Course Curriculum and Detailed Syllabi

For

B. Tech. Computer Science & Engineering

Effective for

Students admitted in the

Academic Session 2026-27

Department of Computer Science & Engineering

School of Engineering

Harcourt Butler Technical University, Kanpur-208002

(As per NEP-2020)

1. About the Department

The Department of Computer Science & Engineering was established in 1984 with a 4-year B. Tech. program in Computer Science & Engineering having an intake of 30 students. A 3-year Post Graduate Program, Master of Computer Application (MCA), with an intake of 60 students was introduced in 1987. Under IT task force recommendations, B. Tech. Information Technology Program with an intake of 60 students was introduced in the year 2000.

Currently, the department is running B. Tech. Computer Science & Engineering, B. Tech. Information Technology and MCA with students' intake of 81, 81 and 78 respectively. One of the youngest, but among the most efficient departments, it is reputed for producing the best quality software engineers who serve in leading companies in India and abroad. The students have an in-depth exposure to computing environment consisting of state-of-the-art machines in different laboratories. In order to identify Industrial projects for the students and to expose them to the industrial environment, the department has continuous interaction with the Industries.

The Department of Computer Science & Engineering at HBTU Kanpur also offers a Ph.D. program focused on advanced research and innovation in key areas such as artificial intelligence, machine learning, cloud computing, data analytics, networks, and security. The program aims to develop research scholars with strong analytical, technical, and problem-solving skills capable of contributing to academia, industry, and society. Admission is based on academic merit, a written test, and an interview as per university norms. The department provides well-equipped research facilities, experienced faculty, and a collaborative environment to promote high-quality research and publications aligned with national and global standards.

2. Vision

To excel in Computer Science & Engineering education, research, innovation and global employability.

3. Mission

1. Achieve academic excellence in Computer Science & Engineering through an innovative teaching-learning process.
2. Inculcate technical competence and collective discipline in students to excel for global employability, higher education and societal needs.
3. Establish focus research groups in leading areas of Computer Science & Engineering.
4. Sustain quality in Computer Science & Engineering education & research through continuous & rigorous assessment.

4. Program Educational Objectives (PEOs)

1. Graduates will be able to take up technical/ professional positions for design, development, and problem solving in software industries and R&D organizations.
2. Graduates will be technical, ethical, responsible solution providers and entrepreneurs in various areas of Computer Science & Engineering.
3. Graduates will be capable and competent to pursue higher studies in Institutions of International / National repute.
4. Technical ability to analyze, develop and innovate systems and technologies in the leading/ever-evolving areas of Computer Science & Engineering.

5. Program Outcomes (POs)

Engineering Graduates will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
8. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
9. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write

effective reports and design documentation, make effective presentations, and give and receive clear instructions.

10. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
11. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

6. Program Specific Outcomes (PSOs)

By the completion of B. Tech. Computer Science & Engineering program, the students will achieve the following program specific outcomes:-

1. The ability to understand, analyse and develop applications in the field of algorithms, system software, databases, web design, networking and artificial intelligence.
2. The ability to apply standard practices and strategies in software project development using suitable programming environment to deliver a quality product.
3. The ability to employ modern computer languages, environments, and platforms in creating innovative career paths to be an entrepreneur, and a zest for higher studies.
4. The ability to use research based knowledge to do literature survey, formulate problem, design & carry-out experimentation, analyse & interpret experimental results for complex research problems.

7. Consistency/Mapping of PEOs with Mission of the Department

PEO	M1	M2	M3	M4
PEO1	2	3	2	3
PEO2	3	3	1	2
PEO3	2	3	3	2
PEO4	3	3	3	2

1:Slight(Low) 2: Moderate (Medium) 3: Substantial (High) "-": No correlation

8. Components of the Curriculum

(Program curriculum grouping based on course components)

Sr. No.	Curriculum Content			
	Course Component	**% of total number of credits of the Program**	**Total number of contact hours**	**Total number of Credits**
1	Basic Sciences (BSC)	11.11	22	20
2	Engineering Sciences (ESC)	20.00	42	36
3	Humanities and Social Sciences (HMSC)	5.00	10	9
4	Program Core (PCC)	36.11	76	65
5	Program Electives (PEC)	10.00	18	18
6	Open Electives (OEC)	3.33	06	06
7	Project(s) (PRC)	12.22	44	22
8	Industrial Training/Internships (ISC)	1.11	4	2
9	Seminar	1.11	4	2
9	Any Other (Please Specify) (MC)	0.00	6	0
	Total	**100.00**	**232**	**180**

Siddhant

Department of Computer Science & Engineering

Course Structure (Semester wise)

B. Tech. Computer Science & Engineering

(Applicable w.e.f. the Session 2024-2025)

I Semester

Sr. no.	Course Type	Subject Code	Course Title	Credits (L-T-P)	Sessional Marks				ESE	Total Marks
					MSE	TA	Lab	Total		
1	BSC	NCY-101/102	Engineering Chemistry	4(3-0-2)	15	20	15	50	50	100
2	ESC	NCS-101/102	Introduction to Computer Science and Engineering	4(3-1-0)	30	20	-	50	50	100
3	ESC	NET-101/102	Introduction to Electronics Engineering	4(3-1-0)	30	20	-	50	50	100
4	ESC	NCE-101/102	Introduction to Civil Engineering	4(3-1-0)	30	20	-	50	50	100
5	ESC	NCT 101	Introduction to Chemical Engineering and Technology	4(3-1-0)	30	20	-	50	50	100
6	ESC	NWS-101/102	Workshop Practice	2(0-0-4)	30	20	-	50	50	100
Total Credits				**22**						**600**

II Semester

Sr. no.	Course Type	Subject Code	Course Title	Credits (L-T-P)	Sessional Marks				ESE	Total Marks
					MSE	TA	Lab	Total		
1	BSC	NPH-101/102	Engineering Physics	4(3-0-2)	15	20	15	50	50	100
2	BSC	NMA-101/102	Engineering Mathematics-I	4(3-1-0)	30	20	-	50	50	100
3	ESC	NEE-101/102	Introduction to Electrical Engineering	4(3-0-2)	15	20	15	50	50	100
4	ESC	NME-101/102	Introduction to Mechanical Engineering	4(3-1-0)	30	20	-	50	50	100
5	HSMC	NHS-103/104	Professional Communication	4(2-1-2)	15	20	15	50	50	100
6	ESC	NCE-103/104	Engineering Graphics	2(0-0-4)	30	20	-	50	50	100
Total Credits				**22**						**600**

III Semester

Sr. no.	Course Type	Subject Code	Course Title	Credits (L-T-P)	Sessional Marks				ESE	Total Marks
					MSE	TA	Lab	Total		
1	BSC	NMA-201	Engineering Mathematics-II	4(3-1-0)	30	20	-	50	50	100
2	ESC	NET-207	Digital Electronics	4(3-1-0)	30	20	-	50	50	100
3	PCC	NCS-201	Data Structure using C	5(3-1-2)	15	20	15	50	50	100
4	PCC	NCS-203	Python Programming	4(2-1-2)	15	20	15	50	50	100
5	PCC	NCS-205	Computer Organization	3(2-1-0)	30	20	-	50	50	100
6	PCC	NCS-207	Introduction to Emerging Technologies in ICT	4(3-1-0)	30	20	-	50	50	100
Total Credits				**24**						**600**

IV Semester

Sr. no.	Course Type	Subject Code	Course Title	Credits (L-T-P)	Sessional Marks				ESE	Total Marks
					MSE	TA	Lab	Total		
1	BSC	NMA-202	Engineering Mathematics -III	4(3-1-0)	**30**	**20**	-	**50**	**50**	**100**
2	ESC	NCS-202	Software Engineering	4(3-0-2)	15	20	15	50	50	100
3	PCC	NCS-204	Principles of Programming Languages	4(3-1-0)	30	20	-	50	50	100
4	PCC	NIT-202	Web Technology	5(3-1-2)	15	20	15	50	50	100
5	PCC	NCS-206	Operating System	4(3-1-0)	30	20	-	50	50	100
6	HSMC	NHS 201/202	Economics & Management	3(3-0-0)	30	20	-	50	50	100
Total Credits				**24**						**600**

V Semester

Sr. no.	Course Type	Subject Code	Course Title	Credits (L-T-P)	Sessional Marks				ESE	Total Marks
					MSE	TA	Lab	Total		
1	PCC	NCS-301	Computer Networks	4(3-0-2)	15	20	15	50	50	100
2	PCC	NCS-303	Database and Management Systems	4(3-0-2)	15	20	15	50	50	100
3	PCC	NCS-305	Design & Analysis of Algorithms	4(3-0-2)	15	20	15	50	50	100
4	PCC	NCS-307	Theory of Automata and formal Languages	4(3-1-0)	30	20	-	50	50	100
5	PCC	NCS-309	Data Science	4(3-0-2)	15	20	15	50	50	100
6	OEC-I		Open Elective-I	2(2-0-0)	30	20	-	50	50	100
Total Credits				**22**						**600**

OEC1(Can be opted by the students of other than CSE/ IT Branch)

1. Human Values
2. Cyber Security (OCS-301)
3. Indian Knowledge Tradition
4. Environment and Ecology
5. One course offered by each degree awarding department
6. One course offered by each School of basic & Applied Sciences
7. One course offered by School of Humanities & social Sciences

VI Semester

Sr. no.	Course Type	Subject Code	Course Title	Credits (L-T-P)	Sessional Marks				ESE	Total Marks
					MSE	TA	Lab	Total		
1	PCC	NCS-302	Compiler Design	4(3-0-2)	15	20	15	50	50	100
2	PCC	NCS-304	Object Oriented Programming System	4(3-0-2)	15	20	15	50	50	100
3	PCC	NCS-306	Computer Graphics	4(3-0-2)	15	20	15	50	50	100
4	PCC	NCS-308	Artificial Intelligence	4(3-0-2)	15	20	15	50	50	100
5	PEC-I		Program Elective-I	4(3-1-0)	30	20	-	50	50	100
6	HSMC	NHS-301/302	Entrepreneurship	2(2-0-0)	30	20	-	50	50	100
Total Credits				**22**						**600**

PEC-I

1. Digital Image Processing (NCS-310)
2. Data warehousing & Data Mining (NCS-312)
3. Advance DBMS (NCS-314)
4. Information Storage & Retrieval (NCS-316)
5. Soft Computing (NCS-318)

VII Semester

Sr. no.	Course Type	Subject Code	Course Title	Credits (L-T-P)	Sessional Marks				ESE	Total Marks
					MSE	TA	Lab	Total		
1	PEC-II		Program Elective-II	4(3-1-0)	30	20	-	50	50	100
2	PEC-III		Program Elective-III	3(2-1-0)	30	20	-	50	50	100
3	PEC-IV		Program Elective-IV	3(2-1-0)	30	20	-	50	50	100
4	Seminar	NCS-471		2(0-0-4)	-	50	-	50	50	100
5	Industrial Training	NCS-481		2(0-0-4)	-	50	-	50	50	100
6	Minor Project	NCS-491		6(0-0-12)	-	50	-	50	50	100
7	OEC-II		Open Elective-II	2(2-0-0)	30	20	-	50	50	100
Total Credits				**22**						**700**

PEC-II

1. Cloud Computing (NCS-401)
2. Real Time Systems (NCS-403)
3. Big Data Analytics (NCS-405)
4. Multimedia Systems (NCS-407)
5. Software Testing (NCS-409)

PEC-III

1. Embedded Systems (NCS-411)
2. Distributed Systems (NCS-413)
3. Software Project Management (NCS-415)
4. ERP Systems (NCS-417)

PEC-IV

1. Machine Learning (NCS-419)
2. Pattern Recognition (NCS-421)
3. Software Quality Engineering (NCS-423)
4. Computer Vision (NCS-425)
5. Virtual Reality (NCS-427)

OEC-II (Can be opted by the students of other than IT Branch)

1. Soft Computing (OCS-403)
2. Artificial Intelligence (OCS-401)
3. 3D Printing
4. Logistic and supply chain management
5. One course offered by each degree awarding department
6. One course offered by each School of basic & Applied Sciences
7. One course offered by School of Humanities & social Sciences

VIII Semester

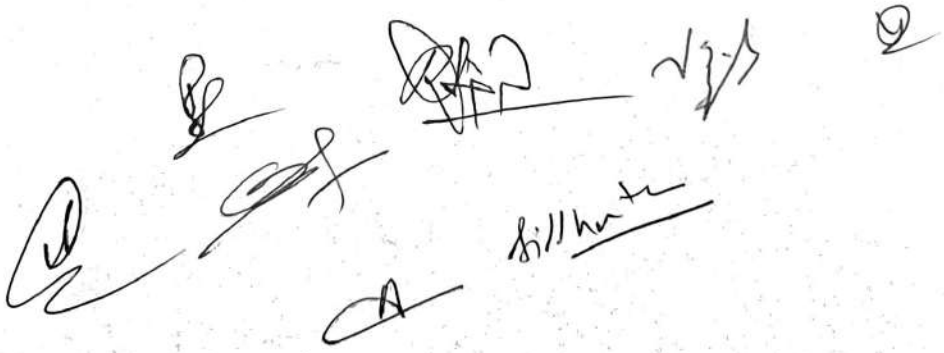
Sr. no.	Course Type	Subject Code	Course Title	Credits (L-T-P)	Sessional Marks				ESE	Total Marks
					MSE	TA	Lab	Total		
1	PEC-V		Program Elective-V	4(3-1-0)	30	20		50	50	100
2	OEC-III		Open Elective-III	2(2-0-0)	30	20	-	50	50	100
3	Project	NCS-492		16(0-0-32)		50		50	50	100
Total Credits				**22**						**300**

PEC-V

1. Robotics (NCS-402)
2. Agile Software Development (NCS-404)
3. Natural Language Processing (NCS-406)
4. Advanced Computer Architecture (NCS-408)
5. Cryptography and Network Security (NCS-410)

OEC-III (Can be opted by the students of other than CSE Branch)

1. Robotics (OCS-402)
2. Data Sciences (OCS-404)
3. Machine learning (OCS-406)
4. Sustainable Development
5. One course offered by each degree awarding department
6. One course offered by each School of basic & Applied Sciences
7. One course offered by School of Humanities & social Sciences



Detailed Syllabus

II Year

ENGINEERING MATHEMATICS-II (NMA-201)

Type	L	T	P	Credits
BSC	3	1	0	4

Course Objectives

The objective of this course is to educate the students about:

- ordinary differential equations and their applications as mathematical models.
- series solutions of ordinary differential equations and special functions.
- Laplace transform, Fourier series, differential equations and boundary value problems.

Course Content

Unit- I: Ordinary Differential Equations:

First order ordinary differential equations, Existence and uniqueness of solutions of initial value problems, Solution of higher order linear differential equation with constant coefficients, Solution of second order differential equations by changing dependent and independent variables, Cauchy-Euler equations, Methods of diagonalization, undetermined coefficients and variation of parameters: Nonlinear equations, Linear and nonlinear models, Initial value and boundary value problems, Systems of equations. Application of differential equations as mathematical models, Models from population dynamics, Newton's Law of cooling, electric circuit, Oscillation of spring.

Unit-II: Series Solutions of Ordinary Differential Equations & Special Functions

Ordinary and singular points of an equation, Power series solutions, Frobenius method, Bessel's and Legendre's equations and their series solutions, Properties of Legendre's polynomials and Bessel's functions, Generating functions, Fourier- Bessel series and Fourier-Legendre series expansions, sturm- Liouville Problem and related theorems.

Unit-III: Laplace Transform:

Laplace transform, Existence conditions and ROC, Inverse Laplace transform, Operational properties, Convolution, Unit step function, Dirac-Delta function, Periodic functions, Applications to solve IVP and BVP: Linear ordinary differential equations, Transfer function and control system analysis.

Unit-IV: Fourier Series and Partial Differential Equations:

Orthogonal functions, Fourier series, existence conditions, Fourier series of even and odd functions, convergence of Fourier series, Fourier half range series, Harmonic analysis, Complex Fourier series and frequency spectrum. Development of partial differential equations and Solutions, Solution of first order partial differential equations, Solutions of linear higher order partial differential equations with constant coefficients.

Unit-V: Boundary-Value Problems:

Classification of second order partial differential equations, Derivation of heat and wave equations, solutions in rectangular coordinates by separation variable method, solution of Laplace equation, D'Alemberts solution of wave equation, non-homogeneous equations and boundary conditions, Orthogonal series expansions, Fourier series in two dimensions, Boundary value problems in polar, cylindrical and spherical coordinate systems and their solutions.

Text Books

1. E.A. Coddington, An Introduction to Ordinary Differential Equations, Practice Hall, 1995.
2. I.N. Sneddon, Elements of Partial Differential equations, McGraw-Hill 1957.
3. Dennis G, Zill & Michael R. Cullen; Advanced Engineering Mathematics, Jones & Bartlett Publishers. 2nd Edition.

Reference Books

1. R.K. Jain & S.R.K. Iyengar; Advanced Engineering Mathematics, Narosa Publishing House, 2002.
2. Erwin Kreyszig; Advaced Engineering Mathematics, John Wiley & Sons 8th Edition.

Course Outcomes

1. Apply and solve first and higher order ordinary differential equations.
2. Analyze series solutions of ordinary differential equations and learn Bessel's and Legendre's function and its applications.
3. Evaluate IVPS and BVPS using Laplace Transform.
4. Understand and apply Fourier series expansion of given function and solve partial differential equations.
5. Evaluate boundary value problems using variable separable method etc.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	1	2	-	1	-	1	-	3
CO2	3	3	2	1	2	-	1	-	1	-	3
CO3	3	3	2	1	2	-	1	-	1	-	3
CO4	3	3	2	1	2	-	1	-	1	-	3
CO5	3	3	2	1	2	-	1	-	1	-	3

DIGITAL ELECTRONICS (NET-207)

Type	L	T	P	Credits
ESC	3	1	0	4

Course Objectives

This course is designed to introduce basic postulates of Boolean algebra, outline the formal procedures for the analysis and design of combinational circuit and sequential circuits and understanding the concepts of memory and programmable logic devices.

Course Content

Unit-1: Number System

Quantization and implementation of digital number system, Binary Numbers, Number base conversion, Data representations and arithmetic using Floating point & fixed point number system: Signed, Unsigned, Fractional & Integer representation, Complements, Binary coded decimal, Gray Code, Excess-3 code, Boolean laws and Postulates, sum of product (SoP) and product of sum (PoS) representation, Minimization using K-Map (upto 5 variables), don't care condition, Implementation of Boolean function using basic and universal gates.

Unit-2: Combinational Circuits

Design procedure, Half adder, Full adder, Half subtractor, Full subtractor, Ripple binary adder, binary adder/subtractor, Carry Look Ahead adder, BCD adder, Binary Multiplier, Binary Divider, Magnitude Comparator, parity checker, parity generators, code converters, Multiplexer, Demultiplexer, decoder, encoder, priority encoder.

Unit-3: Sequential Circuits

Latches, Flip-flops - SR, JK, D, T, Characteristic table and equation, Excitation table, Level Triggering & Edge triggering, Concept of Master-Slave, Design of sequential circuits, Synchronous and Asynchronous circuits, Asynchronous Ripple counter, Up/Down counter, Modulo–n counter, Design of Synchronous counters: state diagram, State assignment, State table, State reduction, Excitation table and maps-Circuit implementation, Programmable counters, Realization of one flip flop using other flip flops, Registers – shift registers, Universal shift registers, Ring counter, Johnson counter, Sequence generators.

Unit-4: Logic Families

Bipolar Logic: Diode Logic, Transistor Logic Inverter, TTL Logic with three types of output configurations, ECL, MOS Logic, designing of all gates using MOS logic, CMOS Dynamic Electrical Behavior, designing of all gates using CMOS logic.

Unit-5: Memory Devices

Classification of memories, ROM organization, PROM, EPROM, EEPROM, EAPROM, RAM – RAM organization, Write operation & Read operation, Memory cycle, Timing wave forms, Memory decoding, memory expansion, Static RAM Cell, Bipolar RAM cell, MOSFET RAM cell, Dynamic RAM cell, Programmable Logic Devices, Programmable Logic Array (PLA), Programmable Array Logic (PAL), Field Programmable Gate Arrays (FPGA), Implementation of combinational logic circuits using ROM, PLA, PAL, Implementation of state machine using Multiplexers and programmable logic devices.

Text Books

1. Mano, M. Morris & Michael D. Ciletti "Digital Design: with an Introduction to Verilog HDL, VHDL and SystemVerilog"6th Ed. Pearson India 2018.
2. Wakerly, John F. "Digital Design: Principles & Practices" 3rd Ed. Pearson Education

Reference Books

1. Bartee, Thomas C. “Fundamentals of Digital Computers” McGraw-Hill education 2001
2. Gopalan, K. “Gopal” “Introduction to Digital Microelectronic Circuits” Indo-American books 2019.
3. Taub, Herbert & Schilling, Donald “Digital Integrated Electronics” McGraw- Hill Education 2017.
4. Millman, Jocob & Taub, Herbert “Pulse, Digital and Switching Waveforms” 3rd, McGraw-Education 2017.
5. Malvino, Leach, Goutam Saha / “Digital Principles & Applications” 7th, McGraw Education, 2010.
6. Mano, M. Morris “Digital Logic and Computer Design” 1stPearson Education 2004
7. Tokheim, H. Roger L. “Digital Electronics Principles & Application” 8thMcGraw-Hill 2013.
8. John. M Yarbrough, “Digital Logic Applications and Design”,1st, Cengage Learning India, 2006.
9. Charles H. Roth. “Fundamentals of Logic Design”, 7th Ed.Cengage Learning 2013.
10. Thomas L. Floyd, “Digital Fundamentals”, 11th Ed, Pearson Education 2015.
11. Donald D. Givone, “Digital Principles and Design”, McGraw Education2017.
12. Lectures of NPTEL

Online Resources

1. https://nptel.ac.in/courses/108105132
2. https://www.udemy.com/topic/digital-electronic/
3. https://in.coursera.org/learn/digital-systems

Course Outcomes

At the end of this course students should be able to:

1. Analyze different methods used for simplification of Boolean expressions.
2. Understand and implement Combinational circuits.
3. Design and implement synchronous and asynchronous sequential circuits.
4. Apply Memory units and their application in function implementation.
5. Understand about logic families and its interfacing with real world.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	3	3	3	-	2	2	1	1
CO2	3	3	3	3	2	3	-	2	2	-	1
CO3	2	3	3	3	3	3	-	2	2	1	-
CO4	2	3	3	3	3	3	-	2	2	1	1
CO5	3	3	3	3	2	3	-	-	2	-	1

DATA STRUCTURE USING C (NCS-201)

Type	L	T	P	Credits
PCC	3	1	2	5

Course Objectives

To understand the basics of data structure like arrays and stacks and analyze the algorithm time and space complexity, study the implementation of queues, linked lists, trees and graphs and implement searching, sorting and hashing techniques**.**

Prerequisite: Computer Concepts & 'C' Programming

Course Content

Unit -1

Introduction: Basic Terminology, Elementary Data Organization, Structure operations, Algorithm Complexity and Time-Space trade-off.

Arrays: Array Definition, Representation and Analysis, Single and Multidimensional Arrays, address calculation, application of arrays, Character String in C, Character string operation, Array as Parameters, Ordered List, Sparse Matrices and Vectors.

Stacks: Array Representation and Implementation of stack, Operations on Stacks: Push & Pop, Array and Linked Representation of Stack, Operations associated with Stacks, Applications of stack: Conversion of Infix to Prefix and Postfix Expressions, Evaluation of postfix expression using stack, Applications of recursion in problems like "Tower of Hanoi".

Unit-2

Queues: Array and linked representation and implementation of queues, Operations on Queue: Create, Add, Delete, Full and Empty, Circular queues, D-queues and Priority Queues**.**

Linked list: Representation and Implementation of Singly Linked Lists, Two-way Header List, Traversing and Searching of Linked List, Overflow and Underflow, Insertion and deletion to/from Linked Lists, Insertion and deletion Algorithms, doubly linked list, Linked List in Array, Polynomial representation and addition, Generalized linked list, Garbage Collection and Compaction.

Unit-3

Trees: Basic terminology, Binary Trees, Binary tree representation, algebraic Expressions, Complete Binary Tree, Extended Binary Trees, Array and Linked Representation of Binary trees, Traversing Binary trees, Threaded Binary trees, Traversing Threaded Binary trees, Huffman algorithm**.**

Searching and Hashing: Sequential search, binary search, comparison and analysis, Hash Table, Hash Functions, Collision Resolution Strategies, Hash Table Implementation.

Unit-4

Sorting: Insertion Sort, Bubble Sort, Quick Sort, Two Way Merge Sort, and Heap Sort, Sorting on Different Keys, Practical consideration for Internal Sorting**.**

Binary Search Trees: Binary Search Tree (BST), Insertion and Deletion in BST, Complexity of Search Algorithm, Path Length, AVL Trees, B-trees.

Unit-5

Graphs: Terminology & Representations, Graphs & Multi-graphs, Directed Graphs, Sequential Representations of Graphs, Adjacency Matrices, Traversal, Connected Component and Spanning Trees, Minimum Cost Spanning Trees.

File Structures: Physical Storage Media File Organization, Organization of records into Blocks, Sequential Files, Indexing and Hashing, Primary indices, Secondary indices, B+ Tree index Files, B Tree index Files, Indexing and Hashing Comparisons.

