuing system, Little's law; Bernoulli single server queuing process: system with limited capacity; M/M/1 system: Evaluating the system performance.

Laboratory Works:

The laboratory work includes implementing concepts of statistics using statistical software tools such as SPSS, STATA etc.

S. No.	Practical problems	No. of practical problems
1	Sampling distribution, random number generation, and computation of sample size	1
2	Methods of estimation (including interval estimation)	1
3	Parametric tests (covering most of the tests)	3
4	Non-parametric test(covering most of the tests)	3
5	Partial correlation	1
6	Multiple regression	1
7	Design of Experiments	3
	Stochastic process	2
	Total number of practical problems	**15**

Text Books:

1. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, & Keying Ye(2012). Probability & Statistics for Engineers & Scientists. 9th Ed., Printice Hall

2. Michael Baron (2013). Probability and Statistics for Computer Scientists. 2nd Ed., CRC Press, Taylor & Francis Group, A Chapman & Hall Book

Reference Books:

1. Douglas C. Montgomery & George C. Runger (2003). Applied Statistics and Probability for Engineers. 3rd Ed., John Willey and Sons, Inc.

2. Sidney Siegel, & N. John Castellan, Jr. Nonparametric Statistics for the Behavioral Sciences, 2nd Ed., McGraw Hill International Editions.

Theory of Computation

Course Title: Theory of Computation **Full Marks:** 60 + 20 + 20
Course No: CSC257 **Pass Marks:** 24 + 8 + 8
Nature of the Course: Theory + Lab **Credit Hrs:** 3
Semester: IV

Course Description: This course presents a study of Finite State Machines and their languages. It covers the details of finite state automata, regular expressions, context free grammars. More, the course includes design of the Push-down automata and Turing Machines. The course also includes basics of undecidabilty and intractability.

Course Objectives: The main objective of the course is to introduce concepts of the models of computation and formal language approach to computation. The general objectives of this course are to, introduce concepts in automata theory and theory of computation, design different finite state machines and grammars and recognizers for different formal languages, identify different formal language classes and their relationships, determine the decidability and intractability of computational problems.

Course Contents:

Unit I: Basic Foundations (3 Hrs.)

1.1. Review of Set Theory, Logic, Functions, Proofs
1.2. Automata, Computability and Complexity: Complexity Theory, Computability Theory, Automata Theory
1.3. Basic concepts of Automata Theory: Alphabets, Power of Alphabet, Kleen Closure Alphabet, Positive Closure of Alphabet, Strings, Empty String, Substring of a string, Concatenation of strings, Languages, Empty Language

Unit II: Introduction to Finite Automata (8 Hrs.)

2.1 Introduction to Finite Automata, Introduction of Finite State Machine
2.2 Deterministic Finite Automata (DFA), Notations for DFA, Language of DFA, Extended Transition Function of DFA Non-Deterministic Finite Automaton (NFA), Notations for NFA, Language of NFA, Extended Transition
2.3 Equivalence of DFA and NFA, Subset-Construction
2.4 Method for reduction of NFA to DFA, Theorems for equivalence of Language accepted by DFA and NFA
2.5 Finite Automaton with Epsilon Transition (ε - NFA), Notations for ε - NFA, Epsilon Closure of a State, Extended Transition Function of ε – NFA, Removing Epsilon Transition using the concept of Epsilon Closure, Equivalence of NFA and ε –NFA, Equivalence of DFA and ε – NFA
2.6 Finite State Machines with output: Moore machine and Mealy Machines

Unit III: Regular Expressions (6 Hrs.)

3.1 Regular Expressions, Regular Operators, Regular Languages and their applications, Algebraic Rules for Regular Expressions

3.2 Equivalence of Regular Expression and Finite Automata, Reduction of Regular Expression to ε – NFA, Conversion of DFA to Regular Expression

3.3 Properties of Regular Languages, Pumping Lemma, Application of Pumping Lemma, Closure Properties of Regular Languages over (Union, Intersection, Complement) Minimization of Finite State Machines: Table Filling Algorithm

Unit IV: Context Free Grammar (9 Hrs.)

