Delhi Technological University

(Formerly Delhi College of Engineering)

DEPARTMENT OF SOFTWARE ENGINEERING

Bachelor Of Technology

B. Tech. Software Engineering														
I Year: First Semester														
Teaching Scheme					Contact Hours/Week			Exam Duration (h)		Relative Weights (%)				
S. No.	Subject Code	Course Title	Subject Area	Credit	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
1	AM101	Mathematics – I	BSC	4	3	1	0	3	0	25	-	25	50	-
2	AP101	Physics	BSC	4	3	0	2	3	0	15	25	20	40	-
3	EC101	Basic Electronics & Communication Engineering	ESC	4	3	0	2	3	0	15	25	20	40	-
4	EE101	Basic Electrical Engineering-I	ESC	4	3	0	2	3	0	15	25	20	40	-
5	SE103	Computer Workshop-I	SEC	2	0	0	4	0	3	-	50	-	-	50
6	AEC/VAC	AEC-1/VAC-1	AEC/VAC	2	2/1/0	0	0/2/4	2/2/0	0/0/3	25/15/0	0/25/50	25/20/0	50/40/0	0/0/50
Total				20										

B. Tech. Software Engineering														
I Year: Second Semester														
1	AM102	Mathematics-II	BSC	4	3	1	0	3	0	25	-	25	50	-
2	CO102	Programming Fundamentals	ESC	4	3	0	2	3	0	15	25	20	40	-
3	SE102	Fundamentals of Computers	ESC	4	3	0	2	3	0	15	25	20	40	-
4	SE104	Fundamentals of Software Engineering	DCC	4	3	1	0	3	0	25	-	25	50	-
5	SE106	Computer Workshop-II	SEC	2	0	0	4	0	3	0	50	-	-	50
6	AEC/VAC	AEC-2/VAC-2	AEC/VAC	2	2/1/0	0	0/2/4	2/2/0	0/0/3	25/15/0	0/25/50	25/20/0	50/40/0	0/0/50
Total				**20**										

B. Tech. Software Engineering														
II Year: Third Semester														
Teaching Scheme					**Contact Hours/Week**			**Exam Duration (h)**		**Relative Weights (%)**				
S. No.	**Subject Code**	**Course Title**	**Subject Area**	**Credit**	**L**	**T**	**P**	**Theory**	**Practical**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
1	SE201	Digital Systens & Design	ESC	4	3	0	2	3	0	15	25	20	40	-
2	SE203	Data Structures	DCC	4	3	0	2	3	0	15	25	20	40	-
3	SE205	Object-Oriented Programming	DCC	4	3	0	2	3	0	15	25	20	40	-
4	SE207	Operating System	DCC	4	3	0	2	3	0	15	25	20	40	-
5	SE209	Software Engineering Methodologies	DCC	4	3	0	2	3	0	15	25	20	40	-
6	AEC/VAC	AEC/VAC	AEC/VAC	2	2/1/0	0	0/2/4	3/3/0	0/2/3	25/15/0	0/25/50	25/20/0	50/40/0	0/0/50
7	MS299	Community Engagement Course	Mandatory	2										
Total				**24**										

B. Tech. Software Engineering														
II Year: Fourth Semester														
1	SE202	Computer System Architecture	ESC	4	3	0	2	3	0	15	25	20	40	-
2	SE204	Object-Oriented Software Engineering	DCC	4	3	0	2	3	0	15	25	20	40	-
3	SE206	Machine Learning	DCC	4	3	0	2	3	0	15	25	20	40	-
4	SE208	Database Mangement Systems	DCC	4	3	0	2	3	0	15	25	20	40	-
5	MSE210	Algorithm Design and Analysis	DCC	4	3	1	0	3	0	25	-	25	50	-
6	AEC/VAC	AEC/VAC	AEC/VAC	2	2/1/0	0	0/2/4	3/3/0	0/2/3	25/15/0	0/25/50	25/20/0	50/40/0	0/0/50
Total				**22**										

B. Tech. Software Engineering														
III Year: Fifth Semester														
Teaching Scheme					**Contact Hours/Week**			**Exam Duration (h)**		**Relative Weights (%)**				
S. No.	**Subject Code**	**Course Title**	**Subject Area**	**Credit**	**L**	**T**	**P**	**Theory**	**Practical**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
1	SE301	Software Testing	DCC	4	3	0	2	3	0	15	25	20	40	-
2	SE303	Software Quality and Metrics	DCC	4	3	0	2	3	0	15	25	20	40	-
3	SE305	Computer Networks	DCC	4	3	0	2	3	0	15	25	20	40	-
4	HU301	Engineering Economics / Fundamentals of Management	SEC	3	3	0	0	3	0	25	-	25	50	-
5	SE3XX	Departmental Elective Course -1	DEC	4	3/3	0/1	2/0	3	0	15/25	25/-	20/25	40/50	-
6	GEC	General Elective Course -1	GEC	4	3/3	0/1	2/0	3	0	15/25	25/-	20/25	40/50	-
Total				**23**										

B. Tech. Software Engineering														
III Year: Sixth Semester														
1	SE302	Empirical Software Engineering	DCC	4	3	0	2	3	0	15	25	20	40	-
2	SE304	Compiler Design	DCC	4	3	1	0	3	0	25	-	25	50	-
3	HU302	Fundamentals of Management / Engineering Economics	SEC	3	3	0	0	3	0	25	-	25	50	-
4	SE3XX	Departmental Elective Course -2	DEC	4	3/3	0/1	2/0	3	0	15/25	25/-	20/25	40/50	-
5	SE3XX	Departmental Elective Course -3	DEC	4	3/3	0/1	2/0	3	0	15/25	25/-	20/25	40/50	-
6	GEC	General Elective Course -2	GEC	4	3/3	0/1	2/0	3	0	15/25	25/-	20/25	40/50	-
Total				**23**										

B. Tech. Software Engineering														
IV Year: Seventh Semester														
Teaching Scheme					Contact Hours/Week			Exam Duration (h)		Relative Weights (%)				
S. No.	Subject Code	Course Title	Subject Area	Credit	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
1	SE401	B. Tech Project-I	DCC	4	-	-	-	-	-	-	40	-	-	60
2	SE403	Internship	DCC	2	-	-	-	-	-	-	40	-	-	60
3	SE4XX	Departmental Elective Course -4	DEC	4	3/3	0/1	2/0	3	0	15/25	25/-	20/25	40/50	-
4	SE4XX	Departmental Elective Course -5	DEC	4	3/3	0/1	2/0	3	0	15/25	25/-	20/25	40/50	-
5	GEC	General Elective Course -3	GEC	4	3/3	0/1	2/0	3	0	15/25	25/-	20/25	40/50	-
6	AEC/VAC	Indian Knowledge System	VAC	Non Credit										
Total				18										

B. Tech. Software Engineering														
IV Year: Eighth Semester														
1	SE402	B. Tech Project-II	DCC	8	-	-	-	-	-	-	40	-	-	60
2	SE4XX	Departmental Elective Course -6	DEC	4	3/3	0/1	2/0	3	0	15/25	25/-	20/25	40/50	-
3	GEC	General Elective Course -4	GEC	4	3/3	0/1	2/0	3	0	15/25	25/-	20/25	40/50	-
Total				**16**										
Cumulative Total				**166**										