Lab Work

Write a Program in C or C++ for the following

1. Array implementation of Stack, Queue, Circular Queue, List.
2. Implementation of Stack, Queue, Circular Queue, List using Dynamic memory Allocation.
3. Implementation of Tree Structures, Binary Tree, Tree Traversal, Binary Search Tree, Insertion and Deletion in BST.
4. Implementation of Searching and Sorting Algorithms.
5. Graph Implementation, BFS, DFS, Min. cost spanning tree, shortest path algorithm.

Text Books

1. Horowitz and Sahani, "Fundamentals of data Structures", Galgotia Publication Pvt. Ltd., New Delhi, 2nd edition, 2012.
2. R. Kruse et. al, "Data Structures and Program Design in C", Pearson Education Asia, Delhi- 2nd edition,2002.

Reference Books

1. A. M. Tenenbaum, "Data Structures using C & C++", PHI Pvt. Ltd., New Delhi, 3rd edition 2002.
2. K Loudon, "Mastering Algorithms with C", Shroff Publisher & Distributors Pvt. Ltd, 2nd edition 1999.
3. Bruno R Preiss, "Data Structures and Algorithms with Object Oriented Design Pattern in C++", Jhon Wiley & Sons, Inc, 1st edition 1998.
4. Adam Drozdek, "Data Structures and Algorithms in C++", Thomson Asia Pvt. Ltd. (Singapore) 6th edition 2003.

Online Resources

1. https://in.coursera.org/learn/data-structures
2. https://nptel.ac.in/courses/106106127
3. https://www.udemy.com/topic/data-structures/

Course Outcomes

1. Analyze the algorithms to determine the time and computation complexity and justify the correctness.
2. Evaluate Arrays, Stacks, Queues and linked list-based problems and analyze the algorithm to determine the time complexity.
3. Apply search and traversal algorithms on Trees and Graphs and determine the time complexity.
4. Understand Algorithms for Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort and compare their performance in term of space and time complexity.
5. Create file structures for file handling.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	1	1	-	-	-	-	-	-	-	-
CO2	2	1	-	-	-	-	-	-	-	-	-
CO3	3	3	2	-	-	-	-	-	-	-	-
CO4	3	3	2	-	-	-	-	-	-	-	-
CO5	2	-	-	-	-	-	-	-	-	-	-

PYTHON PROGRAMING (NCS-203)

Type	L	T	P	Credits
PCC	2	1	2	4

Course Objectives

The course is designed to understand the fundamentals of Python Programming and acquire skills of implementing control structure, string, advanced functions like iteration and recursion and object-oriented programming concepts in Python.

Prerequisite: Computer Concepts & 'C' Programming

Course Content

Unit 1: Introduction

The Programming Cycle for Python, Python IDE, Interacting with Python Programs, Elements of Python, Type Conversion. Basics: Expressions, Assignment Statement, Arithmetic Operators, Operator Precedence, Boolean Expression.

Unit 2: Conditionals and Loops

Conditional statement in Python: if-else statement, its working and execution, Nested-if statement and Else if statement in Python, Expression Evaluation & Float Representation, Loops: Purpose and working of loops, while loop including its working, For Loop, Nested Loops, Break and Continue.

Unit 3: Strings and Functions

Strings: Length of the string, Concatenation and Repeat operations, Indexing and Slicing of Strings. Python Data Structure: Tuples, Unpacking Sequences, Lists, Mutable Sequences, List Comprehension, Sets, Dictionaries, Functions: Parts of a Function, Execution of a Function, Keyword and Default Arguments, Scope Rules, Higher Order Functions: Treat functions as first-class Objects, Lambda Expressions.

Unit 4: Classes and Files

Generate prime numbers with the help of Sieve of Eratosthenes algorithm, File I/O: File input and output operations in Python Programming Exceptions and Assertions Modules: Introduction, Importing Modules, Abstract Data Types: Abstract data types and ADT interface in Python Programming, Classes: Definition and operations in the classes, Special Methods (such as _init_, _str_, comparison methods and Arithmetic methods etc.), Class Example, Inheritance, Inheritance and OOP.

Unit 5: Iterators & Recursion

Recursive Fibonacci, Tower of Hanoi, Search:Simple Search, Binary Search, Estimating Search Time in Simple Search and Binary Search, Sorting & Merging: Selection Sort, Merge List, Merge Sort, Higher Order Sort.

Lab Work

1. To read and write simple Python programs.
2. To develop Python programs with conditionals and loops.
3. To define Python functions and to use Python data structures –- lists, tuples, dictionaries
4. To do input/output with files in Python
5. Write a Python Program to perform Linear Search
6. Write a Python Program to perform Binary Search
7. Write a Python Program to perform selection sort
8. Write a Python Program to perform insertion sort.

Text Books

1. Allen B. Downey, ``Think Python: How to Think Like a Computer Scientist Updated for Python 3, Shroff/O,,Reilly Publishers, 2nd edition 2016, (http://greenteapress.com/wp/thinkpython/)
2. Guido van Rossum and Fred L. Drake Jr, An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2011.
3. John V Guttag, ―Introduction to Computation and Programming Using Python,,,,, Revised and expanded Edition, MIT Press, 2013.

Reference Books

1. Robert Sedgewick, Kevin Wayne, Robert Dondero, Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd.,1st edition 2016.
2. Timothy A. Budd, Exploring Python‖, Mc-Graw Hill Education (India) Private Ltd., 2nd edition 2015.
3. Kenneth A. Lambert, Fundamentals of Python: First Programs‖, CENGAGE Learning, 2nd edition 2012.
4. Charles Dierbach, Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition, 1st edition 2015.
5. Paul Gries, Jennifer Campbell and Jason Montojo, Practical Programming: An Introduction to Computer Science using Python 3‖, Second edition, Pragmatic Programmers, LLC, 2nd edition 2013. Mapped With: https://ict.iitk.ac.in/product/python- programming-a-practical

Online Resource

1. https://onlinecourses.nptel.ac.in/noc21_cs32/preview
2. https://www.udemy.com/topic/python/
3. https://in.coursera.org/courses?query=python

Course Outcomes

1. Understanding Fundamentals of Python Programming
2. Apply and implement Control Structures.
3. Design implement Strings and Functions in Python.
4. Evaluate advance functions like iteration and recursion.
5. Understand object Oriented Programming concepts in Python

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	-	-	-	-	2	-	-	2
CO2	3	3	3	-	-	-	-	2	-	-	2
CO3	3	3	1	-	-	-	-	2	-	-	2
CO4	3	3	3	-	-	-	-	2	-	-	2
CO5	3	3	3	-	-	-	-	2	-	-	2

COMPUTER ORGANIZATION (NCS-205)

Type	L	T	P	Credits
PCC	2	1	0	3

Course Objectives

This course is designed to understand the basic concepts of digital logic design, CPU organization, design of memory organization, working of various I/O devices, buses, interrupt and interfaces, pipelining and Multicore architecture

Prerequisite: Digital Logic design

Course Content

Unit-1: Basic Functional units of Computers

Functional units, basic Operational concepts, Bus structures. Data Representation: Signed number representation, fixed and floating-point Representations. Computer Arithmetic: Addition and subtraction, multiplication Algorithms, Division Algorithms.

Unit-2: Register Transfer Language and Micro Operations

RTL- Registers, Register transfers, Bus and memory transfers. Micro operations: Arithmetic, Logic, and Shift micro-operations, Arithmetic logic shift unit.

Basic Computer Organization and Design: Computer Registers, Computer instructions, Instruction cycle. Instruction codes, Timing and Control, Types of Instructions: Memory Reference Instructions, Input – Output and Interrupt.

Unit-3: Central Processing Unit organization

General Register Organization, Stack organization, Instruction formats, Addressing modes, Data Transfer and Manipulation, Program Control, CISC and RISC processors.

Control unit design: Design approaches, Control memory, Address sequencing, micro program example, design of CU. Micro Programmed Control.

Unit-4: Memory Organization:

Memory hierarchy, Interleaving, Main Memory-RAM and ROM chips, Address map, Associative memory-Hardware organization, Cache memory, Memory mapping schemes. Virtual Memory, hit/miss ratio, Replacement algorithms, write policies. Auxiliary memory, magnetic disk and its performance, magnetic Tape etc.

Unit-5: Input –Output Organization

Peripheral devices, I/O interface, Modes of Transfer, Priority Interrupt, Direct Memory Access, Input Output Processor and Serial Communication. Asynchronous data transfer, Strobe Control, Handshaking.

Pipelining and Vector Processing

Basic concepts, Instruction level Parallelism Throughput and Speedup, Pipeline hazards.

Text Books

1. William Stalling, “Computer Organization & Architecture”, Pearson education Asia, 10th Edition 2016.
2. Mano Morris, “Computer System Architecture”, PHI, 3rd edition, 2016.

Reference Books

1. Zaky & Hamacher, “Computer Organization”, McGraw Hill, 5th edition 2011.
2. B. Ram, “Computer Fundamental Architecture & Organization”, 5th edition 2018.
3. New Age, A.S. Tannenbaum, “Structured Computer Organization”, PHI. 6th edition 2016.

Online Resources

1. https://www.coursera.org/learn/comparch
2. https://nptel.ac.in/courses/106105163
3. https://www.udemy.com/topic/computer-organization/

Course Outcomes

1. Understand Number systems, Logic Gates, Boolean algebra, Design of Combinational and sequential circuits.
2. Design Von Neumann architecture, instruction cycle and the concept of Hardwired and Micro programmed control unit, addressing modes, register organization.
3. Implement the concepts of memory organization in calculating hit-miss ratio and access time of magnetic disks.
4. Understand the working of various I/O devices, buses, interrupt and interfaces etc.
5. Apply the basics of pipelining and Multicore architecture.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	1	1	-	-	-	-	-	-	-	-
CO2	2	2	1	1	-	-	-	-	-	-	-
CO3	2	1	1	1	-	-	-	-	-	-	-
CO4	2	1	1	-	-	-	-	-	-	-	-
CO5	1	1	1	-	-	-	-	-	-	-	-

INTRODUCTION TO EMERGING TECHNOLOGY IN ICT (NCS-207)

Type	L	T	P	Credits
PCC	3	1	0	4

Course Objectives

This course is designed to understand basics of trending technologies such as Internet of Things, Cloud Computing, Blockchain, RFID, Big data, Virtual Reality, Artificial Intelligence and Machine Learning.

Course Content

Unit 1

Internet of Things: Introduction to Internet of Things, Sensors, their types and features, IoT components: layers, Smart Cities, Industrial Internet of Things.

Unit 2

Cloud Computing: Cloud Computing: it's nature and benefits, AWS, Google, Microsoft, Vendor Offering – IBM.

Unit 3

Blockchain: Introduction to Blockchain, Fundamentals, Principles and Technologies, Crypto currencies, Smart Contracts, Blockchain Applications and use cases.

Unit 4

Data, Analytics and Intelligence: Big Data: Processing and Issues, Introduction to Big Data, Data Analytics, Introduction to AI and ML, Current Status and Future scope.

Unit 5

Future Trends: Augmented Reality (AR) and Virtual Reality (VR), History, objective & global scenario of 5G Telecom, 5G in India, Application and Use Cases, Brain Computer Interface, Application, Modal and Global Market, Brain Computer Interface and Human Brain.

Text Books

1. Raj Kamal "INTERNET OF THINGS", McGraw-Hill, 1ST Edition, 2016
2. Rajkumar Buyya, Christian Vecchiola, S. ThamaraiSelvi, ―Mastering Cloud Computing, Tata Mcgraw Hill, 2nd edition 2013.
3. Blockchain by Melanie Swa, O'Reilly, 1t edition 2015.
4. Michael Minelli, Michelle Chambers, and Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 1st edition, 2019.
5. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale Human Computer Interaction, 3rd Edition Prentice Hall, 2004

Reference Books

1. Ben Shneiderman and Catherine Plaisant Designing the User Interface: Strategies for Effective Human-Computer Interaction 5th Edition, 2009 Reading, MA: Addison-Wesley Publishing Co.
2. Arshdeep Bahga, Vijay Madisetti "Internet of Things (A hands on approach)" 1ST edition, VPI publications, 1st edition 2014.

Online Resources

1. https://nptel.ac.in/courses/126104006
2. https://www.udemy.com/course/understanding-ict/

Course Outcomes

1. Analyze different features of IOT.
2. Understand the cloud computing basics and its uses.
3. Design and Implement variety of block chain technologies and their advancements.
4. Understand various processing applications and concept of Data, Analytics and Intelligence.
5. Evaluate variety of future emerging technology trends.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2		3	2	2	-	-	-	3
CO2	3	2	2		3	1	2	-	-	-	3
CO3	3	3	3	2	3	2	2	-	-	-	2
CO4	3	2	3	2	3	2	2	-	-	-	2
CO5	3	2	2		3	3	2	-	-	-	3

ENGINEERING MATHEMATICS- III (NMA-202)

Type	L	T	P	Credits
BSC	3	1	0	4

Course Objectives

The objective of this course is to provide conceptual understanding of:

· Various mathematical tools like Laplace/ Fourier transforms and their applications.
· Concepts and principle of complex analysis in solving various real-life problems.
· Various statistical methods and tests for analyzing experimental data

Course Content

Unit 1- Functions of One Real Variable

Successive differentiation, Leibnitz theorem, Mean value theorems, sequences and series, Expansion of functions, Improper integrals and their convergence.

Unit 2- Functions of Several Real Variables

Limit, Continuity, Partial differentiation, Total differential and approximations, Jacobian, Euler's theorem Expansion of functions, Beta and Gamma Functions, Multiple integral, change of order, Change of variables, Applications to area, volume, mass, surface area etc. Dirichlet's Integral & applications.

Unit 3- Vector Calculus

Point functions, differentiation, Gradient, Directional derivative, Divergence and Curl of a vector and their physical interpretations, Solenoidal & irrotational fields, Integration, Line, Surface and Volume integrals Green's. Stoke's and Gauss Divergence theorems (without proof) and applications.

Unit 4- Matrices and Linear Algebra

Vector space and subspace, linear dependence, dimensions and basis, Linear transformation and its matrix representation, Elementary transformations, Echelon form, rank & nullity, Consistency of linear system of equations and their solutions, characteristic equation, Cayley Hamilton theorem, Real and complex eigenvalues and eigenvectors, diagonalisation, quadratic forms, complex, orthogonal, and unitary matrices, Application to Cryptography, discrete, Compartmental models and system stability.

Unit 5- Optimization

Engineering applications of optimization, statement and classification of optimization problems, Optimization techniques, single variable optimization, multi variable optimization with no constraint, with equality and inequality constraints, Linear Programming Problems, Graphical method and Simplex method.

Text Books

1. R.K. Jain & S. R. K. lyengar; Advanced Engineering Mathematics, Narosa Publishing House 2002.
2. Erwin Kreyszig: Advanced Engineering Mathematics. John Wiley & Sons 8th Edition.
3. Dennis G. Zill & Michael R Cullen; Advanced Engineering Mathematics, Jones & Bartlett Publishers, 2nd Edition.

Reference Books

1. S.S. Rao; Optimization: Theory & application Wiley Eastern Limited.
2. T.M. Apostol, calculus, Vol. I, 2nd ed., Wiley 1967.
3. T.M. Apostol, Calculus, Vol. II, 2nd ed., Wiley 1969.
4. Gilbert Strang, Linear Algebra & its applications, Nelson Engineering 2007.
5. Calculus & Analytic Geometry, Thomas and Finny.

Course Outcomes

1. Apply nth derivative, determine the expansion of functions and find convergence of series and improper integrals.
2. Evaluate partial differentiation and evaluate area and volume using multiple integrals.
3. Understand line integrals to surface integrals and volume integrals, determine potential functions for irrotational force fields.
4. Apply linear system of equations and determine the eigen vectors of the matrix.
5. Design the concept of optimization and optimization techniques.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	2	2	–	–	–	1	–	3
CO2	3	3	3	2	2	–	–	–	1	–	3
CO3	3	3	2	3	2	2	–	–	1	–	3
CO4	3	3	2	2	3	–	–	–	1	1	3
CO5	3	2	3	2	3	–	–	–	1	3	3

SOFTWARE ENGINEERING (NCS-202)

Type	L	T	P	Credits
ESC	3	0	2	4

Course Objectives

This course is designed to study about various SDLC models, SRS preparations, estimation techniques, concepts of Software design, various software testing techniques, coding standards, and apply various maintenance processes and CASE tools.

Course Content

Unit-1

Introduction to Software Engineering, Software Components, Software Characteristics, Software Crisis, Software Engineering Processes, Similarity and Differences from Conventional Engineering Processes, Software Development Life Cycle (SDLC) Models: Water Fall Model, Prototype Model, Spiral Model, Evolutionary Development Models, Iterative Enhancement Models, Selection of Software Development Models,

Unit-2

Software Requirement Specifications (SRS) Requirement Engineering Process: licitation, Analysis, Documentation, Review and Management of User Needs, Feasibility Study, Information Modeling, Data Flow Diagrams, Entity Relationship Diagrams, Decision Tables, SRS Document, IEEE Standards for SRS, Estimation of various Parameters such as Cost, Efforts, Schedule/Duration, Constructive Cost Models (COCOMO), Resource Allocation Models, Software Risk Analysis and Management.

Unit-3

Software Design Basic Concept of Software Design, Architectural Design, Low Level Design: Modularization, Design Structure Charts, Pseudo Codes, Flow Charts, Coupling and Cohesion Measures, Design Strategies: Function Oriented Design, Object Oriented Design, Top-Down and Bottom-Up Design. Software Measurement and Metrics: Various Size Oriented Measures: Halestead‟s Software Science, Function Point (FP) Based Measures, Cyclomatic Complexity Measures: Control Flow Graphs.

Unit-4

Software Testing Objectives, Unit Testing, Integration Testing, Acceptance Testing, Regression Testing, Testing for Functionality and Testing for Performance, Top-Down and Bottom-Up Testing Strategies: Test Drivers and Test Stubs, Structural Testing (White Box Testing), Functional Testing (Black Box Testing), Test Data Suit Preparation, Alpha and Beta Testing of Products. Static Testing Strategies: Formal Technical Reviews (Peer Reviews), Walk Through, Code Inspection, Compliance with Design and Coding Standards.

Unit-5

Software Maintenance: Software as an Evolutionary Entity, Need for Maintenance, Categories of Maintenance: Preventive, Corrective and Perfective Maintenance, Cost of Maintenance,
Software Re-Engineering, Reverse Engineering, Software Configuration Management Activities, Change Control Process, Software Version Control, Defect Detection and Removal: Defect Amplification Model, An Overview of CASE Tools.

Lab Work

Lab exercises or a Mini Project (as per list given below) to be carried out using languages like C++, Java, C# and tools like Visio, ARGOUML, Rational Rose etc. Design and Implementation of an Object based application using any one of the above languages/tools is desirable.

- Hotel Automation System
- Book Shop Automation Software

- Word processing Software
- Software Component Cataloguing Software
- Payroll System
- Banking System
- Purchase Order System
- Library Management System
- Railway Reservation System
- Bill Tracking System
- University Admission System
- Estate Management System.

Text Books

1. R. S. Pressman, Software Engineering: A Practitioners Approach, McGraw Hill, 7th Edition 2009.
2. K. K. Aggarwal and Yogesh Singh, Software Engineering, New Age International Publishers. 3rd Edition 2008
3. Ian Sommerville, Software Engineering, Pearson. 9th Edition, 2009.

Reference Books

1. Pankaj Jalote, Software Engineering, Narosa Publication, 3rd Edition, 2005
2. Pfleeger, Software Engineering, Macmillan Publication, 2nd Edition, 1991

Online Resources

1. https://nptel.ac.in/courses/106105182

Course Outcomes

1. Understand and explain various concepts of software engineering and software life cycle development models.
2. Design SRS and Compute cost and effort required to complete a given project, using various estimation techniques and models.
3. Apply various concepts of Software design and Construct Data Flow Diagrams, Data Dictionaries and UML diagrams for a given software requirement specification.
4. Analyze various testing techniques and use these concepts to design optimal test cases.
5. Understand software configuration management, version control, reverse engineering, defect tracking etc.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	2	-	-	-	-	-	-	-	1
CO2	2	2	1	1	1	-	-	-	-	3	1
CO3	2	2	3	1	3	1	1	3	3	3	1
CO4	2	2	1	-	1	-	-	-	-	3	1
CO5	2	2	1	-	1	-	-	-	-	3	1

PRINCIPLES OF PROGRAMMING LANGUAGES (NCS-204)

Type	L	T	P	Credits
PCC	3	1	0	4

Course Objectives

This course is designed to introduce various programming paradigm, understand the principles and concepts involved in design and implementation of modern programming languages, notations to describe the syntax and semantics, exception handling and abstract data types.

Course Content

Unit-1

Introduction: Characteristics of programming Languages, Factors influencing the evolution of programming language, developments in programming methodologies, desirable features and design issues. Programming language processors: Structure and operations of translators, software simulated computer, syntax, semantics, structure, virtual computers, binding and binding time.

Unit -2

Elementary and Structured Data Types: Data object variables, constants, data types, elementary data types, declaration, assignment and initialization, enumeration, characters, strings. Structured data type and objects: Specification of data structured types, vectors and arrays, records, variable size data structure, pointers and programmer constructed data structure, Sets files. Sub Program and programmer defined data types: Evolution of data types, abstractions, encapsulations, information hiding, sub programs, abstract data types.

Unit -3

Sequence Control; Implicit and Explicit sequence control, sequence control with within expression and statements, recursive sub programs, exception handling, co routines, Scheduled sub programs, concurrent execution. Data control referencing environments, static and dynamic scope, local data local data referencing environment, shared data: Explicit common environment dynamic scope parameter passing mechanism.

Unit-4

Storage Management: Major run time requirements, storage management phases, static storage management, stack based, heap-based storage management. Syntax and translation: General syntactic criteria, syntactic element of a language, stages in translation, formal syntax and semantics.

Unit-5

Operating and Programming Environment: Batch Processing Environments, Embedded system requirements, Theoretical models, Introduction to Functional Programming, Lambda calculus, Data flow language and Object-Oriented language, Comparison in various general and special purpose programming languages e.g. Fortran, C, Pascal, Lisp, etc.

Text Books

1. Terrance W. Pratt, "Programming Languages: Design and Implementation" PHI, 4th Edition, 2000

References Books

1. Sebesta, "Concept of Programming Language", Addison Wesley, 4th Edition, 2019
2. E Horowitz, "Programming Languages", 2nd Edition, Addison Wesley, 1984

Online Resources

1. https://in.coursera.org/learn/programming-languages
2. https://nptel.ac.in/courses/106102067
3. https://www.udemy.com/course/fundamentals-of-programming-languages/

Course Outcomes

1. Understand the evolution of programming languages along with the desirable features and design issues.
2. Create the requirement of elementary and structured data types in programming languages and analyze their features.
3. apply the concept of various program development constructs/mechanisms such as sequence control, recursion, scope rules, co-routines, parameter passing, exception handling etc.
4. Apply the concept of storage management and language translation issues as applicable to a programming language.
5. Analyze and compare features of various types of general/specific purpose programming languages and their programming environment.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	-	-	-	-	-	-	-	-	-
CO2	2	2	2	-	-	-	-	-	-	-	-
CO3	2	2	-	1	-	-	-	-	-	-	1
CO4	2	1	-	-	-	-	-	-	-	-	-
CO5	2	2	-	2	-	-	-	-	-	-	-

WEB TECHNOLOGY (NIT-202)

Type	L	T	P	Credits
PCC	3	1	2	2

Course Objectives

This course is designed to understand the basics of web and web application development using various markup languages like HTML, DHTML, and XML, client-side scripting languages, PHP, JSP, and servlets.

Course Content

Unit-1

History of the web, Protocols governing the web, Growth of the Web, Web 2.0 and its features. Introduction to Cyber Laws in India, Introduction to International Cyber laws, Web project, Web Team, Team dynamics, Communication Issues, the Client, Multi departmental & large-scale Websites, Quality Assurance and testing, Technological advances and Impact on Web Teams.

Unit-2

HTML: Formatting Tags, Links, List, Tables, Frames, forms, Comments in HTML, DHTML, and Introduction to HTML 5, JavaScript: Introduction, Documents, Documents, forms, Statements, functions, objects in JavaScript, Events and Event Handling, Arrays, FORMS, Buttons, Checkboxes, Text fields and Text areas, Introduction to j-Query.

Unit-3

XML: Document type definition, XML Schemas, Document Object model, Presenting XML, Using XML Processors: DOM and SAX parsers, Java Beans: Introduction to Java Beans, Advantages of Java Beans, BDK, Introspection, Using Bound properties, Bean Info Interface, Constrained properties, Persistence, Customizes, Java Beans API, Introduction to EJBs.

Unit-4

Web Servers and Servlets: Tomcat web server, Introduction to Servelets: Lifecycle of a Serverlet, JSDK, The Servelet API, The javax.servelet Package, Reading Servelet parameters, Reading Initialization parameters, The javax.servelet HTTP package, Handling Http Request and Responses, Using Cookies-Session Tracking, Security Issues. Introduction to JSP: The Anatomy of a JSP Page. JSP Application Design with MVC, JSP Application Development: Generating Dynamic Content, Using Scripting Elements Implicit JSP Objects, Conditional Processing Sharing Session and Application Data Memory Usage Considerations

Unit-5

Database Access: Database Programming using JDBC, Studying Javax.sql. * Package, accessing a Database from a JSP Page, Application – Specific Database Actions, Deploying JAVA Beans in a JSP Page, Introduction to struts framework. Semantic Web: Introduction, growth and evolution, goals and vision, need, problems, Architecture, applications.