4.1 Introduction to Context Free Grammar (CFG), Components of CFG, Use of CFG, Context Free Language (CFL)

4.2 Types of derivations: Bottomup and Topdown approach, Leftmost and Rightmost, Language of a grammar

4.3 Parse tree and its construction, Ambiguous grammar, Use of parse tree to show ambiguity in grammar

4.4 Regular Grammars: Right Linear and Left Linear, Equivalence of regular grammar and finite automata

4.5 Simplification of CFG: Removal of Useless symbols, Nullable Symbols, and Unit Productions, Chomsky Normal Form (CNF), Greibach Normal Form (GNF), Backus-Naur Form (BNF)

4.6 Context Sensitive Grammar, Chomsky Hierarchy Pumping Lemma for CFL, Application of Pumping Lemma, Closure Properties of CFL

Unit V: Push Down Automata (7 Hrs.)

5.1 Introduction to Push Down Automata (PDA), Representation of PDA, Operations of PDA, Move of a PDA, Instantaneous Description for PDA

5.2 Deterministic PDA, Non Deterministic PDA, Acceptance of strings by PDA, Language of PDA

5.3 Construction of PDA by Final State , Construction of PDA by Empty Stack,

5.4 Conversion of PDA by Final State to PDA accepting by Empty Stack and vice-versa, Conversion of CFG to PDA, Conversion of PDA to CFG

Unit VI: Turing Machines (10 Hrs.)

6.1 Introduction to Turing Machines (TM), Notations of Turing Machine, Language of a Turing Machine, Instantaneous Description for Turing Machine, Acceptance of a string by a Turing Machines

6.2 Turing Machine as a Language Recognizer, Turing Machine as a Computing Function, Turing Machine with Storage in its State, Turing Machine as a enumerator of stings of a language, Turing Machine as Subroutine

6.3 Turing Machine with Multiple Tracks, Turing Machine with Multiple Tapes, Equivalence of Multitape-TM and Multitrack-TM, Non-Deterministic Turing Machines, Restricted Turing Machines: With Semi-infinite Tape, Multistack Machines, Counter Machines

6.4 Curch Turing Thesis, Universal Turing Machine, Turing Machine and Computers, Encoding of Turing Machine, Enumerating Binary Strings, Codes of Turing Machine, Universal Turing Machine for encoding of Turing Machine

Unit VII: Undecidability and Intractability (5 Hrs.)

7.1 Computational Complexity, Time and Space complexity of A Turing Machine, Intractability

7.2 Complexity Classes, Problem and its types: Absract, Decision, Optimization

7.3 Reducibility, Turing Reducible, Circuit Satisfiability, Cook's Theorem,

7.4 Undecidability, Undecidable Problems: Post's Correspondence Problem, Halting Problem and its proof, Undecidable Problem about Turing Machines

Laboratory Works:

The laboratory work consists of design and implementation of finite state machines like DFA, NFA, PDA, and Turing Machine. Students are highly recommended to construct Tokenizers/ Lexers over/for some language. Students are advised to use regex and Perl (for using regular expressions), or any other higher level language for the laboratory works.

Text Books:

1. John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, Introduction to Automata Theory, Languages, and Computation, 3rd Edition, Pearson - Addison-Wesley.

Reference Books:

1. Harry R. Lewis and Christos H. Papadimitriou, Elements of the Theory of Computation, 2nd Edition, Prentice Hall.
2. Michael Sipser, Introduction to the Theory of Computation, 3rd Edition, Thomson Course Technology
3. Efim Kinber, Carl Smith, Theory of Computing: A Gentle introduction, Prentice- Hall.
4. John Martin, Introduction to Languages and the Theory of Computation, 3rd Edition, Tata McGraw Hill.
5. Kenneth H. Rosen, Discrete Mathematics and its Applications to Computers Science, WCB/Mc-Graw Hill.