B. Tech. Software Engineering Department Electives		
S. No.	**Subject Code**	**Course Title**
Departmental Elective Course -1 (Semester - 5)		
1	SE307	Software Requirement Engineering
2	SE309	Computer Graphics
3	SE311	Information Theory and Coding
4	SE313	Digital Signal Processing
5	SE315	Advanced Data Structures
6	SE317	Microprocessor & Interfacing
7	SE319	Distributed Systems
8	SE321	Soft Computing
9	SE323	Artificial Intelligence
10	SE325	Theory of Computation
11	SE327	Web Technology
12	SE329	Methods for Data Analysis
13	SE331	Predictive Modeling
14	SE333	Minor Project (Only for students who opt for Minor)
Departmental Elective Course -2, Departmental Elective Course -3 (Semester - 6)		
15	SE306	Software Reliability
16	SE308	Multimedia Systems
17	SE310	Parallel Computer Architecture

18	SE312	Bio-Informatics
19	SE314	Natural Language Processing
20	SE316	Advanced Database Management Systems
21	SE318	Data Compression
22	SE320	Real Time Systems
23	SE322	Parallel Algorithms
24	SE324	Probability and Statistics
25	SE326	Business Analytics
Departmental Elective Course -4, Departmental Elective Course -5 (Semester - 7)		
26	SE405	Software Maintenance
27	SE407	Discrete Structures
28	SE409	Grid & Cluster Computing
29	SE411	Pattern Recognition
30	SE413	Agile Software Process
31	SE415	Cyber-Forensics
32	SE417	Robotics
33	SE419	Wireless and Mobile Computing
34	SE421	Intellectual Property Rights & Cyber Laws
35	SE423	Software Project Management
36	SE425	Data Warehouse & Data Mining
Departmental Elective Course -6 (Semester - 8)		
37	SE404	Advances in Software Engineering
38	SE406	Information & Network Security
39	SE408	Swarm & Evolutionary Computing

40	SE410	Semantic Web and Web Mining
41	SE412	Cloud Computing
42	SE414	Big Data Analytics
43	SE416	Data Management and Ethics

DELHI TECHNOLOGICAL UNIVERSITY
DEPARTMENT OF SOFTWARE ENGINEERING
B.TECH 1st YEAR SYLLABUS

Departmental Core Course

Course Title: Basics of Software Engineering

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Basics of Software Engineering	3	0	2	Nil

Course Objective:
Students of Software Engineering are to work with software in the company. Students should get familiar with the basic knowledge software engineering for developing a product. This course will provide students a sufficient knowledge of software development models, categories of software requirements, criterion for designing an efficient software. Thus, this course will enable students to develop a software according to user requirements using appropriate software development process.

Course Outcome (CO):
After completing their course in Basics of Software Engineering, students will be able to
CO1. Describe the phases of software development life cycle for designing an efficient software.
CO2. Identification of user requirements using various requirements elicitation techniques.
CO3. Describe the procedure of designing software requirement specification for designing software as per user requirements.
CO4. Describe the basics of software design using various techniques.

S.No.	Content	Contact Hours
Unit 1	Introduction: Software, Program, Software Crisis, Software Processes, Software Characteristics, Software Myths, Software basic terminologies.	08
Unit 2	Software life cycle models: Build and Fix, Waterfall, Prototype, Iterative Enhancement, Rapid Application Development, Evolutionary, Prototyping, and Spiral Model. Unified Process: Phases, Iterations, and Workflow. Selection of a Life Cycle Model.	08
Unit 3	Software Requirements Analysis and Specifications: Requirement Engineering, Types of Requirements. Requirement Elicitation: Interview, Brainstorming, Quality Functional Deployment, Use Case Approach.	08
Unit 4	Requirements Analysis: Problem Analysis, Data Flow Diagrams, Data Dictionaries, Entity-	10

	Relationship diagrams, Requirements Documentation, Requirements Validation, Software Requirement and Specifications, Requirements Management, Change Management Form, Structure of SRS, Software Prototyping	
Unit 5	Software Design: Design framework, Conceptual and Technical Design, Trade-off between modularity and software cost, Cohesion and Coupling, Types of Cohesion and Coupling, strategy of design, Structure chart, IEEE standard 1016-1998 for Software Design Description.	08
	Total	42

Books:-

S.No.	Name of Books/Authors/Publisher
1.	Software Engineering, K. K. Aggarwal and Yogesh Singh, New Age International Private Limited; Fourth edition.
2.	Software Engineering – A practitioner's approach, R. S. Pressman, 6th ed., McGraw Hill Int. Ed.
3.	Software Engineering Concepts, Richard Fairley, McGraw Hill Education.
4.	An Integrated Approach to Software Engineering, Pankaj Jalote, Narosa.
5.	Software Engineering, Ian Sommerville, Pearson Education; Tenth edition.

Details of Course:

Interdisciplinary Core Course - 3

Course Title: Fundamentals of Computers

Course Title	Course Structure			Pre-Requisite
Fundamentals of Computers	**L**	**T**	**P**	**Nil**
	3	**0**	**2**	

Course Objective:
Everyday, engineering students required to work with computer for problem solving in academia, research, and industry. Students will get knowledge about the evolution of computer, computer architecture, input devices, output devices, computer codes, computer software, operating system, programming language, and internet. Thus, students will be able to learn about the importance of data storage in the computer and computer arithmetic. With the help of this course, the student will be able to understand the functioning of computer units, and storage of data in the computer.

Course Outcome (CO):
After completing their course in Fundamentals of Computer, students will be able to
CO1. Describe the procedure of designing algorithm and drafting pseudocode for problem solving.
CO2. Describe the computer organization and architecture of central processing unit.
CO3. Describe the computer codes, computer arithmetic and number conversion system.
CO4. Describes the procedure of installing functionalities and installation of different operating system, software.
CO5. Demonstrate steps to write a basic program for solving real world problems using high-level language.

S.No.	Content	Contact Hours
Unit 1	Introduction: Evolution of Computers, Generation of Computers, Classification of Computers, Computing Concepts, The Computer System, Applications of Computers. Computer Organization and Architecture: Central Processing Unit, Internal Communications, Machine Cycle, The Bus and Instruction Set.	8
Unit 2	Memory and Storage Systems: Memory Representation, Random Access Memory, Read Only Memory, Storage System - Magnetic, Optical, Magneto, Solid State, Storage evaluation criteria. Input Devices. Output Devices	8
Unit 3	Computer Codes: Decimal System, Binary System, Hexadecimal system, Octal System, 4-bit	10

	Binary Coded Decimal,8-bit BCD System, 16-bit Unicode, Conversion of Numbers. Computer Arithmetic. Boolean Algebra. Logic Gates and Digital Circuits.	
Unit 4	Computer Software: Types of Computer Software, System Management Program, System Development Programs, Standard Application Programs. Operating System: History of Operating System, Functions of Operating System, Process Management, Memory Management, File Management, Device Management, Security Management, Types of Operating System.	8
Unit 5	Programming Languages: History of Programming Languages, Generation of Programming languages, Characteristics of Good Programming Language, Categorization of High-level languages. Internet and World Wide Web.	8
	Total	42

Books:-

S.No.	Name of Books/Authors/Publisher
1.	Fundamentals of Computer Science, Balaguruswamy, McGraw Hill Education (India) Private Ltd.
2.	Fundamentals of Computers, V. Rajaraman, PHI
3.	Handbook of Computer Fundamentals, Nasib Singh, Khanna Books Publishing Co. (P) Ltd.
4.	Computer Fundamentals, P.K. Sinha, BPB Publication.
5.	Introduction to Computer, Norton Peter, McGraw-Hill.

Details of Course:

Course Title: Skill Enhancement Course 1

Course Title	Course Structure			Pre-Requisite
Computer Workshop 1	**L**	**T**	**P**	**Nil**
	0	**0**	**4**	

Course Objective:
Students of Software Engineering are to work with various hardware and software not only in academia but also in the company. Thus, students should get familiar with various hardware, software, operating systems, and networking. This course will provide students a much-needed knowledge of computer hardware and networking, enabling them to identify and rectify onboard computer hardware, software, and network-related problems. With the help of this course, the student will be able to understand the hardware specifications that are required to run an operating system and various application programs.