Lab Work

1. Design a HTML page to display your CV.
2. Design a HTML form to reserve a railway ticket.
3. Write a Java Script program that finds the greatest common divisor of two numbers.
4. In the form mentioned in problem 2 to reserve a railway ticket add the following validations using java Script.
   - From city and to city are two different cities.
   - Age of passengers should not be greater than 150.
   - Name of the passenger should be a string of a maximum length
5. Write a program for illustrating client/server-side scripting with help of ASP.
6. Write a piece of code in XML for creating DTD, which specifies set of rules.
7. Create style sheet in CSS/XSL and display the document in Internet Explorer.

Text Books

1. Burdman, "Collaborative Web Development", Addison Wesley.1st Edition 1999
2. Ivan Bayross, "Web Technologies Part II", BPB Publications.1st Edition, 2003
3. Deitel & Deitel, "Internet and World Wide Web – How to Program", Goldberg, Pearson Education. 3rd Edition 2003

Reference Books

1. Eric Ladd, Jim O‟ Donnel,Using HTML 4, XML and JAVA", Prentice Hall of India, 1st Edition, 1998
2. Hans Bergsten, Java Server Pages, SPD O‟Reilly. 3rd Edition, 2003
3. Patrick Naughton and Herbert Schildt, The complete Reference Java 2 Fifth Edition by TMH, 2002
4. Michael C Daconta, Leo, Kelvin Smith, "The Semantic Web: A guide to the future of XML, Web services, and knowledge management", Wiley. 1st Edition, 2003.

Online Resources

1. https://www.coursera.org/learn/web-development
2. https://nptel.ac.in/courses/106105084
3. https://www.udemy.com/topic/web-development/

Course Outcomes

1. Understand the basics of web and apply the web concepts for web application development.
2. Analyze mark-up languages like HTML, DHTML, and XML for development of different web applications.
3. Design interactive web applications using client-side scripting languages.
4. Design three-tier applications using PHP, JSP and servlets.
5. Create interoperable web applications using XML and related technologies.
6. Apply web services to build the server-side components in web applications.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	2	-	-	-	-	-	-	-	-
CO2	2	2	2	-	2	-	-	-	-	-	-
CO3	2	1	3	1	2	-	-	-	-	-	-
CO4	2	1	3	1	2	-	-	-	-	-	-
CO5	2	1	3	1	2	-	-	-	-	-	-
CO6	2	1	3	1	2	-	-	-	-	-	-

OPERATING SYSTEMS (NCS-206)

Type	L	T	P	Credits
PCC	3	1	0	4

Course Objectives

The course is designed to make aware of different types of Operating System and services, process scheduling algorithms and synchronization techniques to achieve better performance of a computer system, virtual memory concepts and secondary memory management

Course Content

Unit-1

Introduction: Operating System and its functions, Evolution of Operating System, Batch, Interactive, Time Sharing and Real Time Operating System, System Protection. Operating System Structure: System Components, System Structure, Operating System Services.

Unit-2

Process Management: Process Concept, Process State, Process Control Block, Threads. Concurrent Processes: Principle of Concurrency, Mutual Exclusion, Inter Processes Communication, Critical Section Problem, Semaphores, Classical Problems in Concurrency, Producer / Consumer Problem, Readers-Writers Problem, Dining Philosophers Problem.

Unit-3

CPU Scheduling: Scheduling Concept, Scheduling Techniques, Performance Criteria for Scheduling Algorithm, Evolution, Multiprocessor Scheduling. Deadlock: System Model, Deadlock Characterization, Prevention, Avoidance and Detection, Recovery from Deadlock Combined Approach.

Unit-4

Memory Management: Basic Machine, Resident Monitor, Multiprogramming with Fixed Partition, Multiprogramming with Variable Partition, Multiple Base Register, Paging, Segmentation, Paged Segmentation. Virtual Memory: Virtual Memory Concept, Demand Paging, Performance, Paged Replaced Algorithm, Allocation of Frames, Thrashing, Cache Memory Organization, Impact on Performance.

Unit-5

I/O Management & Disk Scheduling: I/O Devices, Organization of I/O Function, Operating System Design Issues, I/O Buffering, Disk Scheduling (FCFS, SCAN, CSCAN). File Management: File Concept, File Organization, File Directories, File Sharing, Allocation Methods, Free Space Management, and Implementation Issues.

Text Books

1. Milenekovik, "Operating System Concept", McGraw Hill, 2nd Edition, 2009
2. Petersons, "Operating Systems", Addison Wesley, 9th Edition, 2012
3. D M Dhamdhere, “Operating Systems: A Concept based Approach”, McGraw Hill Education, 3nd Edition, 2017.

Reference Books

1. Tannenbaum, "Operating System Design and Implementation", PHI, 9th Edition 2018
2. Silveschatz, Peterson J., "Operating System Concepts", Willey, 9th Edition, 2012

Online Resources

1. https://nptel.ac.in/courses/106105214

Course Outcomes

1. Understand types and structure of operating systems. (Understand)
2. Design programs using system-calls related to process, memory and file management.
3. Create solutions for problems related to process scheduling, deadlocks and synchronization in a multi-programmed operating system.
4. Evaluate appropriate solutions for memory management considering challenges due to multi-programming and virtual memory.
5. Apply knowledge of various software and hardware synchronization tools for solving critical section problem in concurrent processes.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	-	-	-	-	-	-	-	-	-	-
CO2	2	1	3	-	-	-	-	-	-	-	-
CO3	2	2	3	-	-	-	-	-	-	-	-
CO4	2	2	3	-	-	-	-	-	-	-	-
CO5	2	2	3	1	2	-	-	-	-	-	2

ECONOMICS & MANAGEMENT (NHS 201/202)

Type	L	T	P	Credits
HSMC	2	1	0	3

Course Objectives

This course is designed to understand essential economic principle for solving economic problem with suitable policy alternatives, production principles and cost analysis, study the contemporary market situations, market strategy to manage the industries and gain market knowledge, gain basic knowledge of management technique, develop entrepreneurship skills towards formation of partnership, companies and their functions

Course Content

Unit-1: Introduction to Economics:
Overview: production possibility curve, choices-what, how and for whom, micro- and macroeconomics, inflation, unemployment, GDP and business cycle; demand and supply, elasticity of demand, consumer surplus and its applications,
Unit-2: Production, Cost and Market: Production function, Cost Function, Types of Market: Perfect Competition, Monopoly, Oligopoly
Unit-3: Fundamentals of Management: Development of Management Thoughts, Objectives, Functions of Management
Unit-4: Functional Areas of Management-I
Human Resource Management: HRP, Recruitment and Selection, Performance Appraisal; Marketing Management: Functions, Strategies
Unit-5: Functional Areas of Management-II
Finance Management: Objectives, Functions; Operations Management: Concepts, Functions, Inventory Management.

Text Books

1. Koutsoyiannis, A., "Modern Microeconomics", English Language Book Society, Macmillan.
2. Joseph, L Massod, "Essential of Management", Prentice Hall, India.
3. S. P. Robbins, "Management", Prentice Hall, India

Reference Books

1. Armstrong, Michel, "A Handbook of Management Techniques", Kogan Page Limited
2. Samuelson, Paul A , Economics, 5th edition, McGraw Hill New York.
3. Henderson, J M and Quadnt, R E , „Microeconomic Theory: A Mathematical Approach.", Tata McGraw Hill, New Delhi,2003.

Course Outcomes

1. Understand essential economic principles for solving economic problems with suitable policy alternatives.
2. Apply the knowledge of production, cost and market functions
3. Understand basic functions of management
4. Design and apply the understanding of people and marketing
5. Create and apply the understanding of finance and operations

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	-	-	-	1	-	2	3	1	3	3	3
CO2	1	-	-	-	-	2	3	3	3	3	3
CO3	-	-	-	1	-	2	3	2	3	3	3
CO4	-	-	-	-	-	2	3	3	3	3	3
CO5	-	-	-	-	-	2	3	3	2	3	3

Detailed Syllabus

III Year

COMPUTER NETWORK (NCS-301)

Type	L	T	P	Credits
PCC	3	0	2	4

Course Objectives

This course is designed the layered concept of Computer network and protocols associated with TCP/IP, it equips the students with a general overview of the concepts and fundamentals of computer networks and familiarize the students with the standard models for the layered approach to communication between machines in a network and the protocols of the various layers.

Course Content

Unit-1

Introduction Concepts: Goals and Applications of Networks, Network structure and architecture, The OSI reference model, services, Network Topology Design – Delay Analysis, Back Bone Design, Local Access Network Design. Physical Layer Transmission Media, Switching methods, ISDN, Terminal Handling.

Unit-2

Medium Access sub layer: Medium Access sub layer - Channel Allocations, LAN protocols - ALOHA protocols - Overview of IEEE standards - FDDI. Data Link Layer - Elementary Data Link Protocols, Sliding Window protocols, Error Handling.

Unit-3

Network Layer: Network Layer - Point - to Pont Networks, routing, Congestion control Internetworking -TCP / IP - IP packet, IP address, IPv6. '

Unit-4

Transport Layer: Transport Layer - Design issues, connection management, session Layer-Design issues, remote procedure call. Presentation Layer-Design issues, Data Compression techniques, cryptography - TCP - Window Management.

Unit-5

Application Layer: Application Layer: File Transfer, Access and Management, Electronic mail, Virtual Terminals, Other application, Example Networks - Internet and Public Networks.

Lab Work

1. Implementation of the Data Link Layer framing method such as character stuffing and bit stuffing in C.
2. Implementation of CRC algorithm in C.
3. Implementation of a Hamming (7, 4) code to limit the noise. We have to code the 4-bit data into 7-bit data by adding 3 parity bits. Implementation will be in C.
4. Implementation of LZW compression algorithm in C.
5. Write a socket program in C to implement a listener and a talker.
6. Simulation of a network of 3 nodes and measure the performance on the same network using network simulator ns3.
7. Simulation of wireless network and its performance evaluation using network simulator ns3.
8. Write a program in C to encrypt and decrypt 64-bit text using DES algorithm.

Text Books

1. Forouzan, B. A., Data Communications and Networking, McGraw-Hill Higher Education, 3rd Edition, 2004.
2. A.S. Tannenbaum, "Computer Networks", 3rd Edition, Prentice Hall India, 1997.

References Books

1. S. Keshav, "An Engineering Approach on Computer Networking", Addison Wesley, 1997
2. W. Stallings, "Data and Computer Communication", Mac-millan Press, 1989.

Online Resources

1. https://onlinecourses.nptel.ac.in/noc22_cs19/preview
2. https://in.coursera.org/learn/fundamentals-network-communications

Course Outcomes

1. Understand the functions of the different layer of the OSI Protocol.
2. Design of wide-area networks (WANs), local area networks (LANs) and Wireless LANs (WLANs) based on available network devices.
3. Create network programming application for a given problem related to TCP/IP protocol stack.
4. Understand the use of IP addressing schemes as per IPV4 and IPV6. (Understand)
5. Analyze the existing protocols of TCP/IP protocol stack for performance improvement.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	1	-	-	-	-	-	-	-	-
CO2	2	2	3	-	2	-	-	-	-	-	-
CO3	2	2	3	-	2	-	-	-	-	-	-
CO4	2	3	2	-	-	-	-	-	-	-	-
CO5	2	1	1	-	-	-	-	-	-	-	-

DATABASE MANAGEMENT SYSTEMS (NCS-303)

Type	L	T	P	Credits
PCC	3	0	2	4

Course Objectives

This course is designed the design methodology for databases and verifying their structural correctness and implementing databases and applications software primarily in the relational model. By using querying languages, primarily SQL, and other database supporting software we applying the theory behind various database models and query languages. this course also covers the basic principles behind data warehousing and preparation for data analytics.

Course Content

Unit-1

Introduction: An overview of database management system, database system Vs file system, Database system concepts and architecture, data models schema and instances, data independence and database language and interfaces, Data definitions language, DML, Overall Database Structure. Data Modeling using the Entity Relationship Model: ER model concepts, notation for ER diagram, mapping constraints, keys, Concepts of Super Key, candidate key, primary key, Generalization, aggregation, reduction of an ER diagrams to tables, extended ER model, relationships of higher degree.

Unit-2

Relational data Model and Language: Relational data model concepts, integrity constraints: entity integrity, referential integrity, Keys constraints, Domain constraints, relational algebra, relational calculus, tuple and domain calculus, Introduction to SQL: Characteristics of SQL, Advantage of SQL.SQL data types and literals, Types of SQL commands, SQL operators and their procedure, Tables, views and indexes. Queries and sub queries, Aggregate functions. Insert, update and delete operations, Joins, Unions, Intersection, Minus, Cursors in SQL.

Unit-3

Data Base Design & Normalization: Functional dependencies, normal forms, first, second, third normal forms, BCNF, inclusion dependences, loss less join decompositions, normalization using FD, MVD, and JDs, alternative approaches to database design.

Unit-4

Transaction Processing Concepts: Transaction system, testing of serializability, Serializability of schedules, conflict & view serializable schedule, recoverability, Recovery from transaction failures, log-based recovery, checkpoints, deadlock handling.

Unit-5

Concurrency Control Techniques: Concurrency control, locking Techniques for concurrency control, Time stamping protocols for concurrency control, validation-based protocol, multiple granularities, Multi version schemes, Recovery with concurrent transaction.

Lab Work

1. Write the queries for Data Definition and Data Manipulation language.
2. Write SQL queries using Logical operators (=, <, >, etc.).

3. Write SQL queries using SQL operators (Between…. AND, IN(List), Like, ISNULL and with negating expressions).
4. Write SQL query using character, number, date and group functions.
5. Write SQL queries for Relational Algebra (UNION, INTERSECT, and MINUS, etc.).
6. Write SQL queries for extracting data from more than one table (Equi-Join, Non-Equi-Join, Outer Join)
7. Write SQL queries for sub queries, nested queries.
8. Write programs by the use of PL/SQL.
9. Concepts for ROLL BACK, COMMIT & CHECK POINTS.
10. Create VIEWS, CURSORS, and TRIGGRS & write ASSERTIONS.
11. Create FORMS and REPORTS.

*Students are advised to use **Developer 2000/Oracle-9i** version or other latest version for above listed experiments. However, depending upon the availability of software"s, students may use **Power Builder**
/SQL SERVER. Students may also work on a Mini Project to understand the important concepts of Database.

Text Books

1. Date C J, "An Introduction to Database System", Addision Wesley, 8th Edition, 2006.
2. Korth, Silbertz, Sudarshan, "Database System Concepts", McGraw Hill, 7th Edition, 2021.
3. Elmasri, Navathe, "Fundamentals of Database Systems", Addision Wesley, 5th Edition, 2018.

Reference Books

1. Leon & Leon, "Database Management System", Vikas Publishing House, First Edition, 2008.
2. Bipin C. Desai, "An introduction to Database Systems", Galgotia Publication, Revised Edition, 2012
3. Majumdar & Bhattacharya, "Database Management System", TMH, 2017.
4. Ramakrishnan, Gehrke, "Database Management System", McGraw Hill, 3rd Edition, 2014.
5. Kroenke, "Database Processing: Fundamentals, Design and Implementation", Pearson Education, First Edition, 2002.
6. Maheshwari Jain, "DBMS: Complete Practical Approach", Firewall Media, New Delhi, First Edition, 2005.

Online Resources

1. https://nptel.ac.in/courses/106105175
2. https://in.coursera.org/learn/database-management

Course Outcomes

1. Understand and Develop Entity Relationship (ER) and Relational Models for a given Application.
2. Design manipulates relational database using Structured Query Language and relational languages
3. Create a normalized database for a given application by incorporating various constraints like integrity and value constraints.
4. apply transaction processing concepts and convert schedules to serializable schedules.
5. Apply Illustrate different concurrency control mechanisms to preserve data consistency in a multi-user environment.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	-	-	-	-	-	-	-	-
CO2	3	2	2	-	-	-	-	-	-	-	-
CO3	3	3	2	-	-	-	-	-	-	-	-
CO4	3	3	2	-	-	-	-	-	-	-	-
CO5	3	3	2	-	-	-	-	-	-	-	-

DESIGN & ANALYSIS OF ALGORITHMS (NCS-305)

Type	L	T	P	Credits
PCC	3	0	2	4

Course Objectives

This course is designed for Analyze the asymptotic performance of algorithms to write rigorous correctness proofs for algorithms. demonstrate a familiarity with major algorithms and data structures to apply important algorithmic design paradigms and methods of analysis. it synthesizes efficient algorithms in common engineering design situations.

Course Content

Unit-1
Algorithms definition and introduction, Analysis of algorithms, Growth of Functions, Master's Theorem, Designing of Algorithms, Partitioning Algorithms, Divide and Conquer design and analysis techniques: Merge Sort and Quick Sort, Sorting and order Statistics: Heap sort, Sorting in linear time, Medians and Order Statistics.

Unit-2
Advanced Data Structures: Introduction of Red-Black Trees, Augmenting Data Structure, B-Trees, Binomial Heaps, Fibonacci Heaps, Data Structure for Disjoint Sets, Amortized Analysis.

Unit-3
Advanced Design and Analysis Techniques: Dynamic Programming, Greedy Algorithms, Back-Tracking, Branch and Bound with their applications.

Unit-4
Graph Algorithms: Elementary Graphs Algorithms, Minimum Spanning Trees, Single-source Shortest Paths, All-Pairs Shortest Paths, Traveling Salesman Problem and Maximum Flow

Unit-5
Selected Topics: Randomized Algorithms, String Matching, Non-deterministic Algorithms: P, NP, NP-Hard and NP Completeness, Approximation Algorithms, PRAM Algorithms.

Lab Work

Programming assignments on each of the following algorithmic strategy:

a. Divide and conquer method (quick sort, merge sort, Strassen's matrix multiplication).
b. Greedy method (knapsack problem, job sequencing, optimal merge patterns, minimal spanning trees).
c. Dynamic programming (multistage graphs, OBST, 0/1 knapsack, traveling sales person problem).
d. Back tracking (n-queens problem, graph coloring problem, Hamiltonian cycles).
e. Sorting: Insertion sort, Heap sort, Bubble sort.
f. Searching: Sequential and Binary Search.
g. Selection: Minimum/ Maximum, K^{th} smallest element.

Text Books

1. Coreman, Rivest, Lisserson, Stein, “Introduction to Algorithm", MIT Press, 3rd Edition, 2009.
2. Basse, "Computer Algorithms: Introduction to Design & Analysis", Addison Wesley, 3rd Edition, 2002.

References Books

1. Horowitz & Sahni, "Fundamental of Computer Algorithm", Universities Press, 2nd Edition, 2012.
2. Mehta, D. P., & Sahni, S., “Handbook of data structures and applications”. Chapman and Hall/CRC, 2nd Edition, 2020

Online Resources

1. https://nptel.ac.in/courses/106106131
2. https://in.coursera.org/learn/algorithms

Course Outcomes

1. Understand and apply mathematical preliminaries to the analysis and design stages of different types of algorithms.
2. Analyze worst-case time complexity of various algorithms using asymptotic methods.
3. Understand and apply the divide-and-conquer paradigm and synthesize divide- and-conquer algorithms on problems of Sorting, Searching, finding MST etc.
4. Understand the greedy paradigm and explain when an algorithmic design situation calls for it. For a given problem develop the greedy algorithms.
5. Apply the dynamic-programming paradigm to model engineering problems using graph and write the corresponding algorithm to solve the problems.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	1	-	-	-	-	-	-	-	-
CO2	3	3	1	-	-	-	-	-	-	-	-
CO3	3	2	3	-	-	-	-	-	-	-	-
CO4	3	2	3	-	-	-	-	-	-	-	-
CO5	3	2	3	-	-	-	-	-	-	-	-

THEORY OF AUTOMATA & FORMAL LANGUAGES (NCS-307)

Type	L	T	P	Credits
PCC	3	1	0	4

Course Objectives

This subject will introduce students to the algorithms, formal languages and grammars, automata theory, decidability, complexity, and computability. It helps students to understand and conduct mathematical proofs for computation and algorithms

Course Content

Unit-1
Defining Languages and Grammars, Chomsky hierarchy, Kleene closures, Regular Expressions, Finite Automata (FA), Transition Graph, Generalised Transition Graph.

Unit-2
Nondeterministic finite Automata (NFA), Deterministic finite Automata (DFA), Construction of DFA from NFA and optimization, Partitioning Algorithm, Equivalence of DFA and NFA and their optimization, FA with output: Moore machine, Mealy machine and their Equivalence, Applications and Limitation of FA.

Unit-3
Arden Theorem, Pumping Lemma for regular expressions, Myhill-Nerode theorem, Context free grammar: Ambiguous Grammars and Simplification, Normal forms for CFGs, Pumping lemma for CFLs, Decidability of CFGs, Ambiguous to Unambiguous CFG.

Unit-4
Push Down Automata (PDA): Description and definition, Working of PDA, Acceptance of a string by PDA, PDA and CFG Equivalence, Deterministic and non-deterministic PDA, Introduction to auxiliary PDA and Two Stack PDA.

Unit-5
Turing machines (TM): Basic model, definition and representation, Language acceptance by TM, TM and Type – 0 Grammar, Integer function computation by TM, Halting problem of TM, Modifications in TM, Universal TM, Properties of recursive and recursively enumerable languages, decision problem, Un-decidability of Post Correspondence Problem, Church‟s Thesis, Recursive function theory, Godel Numbering.

Text Books

1. Hopcroft, Ullman, “Introduction to Automata Theory, Language and Computation”, Nerosa Publishing House, 3rd Edition, 2015.
2. K.L.P. Mishra and N. Chandrasekaran, “Theory of Computer Science (Automata, Languagesand Computation)”, PHI.
3. Peter Linz,”An Introduction to Formal Languages and Automata”, Narosa, 4th Edition, 2010.

References Books

1. Martin J. C., “Introduction to Languages and Theory of Computations”, TMH, 3rd Edition, 2007.
2. Papadimitrou, C. and Lewis, C.L., “Elements of theory of Computations”, PHI, 2nd Edition, 2015.
3. Cohen D. I. A., “Introduction to Computer theory”, John Wiley & Sons, 2nd Edition,

2007.
4. Kumar Rajendra, “Theory of Automata (Languages and Computation)”, PPM, 2010.

Online Resources

1. https://nptel.ac.in/courses/106105196
2. https://www.udemy.com/course/introduction-to-theory-of-computations/

Course Outcome

1. Understand the capabilities and limitations of the abstract machines including finite automata, pushdown automata, and Turing machines and their associated languages.
2. Create finite automata, pushdown automata, Turing machines for the given grammar and vice versa.
3. Apply that a language is not regular / not context-free using pumping lemma.
4. Understand the characteristics of P, NP and NP Complete problems in the context of Turing machines.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	2	2	-	-	-	-	-	-	1
CO2	2	2	2	2	-	-	-	-	-	-	1
CO3	2	2	1	1	-	-	-	-	-	-	1
CO4	2	1	-	-	-	-	-	-	-	-	-

DATA SCIENCE (NCS-309)

Type	L	T	P	Credits
PCC	3	0	2	4

Course Objectives

This course is designed to apply quantitative modeling and data analysis techniques to the solution of real-world business problems, communicate findings, and effectively present results using data visualization techniques. Recognize and analyze ethical issues in business related to intellectual property, data security, integrity, and privacy.

Course Contents

Unit-1: **Introduction to Data Science: Basics of Data Science**
Data science, Data Analytics, Machine Learning (Supervised, Unsupervised Learning & reinforcement), Deep Learning (Artificial Neural Networks, CNN), Working with data sources – (SQL Server, .csv file, excel file etc.), Real world Applications of Machine Learning & Deep Learning, Scope of Data Science.

Unit-2: Data Analysis
Data Definitions and Analysis Techniques: Elements, Variables, and Data categorization; Levels of Measurement; Data management and indexing; Introduction to statistical learning and Python Programming
Descriptive Statistics; Measures of central tendency; Measures of location of dispersions; Basic analysis techniques: Statistical hypothesis generation and testing; Chi-Square test; t-Test; Analysis of variance; Correlation analysis; Maximum likelihood test; Data analysis techniques: Regression analysis; Classification techniques; Clustering; Association rules analysis

Unit-3: Data Modelling
Data Modelling: Introduction; Uses of Data Modelling Tools; Three Perspectives of a Data Model; Data Modelling Techniques: Linear Regression; Non-linear models; Supported Vector Machines.

Unit-4: **Data Manipulation and Visualization: Understanding** Pandas and its architecture, getting to know Series and Data Frames, Columns and Indexes, Getting Summary Statistics of the Data, Data Alignment, Ranking & Sorting, Combining/Splitting Data Frames, Reshaping, Grouping, Data visualization (Scatter Plot, Histogram, Bar chart, Pie chart etc.)

Unit-5: Applications of Data Science
CASE STUDIES: **Banking Case Study:** Applications of Analytics in the Banking Sector; Predicting Bank-Loan Default; Predicting Fraudulent Activity; Logistic Regression Model; **Telecommunication Case Study:** Types of Telecommunications Networks; Role of Analytics in the Telecommunications Industry; Predicting Customer Churn-Network Analysis and Optimization-Fraud Detection.