Computer Networks

Course Title: Computer Networks
Course No: CSC258
Nature of the Course: Theory + Lab
Semester: IV

Full Marks: 60 + 20 + 20
Pass Marks: 24 + 8 + 8
Credit Hrs: 3

Course Description: This course introduces concept of computer networking and discuss the different layers of networking model.

Course Objective: The main objective of this course is to introduce the understanding of the concept of computer networking with its layers, topologies, protocols & standards, IPv4/IPv6 addressing, Routing and Latest Networking Standards

Course Contents:

Unit 1: Introduction to Computer Network (6Hrs.)

1.1. Definitions, Uses, Benefits
1.2. Overview of Network Topologies (Star, Tree, Bus,...)
1.3. Overview of Network Types (PAN, LAN, CAN, MAN,...)
1.4. Networking Types (Client/Server, P2P)
1.5. Overview of Protocols and Standards
1.6. OSI Reference Model
1.7. TCP/IP Models and its comparison with OSI.
1.8. Connection and Connection-Oriented Network Services
1.9. Internet, ISPs, Backbone Network Overview

Unit 2: Physical Layer and Network Media (4Hrs.)

2.1. Network Devices: Repeater, Hub, Switch, Bridge, Router
2.2. Different types of transmission medias (wired: twisted pair, coaxial, fiber optic, Wireless: Radio waves, micro waves, infrared)
2.3. Ethernet Cable Standards (UTP & Fiber cable standards)
2.4. Circuit, Message & Packet Switching
2.5. ISDN: Interface and Standards

Unit 3: Data Link Layer (8Hrs.)

3.1. Function of Data Link Layer (DLL)
3.2. Overview of Logical Link Control (LLC) and Media Access Control (MAC)
3.3. Framing and Flow Control Mechanisms
3.4. Error Detection and Correction techniques
3.5. Channel Allocation Techniques (ALOHA, Slotted ALOHA)
3.6. Ethernet Standards (802.3 CSMA/CD, 802.4 Token Bus, 802.5 Token Ring)
3.7. Wireless LAN: Spread Spectrum, Bluetooth, Wi-Fi
3.8. Overview Virtual Circuit Switching, Frame Relay& ATM
3.9. DLL Protocol: HDLC, PPP

Unit 4: Network Layer (10Hrs.)

- 4.1. Introduction and Functions
- 4.2. IPv4 Addressing & Sub-netting
- 4.3. Class-full and Classless Addressing
- 4.4. IPv6 Addressing and its Features
- 4.5. IPv4 and IPv6 Datagram Formats
- 4.6. Comparison of IPv4 and IPv6 Addressing
- 4.7. Example Addresses: Unicast, Multicast and Broadcast
- 4.8. Routing
    - 4.8.1. Introduction and Definition
    - 4.8.2. Types of Routing (Static vs Dynamic, Unicast vs Multicast, Link State vs Distance Vector, Interior vs Exterior)
    - 4.8.3. Path Computation Algorithms: Bellman Ford, Dijkstra's
    - 4.8.4. Routing Protocols: RIP, OSPF & BGP
- 4.9. Overview of IPv4 to IPv6 Transition Mechanisms
- 4.10. Overview of ICMP/ICMPv6&NATing
- 4.11. Overview of Network Traffic Analysis
- 4.12. Security Concepts: Firewall & Router Access Control

Unit 5: Transport Layer (6Hrs.)

- 5.1. Introduction, Functions and Services
- 5.2. Transport Protocols: TCP, UDP and Their Comparisons
- 5.3. Connection Oriented and Connectionless Services
- 5.4. Congestion Control: Open Loop & Closed Loop, TCP Congestion Control
- 5.5. Traffic Shaping Algorithms: Leaky Bucket & Token Bucket
- 5.6. Queuing Techniques for Scheduling
- 5.7. Introduction to Ports and Sockets, Socket Programming

Unit 6: Application Layer (7Hrs.)

- 6.1. Introduction and Functions
- 6.2. Web &HTTP
- 6.3. DNS and the Query Types
- 6.4. File Transfer and Email Protocols: FTP, SFTP, SMTP, IMAP, POP3
- 6.5. Overview of Application Server Concepts: Proxy, Web, Mail
- 6.6. Network Management: SNMP

Unit 7: Multimedia &Future Networking (4Hrs.)