Course Outcome (CO):
After completing their training in Computer Workshop, students will be able to
CO1. Describe the procedure for installation of software on different systems and identify the various components of hardware systems.
CO2. Identify and demonstrate components of computer and operating system and their troubleshooting.
CO3. Describe the basics of Internet and web design
CO4. Perform the process of software installation

S.No.	Content	Contact Hours
Unit 1	Assembly/Disassembly of Computers: Hardware peripherals like RAM, ROM, input devices, output devices, processors, etc. Processors and processor core counts and frequency etc. motherboards, internal and external connectors. Types of data cables. LAN, Audio, and Video. The physical set-up of Printers- Scanner set-up, Webcam, Bluetooth device, Memory card reader, etc. Working of SMPS. Connection of different types of devices to the ports (CPU), Single board computer: Raspberry Pi. Assembly/Dis-assembly of Laptop: Mounting of processor. Fixing of the motherboard in the tower case. Connection to the power supply. Installation of drivers. Connection of cables. Mount the memory modules. Install the internal cards. Connection of the external devices and power.	2
Unit 2	Computer Network Setup: Networking	4

	components, devices, and tools; Preparing the network cables, network setup, configuration and management commands, Installation and configuration of network interface card and identification of MAC address. Sharing of resources Software Installations: Installation of Windows Operating System, Types of software and their installations, some useful software (MS office, Adobe Acrobat, Google Chrome, VLC Media Player, LibreOffice, Win Rar)	
Unit 3	PC Maintenance: POST (Power on Self-Test), identifying problems by Beep codes errors, checking power supply using Multi-meter, Replacement of components etc. Introduction to MS office: Introduction to MS office - MS Word, MS PPT, MS Excel, Working with MS Word. MS Excel - Introduction to MS Excel, Basic computations, and calculations. Creation of slides including hyperlink, video, audio, and textual content.	4
Unit 4	Tools for Online Teaching and Meetings: Setting & troubleshooting of online meetings and video conferencing like google meet, zoom, Microsoft teams, Webex etc; use of google classroom and google forms for teaching, feedback, and evaluation. Internet and Basic Webpage Design: Searching the Internet, checking the speed of Internet connection, usage of E-Commerce, Creating webpage using HTML, CSS with static text, images, tables, audio, video etc and dynamic contents, animation usage and tools for webpages	4
Unit 5	AI & ML Applications: Case studies using module (Blackbox based) integration for AI & ML and its applications	2
	Total	16

Details of Course:

Course Title: Skill Enhancement Course 2

Course Title	Course Structure			Pre-Requisite
Computer Workshop 2	L	T	P	Nil
	0	0	4	

Course Objective:
Students of Software Engineering require to develop software or product for solving real world problems in academia, and industry. Thus, this course will teach the process of developing a software with feasible solution. Students will gain knowledge about storing the data in a system, using diagrammatic representation and establishing relationship among different attributes of a data. This course will help them in understanding diagrammatically the flow of data among different modules. With the help of this course, students will be able to understand the importance of analyzing problem and it's solution from developer and customer perspective**.**

Course Outcome (CO):
After completing their training in Software Engineering Workshop, students will be able to
CO1. Demonstrate the modelling of data stored in a database.
CO2. Demonstrate the way information is flowing through the system.
escribe the procedure for designing data flow diagram and context diagram.
CO3. Describe the process of interaction among external entities with an internal software system.
CO4. Demonstrate the process of collecting requirements form the user for software development.

S.No.	Content	Contact Hours
Unit 1	Entity Relationship (ER) Diagram: ER Diagram Representation, Generalization, Aggregation, Codd's Rule, Relational Data Model, Relational Algebra. ER to Relational Model.	2
Unit 2	Data Flow Diagrams: Symbols used for constructing DFD, Synchronous and Asynchronous Operations, Data Dictionary, DFD model of a system consisting of hierarchy of DFDs, construction of context diagram, construction of level1 diagram, construction of lower-level diagrams, construction of level 2 diagrams, data dictionary for the DFD model.	4
Unit 3	Structure Chart: Extension of DFD technique for designing real-time systems, Structured design, transformation of a DFD Model into structure chart, transform analysis, transaction analysis, and detailed design.	4
Unit 4	Microsoft Excel: Manage workbook options and settings, apply custom data formats and layouts,	4

	create tables, perform operations with formulas and functions, create charts and objects, manage workbook options and settings, apply advanced conditional formatting and filtering, prepare a workbook for internationalization, create advanced formula, perform data analysis, troubleshoot problems, create and manage pivot tables, create and manage pivot charts.	
Unit 5	Microsoft PowerPoint: Introduction, windows features, presentation slides, create slide presentation, editing techniques, slide master, format slide, transitions and animation, slide illustration and shapes, slide show, print presentation.	2
	Total	16

DELHI TECHNOLOGICAL UNIVERSITY

DEPARTMENT OF SOFTWARE ENGINEERING

B.TECH. 2nd YEAR SYLLABUS

Course Title	Course Structure			Pre-Requisite
EC252 Digital Systems & Design	L	T	P	Concepts of Boolean Algebra, basic Logic gates
	3	0	2	

Course Objective:
To introduce the concepts of digital logic, functioning and design of digital devices, Programmable Devices, memory, and digital system design using VHDL.

Course Outcome (CO):
1. Apply knowledge of minimization techniques to switching functions, and realization of FSM.
2. Apply synchronous sequential logic concept for designing Finite state machines.
3. Apply Asynchronous sequential logic concepts for designing circuits from given statements and apply ASM concepts for designing digital circuits.
4. Understand the concept of various ADC and DAC conversion and various techniques and designing circuits using programmable logic devices.
5. Understand the concept of HDL and demonstrate its knowledge by designing various digital systems.
6. Understand the concept of various logic families and their parameters.

S.No.	Content	Contact Hours
Unit 1	Review of basic concepts of switching functions, and minimization techniques (Karnaugh's Map Method & Tabulation Techniques). Introduction to finite state machine: pulse and fundamental mode of operation, realization of state table from verbal description, state diagram & Transition matrix, Mealy and Moore model machine.	8
Unit 2	Design of sequential circuits: Flip Flops, Shift Registers, Ring counters, Up-Down counters, Asynchronous counters, decade counters.	8
Unit 3	Introduction to design asynchronous sequential circuit flow table realization from verbal description, ASM charts.	8
Unit 4	Concept of Digital to Analog Conversion Ladder Networks, and Concept of Analog to Digital conversion: Dual Slope method, stair case Ramp-method/counter method successive approximation	8

	type of A/D converters etc. Introduction to design with the programmable modules: ROM, PAL, PLA, FPGA .	
Unit 5	Introduction to HDL (VHDL), Behavioral Modeling, Dataflow Modeling, Structural Modeling, and Application in Digital System Designs.	6
Unit 6	Introduction Logic Gates Families TTL, Tristate Logic, ECL, CMOS and I^2L Logic, Logic parameters, Bistable, Monostable, Astable and Schmitt trigger circuit	4
	Total	42

Books:-

S.No.	Name of Books/Authors/Publisher
1.	Thomas L. Floyd, Digital Fundamentals, 10thEdition, Pearson Education, ISBN-13: 9780132359238, 2009.
2.	M. Morris Mano, Digital Design, 4th Edition, Pearson EducationISBN-13: 9780131989245,2007.
3.	Donald P.Leach and Albert Paul Malvino, GoutamSaha, Digital Principles and Applications, 6th Edition, TMH, ISBN: 0070601755, 2006.
4.	John F.Wakerly, Digital Design: principles and practices, 4th Edition, Pearson Education, ISBN-10: 0131863894, 2006.
5.	John.M Yarbrough, Digital Logic Applications and Design, Thomson Learning, ISBN-10: 0314066756, 2002.
6.	Switching And Finite Automata Theory by Z. Kohavi (TMH). 2010
7.	VHDL Primer by J. Bhaskar; BS Publication. 2001

Course Title	Course Structure			Pre-Requisite
Data Structures	L	T	P	Fundamentals of Programming
	3	0	2	

Course Objective:
The objective of data structures and algorithms is to enable students to implement, understand, and analyze basic techniques of algorithm analysis. They define how efficiently we can store and organize data, as well as different algorithms for computational tasks. This subject aims to develop problem-solving skills, algorithmic thinking, and the ability to write efficient programs.