Lab Work

1. Intro to python as calculator application
2. Descriptive statistics using python
3. Reading and writing different types of datasets
4. Visualizations (find the data distributions using box and scatter plot, Find the outliers
1. Using plot, plot the histogram, bar chart and pie chart on sample data)
5. Correlation and covariance (find the correlation matrix, plot the correlation plot on dataset and visualize giving an overview of relationships among data on a dataset)
6. Regression model (import a data from web storage. Name the dataset and now do
2. Logistic regression to find out relation between independent and dependent variables)
7. Multiple regression model
8. Regression model for prediction
9. Classification model
10. Clustering model

Text Books

1. Lillian Pierson, "Data Science for Dummies", For Dummies; 2nd edition.
2. Joel Grus, "Data Science from Scratch: First Principles with Python", Shroff /O'Reilly; Second Edition, 2019.
3. Jake Vander Plas, "Python Data Science Handbook Essential tools for Working with Data", O'Reilly, 1st Edition, 2016.

References Books

1. Allen B. Downey, "Think Stats Exploratory Data Analysis in Python", Green Tea Press, 2nd Edition, 2014.
2. Wes McKinney, "Python for Data Analysis: Data Wrangling with Pandas and IPython" , 2nd Edition, 2014.
3. John D. Kelleher and Brendan Tierney "Data Science" The MIT Press; Illustrated edition, 2018.
4. Andrew Oleksy, "Data Science with R: A Step By Step Guide with Visual Illustrations &
5. Examples", 2018.
6. Nina Zumel and John Mount, "Practical Data Science with R", Dreamtech /Manning, 2014
7. Roger D. Peng, "R Programming for Data Science", Lean publishing, 2015.

Online Resources

1. https://onlinecourses.nptel.ac.in/noc21_cs69/preview
2. https://www.coursera.org/specializations/introduction-data-science

Course Outcomes

1. Creates develop relevant programming abilities in the student.
2. Understand demonstrate proficiency with statistical analysis of data.
3. Design the ability to build and assess data-based models.
4. Apply statistical analyses with professional statistical software.
5. Create skill in data management.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	2	3	-	-	-	-	-	2
CO2	3	3	3	3	2	-	-	-	-	-	2
CO3	3	3	3	3	2	-	-	-	-	-	3
CO4	3	3	3	2	3	-	-	-	-	-	2
CO5	3	3	3	2	3	-	-	-	-	-	2

CYBER SECURITY (OCS-301)

Type	L	T	P	Credits
OEC 1	2	0	0	2

Course Objectives

This course is design to learn the foundations of Cyber security and threat landscape to equip students with the technical knowledge and skills needed to protect and defend against cyber threats to develop skills in students that can help them plan, implement, and monitor cyber security mechanisms to ensure the protection of information technology assets.

Course Content

Unit-1

Introduction to information systems, Types of information systems, Development of Information systems, Introduction to information security, Need for Information security, Threats of Information Systems, Information Assurance, Cyber Security and Security Risk Analysis.

Unit-2

Application security (Database, E-mail and Internet), Data Security Considerations - Backups, Archival Storage and Disposal of Data, Security Technology - Firewall and VPNs, Intrusion Detection, Access Control, Security Threats - Viruses, Worms, Trojan Horse, Bombs, Trapdoors, Spoofs, E-mail viruses, Macro viruses, Malicious Software, Network and Denial of Services Attack, Security Threats to E-Commerce – Electronic Payment System, e-Cash, Credit/Debit Cards, Digital Signature, public Key Cryptography.

Unit-3

Developing Secure Information Systems, Application Development Security, Information Security Governance & Risk Management, Security Architecture & Design, Security Issues in Hardware, Data Storage & Downloadable devices, Physical Security of IT Assets, Access Control, CCTV and intrusion Detection Systems, Backup Security Measures.

Unit-4

Security Policies, why Policies should be developed, WWW Policies, Email Security Policies, Policy Review Process- Corporate policies- Sample Security Policies, Publishing and Notification requirement of the Policies. Information Security Standards- ISO, IT Act, Copyright Act, Patent Law, IPR. Cyber Laws in India: IT Act 2000 Provisions, Intellectual Property Law: Copy Right Law, Software License, Semiconductor Law and Pattern Law.

Text Books

1. Charles, P., and Shari Lawrence Pfleeger, "*Analyzing Computer Security"*. Pearson Education India, 1st Edition, 2011.
2. V.K. Pachghare, "*Cryptography and information security",* PHI Learning Pvt. Ltd., Delhi India, 2nd Edition, 2015.
3. Dr Surya Prakash Tripathi, Ritendra Goyal, and Praveen Kumar Shukla, "Introduction to Information Security and Cyber Law", Willey Dreamtech Press, 2014.

Reference Books

1. Schou, Shoemaker, "Information Assurance for the Enterprise", Tata McGraw Hill, 2006.
2. Chander Harish, "Cyber Laws and their Protection", PHI Learning Private Limited, Delhi, India, 2012.

Online Resources

1. https://onlinecourses.swayam2.ac.in/cec20_cs15/preview
2. https://www.coursera.org/specializations/intro-cyber-security

Course Outcomes

1. Understand information, information systems, information security, Cyber Security and Security Risk Analysis.
2. Apply application security, data security, security technology, security threats from malicious software.
3. Understand the concepts of security threats to e-commerce applications such as electronic payment system, e-Cash, Credit/Debit Cards etc.
4. Create Security Governance & Risk Management, Security of IT Assets and Intrusion Detection Systems.
5. Design various types of Security Policies, Cyber Ethics, IT Act, IPR and Cyber Laws in India.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	-	-	-	-	-	-	-	-	2
CO2	3	3	2	1	2	-	-	-	-	-	2
CO3	2	2	2	-	-	2	-	-	-	-	2
CO4	2	2	3	2	3	2	-	-	-	-	3
CO5	2	1	2	-	-	3	3	2	2	2	2

COMPILER DESIGN (NCS-302)

Type	L	T	P	Credits
PCC	3	0	2	4

Course Objectives

The objective of this course is to acquire the knowledge of various phases of compiler such as lexical analyzer, parser, code optimization and code generation.

Prerequisite: Theory of Automata and Formal Languages

Course Content

Unit-1

Introduction to Compiler, Phases and passes, Bootstrapping, Finite automata & regular expressions and their applications to lexical analysis, Implementation of lexical analyzers, lexical-analyzer generator, LEX-compiler, The syntactic specification of Programming languages: Context free grammars, derivation and parse trees, capabilities of CFG, Application of grammars in syntax analysis, ambiguity and BNF notation, YACC.

Unit-2

Basic Parsing Techniques: Parsers, top-down parsing, Shift reduces parsing, operator precedence parsing, predictive parsers. Automatic Construction of efficient Parsers: LR parsers, the canonical Collection of LR (0) items, constructing SLR parsing tables, constructing Canonical LR parsing tables, Constructing LALR parsing tables, using ambiguous grammars, an automatic parser generator, implementation of LR parsing tables, constructing LALR sets of items.

Unit-3

Syntax-directed Translation: Syntax-directed Translation schemes, Implementation of Syntax directed Translators, Intermediate code, postfix notation, Parse trees & syntax trees, three address code, quadruple & triples, translation of assignment statements, Boolean expressions, statements that alter the flow of control, postfix translation, translation with a top-down parser. More about translation: Array references in arithmetic expressions, procedures call, declarations, Case statements.

Unit-4

Symbol Tables: Data structure and representing scope information, Run-Time Administration: Implementation of simple stack allocation scheme, storage allocation in block structured language. Error Detection & Recovery: Lexical Phase errors, syntactic phase errors semantic errors.

Unit-5

Introduction to code optimization: Loop optimization, the DAG representation of basic blocks, value numbers and algebraic laws, Global Data-Flow analysis.

Lab Work

Write a Program in LEX or C for the following:

1. Write a LEX program to recognize white spaces, identifier, if, then and else.
2. Write a program to convert NFA to DFA
3. Write a program to minimize any given DFA
4. Construct a recursive descent parser for an expression.
5. Construct a Shift Reduce Parser for a given language.
6. Write a C program for constructing of LL (1) parsing.
7. Write program to find Simulate First and Follow of any given grammar.
8. Implement SLR (1) Parsing algorithm.
9. Implement Intermediate code generation for simple expressions.

10. Implement the back end of the compiler which takes the three-address code and produces the 8086 assembly language instructions that can be assembled and run using an 8086 assembler. The target assembly instructions can be simple move, add, sub, jump etc.

Text Books

1. Aho, Sethi Ullman & Lam "Compilers: Principles, Techniques, and Tools", Addition Wesley, 2nd Edition, 2006.

References Books

1. Kenneth C. Louden, "Compiler Construction: Principles and Practice", Thomson Brooks Publication., 1st Edition, 1997.
2. Allen I. Holub, "Compiler Design in C", PHI Publications,1st Edition, 2015.

Online Resources

1. https://nptel.ac.in/courses/106105190
2. https://www.udemy.com/course/compiler-design-n/

Course Outcomes

1. Understand the role of each phase of a compiler with its construction tools.
2. Create a Lexical Analyzer for recognizing tokens of a given language with an understanding of symbol table management and error handling.
3. Create top-down, bottom-up, operator precedence and SLR parsers with an understanding of Context Free Grammars and syntax analysis.
4. Design and develop semantic analyzers for type-checking and intermediate code generators to translate the source program into an intermediate code.
5. Apply optimizers to optimize the target code generated.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	-	-	1	-	-	-	-	-	-
CO2	2	2	3	1	-	-	-	-	-	-	1
CO3	2	2	3	1	-	-	-	-	-	-	1
CO4	2	3	3	1	-	-	-	-	-	-	1
CO5	2	3	3	1	-	-	-	-	-	-	1

OBJECT ORIENTED PROGRAMMING SYSTEM (NCS-304)

Type	L	T	P	Credits
PCC	2	1	2	4

Course Objectives

The objective of this course is to learn and implement the various features of OOP such as inheritance, polymorphism, Exceptional handling. To understand the concepts of software development, core and advance Java Programming.

Course Content

Unit-1

Object Oriented Design and Modeling: Object oriented fundamentals, Objects and Classes, Object-Oriented Design Process, importance of modeling, principles of modeling, OOAD Methods, Software Development Life Cycle, Introduction to Unified Process, Introduction to UML: UML Terminology, conceptual model of the UML, Use of UML in Unified Process.

Unit-2

Basic Structural Modeling: Classes, Relationships, common Mechanisms, and diagrams. Class & Object Diagrams: Terms, concepts, modeling techniques for Class & Object Diagrams, Links and Associations, Link Attributes and Link Classes, Generalization and Inheritance, Aggregation and Composition, Qualified Association, Handling multiplicity in Object creation, Abstract Classes, Specifying constraints in Class Diagrams, Advanced Structural Modeling: Advanced classes, advanced relationships, Interfaces, Types and Roles, Packages, Use Case Modeling: Use Cases and Use Case Diagrams, Use Case driven Methodology.

Unit-3

Behavioral Modeling: Interactions and Interaction Diagrams, Use-Case Realization: Scenario, Events Trace Diagram, Collaboration Diagrams, State Chart Diagrams, Nested State Diagrams, Activity Diagrams, Advanced Behavioral Modeling Concepts, Architectural Modeling: Component, Deployment, Component diagrams and Deployment diagrams. Elementary Design Patterns, The MVC Architecture Pattern, Features of Elegant Software Design: Elegant variable, Elegant Classes, Elegant Methods, Elegant Packages, Introduction to Object Oriented Software Quality Metrics.

Unit-4

Java Programming: Introduction to Java Programming, Operator, Data type, Variable, Arrays, Control Statements, Methods & Classes, Inheritance, Package and Interface, Exception Handling, Multithread programming, I/O, Java Applet, String handling, Networking, Event handling.

Introduction to Advance Java Programming: Demonstration of concepts through example programs for AWT, Java Swing, Java Beans, Java Servlets, JSP, Modern Object Technologies and Web Services.

Lab Work

1. Write a program in Java, to implements the Stack data Structure.
2. Write a program in Java to implement a simple Bank Account.
3. Write a program in Java showing the action from three threads using a suitable example
4. Write a program of threads in Java showing inter leaving of actions from two threads: t1 & t2 synchronizing on a shared object. Let t1 print message Ping -> and t2 prints message <- Pong. Take as command line arguments the following inputs to the program:
   Sleep interval for thread t1Sleep interval for thread t2Messages per cycle Number of Cycles
5. Write a program in Java which converts a text file into all capital letters.
6. Write a program to create a sequential file that could store details about five products. Details include product code, cost, no. of items available and number of items available and are provided through keyboard.

7. Create a Person class with private instance variables for Person's name and birth date. Add appropriate accessor methods to access the variables. Then create a subclass College Graduate with private instance variables for the student's GPA and year of graduation and appropriate accessors for these variables. Don't forget to include appropriate constructors for your classes. Then create a class with a main () method that manages your classes.
8. Develop an applet that receives three numeric values from the user and displays the largest of the three on the screen. Write a HTML page that embeds this applet.
9. Write an applet which draws a human face with ovals and arcs.
10. Write servlets that accepts user preferences (color, hobby etc.) from user, saves it as cookie on user machine and reads the cookie from the user machine.
11. Write an AWT application with checkbox such that all cable TV channels will be displayed from the selected category.
12. Create a simple Swing based applet that displays two buttons. Each time a button is clicked, a message is displayed that states which button was clicked.
13. Create JSP code that uses a persistant cookie (i.e. a cookie with an expiration date in the future) to keep track of how many times the client computer has visited the page. Use set Max Age method to remain on the client's computer for one month. Display the number of page hits (i.e. cookie's value) every time the page loads.
14. Write JSP program that asks user his favourite color as request parameter and sets it as the background color of the page or sets the background color white if the parameter value is null.
15. Write a program in Java to show the mouse click event. The program should change the background colour of window randomly at each mouse click.

Text Books

1. Balagurusamy E, "Programming in JAVA", TMH, 5th Edition, 2013.
2. Herbert Schildt, "The Complete Reference JAVA", TMH, 12th Edition, 2021.
3. Bruce Eckel, "Thinking in Java", Prentice Hall PTR, 4thEdition, 2013.

References Books

1. Grady Booch, James Rumbaugh, Ivar Jacobson "The Unified Modeling Language User Guide,
   Pearson Education", 2nd Edition, 2008.
2. Mark Priestley, "Practical Object-Oriented Design with UML", TATA Mc-Graw Hill, 3rd Edition, 2003.
3. Meilir Page-Jones, "Fundamentals of Object Oriented Designin UML", Pearson Education, 1stEdition, 1999.
4. Pascal Roques, "Modeling Software Systems Using UML 2", WILEY-Dreamtech India Pvt. Ltd, 1stEdition, 2004.
5. Craig Larman, "Appling UML and Patterns: An introduction to Object – Oriented Analysis and Design and Unified Process", Pearson Education., 2ndEdition, 2001.
6. Atul Kahate: Object Oriented Analysis & Design, The Mc Graw-Hill Companies, 1stEdition, 2004.

References Books

1. https://nptel.ac.in/courses/106105153
2. https://www.coursera.org/learn/object-oriented-design

Course Outcomes

1. Analyze information systems in real-world settings and use an object-oriented method for analysis and design.

2. Understand features of object-oriented design such as encapsulation, polymorphism, inheritance, and UML.
3. Understand and prepare different types of UML diagrams like use case diagrams, interaction diagrams, nested state diagrams, state chart diagrams, activity diagram etc.
4. Design Patterns in the Software Development.
5. Apply the core and advance Java Programming features and apply them in complex problem solving

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	2	-	-	-	-	-	-	2
CO2	2	1	1	-	1	-	-	-	-	-	-
CO3	2	2	3	1	2	-		2	-	-	-
CO4	2	2	3	2	-	-	-	-	-	-	-
CO5	2	2	3	3	2	-	-	1	-	-	2

COMPUTER GRAPHICS (NCS-306)

Type	L	T	P	Credits
PCC	2	1	2	4

Course Objectives

The objective of this course is to provide the understanding of the fundamental algorithms and tools of graphics. It also describes the mathematics behind computer graphics, including the use of spline curves and surfaces. It acquires the knowledge of application programming interfaces of graphics.

Course Content

Unit-1

Line generation: Points and Lines, Planes, Pixels and Frame buffers, vector and character generation. Graphics Primitives: Display devices, Primitive devices, Display File Structure, Display control text, Line-drawing Algorithms**:** DDA Algorithm Bresenham's line Algorithm, Circle-generating Algorithm**:** Midpoint Circle of Algorithm, Polygon Filling Algorithm.

Unit-2

2-D Viewing and Clipping: Point Clipping, Line Clipping, Cohen-Sutherland Line Clippings, Cyrus- Beck Line Clipping Algorithm, Polygon Clipping: Sutherland Hodgman Algorithm, Polygon: Polygon Representation, entering polygons, Filling polygons, Segments: Segments table, creating deleting and renaming segments, Visibility.

Unit-3

2-D and 3-D Transformations: Basic Transformations: Translation, Rotation, Scaling, Shear, Composite Transformations: Rotations about a point, Reflection about a line, Homogeneous Coordinate Systems, 3-D Transformations, 3-D geometry primitives, Viewing Transformation, Projections: Parallel Projection, Orthographic & Oblique Projections, Perspective Projections. Interaction: Hardware input devices handling algorithms, Event handling echoing, Interactive techniques.

Unit-4

Hidden Line and Surface: Back face removal algorithms, hidden line methods, Rendering and Illumination: Introduction to curve and Surfaces generation, Bezier, Hermite and B-spline algorithms and their comparisons.

Unit-5

Multimedia and Animation: Basic of Animation, Types of Animation, Simulating, Accelerations, Computer Animation Tools, Multimedia Applications, Concepts of Hypertext/Hypermedia, Images, Audio and Video**,** Multimedia Tools.

Lab Work

Write Program in C or C++ for the following.

1. Implementation of line generation using slope's method, DDA and Bresenham's algorithms.
2. Implementation of circle generation using Mid-point method and Bresenham's algorithm.
3. Implementation of ellipse generation using Mid-point method.
4. Implementation of polygon filling using Flood-fill, Boundary-fill and Scan-line algorithms.
5. Implementation of 2-D transformation: Translation, Scaling, Rotation, Mirror Reflection and Shearing (write a menu driven program).
6. Implementation of Line Clipping using Cohen-Sutherland algorithm and Bisection Method.

7. Implementation of Polygon Clipping using Sutherland-Hodgman algorithm.
8. Implementation of 3-D geometric transformations: Translation, Scaling and rotation.
9. Implementation of Curve generation using Interpolation methods.
10. Implementation of Curve generation using B-spline and Bezier curves.
11. Implementation of any one of Back face removal algorithms: Depth-Buffer algorithm, Painter's algorithm, Warnock's algorithm, Scan-line algorithm.

Text Books

1. Rogers, "Procedural Elements of Computer Graphics", Mc Graw Hill, 2nd Edition, 2017.
2. Bakerand Hearn," Computer Graphics", PHI Publication, 2nd Edition, 2002.

Reference Books

1. Newmanand Sproul, "Principle of Interactive Computer Graphics", Mc Graw Hill, 2ndEdition, 2001.
2. Steven Harrington, "Computer Graphics", A ProgrammingApproach,2ndEdition,1983
3. Rogarand Adams, "Mathematical Elements of Computer Graphics", Mc Graw Hill, 2nd Edition, 1989.

Online Resources

1. https://nptel.ac.in/courses/106106090
2. https://www.coursera.org/learn/interactive-computer-graphics

Course Outcomes

1. Understand and use various mathematical concepts and supporting composite 2-D & 3-D graphics transformations for hidden surface detection/ removal and various graphical algorithms.
2. Design algorithms for various graphics shapes like ellipse, hyperbola, triangle etc. (Apply)
3. Apply various graphical tools and software in 3D Graphics API (e.g. OpenGL or DirectX).
4. Apply geometrical transformation and computer graphics in multi-disciplinary field of engineering.
5. Analyze and implement interactive graphics applications using programming language and graphics application programming interfaces.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	3	-	-	-	-	-	-	-	-
CO2	2	1	3	-	-	-	-	-	-	-	-
CO3	2	2	3	-	3	-	-	-	-	-	-
CO4	2	1	1	2	-	2	-	-	-	-	2
CO5	2	1	-	-	-	-	-	-	-	-	-

ARTIFICIAL INTELLIGENCE (NCS-308)

Type	L	T	P	Credits
PCC	3	0	2	4

Course Objectives

The objective of this course to study the concepts of Artificial Intelligence, Learn the methods of solving problems using Artificial Intelligence, and the knowledge representation techniques, reasoning techniques and to introduce the concepts of Expert Systems and machine learning.

Prerequisite: Discrete Mathematical Structures

Course Content

Unit-1

Introduction to Artificial Intelligence, Brief history, Various approaches to AI, Areas of application, Simulation of sophisticated & Intelligent Behavior in different area, Problem solving in games, natural language processing, automated reasoning, and visual perception, Knowledge and its role in AI, Heuristic algorithm versus solution guaranteed algorithms, Introduction to soft computing.

Unit-2

Representing problems in state space, informed versus uninformed search, Production System Model, Evaluation of the Production System, Depth First Search and Breadth First Search, Heuristics, Heuristic Search Techniques: Hill Climbing, Best First search, A* Algorithm, Branch and Bound, Cryptarithmetic Problem, Means End Analysis, AO* Algorithm, Game Playing: MINMAX Search, Alpha-Beta Pruning, Heuristic Estimation.

Unit-3

Knowledge Representation and Reasoning: Propositional Logic, First Order Predicate Logic, Graphs, Associative Network, Semantic Networks, Conceptual Dependencies, Frames, Scripts, Horn Clauses, Introductory Examples from PROLOG, Case Grammar Theory, Production Rules Knowledge Base, The Interface System, Forward & Backward Deduction, Inference System in Propositional and Predicate Logic, Reasoning under Uncertainty.

Unit-4

Understanding Natural Languages, Various Approaches of NLP, Parsing techniques, Context free and transformational grammars, Transition nets, Augmented transition nets, Fillmore's grammars, Grammar free analyzers, Sentence generation, and translation, Introduction to Pattern Recognition, Structured Description, Symbolic Description, Machine Perception, Object Identification, Speech Recognition.

Unit-5

Expert Systems: Architecture of Expert System, Representing and using domain knowledge, Expert System Shell, Explanation System, Knowledge Acquisition System, Case study of Existing Expert Systems like DENDRAL, MYCIN, Development of a small Expert System using programming Languages and tools like LISP, PROLOG, JESS.

Lab Work

1. Write a LISP Program to solve the water-jug problem using heuristic function.
2. Create a compound object using Turbo Prolog.
3. Write a Prolog Program to show the advantage and disadvantage of green and red cuts.

4. Write a prolog program to use of BEST FIRST SEARCH applied to the eight-puzzle problem.
5. Implementation of the problem-solving strategies: Forward Chaining, Backward Chaining, Protiem Reduction.
6. Write a Lisp Program to implement the STEEPEST ASCENT HILL CLIMBING.
7. Write a Prolog Program to implement COUNTE PROPAGATION NETWORK.
8. Development of a small Expert System using PROLOG/JESS.
9. Develop a prolog program for Monkey-Banana problem.
10. Write a program for parsing a given sentence.

Text Books

1. N. J. Nilsson, "Artificial Intelligence: A New Synthesis", Elsevier Publications, Standard Edition,1998.
2. Charnick, "Introduction to A.I.", Addison Wesley, 1985.
3. Rich & Knight, "Artificial Intelligence", McGraw-Hill Publication, 3rd Edition, 2017.
4. Winston, Horn, "LISP", Addison Wesley, 3rd Edition, 1985.

Reference Books

1. Marcellous, "Expert System Programming in Turbo Prolog", PHI, 1989.
2. Lioyed, "Foundation of Logic Processing", Springer Verlag, 1984.
3. D. W. Patterson, "Introduction to Artificial Intelligence and Expert Systems", PHI, 1990.

Online Resources

1. https://nptel.ac.in/courses/106105077
2. https://www.coursera.org/learn/ai-for-everyone

Course Outcomes

1. Understand different types of AI agents.
2. apply various AI search algorithms (uninformed, informed, heuristic, constraint satisfaction, genetic algorithms.
3. Understand the fundamentals of knowledge representation, reasoning, and machine learning techniques and apply them to real world problems.
4. Apply simple knowledge-based systems using languages like LISP, Prolog, and AI tools like JESS.
5. Analyze independent (or in a small group) research and communicate it effectively in a seminar

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	1	2	-	-	-	-	-	-	-	-
CO2	1	2	3	-	2	-	-	-	-	-	-
CO3	2	2	3	-	2	-	-	-	-	-	-
CO4	1	2	2	-	3	-	-	-	-	-	-
CO5	2	2	3	-	2	-	-	3	-	2	-

PROGRAM ELECTIVE-I

DIGITAL IMAGE PROCESSING (NCS-310)

Type	L	T	P	Credits
PEC	3	1	0	4

Course Objectives

The objective of the course is to study the image fundamentals and mathematical transforms necessary for image processing, the image enhancement techniques, image restoration procedures, image compression procedures.