- 7.1. Overview Multimedia Streaming Protocols: SCTP
- 7.2. Overview of SDN and its Features, Data and Control Plane
- 7.3. Overview of NFV
- 7.4. Overview of NGN

Laboratory Works:

The lab activities under this subject should accommodate at least the following;

1. Understanding of Network equipment, wiring in details
2. OS (Ubuntu/CentOS/Windows) installation, practice on basic Networking commands

(ifconfig/ipconfig, tcpdump, netstat, dnsip, hostname, route...)

3. Overview of IP Addressing and sub-netting, static ip setting on Linux/windows machine, testing
4. Introduction to Packet Tracer, creating of a LAN and connectivity test in the LAN, creation of VLAN and VLAN trunking.
5. Basic Router Configuration, Static Routing Implementation
6. Implementation of Dynamic/interior/exterior routing (RIP, OSPF, BGP)
7. Firewall Implementation, Router Access Control List (ACL)
8. Packet capture and header analysis by wire-shark (TCP,UDP,IP)
9. DNS, Web, FTP server configuration (shall use packet tracer, GNS3)
10. Case Study: Network Operation Center Visit (ISP, Telecom, University Network)
11. LAB Exam, Report and VIVA

Text Books:

1. Data Communications and Networking, 4th Edition, Behrouz A Forouzan. McGraw-Hill
2. Computer Networking; A Top Down Approach Featuring The Internet, 2nd Edition, Kurose James F., Ross W. Keith PEARSON EDUCATION ASIA

Operating Systems

Course Title: Operating Systems
Course No: CSC259
Nature of the Course: Theory + Lab
Semester: IV

Full Marks: 60+ 20+20
Pass Marks: 24+8+8
Credit Hrs: 3

Course Description: This course includes the basic concepts of operating system components. It consists of process management, deadlocks and process synchronization, memory management techniques, File system implementation, and I/O device management principles. It also includes case study on Linux operating system.

Course Objectives:

- Describe need and role of operating system.
- Understand OS components such a scheduler, memory manager, file system handlers and I/O device managers.
- Analyze and criticize techniques used in OS components
- Demonstrate and simulate algorithms used in OS components
- Identify algorithms and techniques used in different components of Linux

Course Contents:

Unit 1: Operating System Overview (4 Hrs.)

1.1. Definition, Two views of operating system, Evolution of operating system, Types of OS.
1.2. System Call, Handling System Calls, System Programs, Operating System Structures, The Shell, Open Source Operating Systems

Unit 2: Process Management (10 Hrs.)

2.1. Process vs Program, Multiprogramming, Process Model, Process States, Process Control Block.
2.2. Threads, Thread vs Process, User and Kernel Space Threads.
2.3. Inter Process Communication, Race Condition, Critical Section
2.4. Implementing Mutual Exclusion: Mutual Exclusion with Busy Waiting (Disabling Interrupts, Lock Variables, Strict Alteration, Peterson's Solution, Test and Set Lock), Sleep and Wakeup, Semaphore, Monitors, Message Passing,
2.5. Classical IPC problems: Producer Consumer, Sleeping Barber, Dining Philosopher Problem
2.6. Process Scheduling: Goals, Batch System Scheduling (First-Come First-Served, Shortest Job First, Shortest Remaining Time Next), Interactive System Scheduling (Round-Robin Scheduling, Priority Scheduling, Multiple Queues), Overview of Real Time System Scheduling

Unit 3: Process Deadlocks (6 Hrs.)

3.1. Introduction, Deadlock Characterization, Preemptable and Non-preemptable Resources, Resource – Allocation Graph, Conditions for Deadlock

3.2. Handling Deadlocks: Ostrich Algorithm, Deadlock prevention, Deadlock Avoidance, Deadlock Detection (For Single and Multiple Resource Instances), Recovery From Deadlock (Through Preemption and Rollback)

Unit 4: Memory Management (8 Hrs.)