Course Outcome (CO):
1. Understand basic data structures such as arrays, linked list, stacks, and queues.
2. Analyze the concepts of algorithm evaluation, and find time and space complexities for searching and sorting algorithms.
3. Implement different types of trees, and apply them to problem solutions.
4. Discuss graph structure, and understand various operations on graphs and their applicability.
5. Apply algorithm for solving problems like sorting, searching, insertion, and deletion of data.

S.No.	Content	Contact Hours
Unit 1	**Introduction:** Introduction to Algorithmic, Complexity- Time-Space Trade off. Introduction to abstract data types, design, implementation, and applications. Introduction to List data structure. **Arrays and Strings:** Representation of Arrays in Memory: one dimensional, Two dimensional, and Multidimensional, Accessing of elements of array, performing operations like Insertion, Deletion, and Searching. Sorting elements of arrays. Strings and String Operations. **Stacks and Queues:** Introduction to data structures like Stacks and Queues. Operations on Stacks and Queues, Array representation of Stacks, Applications of Stacks : recursion, Polish expression and their compilation conversion of infix expression to prefix and postfix expression, Operations of Queues, Representations of Queues Applications of Queues, Priority queues.	9
Unit 2	**Linked Lists:** Singly linked lists, Representation of linked list, Operations of Linked list such as Traversing, Insertion and Deletion, Searching, and Applications of Linked List. Concepts of Circular	8

	linked list and Doubly linked list and their Applications. Stacks and Queues as linked list.	
Unit 3	**Trees:** Basic Terminology, Binary Trees and their representation, binary search trees, various operations on Binary search trees like traversing, searching, Insertion and Deletion, Applications of Binary Search Trees, Complete Binary trees, Extended binary trees. General trees, AVL trees, Threaded trees, B- trees.	8
Unit 4	**Searching and Sorting:** Linear Search, Binary Search, Interpolation Search, Insertion Sort, Quick sort, Merge sort, Heap sort, sorting on different keys, and External sorting.	8
Unit 5	**Graphs:** Terminology and Representations, Graphs & Multi-graphs, Directed Graphs, Representation of graphs and their Transversal, Spanning trees, shortest path and Transitive Closure, Activity Networks, Topological Sort and Critical Paths. **File Structure:** File Organization, Indexing & Hashing, Hash Functions, Collision Resolution Techniques.	9
	Total	42

Books:-

S.No.	Name of Books/Authors/Publisher
1	Fundamentals of Data Structures; E. Horowitz, & S. Sahni, Universities Press, 2nd Edition (2008).
2	Tannenbaum, "Data Structures", PHI
3	An introduction to data structures and application by Jean Paul Tremblay & Pal G. Sorenson (McGraw Hill).
4	R.L. Kruse, B.P. Leary, C.L. Tondo, "Data structure and program design in C", PHI

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Object-Oriented Programming	3	0	2	Nil

Course Objective: To provide knowledge of Object-Oriented programming features.

Course Outcome (CO):

1. To apply mathematics to arrange and manipulate the data in a computational way
2. To differentiate between structured and object-oriented programming.
3. To apply concepts of Constructor, destructor, friend functions and classes & dynamic objects.
4. To apply concepts of polymorphism, inheritance, and abstraction in designing programs
5. Design, implement, test, debug, and document programs in C++
6. Analyze how the stack is used to implement function calls, and parameter passing options.
7. Write programs that perform explicit memory management.
8. Design template functions and classes for generic programming
9. Apply the knowledge of C++ programming in developing the application-oriented projects.

S.No.	Content	Contact Hours
Unit 1	Object oriented paradigm & C++ at a glance: Evolution of programming paradigm, structured versus object-oriented development, elements of object-oriented programming, Objects, classes, methods, popular OOP languages, software reuse. Classes and objects: Introduction, Class revisited, constant objects and constructor, static data members with constructors and destructors, constructor overloading, nested classes, objects as arguments, returning objects, friend functions and friend classes, constant parameters and member functions, static data and member functions.	8
Unit 2	Dynamic objects: Introduction, pointers to objects, array of objects, pointers to object members, this pointer, self-referential classes Operator overloading and Inheritance: overloading of new and delete operators, conversion between objects and basic types, conversion between objects of different classes, overloading with friend functions, abstract classes, inheritance types , virtual base classes, virtual functions, pointer to derived class objects, and base class objects, pure virtual functions, virtual destructors. Generic programming with templates: Introduction, function templates, overloaded function templates, class templates, inheritance of class template, class template containership, class template with overloaded operators.	7
Unit 3	Introduction to byte code, security and portability, Data Types, variables, operators, arrays, type conversion and casting, type promotion, Control statements, standard	6

	input-output, Designing Classes, constructors, methods, access specifiers: public, private, protected, inheritance, packages and interfaces, Math, String, Vectors, and Array List classes, polymorphism: function and operator overloading, function overriding, abstract classes.	
Unit 4	Exception Handling: exception types, nested try-catch, throw, throws and finally statements, Multithread Programming: thread creation, synchronization and priorities. Input-output and file operations: Java.io, stream classes, Byte streams, character streams, serialization. Networking concepts: Client server and socket programming, TCP/IP client and server sockets	13
Unit 6	Applets and Java Swing: Applet design, AWT packages, Applet event handling, parameters to applets, AWT controls, layout manager, Frames, container classes, Introduction to Java Beans, Swing and Servlets.	8
	Total	42

Books:-

S.No.	Name of Books/Authors/Publisher
1	Patrick Naughton, Herbert Schildt: "The Complete Reference: Java 2", TMH.ISBN-13 9780070495432, 1999
2	C Thomas Wu: "An Introduction to OO programming with Java", TMH, ISBN-10: 0073523305, 2009
3	Balaguruswami, "Object oriented with C++", TMH. ISBN 0070669074, 9780070669079, 2008
4	Budd, "Object Oriented Programming", Addison Wesley, 1997
5	Mastering C++ K.R Venugopal Rajkumar, TMH, 2013
6	C++ Primer, "Lip man and Lajole", Addison Wesley, 1986
7	Maria litvin, Gary litvin,"Programming in C++", VPH, 2001
8	D Samantha, "Object oriented Programming in C++ and Java ", PHI, 2007

Course Title	Course Structure			Pre-Requisite
Operating System	L	T	P	Data Structures
	3	0	2	

Course Objective:
To familiarize with the fundamental principles of the operating system, its services and functionalities, the concepts of processes, synchronization and scheduling, memory management and need for protection in computer systems.