Course Contents

Unit-1

Introduction and Fundamentals Motivation and Perspective, Applications, Components of Image Processing System, Element of Visual Perception, A Simple Image Model, Sampling and Quantization. Image Enhancement in Spatial Domain Introduction; Basic Gray Level Functions– Piecewis e-Linear Transformation Functions: Contrast Stretching; Histogram Specification; Histogram Equalization; Local Enhancement; Enhancement using Arithmetic/Logic Operations– Image Subtraction, Image Averaging; Basics of Spatial Filtering; Smoothing - Mean filter, Ordered Statistic Filter; Sharpening – The Laplacian.

Unit-2

Image Enhancement in Frequency Domain Fourier Transform and the Frequency Domain, Basis of Filtering in Frequency Domain, Filters – Low-pass, High-pass; Correspondence Between Filtering in Spatial and Frequency Domain; Smoothing Frequency Domain Filters–Gaussian Lowpass Filters; Sharpening Frequency Domain Filters – Gaussian Highpass Filters; Homomorphic Filtering. Image Restoration A Model of Restoration Process, Noise Models, Restoration in the presence of Noise only Spatial Filtering – Mean Filters: Arithmetic Mean filter, Geometric Mean Filter, Order Statistic Filters
– Median Filter, Max and Min filters; Periodic Noise Reduction by Frequency Domain Filtering– Bandpass Filters; Minimum Mean-square Error Restoration.

Unit-3

Color Image Processing Color Fundamentals, Color Models, converting Colors to different models, Color Transformation, Smoothing and Sharpening, Color Segmentation, Morphological Image Processing Introduction, Logic Operations involving Binary Images, Dilation and Erosion, Opening and Closing, Morphological Algorithms–Boundary Extraction, Region Filling, Extraction of Connected Components, Convex Hull, Thinning, Thickening

Unit-4

Registration Introduction, Geometric Transformation – Plane to P lane transformation, Mapping, Stereo Imaging – Algorithms to Establish Correspondence, Algorithms to Recover Depth Segmentation Introduction, Region Extraction, Pixel-Based Approach, Multi-level Thresholding, Local Thresholding, Region-based Approach, Edge and Line Detection: Edge Detection, Edge Operators, Pattern Fitting Approach, Edge Linking and Edge Following, Edge Elements Extraction by Thresholding, Edge Detector Performance, Line Detection, Corner Detection.

Unit-5

Feature Extraction Representation, Topological Attributes, Geometric Attributes Description Boundary-based Description, Region-based Description, Relationship, Object Recognition Deterministic Methods, Clustering, Statistical Classification, Syntactic Recognition, Tree Search, Graph Matching.

Text Books

1. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing Pearson, Third Edition, 2010
2. Digital Image Processing and Computer Vision, R.J. Schalkoff Published by: John Wiley and Sons, NY.
3. Anil K. Jain, Fundamentals of Digital Image Processing Pearson, 2002.

Reference Books

1. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, Digital Image Processing using MATLAB Pearson Education, Inc., 2011.
2. Kenneth R. Castleman, Digital Image Processing Pearson, 2006.
3. D, E. Dudgeon, and RM. Mersereau, Multidimensional Digital Signal Processing Prentice Hall Professional Technical Reference, 1990.
4. William K. Pratt, Digital Image Processing John Wiley, New York, 2002

Online Source:

1. https://in.coursera.org/specializations/image-processing
2. https://www.udemy.com/topic/image-processing/
3. https://onlinecourses.nptel.ac.in/noc19_ee55/preview
4. https://www.mygreatlearning.com/academy/learn-for-free/courses/digital-image-processing

Course Outcomes

1. Design sampling and quantization techniques for conversion of an analog image into digital form.
2. Understand image using various types of filtering, segmentation and edge detection techniques.
3. Analyze and interpret the effects of high pass and low pass filter in an image.
4. Design the techniques of morphological image processing, image registration and image recognition.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	-	1	2	-	-	-	-	-	-
CO2	3	2	2	-	2	-	-	-	-	-	-
CO3	3	2	2	2	2	-	-	-	-	-	-
CO4	3	2	3	-	2	-	-	-	-	-	-

DATA WAREHOUSING & DATA MINING (NCS-312)

Type	L	T	P	Credits
PEC	3	1	0	4

Course Objectives

This course will introduce the concepts of data ware house and data mining, which gives a complete description about the principles, used, architectures, applications, design and implementation of data mining and data ware housing concepts.

Prerequisite: Database Management Systems

Course Contents

Unit-1

Overview, Motivation (for Data Mining), Data Mining-Definition & Functionalities, Data Processing, Form of Data Preprocessing, Data Cleaning: Missing Values, Noisy Data, Binning, Clustering, Regression, Computer and Human inspection, Inconsistent Data, Data Integration and Transformation. **Data Reduction**: -Data Cube Aggregation, Dimensionality reduction, Data Compression, Numerosity Reduction, Clustering, Discretization and Concept hierarchy generation.

Unit-2

Concept Description: - Definition, Data Generalization, Analytical Characterization, Analysis of attribute relevance, Mining Class comparisons, Statistical measures in large Databases. Measuring Central Tendency, Measuring Dispersion of Data, Graph Displays of Basic Statistical class Description, Mining Association Rules in Large Databases, Association rule mining, mining Single- Dimensional Boolean Association rules from Transactional Databases: Apriori Algorithm, Mining Multilevel Association rules from Transaction Databases and Mining Multi-Dimensional Association rules from Relational Databases

Unit-3

Classification and Predictions: - What is Classification & Prediction, Issues regarding Classification and prediction, Decision tree, Bayesian Classification, Classification by Back propagation, Multilayer feed-forward Neural Network, Back propagation Algorithm, Classification methods K-nearest neighbor classifiers, Genetic Algorithm.

Cluster Analysis:

Data types in cluster analysis, Categories of clustering methods, partitioning methods. Hierarchical Clustering- CURE and Chameleon. Density Based Methods-DBSCAN, OPTICS. Grid Based Methods- STING, CLIQUE. Model Based Method –Statistical Approach, Neural Network approach, Outlier Analysis

Unit-4

Data Warehousing: Overview, Definition, Delivery Process, Difference between Database System and Data Warehouse, Multi-Dimensional Data Model, Data Cubes, Stars, Snow Flakes, Fact Constellations, Concept hierarchy, Process Architecture, 3-Tier Architecture, Data Mart.

Unit-5

Aggregation, Historical information, Query Facility, OLAP function and Tools, OLAP Servers, ROLAP, MOLAP, HOLAP, Data Mining interface, Security, Backup and Recovery, Tuning Data Warehouse, Testing Data Warehouse.

Text Books

1. M. H. Dunham," Data Mining: Introductory and Advanced Topics", Pearson Education
2. Jiawei Han, Micheline Kamber," Data Mining Concepts & Techniques", Elsevier

Reference Books

1. Sam Anahory, Dennis Murray, "Data Warehousing in the Real World: A Practical Guide for Building Decision Support Systems, 1/e "Pearson Education
2. Mallach," Data Warehousing System", McGraw –Hill

Course Outcomes

1. Understand importance of abstraction of Knowledge from unstructured sources at sufficient level.
2. Use of high-level operational skills and real-world case studies for knowledge discovery and data warehousing-based principles.
3. Apply areas of probability, statistics and machine learning algorithms which underpin the knowledge discovery enterprise.
4. Design data mining and data warehousing systems and solutions to meet user requirements and specifications.
5. Analyze OLAP and data mining as techniques for extracting knowledge from a data warehouse

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	1	2	1	2	-	2	1	-	1
CO2	3	2	2	2	1	2	-	1	1	1	1
CO3	2	2	1	2	1	2	-	1	1	1	1
CO4	2	2	3	2	3	2	1	2	2	2	2
CO5	3	2	2	2	3	2	-	1	2	1	2

ADVANCED DATABASE MANAGEMENT SYSTEM (NCS-314)

Type	L	T	P	Credits
PEC	3	1	0	4

Course Objectives

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

Course Contents

UNIT-1

Database System Applications, Purpose of Database Systems, View of Data – Data Abstraction, Instances and Schemas, Data Models – the ER Model, Relational Model, other Models, Database Languages – DDL, DML, Database Access from Applications Programs, Transaction Management, Data Storage and Querying, Database Architecture, Database Users and Administrators, ER Diagrams, Relational Model: Introduction to the Relational Model – Integrity Constraints Over Relations, Enforcing Integrity constraints, Querying relational data, Logical data base Design, Introduction to Views, Altering Tables and Views, Relational Algebra, Basic SQL Queries, Nested Queries, Complex Integrity Constraints in SQL, Triggers.

UNIT-2

Introduction to Schema Refinement – Problems Caused by redundancy, Decompositions – Problem related to decomposition, Functional Dependencies - Reasoning about FDS, Normal Forms – FIRST, SECOND, THIRD Normal forms, BCNF, Properties of Decompositions- Loss less- join Decomposition, Dependency preserving Decomposition, Schema Refinement in Data base Design, Multi valued Dependencies, FOURTH Normal Form, Join Dependencies, FIFTH Normal form.

UNIT-3

Transaction Management: The ACID Properties, Transactions and Schedules, Concurrent Execution of Transactions, Lock Based Concurrency Control, Deadlocks, Performance of Locking, Transaction Support in SQL.

Concurrency Control: Serializability, and recoverability, Introduction to Lock Management, Lock Conversions, Dealing with Dead Locks, Specialized Locking Techniques, Concurrency Control without Locking.

Crash recovery: Introduction to Crash recovery, Introduction to ARIES, the Log, and Other Recovery related Structures, the Write-Ahead Log Protocol, Check pointing, recovering from a System Crash, Media recovery.

UNIT-4

Overview of Storage and Indexing: Data on External Storage, File Organization and Indexing, Clustered Indexes, Primary and Secondary Indexes, Index data Structures, Hash Based Indexing, Tree based Indexing

Storing data: Disks and Files: -The Memory Hierarchy, Redundant Arrays of Independent Disks.
Tree Structured Indexing: Intuitions for tree Indexes, Indexed Sequential Access Methods (ISAM)
B+ Trees: A Dynamic Index Structure, Search, Insert, Delete.

Hash Based Indexing: Static Hashing, Extendable hashing, Linear Hashing, Extendable vs. Linear Hashing.

UNIT-5

Distributed databases: Introduction to distributed databases, Distributed DBMS architectures, storing data in a distributed DBMS, Distributed catalog management, Distributed query processing Updating distributed data, Distributed transactions, Distributed concurrency control, Distributed Recovery.

Text Books

1. Data base Management Systems, Raghu Ramakrishnan, Johannes Gehrke, TMH, 3rd Edition, 2003.
2. Database System Concepts, A. Silberschatz, H.F. Korth, S. Sudarshan, McGraw hill, VI editions, 2006.
3. Fundamentals of Database Systems 5th edition. Ramez Elmasri, Shamkant B.Navathe, Pearson Education, 2008.

Reference Books

1. Introduction to Database Systems, C. J. Date, Pearson Education, 8th Edition, 2003.
2. Database Management System Oracle SQL and PL/SQL,P. K. Dass Gupta, PHI, e-book.
3. Database System Concepts, Peter Rob & Carlos Coronel, Cengage Learning, 2008.

Course Outcomes

1. Understand database systems, create ER models and write queries using relational algebra and SQL
2. Create databases using Relational Model and normalizing databases to suitable normal forms
3. Understand the concept of transactions and concurrent transactions
4. Apply the data storage and indexing methods and study memory hierarchy,
5. analyze various types of databases including distributed database environment

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	2	3	–	–	-	-	–	3
CO2	3	3	3	2	3	–	–	-	1	-	2
CO3	3	3	2	3	3	-	-	1	1	-	2
CO4	3	2	2	3	3	–	–	-	1	-	2
CO5	3	3	3	3	3	-	1	-	2	-	3

INFORMATION STORAGE AND RETRIEVAL (NCS-316)

Type	L	T	P	Credits
PEC	3	1	0	4

Course Objectives

The objective of this course is to understand the concepts of Information Retrieval Systems, relations to databases, capabilities and digital libraries, the various data structures for indexing the databases, the knowledge to use clustering algorithms and Multimedia information Retrieval.

Course Content

Unit-1

Introduction to Information Retrieval Systems: Definition of Information Retrieval System, Objectives of Information Retrieval Systems, Functional Overview, Relationship to Database Management Systems, Digital Libraries and Data Warehouses.

Information Retrieval System Capabilities: Retrieval strategies: vector space model, Probabilistic retrieval strategies: Simple term weights, non-binary independence model, Language models. Search Capabilities, Browse Capabilities, Miscellaneous Capabilities.

Unit-2

Cataloging and Indexing: History and Objectives of Indexing, Indexing Process, Automatic Indexing, Information Extraction.

Data Structure: Introduction to Data Structure, Stemming Algorithms, Inverted File Structure, N-Gram Data Structures, PAT Data Structure, Signature File Structure, Hypertext and XML Data Structures, Hidden Markov Models.

Unit-3

Automatic Indexing and Document and Term Clustering: Automatic Indexing: Classes of Automatic Indexing, Statistical Indexing, Natural Language, Concept Indexing, Hypertext Linkages

Document and Term Clustering: Introduction to Clustering, Thesaurus Generation, Item Clustering, Hierarchy of Clusters

Unit-4

User Search Techniques and information visualization User Search Techniques: Search Statements and Binding, Similarity Measures and Ranking, Relevance Feedback, Selective Dissemination of Information Search, Weighted Searches of Boolean Systems, Searching the INTERNET and Hypertext

Information Visualization: Introduction to Information Visualization, Cognition and Perception, Information Visualization Technologies

Unit-5

Text Search Algorithms and Multimedia information Retrieval: Text Search Algorithms: Introduction to Text Search Techniques, Software Text Search Algorithms, Hardware Text Search Systems.

Multimedia Information Retrieval: Spoken Language Audio Retrieval, Non-Speech Audio Retrieval, Graph Retrieval, Imagery Retrieval, Video Retrieval

Text Books

1. Information Storage and Retrieval Systems – Theory and Implementation, Second Edition, Gerald J. Kowalski, Mark T. Maybury, Springer

Reference Books

1. Frakes, W.B., Ricardo Baeza-Yates: Information Retrieval Data Structures and Algorithms, Prentice Hall, 1992.
2. Information Storage & Retrieval by Robert Korfhage – John Wiley & Sons.
3. Modern Information Retrieval by Yates and Neto Pearson Education.

Course Outcomes

1. Understand the concepts of Information Retrieval Systems, relations to databases, capabilities and digital libraries
2. Apply the various data structures for indexing the databases
3. Understand the knowledge to use clustering algorithms in order to the use clustering
4. Evaluate the various data structures for searching the databases
5. Creating environment for text search and Multimedia information Retrieval

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	-	-	-	-	-	-	-	-	2
CO2	3	2	2	-	2	-	-	-	-	-	2
CO3	2	2	-	1	2	-	-	-	-	-	3
CO4	2	3	-	2	2	-	-	-	-	-	2
CO5	2	-	3	-	3	-	-	-	2	2	3

SOFT COMPUTING (NCS-318)

Type	L	T	P	Credits
PEC	3	1	0	4

Course Objectives

The objective of this course is to introduce the basic concepts of Soft Computing such as Artificial Intelligence, Neural Networks, Fuzzy logic-based systems, supervised and unsupervised learning, genetic algorithm-based systems and their hybrids.

Prerequisite: Discrete Mathematical Structure

Course Content

Unit-1

Introduction to Intelligent Systems and Soft Computing Characteristic behavior of Intelligent systems, Knowledge based systems, Knowledge Representation and Processing, Soft Computing characteristics, Constitutes of Soft Computing-Fuzzy Logic and Computing, Neural Computing, Evolutionary Computing, Rough Sets, Probabilistic Reasoning and Machine Learning.

Unit-2

Neuro Computing - Supervised Learning Biological background, Pattern recognition tasks, Features of artificial neural networks, Activation functions, Perceptron model, Perceptron for classification and its limitations, Architectures of multilayer feed-forward neural networks, Back-propagation learning algorithm, Limitations of MLP.

Unit-3

Neuro Computing - Unsupervised Learning Hebb‟s learning rule for competitive learning, Kohonen's self-organizing map and network topology, applications of SOM, Hopfield network and its topology, Boltzman Machines, Adaptive Resonance Theory.

Unit-4

Fuzzy Logic and Fuzzy Systems Text and Reference Books: Course Outcomes: Course Content: Evolution of fuzzy logic, fuzzy sets, fuzzy logic operations, fuzzy relations, Fuzzy arithmetic and fuzzy measures. Fuzzy rules and reasoning, Fuzzy inference systems, Fuzzy modeling and decision making, Neuro-fuzzy modeling.

Unit-5

Evolutionary Computing Biological background and Overview of evolutionary computing, Genetic algorithm and search space, Operators in genetic algorithm- encoding, selection, crossover, and mutation, Classification of GA, Evolutionary Programming and Strategies, Applications of fuzzy in pattern recognition character recognition. Applications of evolutionary computing in Image processing and computer vision, applications of soft computing in mobile ad-hoc networks, Information Retrieval, Semantic web, and Software Engineering.

Text Books

1. Fakhreddine O. Karray, Clarence De Silva, 'Soft Computing and Intelligent systems design' Pearson Education, ISBN 978-81-317-2324-1, 1st ed., 2009.
2. B. K. Tripathy, J. Anuradha, 'Soft Computing: advances and applications', Cengage learning, ISBN-13: 978-81-315-2619-4.

Reference Books

1. S. N. Sivanandam, S. N. Deepa, Principles of Soft Computing, Wiley publications, 2nd Edition,2015.
2. J. S. R. Jang, C. T. Sun, E. Mizutani, 'Neuro-Fuzzy and Soft Computing- A computational approach to Learning and Machine Intelligence' PHI, 1st ed., 1996.
3. David E. Goldberg, Genetic Algorithms - Pearson Education,1st ed., 2006.
4. Satish Kumar, "Neural Networks - A Classroom Approach", Tata McGraw-Hill, 1st ed., 2009.
5. Weblink: (https://nptel.ac.in/courses/106105173)

Course Outcomes

1. Understand differential behavior of Human and Intelligent Systems.
2. Understand and use supervised and un-supervised learning techniques in ANN.
3. Apply different soft computing techniques like Genetic Algorithms, Fuzzy Logic, Neural Network and their combination.
4. Analyze human-like processing in problem solving with current technologies in various domains like Bio Informatics, Multimedia Systems, Big Data Analytics, etc.
5. Design evolutionary computing techniques in real life problems.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	1	2	1	2	1	2	1	1	2
CO2	2	3	3	2	3	2	-	1	1	1	2
CO3	2	3	3	3	3	2	1	2	1	2	2
CO4	3	3	3	3	3	2	2	2	1	2	2
CO5	2	3	3	3	3	2	1	2	-	2	2

ENTREPRENEURSHIP (NHS-301/302)

Type	L	T	P	Credits
HSMC	2	0	0	2

Course Objectives

To provide a comprehensive understanding of the concept of an entrepreneur and intricacies involved in managing entrepreneurial projects the prime aim is to imbibe the necessary entrepreneurial competencies among students and motivate them choose Entrepreneurship as a feasible and desirable career option.

Course Contents

Unit-1

Entrepreneurship: Entrepreneur and manager, Growth of entrepreneurship in India, Government's policy actions towards entrepreneurial motivation, entrepreneurship development programmes.

Unit-2

Business Enterprises and Ownership Structure: Small scale, medium scale and large-scale enterprises, role of small enterprises in economic development; proprietorship, partnership, companies and co-operatives firms: their formation,

Unit-3

Project Management: Identification and selection of projects; project report: contents and formulation, project evaluation, method

Unit-4

Project Financing and Working Capital Management: Cost of Project, Capital Structure Planning, Sources of long-term financing, Working Capital Management

Unit-5

Institutional Support and Policies: Institutional support towards the development of entrepreneurship in India: technical consultancy organizations (TCOs), government policies for small scale enterprises.

Text Books

1. Khanka, S S. „Entrepreneurial Development", S Chand & Company Ltd. New Delhi
2. Desai, Vasant, „ Project Management and Entrepreneurship", Himalayan Publishing House, Mumbai, 2002.

Reference Books

1. Gupta and Srinivasan, „Entrepreneurial Development", S Chand & Sons, New Delhi.
2. Ram Chandran, „Entrepreneurial Development", Tata McGraw Hill, New Delhi
3. Saini, J. S. „Entrepreneurial Development Programmes and Practices", Deep & Deep Publications (P), Ltd.
4. Holt, Davis, 'Entrepreneurship: New Venture Creations, PHI

Course Outcomes

1. Design understanding of basics of entrepreneurship.
2. Apply the beginner's concept, ownership and various forms
3. Apply opportunities using identification; project conceptualization, formulation & evaluation.
4. Analyze evaluate the project financing and working capital management
5. Understand the role of Institution support and policy framework of Government for entrepreneurship development in India.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	3	1	1	2	2	2	2	3	2
CO2	2	3	2	2	2	2	-	2	1	2	3
CO3	2	2	2	2	-	2	-	2	1	2	2
CO4	3	2	3	2	-	1	-	1	1	2	2
CO5	2	2	2	1	1	-	2	2	2	3	3

Detailed Syllabus

IV Year

OPEN ELECTIVE-II
SOFT COMPUTING (OCS-401)

Type	L	T	P	Credits
OEC	2	0	0	2

Course Objectives

To expose the students to soft computing, various types of soft computing techniques, and applications of soft computing. The student should be able to get an idea on Artificial Intelligence, Various types of production systems, characteristics of production systems and get an idea on Fuzzy Logic, Various fuzzy systems and their functions

Prerequisite: Discrete Mathematical Structures

Course Content

Unit-1

Introduction to Intelligent Systems and Soft Computing Characteristic behavior of Intelligent systems, Knowledge based systems, Knowledge Representation and Processing, Soft Computing characteristics, Constitutes of Soft Computing-Fuzzy Logic and Computing, Neural Computing, Evolutionary Computing, Rough Sets, Probabilistic Reasoning and Machine Learning.

Unit-2

Neuro Computing - Supervised Learning Biological background, Pattern recognition tasks, Features of artificial neural networks, Activation functions, Perceptron model, Perceptron for classification and its limitations, Architectures of multilayer feed-forward neural networks, Back-propagation learning algorithm, Limitations of MLP.

Unit-3

Neuro Computing - Unsupervised Learning Hebb‟s learning rule for competitive learning, Kohonen‟s self-organizing map and network topology, applications of SOM, Hopfield network and its topology, Boltzman Machines, Adaptive Resonance Theory.

Unit-4

Fuzzy Logic and Fuzzy Systems Text and Reference Books: Course Outcomes: Course Content: Evolution of fuzzy logic, fuzzy sets, fuzzy logic operations, fuzzy relations, Fuzzy arithmetic and fuzzy measures. Fuzzy rules and reasoning, Fuzzy inference systems, Fuzzy modeling and decision making, Neuro-fuzzy modeling.

Unit-5

Evolutionary Computing Biological background and Overview of evolutionary computing, Genetic algorithm and search space, Operators in genetic algorithm- encoding, selection, crossover, and mutation, Classification of GA, Evolutionary Programming and Strategies, Applications of fuzzy in pattern recognition character recognition. Applications of evolutionary computing in Image processing and computer vision, applications of Soft computing in mobile ad-hoc networks, Information Retrieval, Semantic web, and Software Engineering.

Text Books

1. Fakhreddine O. Karray, Clarence De Silva, 'Soft Computing and Intelligent systems design' Pearson Education, ISBN 978-81-317-2324-1, 1st ed., 2009.
2. B. K. Tripathy, J. Anuradha, 'Soft Computing: advances and applications', Cengage learning, ISBN-13: 978-81-315-2619-4.

3. S. N. Sivanandam, S. N. Deepa, Principles of Soft Computing, Wiley publications, 2nd Edition,2015.
4. J. S. R. Jang, C. T. Sun, E. Mizutani, 'Neuro-Fuzzy and Soft Computing- A computational approach to Learning and Machine Intelligence' PHI, 1st ed., 1996.

Reference Books

1. David E. Goldberg, Genetic Algorithms - Pearson Education,1st ed., 2006.
2. Satish Kumar, "Neural Networks - A Classroom Approach", Tata McGraw-Hill, 1st ed., 2009.
3. Weblink: (https://nptel.ac.in/courses/106105173)

Course Outcomes

1. Understand differential behavior of Human and Intelligent Systems.
2. Understand supervised and un-supervised learning techniques in ANN.
3. Apply different soft computing techniques like Genetic Algorithms, Fuzzy Logic, Neural Network and their combination.
4. Create human-like processing in problem solving with current technologies in various domains like Bio Informatics, Multimedia Systems, Big Data Analytics, etc.
5. Design evolutionary computing techniques in real life problems.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	1	2	1	2	1	2	1	1	2
CO2	2	3	3	2	3	2	-	1	1	1	2
CO3	2	3	3	3	3	2	1	2	1	2	2
CO4	3	3	3	3	3	2	2	2	1	2	2
CO5	2	3	3	3	3	2	1	2	-	2	2

ARTIFICIAL INTELLIGENCE (OCS-403)

Type	L	T	P	Credits
OEC	2	0	0	2

Course Objectives

Gain a historical perspective of AI and its foundations. Become familiar with basic principles of AI toward problem solving, inference, perception, knowledge representation, and learning. Learn the methods of solving problems using Artificial Intelligence.