4.1. Introduction, Monoprogramming vs. Multi-programming, Modelling Multiprogramming, Multiprogramming with fixed and variable partitions, Relocation and Protection.
4.2. Memory management (Bitmaps & Linked-list), Memory Allocation Strategies
4.3. Virtual memory: Paging, Page Table, Page Table Structure, Handling Page Faults, TLB's
4.4. Page Replacement Algorithms: FIFO, Second Chance, LRU, Optimal, LFU, Clock, WS-Clock, Concept of Locality of Reference, Belady's Anomaly
4.5. Segmentation: Need of Segmentation, its Drawbacks, Segmentation with Paging(MULTICS)

Unit 5: File Management (6 Hrs.)

5.1. File Overview: File Naming, File Structure, File Types, File Access, File Attributes, File Operations, Single Level, two Level and Hierarchical Directory Systems, File System Layout.
5.2. Implementing Files: Contiguous allocation, Linked List Allocation, Linked List Allocation using Table in Memory, Inodes.
5.3. Directory Operations, Path Names, Directory Implementation, Shared Files
5.4. Free Space Management: Bitmaps, Linked List

Unit 6: Device Management (6 Hrs.)

6.1. Classification of IO devices, Controllers, Memory Mapped IO, DMA Operation, Interrupts
6.2. Goals of IO Software, Handling IO(Programmed IO, Interrupt Driven IO, IO using DMA), IO Software Layers (Interrupt Handlers, Device Drivers)
6.3. Disk Structure, Disk Scheduling (FCFS, SSTF, SCAN, CSCAN, LOOK, CLOOK), Disk Formatting (Cylinder Skew, Interleaving, Error handling), RAID

Unit 7: Linux Case Study (5 Hrs.)

7.1 History, Kernel Modules, Process Management, Scheduling, Inter-process Communication, Memory Management, File System Management Approaches, Device Management Approaches.

Laboratory Works:

The laboratory work includes solving problems in operating system. The lab work should include at least;

- Learn basic Linux Commands
- Create process, threads and implement IPC techniques
- Simulate process Scheduling algorithms and deadlock detection algorithms
- Simulate page replacement algorithms
- Simulate free space management techniques and disk scheduling algorithms.

Text Books:

1. Modern Operating Systems: Andrew S. Tanenbaum, PH1 Publication, Third edition, 2008

Reference Books:

1. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, “Operating System Concepts”, John Wiley & Sons (ASIA) Pvt. Ltd, Seventh edition, 2005.
2. Harvey M. Deitel, Paul J. Deitel, and David R. Choffnes, “Operating Systems, Prentice Hall, Third edition, 2003.

Database Management System

Course Title: Database Management System | **Full Marks:** 60 + 20 + 20
Course No: CSC260 | **Pass Marks:** 24 + 8 + 8
Nature of the Course: Theory + Lab | **Credit Hrs:** 3
Semester: IV

Course Description: The course covers the basic concepts of databases, database system concepts and architecture, data modeling using ER diagram, relational model, SQL, relational algebra and calculus, normalization, transaction processing, concurrency control, and database recovery.

Course Objective: The main objective of this course is to introduce the basic concepts of database, data modeling techniques using entity relationship diagram, relational algebra and calculus, basic and advanced features SQL, normalization, transaction processing, concurrency control, and recovery techniques.

Course Contents:

Unit 1: Database and Database Users (2 Hrs.)

Introduction; Characteristics of the Database Approach; Actors on the Scene; Workers behind the Scene; Advantages of Using the DBMS Approach

Unit 2: Database System – Concepts and Architecture (3 Hrs.)

Data Models, Schemas, and Instances; Three-Schema Architecture and Data Independence; Database Languages and Interfaces; the Database System Environment; Centralized and Client/Server Architectures for DBMSs; Classification of Database Management Systems

Unit 3: Data Modeling Using the Entity-Relational Model (6 Hrs.)