Course Outcome (CO):
1. Identify the basic concepts and functions of operating systems. Understand differentiation of various operating systems by their functionality.
2. Assess various process synchronization mechanisms and use different CPU scheduling methods in order to allocate resources effectively.
3. Understand various deadlock handling techniques to prevent and/or avoid deadlock.
4. Apply concepts of memory management including Virtual Memory and Page Replacement to the issues that occur in Real time applications.
5. Analyze the concepts related to file system interface, implementation, disk management, protection and security mechanisms

S.No.	Content	Contact Hours
Unit 1	Introduction: Operating system and function, Evolution of operating system, Batch, Interactive, Time Sharing and Real Time System, System protection. Operating System Structure: System Components, System structure, Operating System Services.	4
Unit 2	Concurrent Processes: Process concept, Principle of Concurrency, Producer Consumer Problem, Critical Section problem, Semaphores, Classical problems in Concurrency, Inter Process Communication, Process Generation, Process Scheduling. CPU Scheduling: Scheduling Concept, Performance Criteria Scheduling Algorithm, Evolution, Multiprocessor Scheduling.	9
Unit 3	Deadlock: System Model, Deadlock Characterization, Prevention, Avoidance and Detection, Recovery from deadlock combined approach.	8
Unit 4	Memory Management: Base machine, Resident monitor, Multiprogramming with fixed partition, Multiprogramming with variable partition, Multiple base register, Paging, Segmentation, Virtual memory concept, Demand paging, Performance, Paged replaced algorithm, Allocation of frames, Thrashing, Cache memory, Organization, Impact on performance.	9

Unit 5	I/O Management & Disk Scheduling: I/O devices and organization of I/O function, I/O Buffering, DISK I/O, Operating System Design Issues. File System: File Concept, File Organization and Access Mechanism, File Directories, File Sharing, Implementation Issues Case Studies: Windows, Linux and Unix	12
	Total	42

Books:-

S.No.	Name of Books/Authors/Publisher
1	Silbersachatz , Galvin, Gagne "Operating System Concepts", Wiley, 9th Ed 2013
2	Tannenaum, "Operating Systems", PHI, 4th Edition 2000
3	Milenekovic, "Operating System Concepts", McGraw Hill 1992
4	Harvey M Dietel, " An Introduction to Operating System", Pearson Education 2004

Course Title	Course Structure			Pre-Requisite
Software Engineering Methodologies	L	T	P	Fundamentals of SE
	3	0	2	

Course Objective:

To introduce the concepts of software engineering including requirement specifications, software design, testing and maintenance.

Course Outcome (CO):

1. Explain various software characteristics and analyse different software Development Models
2. Demonstrate the contents of a SRS and apply basic software quality assurance practices to ensure that design, development meet or exceed applicable standards
3. Compare and contrast various methods for software design
4. Formulate testing strategy for software systems, employ techniques such as unit testing, Test driven development and functional testing
5. Manage software development process independently as well as in teams and make use of Various software management tools for development, maintenance, and analysis

S.No.	Content	Contact Hours
Unit 1	Software Requirement Specification: Requirements Elicitation Techniques, Requirements analysis, Models for Requirements analysis, requirements specification, requirements validation.	9
Unit 2	System Design: Design Principles: Problem partitioning, abstraction. Top down and bottom up – design, structured approach. Functional versus 6object oriented approach of design, design specification, Cohesiveness and Coupling. Overview of SA/SD Methodology, structured analysis, data flow diagrams, extending DFD to structure chart.	8
Unit 3	Software project Management: Project planning and Project scheduling. Software Metrics: Size Metrics like LOC, Token Count, Function Count. Cost estimation using models like COCOMO. Risk management activities. Software Reliability and Quality Assurance: Reliability issues, Reliability metrics, reliability models, Software quality, ISO 9000 certification for software industry, SEI capability maturity model.	10
Unit 4	Testing: Verification and validation, code inspection, test plan, test case specification. Level of testing: Unit, Integration Testing, Top down and bottom-up integration testing, Alpha and Beta testing, System testing and debugging. functional testing, structural testing, Software testing strategies.	10

Unit 5	Software Maintenance: Structured Vs unstructured maintenance, Maintenance Models, Configuration Management, Reverse Engineering, Software Re-engineering. Case study: Practical applications of SDLC phases	5
	Total	42

Books:-

S.No.	Name of Books/Authors/Publisher
1	R. S. Pressman, "Software Engineering – A practitioner's approach", 3rd ed., McGraw Hill Int. Ed..
2	K. K. Aggarwal & Yogesh Singh, "Software Engineering", 2ndEd., New Age International.
3	Sommerville, "Software Engineering", Addison Wesley.

4th Semester

Course Title	Course Structure			Pre-Requisite
SE 204 Computer System Architecture	**L**	**T**	**P**	Digital Electronics
	3	**0**	**2**	

Course Objective:
To provide knowledge about the principles, concepts and applications of Computer Architecture.

Course Outcome (CO):
1. Describe the functionalities of various units of a computer
2. Illustrate the logic design of Control Unit
3. Understand the architecture and functionality of central processing unit.
4. Learn the different types of serial communication techniques.
5. Illustrate various memory components and memory mapping techniques

S.No.	Content	Contact Hours
Unit 1	Introduction: Digital computer generation, computer types and classifications, functional units and their interconnections, bus architecture, types of buses and bus arbitration. Register, bus and memory transfer. REGISTER TRANSFER LANGUAGE: Data movement around registers. Data transfer from/to memory, arithmetic, logic and shift micro operations. Concept of bus and timing in register transfer.	8
Unit 2	Control Unit: Instruction types, Instruction formats, Instruction cycles and sub-cycles (fetch and execute etc.), micro-operations, execution of a complete instruction. Hardwired Control Unit and Microprogrammed Control Unt: microprogrammed sequencing, wide branch addressing, and micro-instruction with next address field, pre-fetching microinstructions, concept of horizontal and vertical microprogramming.	8
Unit 3	Central Processing Unit: Processor organization, general register organization, stack organization and addressing modes. Computer Arithmetic: Addition and subtraction of signed numbers, Signed operand multiplication, Booth's algorithm and array multiplier. Division	9

	and logic operations. Floating point arithmetic operation	
Unit 4	Input/Output organization: Peripheral devices, I/O interface, I/O ports, Interrupts: interrupt hardware, types of interrupts and exceptions. Modes of Data Transfer: Programmed I/O, interrupt initiated I/O and Direct Memory Access. I/O channels and processors. Serial Communication: Synchronous & asynchronous communication, standard communication interfaces.	9
Unit 5	Memory: Basic concept and hierarchy, Main memory, Auxiliary memory, Associative memory, Cache memories: concept and design issues, associative mapping, direct mapping, set-associative mapping, cache writing and initialization.	8
	Total	42

Books:-

S.No.	**Name of Books/Authors/Publisher**
1)	Patterson, Computer Organization and Design, Elsevier Pub. 2009
2)	Morris Mano, Computer System Architecture, PHI 1992
3)	William Stalling, Computer Organization, PHI 2012
4)	Vravice, Hamacher&Zaky, Computer Organization, TMH 2009
5)	Tannenbaum, Structured Computer Organization, PHI 2006

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Object-Oriented Software Engineering	3	0	2	Basics of Software Engineering

Course Objective:

The objective of object-oriented software engineering is to provide students with a comprehensive understanding of principles, practices, and techniques related to software development using object-oriented programming paradigms. It also focuses on applying the Unified Modeling Language (UML) for visualizing software designs, which includes use case diagrams, class diagrams, sequence diagrams, activity diagrams, etc. This subject also enables students to generate a detailed software requirement specification document. This subject aims to apply object-oriented principles to real-world problems, and case studies, demonstrating the relevance and applicability of object-oriented software engineering concepts.