Prerequisite: Discrete Mathematical Structure

Course Content

Unit-1

Introduction to Artificial Intelligence, Brief history, Various approaches to AI, Areas of application, Simulation of sophisticated & Intelligent Behavior in different area, Problem solving in games, natural language processing, automated reasoning, and visual perception, Knowledge and its role in AI, Heuristic algorithm versus solution guaranteed algorithms, Introduction to soft computing.

Unit-2

Representing problems in state space, informed versus uninformed search, Production System Model, Evaluation of the Production System, Depth First Search and Breadth First Search, Heuristics, Heuristic Search Techniques: Hill Climbing, Best First search, A* Algorithm, Branch and Bound, Cryptarithmatic Problem, Means End Analysis, AO* Algorithm, Game Playing: MINMAX Search, Alpha-Beta Pruning, Heuristic Estimation.

Unit-3

Knowledge Representation and Reasoning: Propositional Logic, First Order Predicate Logic, Graphs, Associative Network, Semantic Networks, Conceptual Dependencies, Frames, Scripts, Horn Clauses, Introductory Examples from PROLOG, Case Grammar Theory, Production Rules Knowledge Base, The Interface System, Forward & Backward Deduction, Inference System in Propositional and Predicate Logic, Reasoning under Uncertainty.

Unit-4

Understanding Natural Languages, Various Approaches of NLP, Parsing techniques, Context free and transformational grammars, Transition nets, Augmented transition nets, Fillmore's grammars, Grammar free analyzers, Sentence generation, and translation, Introduction to Pattern Recognition, Structured Description, Symbolic Description, Machine Perception, Object Identification, Speech Recognition.

Unit-5

Expert Systems: Architecture of Expert System, Representing and using domain knowledge, Expert System Shell, Explanation System, Knowledge Acquisition System, Case study of Existing Expert Systems like DENDRAL, MYCIN, Development of a small Expert System using programming Languages and tools like LISP, PROLOG, JESS.

Text and Books

1. N. J. Nilsson, "Artificial Intelligence: A New Synthesis", 1st edition, 1997, Elsevier Publications.
2. Charnick, "Introduction to A.I.", 1st edition, 1985, Addison Wesley.
3. Rich & Knight, "Artificial Intelligence", 3rd ed.,2009, McGraw-Hill Publication.
4. Winston, "LISP", 3rd ed., 1989, Addison Wesley
5. Marcellous, "Expert System Programming", 2nd ed., 1989, PHI

Reference Books

1. Elamie, "Artificial Intelligence", 3rd ed., 1991, Academic Press
2. Lioyed, "Foundation of Logic Processing", 1st ed., 1970, Springer Verlag
3. D. W. Patterson, "Introduction to Artificial Intelligence and Expert Systems", 1990, PHI.
4. Weblink: (https://nptel.ac.in/courses/106105077)

Course Outcomes

1. Understand different types of AI agents.
2. Apply various AI search algorithms (uninformed, informed, heuristic, constraint satisfaction, genetic algorithms.
3. Understand the fundamentals of knowledge representation, reasoning, and machine learning techniques and apply them to real world problems.
4. Design simple knowledge-based systems using languages like LISP, Prolog, and AI tools like JESS. (Apply)
5. Analyze independent (or in a small group) research and communicate it effectively in a seminar.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	1	2	-	-	-	-	-	-	-	-
CO2	1	2	3	-	2	-	-	-	-	-	-
CO3	2	2	3	-	2	-	-	-	-	-	-
CO4	1	2	2	-	3	-	-	-	-	-	-
CO5	2	2	3	-	2	-	-	3	-	2	-

PROGRAM ELECTIVE-II

CLOUD COMPUTING (NCS-401)

Type	L	T	P	Credits
PEC	3	1	0	4

Course Objectives

To provide students with the fundamentals and essentials of Cloud Computing. Provide them sound foundation of the Cloud Computing so that they are able to start using and adopting Cloud Computing services and tools in their real life scenarios. Student will learn different CPU, memory and I/O virtualization techniques that serve in offering software, computation and storage services on the cloud; Software Defined Networks (SDN) and Software Defined Storage (SDS).

Course Content

Unit-1
Distributed computing models and technologies, Enabling Technologies and System Models for Cloud Computing, techniques, and architectures, Introduction to Cloud Computing including benefits, challenges, and risks.

Unit-2
Cloud Computing Models including Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), Software-as-a-Service (SaaS), virtualization, security and privacy issues, performance and systems issues, capacity planning, disaster recovery, Public cloud, private cloud and hybrid clouds.

Unit-3
Cloud OS, Cloud architectures including federated clouds, challenges in implementing clouds, data centers, hypervisor CPU and memory management, Scalability, Performance, and QoS.

Unit-4
Cloud hosted applications, Data centers for Cloud Computing, Principles of Virtualization platforms and other advanced and research topics in cloud computing.

Unit-5
Security and Privacy issues in the Cloud, VM Ware ESX Memory Management, Capacity Planning and Disaster Recovery in Cloud Computing.

Text Books

1. Distributed and Cloud Computing, 1st edition, Morgan Kaufmann, 2011.

Reference Books

1. Technical papers from major journals and major conferences on computing, networking, cloud computing.
2. Weblink: (https://nptel.ac.in/courses/106105167)

Course Outcomes

1. Understand various basic concepts related to cloud computing technologies.
2. Understand the architecture and concept of different cloud models: IaaS, PaaS, SaaS.
3. Apply the underlying principle of cloud virtualization, cloud storage, data management and data visualization.
4. Create different cloud programming platforms and tools.
5. Design and deploy cloud application using cloud platforms

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	1	-	3	3	-	2	1	3	3
CO2	3	-	3	-	2	1	-	1	2	2	2
CO3	3	2	3	-	3	2	2	3	-	2	2
CO4	2	-	2	-	3	1	-	2	-	2	3
CO5	2	-	3	-	2	3	-	1	-	2	2

REAL TIME SYSTEMS (NCS-403)

Type	L	T	P	Credits
PEC	3	1	0	4

Course Objectives

Introduction of the real-time systems. Computing required for the real-time embedded systems. Communication required for the real-time embedded systems. To form a solid foundation of knowledge, practical skills sufficient for successful production activities.

Course content

Unit-1: Introduction

Definition, Issues in Real-Time Computing, Typical Real Time Applications: Digital Control, High Level Controls, Signal Processing etc., Characterizing Real-Time System and Tasks, Release Times, Deadlines, and Timing Constraints, Hard Real Time Systems and Soft Real Time Systems, Reference Models for Real Time Systems: Processors and Resources, Temporal Parameters of Real Time Workload, Periodic Task Model, Modeling Real Time Systems.

Unit-2: Real Time Scheduling

Common Approaches to Real Time Scheduling: Clock Driven Vs Event Driven Approach, Rate Monotonic Scheduling Algorithm, Preemptive Earliest Deadline First Algorithm, Optimality of Effective-Deadline-First (EDF) and Least-Slack-Time-First (LST) Algorithms, Allowing for Precedence Constraints, Offline Versus Online Scheduling, Scheduling Aperiodic and Sporadic jobs in Priority Driven and Clock Driven Systems.

Unit-3: Resources Access Control

Effect of Resource Contention and Resource Access Control (RAC), Non-preemptive Critical Sections, Basic Priority-Inheritance and Priority-Ceiling Protocols, Use of Priority-Ceiling Protocol in Dynamic n-Priority Systems, Preemption Ceiling Protocol, Access Control in Multiple-Unit Resources, Controlling Concurrent Accesses to Data Objects, Real Time Databases

Unit-4: Multiprocessor and Distributed System Environment Multiprocessor and Distributed System Model, Task Assignment Issues and Challenges, Utilization Balancing Algorithm, A Next-Fit Algorithm for RM Scheduling, A Bin-Packing Assignment Algorithm for EDF, Focused Addressing and Bidding Algorithm, The Buddy Strategy, Assignment with precedence condition. Fault Tolerant Scheduling, Clock Synchronization in Distributed Real Time Systems

Unit-5: Real Time Communication

Network Topologies, Protocols, Real Time Communication over LAN and Internet, Routing, Resource Reservation, Traffic Shaping and Policing, Quality of Service Model.

Text Books

1. Real Time Systems by Jane W. S. Liu, 1st ed., 2018, Pearson Education Publication.
2. Real-Time Systems: Scheduling, Analysis, and Verification by Prof. Albert M. K. Cheng, 1st ed., 2002, John Wiley Publications.

Reference Books

1. Real Time Systems, C.M. Krishna, Kang G. Shin, 1st ed., 2010, Tata McGraw Hill.
2. Real Time Systems: Theory and Practice by Rajib Mall, 1st ed., 2006, Pearson.
3. Weblink: (https://nptel.ac.in/courses/106105229)

Course Outcomes

1. Understand the characteristics of Real Time Systems and their applications in various fields.
2. Analyze various Scheduling Algorithms for real time systems and apply the appropriate one to prepare a feasible Schedule for given task set.
3. Design a precedence constraints and mutual exclusion constraints to a given Real Time Schedule.
4. Apply various Scheduling Algorithms for Multiprocessor Real Time Systems and apply the appropriate one to prepare a feasible Schedule for given task set
5. Understand Distributed and Network related issues for Distributed Real Time Systems.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	2	2	1	1	1	2	2	1	2
CO2	2	2	2	3	2	2	2	2	2	1	2
CO3	1	2	2	1	2	1	1	2	2	2	1
CO4	3	3	3	2	2	2	2	2	2	2	1
CO5	2	2	2	2	1	1	1	2	1	1	2

BIG DATA ANALYTICS (NCS-405)

Type	L	T	P	Credits
PEC	3	1	0	4

Course Objectives

It focuses on the "technologies", i.e., the tools/algorithms that are available for storage, processing of Big Data. It helps a student to perform a variety of "analytics" on different data sets and to arrive at positive conclusions. They will uncover various terminologies and techniques used in Big Data.

Course Contents

Unit-1: Introduction

Introduction– Big Data: Issues and Challenges, Traditional Business Intelligence (BI) versus Big Data, Distributed file system–Big Data and its importance, Four Vs, Drivers for Big data, Big data analytics, Big data applications, Introduction to Data Science.

Unit-2: Introduction to Hadoop and Hadoop Architecture

Big Data – Apache Hadoop & Hadoop EcoSystem, Moving Data in and out of Hadoop – Understanding inputs and outputs of MapReduce -, Data Serialization.

Unit-3: HDFS, HIVE AND HIVEQL, HBASE

HDFS-Overview, Installation and Shell, Java API; Hive Architecture and Installation, Comparison with Traditional Database, HiveQL Querying Data, Sorting And Aggregating, Map Reduce Scripts, Joins & Sub queries, HBase concepts, Advanced Usage, Schema Design, Advance Indexing, PIG, Zookeeper, how it helps in monitoring a cluster, HBase uses Zookeeper and how to Build Applications with Zookeeper.

Unit-4: SPARK

Introduction to Data Analysis with Spark, Natural Language Processing with SPARK 2.0. Downloading Spark and Getting Started, Programming with RDDs, Machine Learning with MLlib.

NoSQL

What is it? Where It is Used Types of NoSQL databases, Why NoSQL?, Advantages of NoSQL, Use of NoSQL in Industry, SQL vs NoSQL, NewSQL

Unit-5: Data Base for the Modern Web

Introduction to MongoDB key features, Core Server tools, MongoDB through the Java Script‟s Shell, Creating and Querying through Indexes, Document-Oriented, principles of schema design, Constructing queries on Databases, collections and Documents, MongoDB Query Language.

Text Books

1. Radha Shankarmani, M.Vijayalakshmi, Big Data Analytics; 2nd ed., 2016, Wiley.
2. Nathan Marz, Big Data: Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems, Shroff/O'Reilly, 1st edition, 2017.

References Books

1. Seema Acharya, Subhashini Chellappan, Big Data and Analytics, 2nd ed., 2019, Wiley.
2. Weblink: (https://nptel.ac.in/courses/106104189)

Course Outcomes

1. Understand the need for Big Data with reference to Google Search, You Tube, Facebook etc.
2. Apply the concepts of Big Data, Business Intelligence, and Data Science.
3. Understand Hadoop, Hadoop Architecture, and Data Serialization
4. Create Big Data analysis in Web applications.
5. Analyze NoSQL and SPARK for Big Data analysis.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	3	-	3	2	-	2	2	2	-	-
CO2	1	2	3	2	2	-	2	2	-	-	-
CO3	2	1	3	-	2	-	2	3	2	-	-
CO4	2	3	2	-	2	-	2	3	-	-	-
CO5	2	3	1	-	2	-	2	2	-	-	-

MULTIMEDIA SYSTEMS (NCS-407)

Type	L	T	P	Credits
PEC	3	1	0	4

Course Objectives

To introduce various aspects of multimedia components like Images, audio, sound and computer graphics. Provides hands-on training in the use of Image Editing tools with software. Students will gain hands-on experience through a series of practical skill building tasks and exercises designed to extend their knowledge.

Course Contents

Unit-1: Introduction

Introduction to Multimedia, Multimedia Information, Multimedia Objects, Multimedia in business and work. Convergence of Computer, Communication and Entertainment products.

Stages of Multimedia Projects

Multimedia hardware, Memory & storage devices, Communication devices, Multimedia software's, presentation tools, tools for object generations, video, sound, image capturing, authoring tools, card and page-based authoring tools.

Unit-2: Multimedia Building Blocks

Text, Sound MIDI, Digital Audio, audio file formats, MIDI under windows environment Audio& Video Capture.

Unit-3: Data Compression

Huffman Coding, Shannon Fano Algorithm, Huffman Algorithms, Adaptive Coding, Arithmetic Coding Higher Order Modelling. Finite Context Modelling, Dictionary based Compression, Sliding Window Compression, LZ77, LZW compression, Compression, Compression ratio lossless & lossy compression.

UNIT-4: Multimedia Communication

Stream characteristics for Continuous media – Temporal Relationship – Object Stream Interactions, Media Levity, Media Synchronization – Models for Temporal Specifications – Streaming of Audio and Video – Jitter – Fixed playout and Adaptive playout – Recovering from packet loss – RTSP – Multimedia Communication Standards – RTP/RTCP – SIP and H.263

UNIT-5

Wireless Multimedia Communication: End to End QoS provisioning in Wireless Multimedia Networks – Adaptive Framework – MAC layer QoS enhancements in Wireless Networks – A Hybrid MAC protocol for 10 Multimedia Traffic – Call Admission Control in Wireless Multimedia Networks – A Global QoS Management for Wireless Networks

Text Books

1. Tay Vaughan, "Multimedia, Making IT Work", McGraw Hill, 8th ed., 2014.
2. Buford, "Multimedia Systems", Addison Wesley, 1st ed., 1994.
3. Nalin K Sharda, 'Multimedia Information Networking', Prentice Hall of India, 1st ed., 1999
4. Ellen Kayata Wesel, 'Wireless Multimedia Communications: Networking Video, Voice and Data', Addision Wesley, 1st ed., 1998

Reference Books

1. Mark Nelson, "Data Compression Hand Book", BPB, 2nd ed., 2001.
2. Sleinreitz, "Multimedia System", Addison Wesley, 5th ed., 2000.
3. Aura Ganz, Zvi Ganz and Kitti Wongthawaravat, 'Multimedia Wireless Networks: Technologies, Standards and QoS', Prentice Hall, 1st ed., 2003.
4. Weblink: (https://nptel.ac.in/courses/117105083)

Course Outcomes

1. Understand the basics of multimedia and multimedia system architecture.
2. Understand different multimedia components and tools.
3. Apply variety of data compression techniques.
4. Design the fundamentals of multimedia communication.
5. Analyze concept of wireless multimedia combination.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	3	-	3	2	-	2	2	2	-	-
CO2	1	2	3	2	2	-	2	2	-	-	-
CO3	2	1	3	-	2	-	2	3	2	-	-
CO4	2	3	2	-	2	-	2	3	-	-	-
CO5	2	3	1	-	2	-	2	2	-	-	-

SOFTWARE TESTING (NCS-409)

Type	L	T	P	Credits
PEC	3	1	0	4

Course Objectives

To study fundamental concepts in software testing, including software testing objectives, process, criteria, strategies, and methods. Discuss various software testing issues and solutions in software unit test; integration, regression, and system testing. Learn how to planning a test project, design test cases and data, conduct testing operations, manage software problems and defects, generate a testing report.

Course Contents

Unit-1: Introduction

Faults, Errors, and Failures, Basics of software testing, Testing objectives, Principles of testing, Requirements, behavior and correctness, Testing and debugging, Test metrics and measurements, Verification, Validation and Testing, Types of testing, Software Quality and Reliability, Software defect tracking.

Unit-2: White Box and Black Box Testing

White box testing, static testing, static analysis tools, Structural testing: Unit/Code functional testing, Code coverage testing, Code complexity testing, Black Box testing, Requirements based testing, Boundary value analysis, Equivalence partitioning, state/graph-based testing, Model based testing and model checking, Differences between white box and Black box testing.

Unit-3: Integration, System, and Acceptance Testing

Top down and Bottom-up integration, Bi-directional integration, System integration, Scenario Testing, Defect Bash, Functional versus Non-functional testing, Design/Architecture verification, Deployment testing, Beta testing, Scalability testing, Reliability testing, Stress testing, Acceptance testing: Acceptance criteria, test cases selection and execution.

Unit-4: Test Selection & Minimization for Regression Testing

Regression testing, Regression test process, Initial Smoke or Sanity test, Selection of regression tests, Execution Trace, Dynamic Slicing, Test Minimization, Tools for regression testing, Ad hoc Testing: Pair testing, Exploratory testing, Iterative testing, Defect seeding.

Unit-5: Test Management and Automation

Test Planning, Management, Execution and Reporting, Software Test Automation: Scope of automation, Design & Architecture for automation, Generic requirements for test tool framework, Test tool selection, Testing in Object Oriented Systems.

Text Books

1. S. Desikan and G. Ramesh, "Software Testing: Principles and Practices", Pearson Education, 1st ed., 2005.
2. Aditya P. Mathur, "Fundamentals of Software Testing", Pearson Education. 2013.

Reference Books

1. K. K. Aggarwal and Yogesh Singh, "Software Engineering", 3rd Edition, New Age International Publication. 2007
2. Weblink: (https://nptel.ac.in/courses/106105150)

Course Outcomes

1. Understand the various types and principles of Software Testing
2. Understand white box and black box testing.
3. Apply Integration, system and Acceptance Testing.
4. Design Test selection & minimization for regression testing
5. Analyze Test Management and Automation.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	3	3	-	-	2	2	-	-
CO2	3	2	3	2	3	2	-	2	-	-	-
CO3	3	1	3	2	3	-	-	3	2	-	-
CO4	3	3	2	2	3	-	-	3	-	-	-
CO5	3	3	2	2	3	-	-	2	-	-	-

PROGRAMME ELECTIVE-III

EMBEDDED SYSTEMS (NCS-411)

Type	L	T	P	Credits
PEC	2	1	0	3

Course Objectives

This course emphasizes on comprehensive treatment of embedded hardware and real time operating systems along with case studies, in tune with the requirements of Industry. The objective of this course is to enable the students to understand embedded-system programming and apply that knowledge to design and develop embedded solutions. To introduce the Building Blocks of Embedded System. Educate in Various Embedded Development Strategies. .

Course Contents

Unit-1

Introduction to Embedded Systems Definition and Classification – Overview of Processors and hardware units in an embedded system – Software embedded into the system – Exemplary Embedded Systems – Embedded Systems on a Chip (SoC) and the use of VLSI designed circuits.

Unit-2

Devices and Buses for Devices Network I/O Devices -Device I/O Types and Examples – Synchronous-Iso-synchronous and Asynchronous Communications from Serial Devices - Examples of Internal Serial-Communication Devices -UART and HDLC -Parallel Port Devices - Sophisticated interfacing features in Devices/Ports-Timer and Counting Devices -„12C‟, „USB‟, „CAN and advanced I/O Serial high speed buses-ISA, PCI, PCI-X, cPCI and advanced buses.

Unit-3

Programming Concepts and Embedded Programming in C, Programming in assembly language (ALP) vs. High Level Language, C Program Elements, Macros and functions -Use of Pointers - NULL Pointers-Use of Function Calls–Multiple function calls in a Cyclic Order in the Main Function Pointers – Function Queues and Interrupt Service Routines Queues Pointers – Concepts of „C‟ Program compilers–Cross compiler–Optimization of memory codes.

Unit-4

Real Time Operating Systems Timing and clocks in embedded system, Task modelling and management: RTOS Task scheduling models -Handling of task scheduling and latency and deadlines as performance metrics – Co-operative Round Robin Scheduling – Cyclic Scheduling with Time Slicing (Rate Monotonics Co-operative Scheduling) – Preemptive Scheduling Model strategy by a Scheduler – Critical Section Service by a Pre emptive Scheduler – Fixed (Static) Real time scheduling of tasks

Unit-5

Embedded control and control hierarchy, communication strategies for embedded system: encoding and flow chart. Fault tolerance and formal verification.

Text Books

1. William Stalling, "Computer Organization & Architecture", 10th ed., 2018, Pearson education Asia

Reference Books

2. Mano Morris, "Computer System Architecture", 3rd ed., 1992, PHI
3. Weblink: (https://nptel.ac.in/courses/108102045)

Course Outcomes

1. Understand the difference between general computing system and embedded system.
2. Understand the working of devices, buses and types of communications like serial, parallel etc.
3. Apply cross compiler and implement embedded programming using assembly and C languages.
4. Analyze real time operating system concepts and develop real time embedded systems.
5. Design concept of embedded control and communication

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-

DISTRIBUTED SYSTEMS (NCS-413)

Type	L	T	P	Credits
PEC	2	1	0	3

Course Objectives

This course is an introduction to the design of distributed systems and algorithms that support distributed computing. It aims to provide a practical exposure into the design and functioning of existing distributed systems. The major themes this course will teach include process distribution and communication, data distribution, scheduling, concurrency, resource sharing, synchronization, naming, abstraction and modularity, failure handling, protection from accidental and malicious harm, distributed programming models, distributed file systems, virtualization, and the use of instrumentation, monitoring and debugging tools in problem solving.

Course content

Unit-1

Characterization of Distributed Systems: Introduction, Examples of distributed Systems, Resource sharing and the Web Challenges. **System Models:** Architectural models, Fundamental Models **Theoretical Foundation for Distributed System**: Limitation of Distributed system, absence of global clock, shared memory, Logical clocks, Lamport's & vectors logical clocks, Causal ordering of messages, global state, termination detection.

Distributed Mutual Exclusion: Classification of distributed mutual exclusion, Requirement of mutual exclusion theorem, Token based and non-token-based algorithms, Performance metric for distributed mutual exclusion algorithms.

Unit-2

Distributed Deadlock Detection: System model, resource vs communication deadlocks, deadlock prevention, avoidance, Detection & resolution, centralized dead lock detection, distributed dead lock detection, Path pushing algorithms, Edge chasing algorithms, **Agreement Protocols**: Introduction, System models, classification of Agreement Problem, Byzantine agreement problem, Consensus problem, Interactive consistency Problem, Solution to Byzantine Agreement problem, Application of Agreement problem, Atomic Commit in Distributed Database system.

Unit-3

Distributed Objects and Remote Invocation: Communication between distributed objects, Remote procedure call, Events and notifications, Java RMI case study. **Security**: Overview of security techniques, Cryptographic algorithms, Digital signatures Cryptography pragmatics, **Case studies:**

Needham Schroeder, Kerberos, SSL & Millicent. **Distributed File Systems**: File service architecture, Sun Network File System, The Andrew File System, Recent advances.

Unit-4

Transactions and Concurrency Control: Transactions, Nested transactions, Locks, Optimistic Concurrency control, Timestamp ordering, Comparison of methods for concurrency control. **Distributed Transactions**: Flat and nested distributed transactions, Atomic Commit protocols, Concurrency control in distributed transactions, Distributed deadlocks, Transaction recovery. Replication: System model and group communication, Fault - tolerant services, highly available services, Transactions with replicated data.

Unit-5

Distributed Algorithms: Introduction to communication protocols, Balanced sliding window protocol, Routing algorithms, Destination based routing, APP problem, Deadlock free Packet switching, Introduction to Wave & traversal algorithms, Election algorithm. **CORBA Case Study**: CORBA RMI, CORBA services.

Text Books

1. Singhal & Shivaratri, "Advanced Concept in Operating Systems", 2017, McGraw Hill
2. Coulouris, Dollimore, Kindberg, "Distributed System: Concepts and Design", 2021, Pearson Ed.

References Books

1. Gerald Tel, "Distributed Algorithms", 2nd ed., 2000, Cambridge University Press
2. Nancy A. Lynch, "Distributed Algorithms", 2003, Elsevier Publication
3. Weblink: (https://nptel.ac.in/courses/106106168)

Course Outcomes

1. Understand the concepts of distributed systems in solving real world problems.
2. Apply various concepts of synchronization and agreement protocols.
3. Design various distributed applications using remote procedure calls and remote method invocation for real time problems.
4. Apply Configure, deploy and access network file system.
5. Create distributed algorithms for MAC, routing and transport layer protocols.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	2	2	1	–	1	2	1	3
CO2	3	3	2	3	2	1	–	1	2	–	3
CO3	3	3	3	3	3	1	1	2	3	2	3
CO4	3	2	3	2	3	1	–	2	2	2	3
CO5	3	3	3	3	3	1	1	2	2	2	3

SOFTWARE PROJECT MANAGEMENT (NCS-415)

Type	L	T	P	Credits
PEC	2	1	0	3

Course Objectives

This course is aimed at introducing the primary important concepts of project management related to managing software development projects. They will also get familiar with the different activities involved in Software Project Management. Further, they will also come to know how to successfully plan and implement a software project management activity, and to complete a specific project in time with the available budget.