Using High-Level Conceptual Data Models for Database Design; Entity Types, Entity Sets, Attributes, and Keys; Relationship Types, Relationship Sets, Roles, and Structural Constraints; Weak Entity Types; ER Diagrams, Naming Conventions, and Design Issues; Relationship Types of Degree Higher Than Two; Subclasses, Superclasses, and Inheritance; Specialization and Generalization; Constraints and Characteristics of Specialization and Generalization

Unit 4: The Relational Data Model and Relational Database Constraints (3 Hrs.)

Relational Model Concepts; Relational Model Constraints and Relational Database Schemas; Update Operations, Transactions, and Dealing with Constraint Violations

Unit 5: The Relational Algebra and Relational Calculus (5 Hrs.)

Unary Relational Operations: SELECT and PROJECT; Relational Algebra Operations from Set Theory; Binary Relational Operations: JOIN and DIVISION; Additional Relational Operations; the Tuple Relational Calculus; the Domain Relational Calculus

Unit 6: SQL (8 Hrs.)

Data Definition and Data Types; Specifying Constraints; Basic Retrieval Queries; Complex Retrieval Queries; INSERT, DELETE, and UPDATE Statements; Views

Unit 7: Relational Database Design (7 Hrs.)
Relational Database Design Using ER-to-Relational Mapping; Informal Design Guidelines for Relational Schemas; Functional Dependencies; Normal Forms Based on Primary Keys; General Definitions of Second and Third Normal Forms; Boyce-Codd Normal Form; Multivalued Dependency and Fourth Normal Form; Properties of Relational Decomposition

Unit 8: Introduction to Transaction Processing Concepts and Theory (4 Hrs.)
Introduction to Transaction Processing; Transaction and System Concepts; Desirable Properties of Transactions; Characterizing Schedules Based on Recoverability; Characterizing Schedules Based on Serializability

Unit 9: Concurrency Control Techniques (4 Hrs.)
Two-Phase Locking Technique; Timestamp Ordering; Multiversion Concurrency Control**;** Validation (Optimistic) Techniques and Snapshot Isolation Concurrency Control

Unit 10: Database Recovery Techniques (3 Hrs.)
Recovery Concepts; NO-UNDO/REDO Recovery Based on Deferred Update; Recovery Technique Based on Immediate Update; Shadow Paging; Database Backup and Recovery from Catastrophic Failures

Laboratory Works:
The laboratory work includes writing database programs to create and query databases using basic and advanced features of structured query language (SQL).

Text Books:
1. Fundamentals of Database Systems; Seventh Edition; Ramez Elmasri, Shamkant B. Navathe; Pearson Education
2. Database System Concepts; Sixth Edition; Avi Silberschatz, Henry F Korth, S Sudarshan; McGraw-Hill

Reference Books:
1. Database Management Systems; Third Edition; Raghu Ramakrishnan, Johannes Gehrke; McGraw-Hill
2. A First Course in Database Systems; Jaffrey D. Ullman, Jennifer Widom; Third Edition; Pearson Education Limited

Artificial Intelligence

Course Title: Artificial Intelligence
Course No: CSC261
Nature of the Course: Theory + Lab
Semester: IV

Full Marks: 60 + 20 + 20
Pass Marks: 24 + 8 + 8
Credit Hrs: 3

Course Description: The course introduces the ideas and techniques underlying the principles and design of artificial intelligent systems. The course covers the basics and applications of AI, including: design of intelligent agents, problem solving, searching, knowledge representation systems, probabilistic reasoning, neural networks, machine learning and natural language processing.

Course Objectives: The main objective of the course is to introduce fundamental concepts of Artificial Intelligence. The general objectives are to learn about computer systems that exhibit intelligent behavior, design intelligent agents, identify AI problems and solve the problems, design knowledge representation and expert systems, design neural networks for solving problems, identify different machine learning paradigms and identify their practical applications.

Course Contents:

Unit I: Introduction (3 Hrs.)