Course Outcome (CO):

1. Understand the basics of software engineering, object-oriented paradigms, object-oriented methodologies used, and various basic terminologies.
2. Develop real-world software using conventional software development life cycle models, and object-oriented software development life cycle models.
3. Apply various techniques to gather requirements from the customers such as interviews, brainstorming session, FAST, and prototyping.
4. Design software requirement specification document, software design document, and test case matrix.
5. Design UML diagrams such as use case diagrams, class diagrams, sequence diagrams, state chart diagrams, and activity diagrams.
6. Analyze existing software by considering the issues of software risk management, and approaches to estimate the risk.

S.No.	Content	Contact Hours
Unit 1	**Introduction:** Object-oriented system concepts and Principles, Object Oriented Methodologies, Overview of Conventional Software Development Lifecycle Models, Fountain Model, Rational Unified Process, Some Basic Terminologies	8
Unit 2	**Software Requirement Elicitation and Analysis:** Software Requirement, Requirement Elicitation Techniques, Initial Requirement Documents, Use Case Approach, Characteristics of a Good Requirement, Software Requirements Specification Document, Requirement Change Management.	8
Unit 3	**Object Oriented Analysis**: Structured Analysis vs Object Oriented Analysis, Identification of Classes, Identification of Relationships, Identifying State and Behaviour.	9

Unit 4	**Object Oriented Design:** What is Done in Object Oriented Design, Interaction Diagrams, Sequence Diagrams, Collaboration Diagrams, Refinement of Use Case Description, Refinement of Classes and Relationship, Identification of Operations to Reflect the Implementation Environment, Construction of Detailed Class Diagram, Development of Detailed Design, and Creation of Software Design Document, Generating Test Cases from Use Cases, Object Oriented Design, Principles for Improving Software Quality.	9
Unit 5	**Moving Towards Implementation:** Activity Diagram, Statechart Diagram, Storing Persistent data in Database, implementing the classes, and object-oriented testing. Real world case study/project based on object-oriented concepts and UML diagrams.	8
	Total	42

Books:-

S.No.	Name of Books/Authors/Publisher
1	Y. Singh & R. Malhotra, "Object-Oriented Software Engineering", 1st Ed., PHI Learning.
2	I. Jacobson, M. Christerson, P. Jonsson, G. Overgaard, "Object-Oriented Software Engineering", 2nd Edition, Pearson Education.
3	I. Sommerville, "Software Engineering", Addison Wesley.

Course Title	Course Structure			Pre-Requisite
Machine Learning	L	T	P	Basic Programming
	3	0	2	

Course Objective:
The objective of the machine learning course is to understand the basic theory underlying machine learning. It will help students will be able to understand a range of machine learning algorithms along with their strengths, and weaknesses. Students will be able to apply machine learning algorithms to solve real-world problems to design optimized solutions and report on the expected accuracy that can be achieved by applying the models

Course Outcome (CO):
1. Understand the basic concepts of machine learning, supervised, unsupervised, regression analysis, and machine learning algorithms.
2. Apply the learned concepts of machine learning to interpret various problems.
3. Analyze the different mathematical machine learning models for various systems.
4. Evaluate the performance of the machine learning model using various performance measures.
5. Develop an efficient machine learning system to solve various real-time problems.

S.No.	Content	Contact Hours
Unit 1	**Introduction to Machine Learning:** Need, Objective, History of Machine Learning, Introduction of Machine Learning Approaches (Artificial Neural Network, Clustering, Reinforcement Learning, Classification, Regression), Types of Machine Learning Algorithms, Applications of Machine Learning, Data Science vs Machine Learning, Understanding the data-scale of measurement, Research Variables and Data analysis methods, Issues in Machine Learning Techniques, Steps in Model Prediction, Validation and performance evaluation, Confusion Matrix	8
Unit 2	**Supervised Learning - I:** Classification vs Regression. Decision Tree: Basic Methodology, ID3 Algorithm: Information Gain, Entropy, Inductive Bias, Occam's Razor, Issues in Decision Tree, Problem with IDE3 Algorithm, Problem with Information Gain Approach, C4.5 algorithm: Gain ratio and Decision Trees using Gain Ratio, CART algorithm: Gini Index and Decision trees using Gini Index, Implementing Decision trees, K-Nearest Neighbor- Introduction, Nearest Neighbor Algorithm, Feature Weighting in KNN, Random Forest, Ensemble Learning-Standard Ensemble Learning Strategies, Bagging, AdaBoost, Stacking.	8
Unit 3	**Supervised Learning - II:** Artificial Neural Network(ANN): Introduction, advantages and disadvantages Introduction, Characteristics of ANN, Topologies, Neuron and its terminologies, ANN: Transfer Functions (Purelin, Sign, Step, Log Sigmoid, Tan Sigmoid, Unipolar and Bipolar), Perceptron, Perceptron Convergence Theorem.	10

	Single Layer ANN, Multilayer Perceptron: Back Propagation Learning Algorithm, Implementing Back propagation algorithm, ANN: Learning and Generalization, Bias and Variance, Bias/Variance Trade-off, Preventing Over-fitting and Under-fitting, Applications of Neural Networks. Support Vector Machine (SVM): Baic, Maximal Margin Hyperplane, Linear SVM, Non-Linear SVM, Attribute Transformation, Kernel Trick, Applications of SVM. Bayesian Learning: Probability Theory, Bayes theorem, Naïve Bayes Learning Algorithm, Nearest Neighbor Classifiers	
Unit 4	**Unsupervised Learning:** Introduction, Clustering Introduction and its applications, Partitional Clustering vs Hierarchical Clustering, Partial vs Complete Clustering, Hard Clustering vs Soft Clustering, K-means Clustering. Need and Classification of Dimensionality Reduction Methods**,** Univariate Analysis, Correlation-Based Feature Selection (CFS), Feature Extraction, and Principal Component Analysis-Variance, Covariance, Covariance Matrix, Eigenvectors, Eigen values, PCA	8
Unit 5	**Recent Applications & Research Topics:** Case Studies based on various Supervised Learning Approaches. Cross Validation Methods, Bias Variance trade-off, Techniques to deal with Imbalanced dataset, Resampling, Measuring, and Comparing two classification algorithms using statistical tests.	8
	Total	42

Books:-

S.No.	Name of Books/Authors/Publisher
1	Introduction to Machine Learning, Alpaydin, E., MIT Press, 2004
2	Machine Learning, Tom Mitchell, McGraw Hill, 1997.
3	Elements of Machine Learning, Pat Langley Morgan Kaufmann Publishers, Inc. 1995. ISBN 1-55860-301-8
4	The elements of statistical learning, Friedman, Jerome, Trevor Hastie, and Robert Tibshirani. Vol. 1. Springer, Berlin: Springer series in statistics, 2001.
5	Machine Learning: A probabilistic approach, by David Barber, 2006.

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Database Management Systems	3	0	2	MS Excel

Course Objective: To provide knowledge about the principles, concepts and applications of Database Management Systems.

Course Outcome (CO):

1. To understand the concepts of DBMS and would have acquired skills to analyse the real-world problem domains in the context of DBMS and demonstrate the same through ER diagram.
2. To apply and demonstrate with understanding of relational query languages such as SQL, Relational Algebra and Relational Calculus.
3. To relate the concepts of inference rules, data constraints and normalization. Students would also have acquired skills to identify application of the same.
4. Familiar with basic database storage structures and access techniques: file and page organizations, indexing methods including B tree, and hashing. To appraise the basic issues of Transaction processing and Serializability.
5. To classify various concurrency control techniques and recovery procedures
6. Familiar with case studies regarding commercial database, Oracle platforms, Postgres and MYSQL.