Course Content

Unit-1

Introduction and Software Project Planning: Fundamentals of Software Project Management (SPM), Need Identification, Vision and Scope document, Project Management Cycle, SPM Objectives, Management Spectrum, SPM Framework, Software Project Planning, Planning Objectives, Project Plan, Types of project plan, Structure of a Software Project Management Plan.

Unit-2

Project Organization and Scheduling: Project Elements, Work Breakdown Structure (WBS), Types of WBS, Functions, Activities and Tasks, Project Life Cycle and Product Life Cycle, Ways to Organize Personnel, Project schedule, Scheduling Objectives, Building the project schedule, Scheduling terminology and techniques, Network Diagrams: PERT, CPM, Bar Charts: Milestone Charts, Gantt Charts.

Unit-3

Project Monitoring and Control: Dimensions of Project Monitoring & Control, Earned Value Analysis, Earned Value Indicators: Budgeted Cost for Work Scheduled (BCWS), Cost Variance (CV), Schedule Variance (SV), Cost Performance Index (CPI), Schedule Performance Index (SPI), Interpretation of Earned Value Indicators.

Unit-4

Software Quality Assurance: Concept of Software Quality, Software Quality Attributes, Software Quality Metrics and Indicators, Software Quality Assurance (SQA), SQA Activities, SQA Plans, Software Quality Frameworks, ISO 9000 Models, SEI Capability Maturity Model (CMM), Software verification and validation, Formal SQA Approaches: Proof of correctness, Statistical quality assurance, Clean room process.

Unit-5

Software project estimation, Estimation methods, Estimation models, Decision process. Risk Management: Risks and risk types, Risk Breakdown Structure (RBS), Risk Management Process: Risk identification, Risk analysis, Risk planning, Risk monitoring, Cost Benefit Analysis, Software Project Management Tools: CASE Tools, Planning and Scheduling Tools like MS-Project.

Text Books

1. Software Project Management, M. Cotterell, 5th ed., 1968, Tata McGraw-Hill Publication.
2. Information Technology Project Management, Kathy Schwalbe, 7th ed., 2013, Vikas Pub. House.

References Books

1. Software Project Management, S. A. Kelkar, 3rd ed., 2012, PHI Publication
2. Weblink: (https://nptel.ac.in/courses/106105218)

Course Outcomes

1. Understand various concepts of Software Project Planning and Management.
2. Apply various techniques of Human Resource Organization and Develop schedule of software projects using PERT/CPM.
3. Understand cost benefit analysis, risk management and techniques of monitoring & control of software projects.
4. Design the concepts of software quality assurance in the development of software projects.
5. Analyze the project to develop the scope of work, provide accurate size, cost, time and effort estimates for software projects

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	3	3	-	-	2	2	-	-
CO2	3	2	3	2	3	2	-	2	-	-	-
CO3	3	1	3	2	3	-	-	3	2	-	-
CO4	3	3	2	2	3	-	-	3	-	-	-
CO5	3	3	2	2	3	-	-	2	-	-	-

ERP SYSTEMS (NCS-417)

Type	L	T	P	Credits
PEC	2	1	0	3

Course Objectives

The objectives of this Course is to provide a contemporary and forward-looking on the theory and practice of Enterprise Resource Planning Technology and to train the students to develop the basic understanding of how ERP enriches the business organizations in achieving a multidimensional growth.

Course Content

Unit-1

ERP Introduction, Benefits, Origin, Evolution and Structure: Conceptual Model of ERP, the Evolution of ERP, the Structure of ERP.

Unit-2

Business Process Reengineering, Data ware Housing, Data Mining, Online Analytic Processing (OLAP), Product Life Cycle Management (PLM), LAP, Supply chain Management.

Unit-3

ERP Marketplace and Marketplace Dynamics: Market Overview, Marketplace Dynamics, the Changing ERP Market. ERP- Functional Modules: Introduction, Functional Modules of ERP Software, Integration of ERP, Supply chain and Customer Relationship Applications.

Unit-4

ERP Implementation Basics, ERP Implementation Life Cycle, Role of SDLC/SSAD, Object Oriented Architecture, Consultants, Vendors and Employees.

Unit-5

ERP & E-Commerce, Future Directives- in ERP, ERP and Internet, Critical success and failure factors, Integrating ERP into organizational culture. Using ERP tool: either SAP or ORACLE format to case study.

Text Books

1. Vinod Kumar Garg and Venkitakrishnan N K, “Enterprise Resource Planning Concepts and Practice”, 2nd ed., 2011, PHI.
2. Joseph A Brady, Ellen F Monk, Bret Wagner, “Concepts in Enterprise Resource Planning”, 4th ed., 2012, Thompson Course Technology.

Reference Books

1. Alexis Leon, “ERP Demystified”, 2nd ed., 2007, Tata McGraw Hill
2. Rahul V. Altekar “Enterprise Resource Planning”, 1st ed., 2004, Tata McGraw Hill,
3. Vinod Kumar Garg and Venkitakrishnan N K, “Enterprise Resource Planning – A Concepts and Practice”, 2nd ed., 2011, PHI
4. Mary Summer, “Enterprise Resource Planning”, 4th ed., 2009, Pearson Education
5. Weblink: (https://nptel.ac.in/courses/110105148)

Course Outcomes

1. Design the model for ERP for large projects
2. Design model for E-commerce architecture for any application
3. Understand the advantages, strategic value, and organizational impact of utilizing an ERP system for the management of information across the functional areas of a business: sales and marketing, accounting and finance, human resource management, and supply chain.
4. Apply working knowledge of how data and transactions are integrated in an ERP system to manage the sales order process, production process, and procurement process.
5. Analyze organizational opportunities and challenges in the design system within a business scenario.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	-	3	-	-	2	-	-	-
CO2	3	3	3	-	2	-	3	2	-	-	-
CO3	1	3	2	3	2	-	-	2	-	-	-
CO4	1	3	3	3	2	-	3	2	-	-	-
CO5	2	3	3	-	2	-	-	2	-	-	-

PROGRAMME ELECTIVE-IV

MACHINE LEARNING (NCS-419)

Type	L	T	P	Credits
PEC	2	1	0	3

Course Objectives

The main objective of this course is to enabling the student with basic knowledge on the techniques to build an intellectual machine for making decisions behalf of humans. This course covers the techniques on how to make learning by a model, how it can be evaluated, what are all different algorithms to construct a learning model.

Course Content

Unit-1: Introduction to Machine Learning
Why Machine learning, Examples of Machine Learning Problems, Structure of Learning, Learning versus Designing, Training versus Testing, Characteristics of Machine learning tasks, Predictive and descriptive tasks, Machine learning Models: Geometric Models, Logical Models, Probabilistic Models. Features: Feature types, Feature Construction and Transformation, Feature Selection.

Unit-2: Classification and Regression
Classification: Binary Classification- Assessing Classification performance, Class probability Estimation- Assessing class probability Estimates, Multiclass Classification. Regression: Assessing performance of Regression- Error measures, Overfitting: Catalysts for Overfitting, Case study of Polynomial Regression. Theory of Generalization: Effective number of hypothesis, Bounding the Growth function, VC Dimensions, Regularization theory.

Unit-3: Linear Models
Least Squares method, Multivariate Linear Regression, Regularized Regression, Using Least Square regression for Classification. Perceptron, Support Vector Machines, Soft Margin SVM, Obtaining probabilities from Linear classifiers, Kernel methods for non-Linearity.

Unit-4: Logic Based and Algebraic Models
Distance Based Models: Neighbours and Examples, Nearest Neighbours Classification, Distance based clustering-K means Algorithm, Hierarchical clustering, Rule Based Models: Rule learning for subgroup discovery, Association rule mining. Tree Based Models: Decision Trees, Ranking and Probability estimation Trees, Regression trees, Clustering Trees.

Unit-5: Probabilistic Models
Normal Distribution and Its Geometric Interpretations, Naïve Bayes Classifier, Discriminative learning with Maximum likelihood, Probabilistic Models with Hidden variables: Estimation-Maximization Methods, Gaussian Mixtures, and Compression based Models.
Trends in Machine Learning: Model and Symbols- Bagging and Boosting, Multitask learning, Online learning and Sequence Prediction, Data Streams and Active Learning, Deep Learning, Reinforcement Learning.

Text Books

1. Peter Flach, Machine Learning: The Art and Science of Algorithms that Make Sense of Data, Cambridge University Press, Edition 2012.
2. Hastie, Tibshirani, Friedman: Introduction to Statistical Machine Learning with Applications in R, Springer, 2nd Edition-2012.
3. C. M. Bishop, Pattern Recognition and Machine Learning, Springer 1st Edition-2013.

Reference Books

1. Ethem Alpaydin, Introduction to Machine Learning, PHI 2nd Edition-2013.
2. Parag Kulkarni, Reinforcement and Systematic Machine Learning for Decision Making, Wiley, IEEE Press, Edition July 2012.
3. Weblink: (https://nptel.ac.in/courses/106106139)

Course Outcomes

1. Understand Machine learning and Machine Learning Models.
2. Apply various classification and regression techniques and assess their performance.
3. Design various clustering algorithms for the problems to be solved with machine learning.
4. Analyze assessment of various machine learning models.
5. Create probabilistic learning models and trends in machine learning.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	-	2	-	-	-	-	-	-
CO2	1	3	3	-	3	-	-	-	-	-	-
CO3	3	3	2	-	3	-	-	-	-	-	-
CO4	2	3	3	-	2	-	-	-	-	-	-
CO5	2	3	1	-	2	-	-	-	-	-	-

PATTERN RECOGNITION (NCS-421)

Type	L	T	P	Credits
PEC	2	1	0	3

Course Objectives

This course covers the techniques and gain proficiency of pattern recognition that are fundamental to a wide variety of application areas such as medical research, biometrics, computer vision, etc. It also covers the methodologies, technologies, and algorithms of statistical pattern recognition from a variety of perspectives.

Prerequisite: Fundamental knowledge of, Linear Algebra, Calculus, Probability analysis, and Artificial Intelligence.

Course Content

Unit-1

Introduction: Basics of pattern recognition, Design principles of the pattern recognition system, Learning, and adaptation, Pattern recognition approaches, Mathematical foundations – Linear algebra, Probability Theory, Expectation, mean and covariance, Normal distribution, multivariate normal densities, Chi-squared test.

Unit-2

Statistical Pattern Recognition: Minimum-error-rate classification, Classifiers, Discriminant functions, Decision surfaces, Normal density, and discriminant functions, discrete features.

Unit-3

Parameter estimation methods: Maximum-Likelihood estimation, Bayesian Parameter estimation, Dimension reduction methods - Principal Component Analysis (PCA), Fisher Linear discriminant analysis, Expectation-maximization (EM), Hidden Markov Models (HMM), Gaussian mixture models.

Unit-4

Nonparametric Techniques: Density Estimation, Parzen Windows, K-Nearest Neighbor Estimation, Nearest Neighbor Rule, Fuzzy classification.

Unit-5

Unsupervised Learning & Clustering: Criterion functions for clustering; Algorithms for clustering: K-Means, Hierarchical and other methods; Cluster validation; Gaussian mixture models; Expectation Maximization method for parameter estimation; Maximum entropy estimation.

Text Books

1. R. O. Duda, P. E. Hart and D. G. Stork, Pattern classification, John Wiley & Sons, 2002C. M. Bishop, “Pattern Recognition and Machine Learning”, Springer, first edition, 2009.
2. S. Theodoridis and K. Koutroumbas, “Pattern Recognition”, 4th Edition, Academic Press, 2009.

Reference Books

1. Bishop C. M., “Neural Network for Pattern Recognition”, Oxford University Press, first edition, 1995.
2. Singhal R., “Pattern Recognition: Technologies & Applications”, Oxford University Press, first edition, 2005.
3. V. N. Vapnik, The Nature of Statistical Learning Theory, Springer, first edition, 2000.

Online Source

1. https://nptel.ac.in/courses/117105101
2. https://www.udemy.com/tutorial/technical-analysis-traditional-harmonic-chart-patterns/pattern-recognition-platform/
3. https://www.classcentral.com/course/swayam-pattern-recognition-and-application-14228

Course Outcomes

1. Understand the basics of Pattern recognition. Understand the designing principles and Mathematical foundation used in pattern recognition.
2. Analyze of the statistical pattern Recognition.
3. Understanding the different Parameter estimation methods.
4. Apply the different Nonparametric Techniques
5. Design a unsupervised learning and Clustering in Pattern recognition

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	1	2	-	-	-	-	-	-	-	-
CO2	1	2	3	-	2	-	-	-	-	-	-
CO3	2	2	3	-	2	-	-	-	-	-	-
CO4	1	2	2	-	3	-	-	-	-	-	-
CO5	2	2	3	-	2	-	-	3	-	2	-

SOFTWARE QUALITY ENGINEERING (NCS-423)

Type	L	T	P	Credits
PEC	2	1	0	3

Course Objectives

This course provides the students with a good grasp of software quality metrics and models. The students would learn software testing techniques and software reliability analysis techniques. Demonstrate by means of example – software quality management processes such as quality assurance, verification and validation, and reviews/audits.

Course Content

Unit-1

Introduction: Defining Software Quality, Software Quality Attributes and Specification, Cost of Quality, Defects, Faults, Failures, Defect Rate and Reliability, Defect Prevention, Reduction, and Containment, Overview of Different Types of Software Review, Introduction to Measurement and Inspection Process, Documents and Metrics.

Unit-2

Software Quality Metrics: Product Quality Metrics: Defect Density, Customer Problems Metric, Customer Satisfaction Metrics, Function Points, In-Process Quality Metrics: Defect Arrival Pattern, Phase-Based Defect Removal Pattern, Defect Removal Effectiveness, Metrics for Software Maintenance: Backlog Management Index, Fix Response Time, Fix Quality, Software Quality Indicators.

Unit-3

Software Quality Management and Models: Modeling Process, Software Reliability Models: The Rayleigh Model, Exponential Distribution and Software Reliability Growth Models, Software Reliability Allocation Models, Criteria for Model Evaluation, Software Quality Assessment Models: Hierarchical Model of Software Quality Assessment.

Unit-4

Software Quality Assurance: Quality Planning and Control, Quality Improvement Process, Evolution of Software Quality Assurance (SQA), Major SQA Activities, Major SQA Issues, Zero Defect Software, SQA Techniques, Statistical Quality Assurance, Total Quality Management, Quality Standards and Processes.

Unit-5

Software Verification, Validation & Testing: Verification and Validation, Evolutionary Nature of Verification and Validation, Impracticality of Testing all Data and Paths, Proof of Correctness, Software Testing, Functional, Structural and Error-Oriented Analysis & Testing, Static and Dynamic Testing Tools, Characteristics of Modern Testing Tools.

Text Books

1. Jeff Tian, Software Quality Engineering (SQE), Wiley-Inter Science, first edition, 2005; ISBN 0-471- 71345-7.

References Books

1. Metrics and Models in Software Quality Engineering, Stephen H. Kan, Addison-Wesley, first edition, 2002
2. Weblink: (https://nptel.ac.in/courses/106105150)

Course Outcomes

1. Understand and explain various concepts of software quality engineering measurement and inspection Process.
2. Analyze software configuration management, version control, reverse engineering, defect tracking etc.
3. Design various concepts of Software design and Construct Data Flow Diagrams, Data Dictionaries and UML diagrams for a given software requirement specification.
4. Apply various testing techniques and use these concepts to design optimal test cases.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	3	3	-	-	2	2	-	-
CO2	3	2	3	2	3	2	-	2	-	-	-
CO3	3	1	3	2	3	-	-	3	2	-	-
CO4	3	3	2	2	3	-	-	3	-	-	-

COMPUTER VISION (NCS-425)

Type	L	T	P	Credits
PEC	2	1	0	3

Course Objectives

To introduce students the fundamentals of image formation; To introduce students the major ideas, methods, and techniques of computer vision and pattern recognition; To develop an appreciation for various issues in the design of computer vision and object recognition systems; and to provide the student with programming experience from implementing computer vision and object recognition applications.

Course Contents

Unit-1 IMAGE PROCESSING FOUNDATIONS

Review of image processing techniques, Classical Filtering Operations, Thresholding Techniques, Edge Detection Techniques, Corner and Interest Point Detection, Mathematical Morphology, Texture.

Unit-2 SHAPES AND REGIONS

Binary Shape Analysis, Connectedness, Object Labelling and Counting, Size Filtering, Distance Functions, Skeletons and Thinning, Boundary Tracking Procedures, Contours, Shape Models and Shape Recognition, Boundary Length Measures, Boundary Descriptors, Chain Codes, Moments.

Unit-3 HOUGH TRANSFORM

Line Detection, Hough Transform (HT) For Line Detection, HT Based Circular Object Detection, Ellipse Detection, Case Study: Human Iris Location,

Unit-4 3D VISION AND MOTION

Methods For 3D Vision, Projection Schemes, Shape from Shading, Active Range Finding, Surface Representations, Point-Based Representation, Volumetric Representations, 3D Object Recognition Introduction to Motion, Triangulation, Parametric Motion, Spline-Based Motion

Unit-5 APPLICATIONS

Application: Photo album – Face detection – Face recognition – Eigen faces – Active appearance and 3D shape models of faces Application: Surveillance – foreground-background separation – particle filters tracking, and occlusion – combining views from multiple cameras – human gait analysis Application: In-vehicle vision system: locating roadway – road markings – identifying road signs – locating pedestrians.

Text Books

1. D. L. Baggio et al., ―Mastering OpenCV with Practical Computer Vision Projects‖, Packt Publishing, first edition, 2012.
2. E. R. Davies, Computer & Machine Vision‖, Fourth Edition, Academic Press, 2012.
3. Jan Erik Solem, Programming Computer Vision with Python: Tools and algorithms for analyzing images‖, O'Reilly Media, first edition, 2012.

Reference Books

1. Mark Nixon and Alberto S. Aquado, ―Feature Extraction & Image Processing for Computer Vision‖, Third Edition, Academic Press, 2012.
2. R. Szeliski, ―Computer Vision: Algorithms and Applications‖, Springer, first edition, 2011.
3. Simon J. D. Prince, ―Computer Vision: Models, Learning, and Inference‖, Cambridge University Press, first edition, 2012.
4. Weblink: (https://nptel.ac.in/courses/106105216)

Course Outcomes

1. Understand image processing techniques for computer vision.
2. Create the shape and region analysis.
3. Understand Hough, Transform and apply it to detect lines, circles, ellipses.
4. Apply three-dimensional image analysis techniques and understand concept of motion
5. Design some applications of computer vision algorithms.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	-	1	2	-	-	-	-	-	-
CO2	3	2	2	-	2	-	-	-	-	-	-
CO3	3	2	2	2	2	-	-	-	-	-	-
CO4	3	2	3	-	2	-	-	-	-	-	-
CO5	3	2	-	-	2	-	-	-	-	-	-

VIRTUAL REALITY (NCS-427)

Type	L	T	P	Credits
PEC	2	1	0	3

Course Objectives

Understand how the design of VR technology relates to human perception and cognition. Discuss applications of VR to the conduct of scientific research, training, and industrial design. Gain first-hand experience with using virtual environment technology, including 3D rendering software, tracking hardware, and input/output functions for capturing user data.

Course Contents

Unit-1

Introduction: The three I's of virtual reality, commercial VR technology and the five classic components of a VR system. **Input Devices:** Trackers, Navigation, and Gesture Interfaces, Three-dimensional position trackers, navigation and manipulation, interfaces and gesture interfaces. **Output Devices:** Graphics displays, sound displays & haptic feedback.

Unit-2

Modeling: Geometric modeling, kinematics modeling, physical modeling, behaviour modeling, model management.

Modeling objects and virtual environments Domain Dependent applications: Medical, Visualization, Entertainment, etc. Introduction to VRML Programming

Unit-3

Tele-operation and Augmented Reality Systems, **Human Factors:** Methodology and terminology, user performance studies, VR health and safety issues.

Unit-4

VR Programming: Introducing Java 3D, loading and manipulating external models, using a lathe to make shapes. 3D Sprites, animated 3D sprites, particle systems.

Unit-5

Virtual Reality Applications: Medical applications, military applications, robotics applications.

Text Books

1. Virtual Reality Technology, Second Edition, Gregory C. Burdea& Philippe Coiffet, John Wiley & Sons, Inc.,
2. Virtual Reality Systems, John Vince, first edition, 2002, Pearsn Education.

Reference Books

1. Killer Game Programming in Java, Andrew Davison, Oreilly-SPD, first edition, 2005.
2. Weblink: (https://nptel.ac.in/courses/106106138)

Course Outcome

1. Understand the basics of Virtual Reality and specialized Input Output Devices used in the field.
2. Apply the Modeling for VR Systems using Introductory VRML.
3. Understand Human Factors in VR with special reference to health and safety issues.
4. Analyze VR Programming for basic VR Models,
5. Design VR Applications as used in various Areas.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	3	-	-	-	-	-	-	-	-
CO2	2	1	3	-	-	-	-	-	-	-	-
CO3	2	2	3	-	3	-	-	-	-	-	-
CO4	2	1	1	2	-	2	-	-	-	-	2
CO5	2	1	-	-	-	-	-	-	-	-	-

PROGRAM ELECTIVE-V

ROBOTICS (NCS-402)

Type	L	T	P	Credits
PEC	3	1	0	4

Course Objectives

To understand basic components of robotics, classification of robots and their applications. Expose students to the history and current developments in the field of robotics; Strengthen students' grasp of the mathematics and physics involved in the design, construction and control of robots, with a focus on linear algebra and geometry.

Course Contents

Unit-1

Introduction, Representing Position and Orientation, Spatial description and Transformation, Time and Motion,

Unit-2

Mobile Robots: Mobile Robot Vehicles, Navigation, Localization.

Unit-3

Arm Type Robots: Robot Arm Kinematics, Linear and nonlinear control of Manipulator.

Unit-4

Computer Vision: Light and Colour, Image Formation, Images and Image Processing, Image Feature Extraction, Using Multiple Images

Unit-5

Vision based Control, Advanced Visual Servo Techniques and Applications. Robot Programming Languages and Systems.

Text Books

1. Robotics, Vision, and Control, Peter Corke, Springer, first edition, 2011.
2. Introduction to Robotics, John J. Craig, Addison-Wesley Publishing, Inc., second edition, 1989.
3. Introduction to Robotics, P. J. McKerrow, ISBN: 0201182408, first edition,1991.

Reference Books

1. Modern Robotics: Mechanics, Planning, and Control, Kevin Lynch and Frank Park, Cambridge University Press, first edition, 2017. ISBN: 9781107156302
2. Weblink: (https://nptel.ac.in/courses/112105249)

Course Outcomes

1. Understand the basics of Robotics with reference to spatial and time motion.
2. Design Navigation and Localization related issues for Robotic Control.
3. Create the Robotic Arm Controls of manipulator.
4. Apply Computer Vision and Image Processing related aspects of Robotic Control.
5. Analyze vision based Controls through Robot specific Programming Languages.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	1	2	-	-	-	-	-	-	-	-
CO2	1	2	3	-	2	-	-	-	-	-	-
CO3	2	2	3	-	2	-	-	-	-	-	-
CO4	1	2	2	-	3	-	-	-	-	-	-
CO5	2	2	3	-	2	-	-	3	-	2	-

AGILE SOFTWARE DEVELOPMENT (NCS-404)

Type	L	T	P	Credits
PEC	3	1	0	4

Course Objectives

Explain the purpose behind common agile practices and ability to apply agile principles and values to a given situation. It also demonstrates the ability to participate effectively in agile practices/process for software development.

Course Contents

Unit-1

Theories for Agile Management – Agile Software Development – Traditional Model vs. Agile Model - Classification of Agile Methods – Agile Manifesto and Principles – Agile Project Management – Agile Team Interactions – Ethics in Agile Teams - Agility in Design, Testing – Agile Documentations – Agile Drivers, Capabilities and Values

Unit-2

Lean Production - SCRUM, Crystal, Feature Driven Development- Adaptive Software Development - Extreme Programming: Method Overview – Lifecycle – Work Products, Roles and Practices.

Unit-3

Agile Information Systems – Agile Decision Making - Earl_S Schools of KM – Institutional Knowledge Evolution Cycle – Development, Acquisition, Refinement, Distribution, Deployment, leveraging – KM in Software Engineering – Managing Software Knowledge – Challenges of Migrating to Agile Methodologies – Agile Knowledge Sharing – Role of Story-Cards – Story-Card Maturity Model (SMM).

Unit -4

Impact of Agile Processes in RE–Current Agile Practices – Variance – Overview of RE Using Agile – Managing Unstable Requirements – Requirements Elicitation – Agile Requirements Abstraction Model – Requirements Management in Agile Environment, Agile Requirements Prioritization – Agile Requirements Modeling and Generation – Concurrency in Agile Requirements Generation.

Unit-5

Agile Product Development – Agile Metrics – Feature Driven Development (FDD) – Financial and Production Metrics in FDD – Agile Approach to Quality Assurance - Test Driven Development – Agile Approach in Global Software Development.