1.1. Artificial Intelligence (AI), AI Perspectives: acting and thinking humanly, acting and thinking rationally
1.2. History of AI
1.3. Foundations of AI
1.4. Applications of AI

Unit II: Intelligent Agents (4 Hrs.)

2.1. Introduction of agents, Structure of Intelligent agent, Properties of Intelligent Agents
2.2. Configuration of Agents, PEAS description of Agents
2.3. Types of Agents: Simple Reflexive, Model Based, Goal Based, Utility Based.
2.4. Environment Types: Deterministic, Stochastic, Static, Dynamic, Observable, Semi-observable, Single Agent, Multi Agent

Unit III: Problem Solving by Searching (9 Hrs.)

3.1. Definition, Problem as a state space search, Problem formulation, Well-defined problems,
3.2. Solving Problems by Searching, Search Strategies, Performance evaluation of search techniques
3.3. Uninformed Search: Depth First Search, Breadth First Search, Depth Limited Search, Iterative Deepening Search, Bidirectional Search
3.4. Informed Search: Greedy Best first search, A* search, Hill Climbing, Simulated Annealing
3.5. Game playing, Adversarial search techniques, Mini-max Search, Alpha-Beta Pruning.
3.6. Constraint Satisfaction Problems

Unit IV: Knowledge Representation (14 Hrs.)

4.1. Definition and importance of Knowledge, Issues in Knowledge Representation, Knowledge Representation Systems, Properties of Knowledge Representation Systems.
4.2. Types of Knowledge Representation Systems: Semantic Nets, Frames, Conceptual Dependencies, Scripts, Rule Based Systems, Propositional Logic, Predicate Logic
4.3. Propositional Logic(PL): Syntax, Semantics, Formal logic-connectives, truth tables, tautology, validity, well-formed-formula, Inference using Resolution, Backward Chaining and Forward Chaining
4.4. Predicate Logic: FOPL, Syntax, Semantics, Quantification, Inference with FOPL: By converting into PL (Existential and universal instantiation), Unification and lifting, Inference using resolution
4.5. Handling Uncertain Knowledge, Radom Variables, Prior and Posterior Probability, Inference using Full Joint Distribution, Bayes' Rule and its use, Bayesian Networks, Reasoning in Belief Networks
4.6. Fuzzy Logic

Unit V: Machine Learning (9 Hrs.)

5.1. Introduction to Machine Learning, Concepts of Learning, Supervised, Unsupervised and Reinforcement Learning
5.2. Statistical-based Learning: Naive Bayes Model
5.3. Learning by Genetic Algorithm
5.4. Learning with Neural Networks: Introduction, Biological Neural Networks Vs. Artificial Neural Networks (ANN), Mathematical Model of ANN, Types of ANN: Feed-forward, Recurrent, Single Layered, Multi-Layered, Application of Artificial Neural Networks, Learning by Training ANN, Supervised vs. Unsupervised Learning, Hebbian Learning, Perceptron Learning, Back-propagation Learning

Unit VI: Applications of AI (6 Hrs.)

6.1. Expert Systems, Development of Expert Systems
6.2. Natural Language Processing: Natural Language Understanding and Natural Language Generation, Steps of Natural Language Processing
6.3. Machine Vision Concepts
6.4. Robotics

Laboratory Works:

The laboratory work consists of design and implementation of intelligent agents and expert systems, searching techniques, knowledge representation systems and machine learning techniques. Students are also advised to implement Neural Networks, Genetic Algorithms for solving practical problems of AI. Students are advised to use LISP, PROLOG, or any other high level language.

Text Books:

1. Stuart Russel and Peter Norvig, *Artificial Intelligence A Modern Approach*, Pearson

Reference Books:

1. E. Rich, K. Knight, Shivashankar B. Nair, *Artificial Intelligence*, Tata McGraw Hill.
2. George F. Luger, *Artificial Intelligence: Structures and Strategies for Complex Problem Solving*, Benjamin/Cummings Publication
3. D. W. Patterson, *Artificial Intelligence and Expert Systems*, Prentice Hall.
4. P. H. Winston, *Artificial Intelligence*, Addison Wesley.