S.No.	Content	Contact Hours
Unit 1	Introduction: Database system concepts and its architecture, Data models schema and instances, Data independence and database language and interface, Data definition languages, DML. Overall database structure. Data modeling using Entity Relationship Model: E.R. model concept, notation for ER diagrams mapping constraints, Keys, Concept of super key, candidate key, primary key generalizations, Aggregation, reducing ER diagrams to tables, extended ER model.	7
Unit 2	Relational Data Model and Language: Relational data model concepts, integrity constraints, Keys domain constraints, referential integrity, assertions, triggers, foreign key relational algebra, relational calculus, domain and tuple calculus, SQL data definition queries and updates in SQL.	7
Unit 3	Data Base Design: Functional dependencies, normal forms, 1NF, 2NF, 3NF and BCNF, multi-valued dependencies fourth normal form, join dependencies and fifth normal form. Inclusion dependencies, lossless join decompositions, normalization using FD, MVD and JDs, alternatives approach to database design.	6
Unit 4	File Organization, Indexing and Hashing Overview of file organization techniques,	8

	Indexing and Hashing- Basic concepts, Static Hashing, Dynamic Hashing, ordered indices, Multi-level indexes, B-Tree index files, B+- Tree index files, Buffer management Transaction processing concepts: Transaction processing system, schedule and recoverability, Testing of serializability, Serializability of schedules, conflict & view serializable schedule, recovery from transaction failures, deadlock handling.	
Unit 5	Concurrency Control Techniques: Locking Techniques for concurrency control, time stamping protocols for concurrency control, concurrency control in distributed systems. multiple granularities and multi-version schemes. Case Studies: Commercial databases, Oracle, Postgress, MySQL	14
	Total	42

Books:-

S.No.	Name of Books/Authors/Publisher
1	Elmasri, Navathe,"Fundamentals of Database systems", Addision Wesley, 2006.
2	Korth, Silbertz, Sudarshan,"Data base concepts", McGraw-Hill, 2001.
3	Ramakrishna, Gehkre, "Database Management System", McGraw Hill,2002.
4	Date C.J.,"An Introduction to Database systems", 2004

Course Title	Course Structure			Pre-Requisite
Algorithm Design and Analysis	L	T	P	Fundamentals of Programming
	3	1	0	

Course Objective:
To introduce the concept of algorithmic efficiency by analyzing various algorithms such as Searching, Sorting, Divide-and-Conquer algorithms and to know details about the Greedy Paradigm, Principle of Dynamic Programming, Back Tracking, Branch and Bound, and Computational Complexity.

Course Outcome (CO):

1. To learn the Algorithm and Design Concepts of linear and non-linear structures and complexity.
2. To understand the concept of searching and sorting
3. To learn concepts of searching and sorting.
4. To learn concepts of the Greedy method.
5. To understand concepts of Dynamic programming.
6. To understand the concepts of Branch and Bound.
7. To understand computational complexity.

S.No.	Content	Contact Hours
Unit 1	**Introduction:** Concept of algorithmic efficiency, run time analysis of algorithms, Asymptotic Notations. Growth of Functions, Master's Theorem.	6
Unit 2	**Searching and Sorting:** Structure of divide-and-conquer algorithms; examples: binary search, quick sort, Stassen Multiplication; merge sort, heap sort, and Analysis of divide and conquer run time recurrence relations.	7
Unit 3	**Greedy Method**: Overview of the greedy paradigm examples of exact optimization solution: minimum cost spanning tree, approximate solutions: Knapsack problem, Kruskal's algorithm and Prim's algorithm for finding Minimum cost Spanning Trees, Dijkstra's and Bellman Ford Algorithm for finding Single source shortest paths, Huffman coding, Activity Selection Problem.	8
Unit 4	**Dynamic programming**: Principles of dynamic programming. Applications: Rod cutting problem, Floyd-Warshall algorithm for all pair shortest paths. Matrix multiplication, Travelling salesman Problem, Longest Common sequence,	7

	Back tracking: Overview, 8-queen problem, and Knapsack problem, Traveling Salesman problem	
Unit 5	**Branch and bound**: LC searching Bounding, FIFO branch and bound, LC branch and bound application: 0/1 Knapsack problem. **Computational Complexity**: Complexity measures, Polynomial Vs non-polynomial time complexity; NP-hard and NP-complete classes, examples: Circuit Satisfiability, Vertex cover, Subset Sum problem, Randomized Algorithms, String Matching, NP-Hard and NP-Completeness, Approximation Algorithms, Sorting Network, Matrix Operations, Polynomials and FFT, Number Theoretic Algorithms.	14
	Total	42

Books:-

S.No.	Name of Books/Authors/Publisher
1	T .H . Cormen, C . E . Leiserson, R. L. Rivest "Introduction to Algorithms", 3rd Ed., PHI.
2	E. Horowitz, S. Sahni, and S. Rajsekaran, "Fundamentals of Computer Algorithms," Galgotia Publication, 2008.
3	Sara Basse, A. V. Gelder, "Computer Algorithms," Addison Wesley, 1999.
4	Aho, Hopcroft, Ullman: The Design and Analysis of Algorithms, Addison Wesley, 1974.

Course Title	Course Structure			Pre-Requisite
SE102 : Fundamentals of Mathematics in Computer Science	**L**	**T**	**P**	**Nil**
	3	**1**	**0**	

Course Objective:
This course will introduce fundamental concepts of mathematics with emphasis on their applications in computer science. Topics include introduction to probability, statistical measures and models, graph theory used in computer science. It will help students to understand a range of computer science algorithms and real world problems mathematically.

Course Outcome (CO):
1. Understand the elementary concept of probability and set theory.
2. Apply concepts of probabilistic distribution functions and statistical inferences to solve computing problems.
3. Understanding multivariate statistical models.
4. Illustrate number theory & group theory to solve real world computing problems.
5. Understanding mathematics involved in recent computer science and engineering applications.

S.No.	Content	Contact Hours
Unit 1	Introduction to probability theory: Sets, Probability Set function, Experiments and Sample Spaces, Discrete and Continuous Sample Spaces, Events, Random Variables, Probability and Axioms, Probability as a Relative Frequency, Joint and Conditional probability.	8
Unit 2	Distribution Function, Density Function, Random Samples, sampling distributions, Methods of moments and maximum like hood. Covariance and correlation, Statistical Inference.	8
Unit 3	Introduction of multivariate statistical models, Classification and regression, principal component analysis, overfitting problem.	8
Unit 4	Graph theory: Graph isomorphism, Paths and Cycles, Graph coloring, Critical Path, Eulerian paths and circuits, Hamiltonian paths and circuits, Bipartite Graphs, Digraphs, Multigraphs, planar graphs, permutations and combinations.	10
Unit 5	Computer science and Engineering application: Software Engineering, data Mining, Machine learning, Recent Trends.	8
	Total	42

Books:-

S.No.	Name of Books/Authors/Publisher
1	Robert V. Hogg , J.W. McKean , allen T Craig, "Introduction to Mathematical Statistics",Pearson.
2	J.Vince, "Foundation mathematics for Computer Science" , Spinger, 2015.
3	Keneth H. Rosen, "Discrete Mathematics and Its Applications", TMH.
4	The elements of statistical learning, Friedman, Jerome, Trevor Hastie, and Robert Tibshirani. Vol. 1. Springer, Berlin: Springer series in statistics,2001.

DELHI TECHNOLOGICAL UNIVERSITY

DEPARTMENT OF SOFTWARE ENGINEERING

B.Tech. 3rd YEAR SYLLABUS

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
SE301: Software Testing	3	0	2	Software Engineering

Course Objective: To understand software testing concepts and applications.