Text Books

1. David J. Anderson and Eli Schragenheim, ―Agile Management for Software Engineering: Applying the Theory of Constraints for Business Results‖, Prentice Hall, first edition, 2003.
2. Hazza and Dubinsky, ―Agile Software Engineering, Series: Undergraduate Topics in Computer Science‖, Springer, first edition, 2009.

Reference Books

1. Craig Larman, ―Agile and Iterative Development: A Manager_s Guide‖, Addison-Wesley, first edition, 2004.
2. Kevin C. Desouza, ―Agile Information Systems: Conceptualization, Construction, and Management‖, Butterworth-Heinemann, first edition, 2007.
3. Weblink: (https://nptel.ac.in/courses/110104073)

Course Outcomes

1. Understand the importance of interacting with business stakeholders in determining the requirements for a software system.
2. Understand iterative software development processes: how to plan them, how to execute them.
3. Create the impact of social aspects on software development success.
4. Design techniques and tools for improving team collaboration and software quality.
5. Apply Software process improvement as an ongoing task for development teams.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	2	-	-	-	-	-	-	-	1
CO2	2	2	1	1	1	-	-	-	-	3	1
CO3	2	2	3	1	3	1	1	3	3	3	1
CO4	2	2	1	-	1	-	-	-	-	3	1
CO5	2	2	1	-	1	-	-	-	-	3	1

NATURAL LANGUAGE PROCESSING (NCS-406)

Type	L	T	P	Credits
PEC	3	1	0	4

Course Objectives

Teach students the leading trends and systems in natural language processing. Teach them to recognize the significance of pragmatics for natural language understanding. Enable students to be capable to describe the application based on natural language processing and to show the points of syntactic, semantic and pragmatic processing. Understand approaches to syntax and semantics in NLP. Understand approaches to discourse, generation, dialogue and summarization within NLP.

Course Contents

Unit-1

Overview and Morphology

Introduction, Models and Algorithms, Regular Expressions, Basic Regular Expression, Patterns, Finite State Automata, Morphology, Inflectional Morphology, Derivational Morphology, Finite-State Morphological Parsing, Porter Stemmer

Unit-2

Word Level and Syntactic Analysis

N- grams, Models of Syntax, Counting Words, Unsmoothed N- grams, Smoothing, Backoff Deleted Interpolation, Entropy, English Word Classes, Tag sets for English, Parts of Speech, Tagging-Rule, Based Part of Speech Tagging, Stochastic Part of Speech Tagging, Transformation-Based Tagging

Unit-3

Context Free Grammars

Context Free Grammars for English Syntax, Context- Free Rules and Trees, Sentence- Level Constructions, Agreement, Sub Categorization Parsing, Top-down, Earley Parsing, feature Structures, Probabilistic Context-Free Grammars

Unit-4

Semantic Analysis

Representing Meaning, Meaning Structure of Language, First Order Predicate Calculus, Representing Linguistically Relevant Concepts, Syntax, Driven Semantic Analysis, Semantic Attachments, Syntax, Driven Analyzer, Robust Analysis, Lexemes and Their Senses, Internal Structure, Word Sense Disambiguation, Information Retrieval

Unit-5

Language Generation and Discourse Analysis:

Discourse, Reference Resolution, Text Coherence, Discourse Structure, Coherence, Dialog and Conversational Agents, Dialog Acts, Interpretation, Conversational Agents, Language Generation, Architecture, Surface Realizations, Discourse Planning, Machine Translation, Transfer Metaphor, Interlingua, Statistical Approaches

Text Books

1. Daniel Jurafsky and James H Martin," Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", Prentice Hall, 2nd Edition, 2008.
2. C. Manning and H. Schutze, "Foundations of Processing", MIT Press. Cambridge, MA:,first edition, 1999

Reference Books

1. J. Eisenstein, Introduction to Natural Language Processing, MIT Press, first edition, 2019.
2. D. Jurafsky, J.H. Martin, Speech and Language Processing, 3rd Online Edition (available at https://web.stanford.edu/~jurafsky/slp3/).
3. Weblink: (https://nptel.ac.in/courses/106105158)

Course Outcome

1. Understand the various levels of analysis involved in NLP
2. Apply the word level analysis in NLP
3. Understand the automated Natural Language Generation and Machine Translation
4. Design semantic algorithms in NL
5. Create the NLP applications

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	-	2	-	-	-	-	-	-
CO2	1	3	3	-	3	-	-	-	-	-	-
CO3	3	3	2	-	3	-	-	-	-	-	-
CO4	2	3	3	-	2	-	-	-	-	-	-
CO5	2	3	1	-	2	-	-	-	-	-	-

ADVANCE COMPUTER ARCHITECTURE (NCS-408)

Type	L	T	P	Credits
PEC	3	1	0	4

Course Objectives

Teach students different techniques to estimate, analyze and enhance performance as well as reduce power dissipation of computing systems. To make students know about the Parallelism concepts in Programming. Give the students an elaborate idea about the different memory systems and buses. Introduce the advanced processor architectures to the students. To make the students know about the importance of multiprocessor and multicomputer.

Prerequisite: Computer Organization

Course Contents

Unit-1 Introduction

Introduction to parallel computing, need for parallel computing, parallel architectural classification schemes, Flynn's, Feng's classification, performance of parallel processors, distributed processing, processor and memory hierarchy, bus, cache & shared memory, introduction to super scalar architectures, quantitative evaluation of performance gain using memory, cache miss/hits.

Unit-2 Multi-core Architectures

Introduction to multi-core architectures, issues involved into writing code for multi-core architectures, development of programs for these architectures, program optimizations techniques, building of some of these techniques in compilers, OpenMP and other message passing libraries, threads, mutex etc.

Unit-3 Multi-threaded Architectures

Parallel computers, Instruction level parallelism (ILP) vs. thread level parallelism (TLP), Performance issues: Brief introduction to cache hierarchy and communication latency, Shared memory multiprocessors, General architectures and the problem of cache coherence, Synchronization primitives: Atomic primitives; locks: TTS, ticket, array; barriers: central and tree; performance implications in shared memory programs; Chip multiprocessors: Why CMP (Moore's law, wire delay); shared L2 vs. tiled CMP; core complexity; power/performance; Snoopy coherence: invalidate vs. update, MSI, MESI, MOESI, MOSI; performance trade-offs; pipelined snoopy bus design; Memory consistency models: SC, PC, TSO, PSO, WO/WC, RC; Chip multiprocessor case studies: Intel Montecito and dual-core, Pentium4, IBM Power4, Sun Niagara

Unit-4 Compiler Optimization Issues

Introduction to optimization, overview of parallelization; Shared memory programming, introduction to OpenMP; Dataflow analysis, pointer analysis, alias analysis; Data dependence analysis, solving data dependence equations (integer linear programming problem); Loop optimizations; Memory hierarchy issues in code optimization.

Unit-5: Operating System Issues and Applications

Operating System issues for multiprocessing Need for pre-emptive OS; Scheduling Techniques, Usual OS scheduling techniques, Threads, Distributed scheduler, Multiprocessor scheduling, Gang scheduling; Communication between processes, Message boxes, Shared memory; Sharing issues and Synchronization, Sharing memory and other structures, Sharing I/O devices, Distributed Semaphores, monitors, spin-locks, Implementation techniques on multi-cores; OpenMP, MPI and case studies Case studies from Applications: Digital Signal Processing, Image processing, Speech processing

Text Books

1. Kai Hwang," Advance Computer Architecture", TMH, first edition, 2003.
2. Matthew," Beginning Linux Programming", SPD/WROX, second edition, 1999.

3. Hennessy and Patterson," Computer Architecture: A Quantitative Approach", Elsevier, sixth edition, 2017.

Reference Books

1. Dezso and Sima, "Advanced Computer Architecture", Pearson, first edition, 2002.
2. Quinn, "Parallel Computing: Theory & Practice", TMH, second edition, 2017.
3. Quinn, "Parallel Programming in C with MPI and Open MP", TMH, first edition, 2004.
4. Weblink: (www.openmp.org)

Course Outcomes

1. Understand different processor architectures, system-level design processes and apply the concepts of cache memory & virtual memory to high performance computer architecture.
2. Apply the concept to design pipelined logic/pipelined processors.
3. Design principles of I/O in computer systems, including viable mechanisms for I/O and secondary storage organisation.
4. Analyse various multiprocessing configurations.
5. Apply systems programming skills in the context of computer system design and organisation.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	1	1	-	-	-	-	-	-	-	-
CO2	2	2	1	1	-	-	-	-	-	-	-
CO3	2	1	1	1	-	-	-	-	-	-	-
CO4	2	1	1	-	-	-	-	-	-	-	-
CO5	1	1	1	-	-	-	-	-	-	-	-

CRYPTOGRAPHY AND NETWORK SECURITY (NCS-410)

Type	L	T	P	Credits
PEC	3	1	0	4

Course Objectives

To understand basics of Cryptography and Network Security. It also focuses on the practical applications that have been implemented and are in use to provide email and web security. To be able to secure a message over insecure channel by various means.

Course Contents

Unit-1

Introduction to security attacks, services and mechanism, introduction to cryptography. Conventional Encryption: Conventional encryption model, classical encryption techniques substitution ciphers and transposition ciphers, cryptanalysis, stereography, stream and block ciphers. Modern Block Ciphers: Block ciphers principals, Shannon‟s theory of confusion and diffusion, fiestal structure, data encryption standard (DES), strength of DES, differential and linear crypt analysis of DES, block cipher modes of operations, triple DES, IDEA encryption and decryption, strength of IDEA, confidentiality using conventional encryption, traffic confidentiality, key distribution, random number generation.

Unit-2

Introduction to graph, ring and field, prime and relative prime numbers, modular arithmetic, Fermat's and Euler's theorem, primality testing, Euclid's Algorithm, Chinese Remainder theorem, discrete logarithms. Principals of public key crypto systems, RSA algorithm, security of RSA, key management, Diffie-Hellman key exchange algorithm, introductory idea of Elliptic curve cryptography, Elgamel encryption.

Unit-3

Message Authentication and Hash Function: Authentication requirements, authentication functions, message authentication code, hash functions, birthday attacks, security of hash functions and MACS, MD5 message digest algorithm, Secure hash algorithm (SHA). Digital Text and References Books: Course Outcomes: Signatures: Digital Signatures, authentication protocols, digital signature standards (DSS), proof of digital signature algorithm.

Unit-4

Authentication Applications: Kerberos and X.509, directory authentication service, electronic mail security-pretty good privacy (PGP), S/MIME. Unit-5: IP Security: Architecture, Authentication header, Encapsulating security payloads, combining security associations, key management. Web Security: Secure socket layer and transport layer security, secure electronic transaction (SET). System Security: Intruders, Viruses and related threads, firewall design principals, trusted systems.

Text Books

1. William Stallings, "Cryptography and Network Security: Principals and Practice", Prentice Hall, New Jersy.

Reference Books

1. Johannes A. Buchmann, "Introduction to Cryptography", Springer-Verlag.
2. Bruce Schiener, "Applied Cryptography".
3. Weblink: (https://nptel.ac.in/courses/106105031)

Course Outcomes

1. Understand and deploy cryptographic techniques to secure data in networks.
2. Analyze the vulnerabilities in any computing system and design a security solution.
3. Understand and use standard algorithms for confidentiality, integrity and authenticity.
4. Apply various key distribution and management schemes in network system.
5. Apply security protocols in various IT applications.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	2	1	1	1	1	-	2	2	2
CO2	3	3	2	2	1	1	-	2	2	2	2
CO3	3	3	3	2	2	2	2	2	2	2	3
CO4	2	2	3	2	2	3	1	2	1	2	2
CO5	3	3	2	2	2	2	2	2	2	2	2

OPEN ELECTIVE-III

ROBOTICS (OCS-402)

Type	L	T	P	Credits
PEC	3	1	0	4

Course Objectives

The objective of the course is to enable students to understand robot configuration, structures, basic components, workspace and generations of robots. To provide the details of operations for a variety of sensory devices that are used on robot, the meaning of sensing, classification of sensor, that measure position, velocity & acceleration of robot joint.

Course Contents

Unit-1

Introduction, Representing Position and Orientation, Spatial description and Transformation, Time and Motion,

Unit-2

Mobile Robots: Mobile Robot Vehicles, Navigation, Localization.

Unit-3

Arm Type Robots: Robot Arm Kinematics, Linear and nonlinear control of Manipulator.

Unit-4

Computer Vision: Light and Colour, Image Formation, Images and Image Processing, Image Feature Extraction, Using Multiple Images

Unit-5

Vision based Control, Advanced Visual Servo Techniques and Applications. Robot Programming Languages and Systems.

Text Books

1. Robotics, Vision, and Control, Peter Corke, Springer, first edition, 2011.
2. Introduction to Robotics, John J. Craig, Addison-Wesley Publishing, Inc., second edition, 1989.
3. Introduction to Robotics, P. J. McKerrow, ISBN: 0201182408, first edition,1991.

Reference Books

1. Modern Robotics: Mechanics, Planning, and Control, Kevin Lynch and Frank Park, Cambridge University Press, first edition, 2017. ISBN: 9781107156302
2. Weblink: (https://nptel.ac.in/courses/112105249)

Course Outcomes

1. Understand the basics of Robotics with reference to spatial and time motion.
2. Create Navigation and Localization related issues for Robotic Control.
3. Understand the Robotic Arm Controls of manipulator.
4. Design the concept computer Vision and Image Processing related aspects of Robotic Control.
5. Apply Vision based Controls through Robot specific Programming Languages.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	1	2	-	-	-	-	-	-	-	-
CO2	1	2	3	-	2	-	-	-	-	-	-
CO3	2	2	3	-	2	-	-	-	-	-	-
CO4	1	2	2	-	3	-	-	-	-	-	-
CO5	2	2	3	-	2	-	-	3	-	2	-

DATA SCIENCE (OCS-404)

Type	L	T	P	Credits
OEC	2	0	0	2

Course Objectives

To recognize and analyze ethical issues in business related to intellectual property, data security, integrity, and privacy. Apply principles of Data Science to the analysis of business problems. Employ cutting edge tools and technologies to analyze Big Data. Apply algorithms to build machine intelligence. Demonstrate use of team work, leadership skills, decision making and organization theory.

Course Contents

Unit-1

Introduction to Data Science: Basics of Data Science Data science, Data Analytics, Machine Learning (Supervised, Unsupervised Learning & reinforcement), Deep Learning (Artificial Neural Networks, CNN), Working with data sources – (SQL Server, .csv file, excel file etc.), Real world Applications of Machine Learning & Deep Learning, Scope of Data Science.

Unit-2

Data Analysis Data Definitions and Analysis Techniques: Elements, Variables, and Data categorization; Levels of Measurement; Data management and indexing; Introduction to statistical learning and Python Programming Descriptive Statistics; Measures of central tendency; Measures of location of dispersions; Basic analysis techniques: Statistical hypothesis generation and testing; Chi-Square test; t-Test; Analysis of variance; Correlation analysis; Maximum likelihood test; Data analysis techniques: Regression analysis; Classification techniques; Clustering; Association rules analysis

Unit-3

Data Modelling Data Modelling: Introduction; Uses of Data Modelling Tools; Three Perspectives of a Data Model; Data Modelling Techniques: Linear Regression; Non-linear models; Supported Vector Machines.

Unit-4

Data Manipulation and Visualization: Understanding Pandas and its architecture, getting to know Series and Data Frames, Columns and Indexes, Getting Summary Statistics of the Data, Data Alignment, Ranking & Sorting, Combining/Splitting Data Frames, Reshaping, Grouping, Data visualization (Scatter Plot, Histogram, Bar chart, Pie chart etc.)

Unit-5

Applications of Data Science CASE STUDIES: Banking Case Study: Applications of Analytics in the Banking Sector; Predicting Bank-Loan Default; Predicting Fraudulent Activity; Logistic Regression Model; Telecommunication Case Study: Types of Telecommunications Networks; Role of Analytics in the Telecommunications Industry; Predicting Customer Churn-Network Analysis and Optimization-Fraud Detection.

Text Books

1. Lillian Pierson, “Data Science for Dummies”, For Dummies; 2nd edition, 2017.
2. Joel Grus, “Data Science from Scratch: First Principles with Python”, Shroff/O'Reilly; Second edition, 2016.
3. Jake VanderPlas, “Python Data Science Handbook Essential tools for Working with Data”, first edition, 2016.
4. Allen B. Downey, “Think Stats Exploratory Data Analysis in Python”, Green Tea Press, first edition, 2014.

Reference Books

1. Wes McKinney, “Python for Data Analysis: Data Wrangling with Pandas and Python”, first edition, 2017
2. John D. Kelleher and Brendan Tierney “Data Science” The MIT Press; Illustrated edition, 2018.
3. Andrew Oleksy, “Data Science with R: A Step-by-Step Guide with Visual Illustrations & Examples”, first edition, 2018.
4. Nina Zumel and John Mount, “Practical Data Science with R”, Dreamtech/Manning, first edition, 2014.
5. Roger D. Peng, “R Programming for Data Science”, first edition, Lean publishing, 2015.
6. Weblink: (https://nptel.ac.in/courses/106106179)

Course Outcomes

1. Creates relevant programming abilities in the student.
2. Creates proficiency with statistical analysis of data.
3. Design the ability to build and assess data-based models.
4. Apply statistical analyses with professional statistical software.
5. Understand demonstrates skill in data management.
6. Analyze data science concepts and methods to solve problems in real-world contexts and will communicate these solutions effectively.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	2	3	-	-	-	-	-	2
CO2	3	3	3	3	2	-	-	-	-	-	2
CO3	3	3	3	3	2	-	-	-	-	-	3
CO4	3	3	3	2	3	-	-	-	-	-	2
CO5	3	3	3	2	3	-	-	-	-	-	2
CO6	3	3	3	2	3	-	-	-	-	-	2

MACHINE LEARNING (OCS-406)

Type	L	T	P	Credits
PEC	2	1	0	3

Course Objectives

The main objective of this course is to enabling the student with basic knowledge on the techniques to build an intellectual machine for making decisions behalf of humans. This course covers the techniques on how to make learning by a model, how it can be evaluated, what are all different algorithms to construct a learning model.

Course Contents

Unit-1: Introduction to Machine Learning

Why Machine learning, Examples of Machine Learning Problems, Structure of Learning, learning versus Designing, Training versus Testing, Characteristics of Machine learning tasks, Predictive and descriptive tasks, Machine learning Models: Geometric Models, Logical Models, Probabilistic Models. Features: Feature types, Feature Construction and Transformation, Feature Selection.

Unit-2: Classification and Regression

Classification: Binary Classification- Assessing Classification performance, Class probability Estimation- Assessing class probability Estimates, Multiclass Classification. Regression: Assessing performance of Regression- Error measures, Overfitting: Catalysts for Overfitting, Case study of Polynomial Regression. Theory of Generalization: Effective number of hypotheses, Bounding the Growth function, VC Dimensions, Regularization theory.

Unit-3: Linear Models

Least Squares method, Multivariate Linear Regression, Regularized Regression, Using Least Square regression for Classification. Perceptron, Support Vector Machines, Soft Margin SVM, Obtaining probabilities from Linear classifiers, Kernel methods for non-Linearity.

Unit-4: Logic Based and Algebraic Models

Distance Based Models: Neighbours and Examples, Nearest Neighbours Classification, Distance based clustering-K means Algorithm, Hierarchical clustering, Rule Based Models: Rule learning for subgroup discovery, Association rule mining. Tree Based Models: Decision Trees, Ranking and Probability estimation Trees, Regression trees, Clustering Trees.

Unit-5: Probabilistic Models

Normal Distribution and Its Geometric Interpretations, Naïve Bayes Classifier, Discriminative learning with Maximum likelihood, Probabilistic Models with Hidden variables: Estimation-Maximization Methods, Gaussian Mixtures, and Compression based Models.

Trends in Machine Learning: Model and Symbols- Bagging and Boosting, Multitask learning, Online learning and Sequence Prediction, Data Streams and Active Learning, Deep Learning, Reinforcement Learning.

Text Books

1. Peter Flach, Machine Learning: The Art and Science of Algorithms that Make Sense of Data, Cambridge University Press, Edition 2012.
2. Hastie, Tibshirani, Friedman: Introduction to Statistical Machine Learning with Applications in R, Springer, 2nd Edition-2012.
3. C. M. Bishop, Pattern Recognition and Machine Learning, Springer 1st Edition-2013.

Reference Books

1. Ethem Alpaydin, Introduction to Machine Learning, PHI 2nd Edition-2013.
2. Parag Kulkarni, Reinforcement and Systematic Machine Learning for Decision Making, Wiley, IEEE Press, Edition July 2012.
3. Weblink: (https://nptel.ac.in/courses/106106139)

Course Outcomes

1. Understand Machine learning and Machine Learning Models.
2. Apply various classification and regression techniques and assess their performance.
3. Design various clustering algorithms for the problems to be solved with machine learning
4. Analyze assessment of various machine learning models.
5. Create probabilistic learning models and trends in machine learning.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	-	2	-	-	-	-	-	-
CO2	1	3	3	-	3	-	-	-	-	-	-
CO3	3	3	2	-	3	-	-	-	-	-	-
CO4	2	3	3	-	2	-	-	-	-	-	-
CO5	2	3	1	-	2	-	-	-	-	-	-

SEMINAR (NCS-471) & INDUSTRIAL REPORT (NCS-481)

Type	L	T	P	Credits
Seminar	0	0	4/4	2/2

Course Objectives

The purpose of Industrial Training is to expose students to real work of environment experience and at the same time, to gain the knowledge through hands on observation and job execution. From the industrial training, the students will also develop skills in work ethics, communication, management and others. Moreover, this practical training program allows students to relate theoretical knowledge with its application in the manufacturing industry.

Course Contents

As a part of academic curriculum, students undergo industrial training/internship of 4-6 weeks after completion of III-year B. Tech. program during summer vacations. The main objectives of the industrial training are: -

1. To give students the opportunity to apply the acquired knowledge and skills in development of a real-life project.
2. To provide students with an opportunity of practical and hands-on learning from practitioners in the students' field of study.
3. To provide the students the exposure of the work environment, common practices, employment opportunities and work ethics in the relevant field of study.
4. To inculcate presentation and soft skills relevant to the needs of employers.
5. To provide an opportunity of offered jobs in the organization where they undergo Industrial Training.

Course Outcomes

1. Understand their knowledge and skills relevant to their area of study.
2. Design the knowledge and skills acquired at the workplace, to their on-campus studies.
3. Analyze effectively in the job market, because they have been equipped with the requisite knowledge, skills, attitudes and practical experience

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	3	3	3	2	3	3	2	3
CO2	3	3	3	3	3	3	2	2	3	2	3
CO3	3	3	3	2	3	3	2	3	3	2	3

MINOR PROJECT (NCS-491)

Type	L	T	P	Credits
Project	0	0	12	6

Course Objectives

To gain insight to current industrial trends, identify solvable and feasible solutions for problems of interest of mankind. Get exposure to all stages of project development, gain research insight and develop coding skills.

Course Content

The practical implementation of theoretical knowledge gained during the study from first year to third year. Students are required to implement their original ideas, modification/enhancement of the existing engineering techniques, real time industrial problems, and current applications of their courses of study. Projects work can be of two types: Projects based on implementation of any application oriented problem which will be more or less experimental in nature and the others will be based on some innovative/ theoretical work.

The project work may be carried out in two modes: -

1. **In-house Project:** The project work assigned by some Faculty member of the department which will have to be carried out during VII and VIII semesters along with regular course of study. It is expected that the complete SRS document will be prepared during VII semester and design & implementation work will be done in the VIII semester.
2. **Industrial Project:** Student will work on a problem assigned by some industry under the guidance and supervision of some industrial practitioner. The first phase of the work related to SRS document etc. will be completed during VII semester in the department along with the regular course of study. But the design & implementation work will be done in the respective industry itself during the VIII semester.

Course Outcomes

1. Design preparedness to work independently on real time problem scenarios to be addressed using knowledge of fundamentals, techniques, programming languages and tools in the area of Computer Science & Engineering. (Analyze, Create)
2. Create innovative ideas and thoughts to address real life issues and provide efficient solutions for process-oriented work

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	3	3	3	2	2	2	2	2	3	3
CO2	1	3	3	3	2	2	2	3	2	3	3

PROJECT (NCS-492)

Type	L	T	P	Credits
PROJECT	0	0	32	16

Course Objectives

To gain insight to current industrial trends, identify solvable and feasible solutions for problems of interest of mankind. Get exposure to all stages of project development, gain research insight and develop coding skills.

Course Content

The practical implementation of theoretical knowledge gained during the study from first year to third year. Students are required to implement their original ideas, modification/enhancement of the existing engineering techniques, real time industrial problems, and current applications of their courses of study. Projects work can be of two types: Projects based on implementation of any application - oriented problem which will be more or less experimental in nature and the others will be based on some innovative/ theoretical work.

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Course Outcomes

1. Design preparedness to work independently on real time problem scenarios to be addresses using knowledge of fundamentals, techniques, programming languages and tools in the area of Computer Science & Engineering. (Analyze, Create)
2. Create the innovative ideas and thoughts to address real life issues and provide efficient solutions for process-oriented works.

CO and PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	3	3	3	2	2	2	2	2	3	3
CO2	1	3	3	3	2	2	2	3	2	3	3