S. NO	Course Outcomes (CO)
CO1	Explain basics of software testing process, limitations, and the V-shaped life cycle model.
CO2	Apply various types of testing to ensure software functionality and reliability.
CO3	Demonstrate various functional testing techniques.
CO4	Implement structural and object-oriented testing methods.
CO5	Investigate automated testing tools and various testing activities.

S. NO	Contents	Contact Hours
UNIT 1	**Introductory concepts:** Verification &Validation Terminologies like Goals, Role, Objectives, Limitations, Approaches & Applicability.	4
UNIT 2	**Software Testing:** Testing Process, Limitations of Testing, Testing activities. Levels of Testing: Unit Testing, Integration Testing, System Testing, Debugging, Domain Testing, Regression Testing, Stress Testing, Slice based testing.	8
UNIT 3	**Verification Testing:** Verification Methods, SRS Verification, Software Design Document Verification, Code Reviews, User Documentation Verification, Software Project Audits. Functional Testing techniques: Boundary Value Analysis, Equivalence Class Testing, Decision Table Based Testing, Cause Effect Graphing Technique.	8
UNIT 4	**Structural Testing:** Path testing, DD-Paths, Cyclomatic Complexity, Graph Metrics, Data Flow Testing, Mutation testing. Object Oriented Testing: Class Testing, GUI Testing.	8
UNIT 5	**Testing Activities:** Unit Testing, Levels of Testing, Integration Testing, System Testing, Debugging. **Software Testing Tools Taxonomy:** Methodology to evaluate automated testing. Using tools: Load Runner, Win runner and Rational Testing Tools, Java Testing Tools, JMeter, JUNIT Cactus and other recent tools.	8
UNIT 6	**Advanced Topics on Testing:** Prioritizing the Test-cases, Testing Web Applications, Automated Test Data Generation.	6
	TOTAL	42

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Yogesh Singh, "Software Testing", Cambridge University Press India Private Limited, 1st Edition.	**2012**
2	Paul C. Jorgensen, "Software Testing: A Craftsman's Approach", Auerbach Publications, 4th Edition.	**2013**
3	Louise Tamres, "Introducing Software Testing", Pearson Education, 1st Edition.	**2002**
4	Boris Beizer, "Software Testing Techniques", Wiley India, 2nd Edition.	**2002**

Course code: Course Title	Course Structure			Pre-Requisite
SE303: Software Quality and Metrics	L	T	P	NIL
	3	1	0	

Course Objective: To understand software quality concepts, models and learn basics of metrics, their types and applications.

S. NO	Course Outcomes (CO)
CO1	Understand basic concepts of software quality, the components of SQA, and SQA plan.
CO2	Analyze various software quality models and assess their impact on software quality.
CO3	Demonstrate internal and external product attributes using software metrics, including size, complexity, and modularity.
CO4	Assess software quality at different levels (product, process, and maintenance) using appropriate quality metrics and methodologies, including object-oriented metrics.
CO5	Demonstrate quality estimation tools and evaluate computer aided quality engineering technique for quality assurance.

S. NO	Contents	Contact Hours
UNIT 1	**Software Quality Assurance Framework:** What is Quality? Software Quality Assurance, Components of Software Quality Assurance, Software Quality Assurance Plan. Steps to develop and implement a Software Quality Assurance Plan.	7
UNIT 2	**Quality Standards:** ISO 9000 and Comparison ISO Standards, CMM, CMMI, PCMM, Malcolm Balridge, 3 Sigma, 6 Sigma, Software Quality Models.	8
UNIT 3	**Measurement in Software Engineering:** scope of software metrics, Basics of Measurement: Measuring External Product Attributes: Modeling Software Quality, Measuring aspects of quality, Framework for Software Measurement, Measuring Internal Product Attributes, Size and Structure: Aspects of Software Size, Length, Reuse, Functionality, Complexity, Types of Structural Measures, Modularity and information flow attributes.	8
UNIT 4	**Software Quality Assurance Metrics and Measurement:** Software Quality Metrics, Product Quality metrics, Process Quality Metrics, Metrics for Software Maintenance, Software Quality metrics methodology, Object-Oriented Metrics in quality.	8
UNIT 5	**Software Quality Estimation Tools:** Desirable features in software Quality estimation tools, Study of some existing Tools for quality estimation.	7
UNIT 6	**Computer Aided Quality Engineering (CAQE):** CAQE Concepts, Design Techniques for CAQE.	4
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Yogesh Singh, Ruchika Malhotra, "Object-Oriented Software Engineering", PHI Learning Private Limited, 1st Edition.	2012

2	Norman Fenton, James Bieman, " Software Metrics", 3rd Edition, CRC Press.	**2020**
3	Alan C. Gillies, "Software Quality: Theory and Management, Cengage Learning, 2nd Edition.	**2003**
4	Stephen H. Kan, "Metrics and Models in Software Engineering", Addison-Wesley, 2nd Edition.	**2014**
5	Anirban Basu, "Software Quality Assurance, Testing and Metrics", PHI Learning Private Limited.	**2015**

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
SE305: Computer Networks	3	0	2	Operating systems, Algorithm Design and Analysis

Course Objective: To introduce the layered concept of Computer network and protocols associated with TCP/IP.

S. NO	Course Outcomes (CO)
CO1	Understand and analyze the classification of network services, protocols, architectures and internet applications.
CO2	Learn basic concepts of MAC protocols and their protocols.
CO3	Design and analysis of the routing protocols.
CO4	Demonstrate the connection oriented and connection less protocols.
CO5	Investigate various design issues in Application layer.

S. NO	Contents	Contact Hours
UNIT 1	**Introduction Concepts:** Goals and Applications of Networks, Network structure and architecture, The OSI reference model, services, Network Topology Design - Delay Analysis, Physical Layer Transmission Media, Switching methods, ISDN.	8
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.	8
UNIT 3	**Network Layer:** Network Layer - Point - to Pont Networks, routing, Congestion control, Internetworking -TCP / IP, IP packet, IP address, IPv6.	8
UNIT 4	**Transport Layer:** Transport Layer - Design issues, connection management, session Layer-Design issues, remote procedure call.	6
UNIT 5	**Presentation Layer:** Data compression techniques, cryptography.	6
UNIT 6	**Application Layer:** Application Layer: File Transfer, Access and Management, Electronic mail, Virtual Terminals, Internet and Public Networks.	6
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Andrew S. Tanenbaum, "Computer Networks", Prentice Hall, 3rd Edition.	2013
2	Uyless Black, "Computer Networks-Protocols, Standards and Interfaces", Prentice Hall India Learning Private Limited, 2nd Edition.	1996
3	Laura Chappell, "Introduction to Cisco Router Configuration", Cisco Press.	1998
4	Stallings William, "Data and Computer Communications", Pearson Education, 10th Edition.	2017

5	William A. Shay, "Understanding Data Communications & Networks", Thomson-Brooks/Cole - Vikas publishing House, 2nd Edition.	**1999**
6	Michael A. Miller, "Data & Network Communication", Delmar Cengage Learning, 1st Edition.	**1999**

Course code: Course Title	Course Structure			Pre-Requisite
SE307: Software Requirement Engineering	L	T	P	Software Engineering
	3	1	0	

Course Objective: Understand the fundamentals of software requirement engineering, management, tools and latest trends.

S. NO	Course Outcomes (CO)
CO1	Understand fundamentals of software requirements, best practices in requirements engineering, and risk management.
CO2	Analyze various activities used for requirements engineering.
CO3	Apply requirements management principles, including change management, requirements traceability, and maintaining links in the requirements chain.
CO4	Demonstrate requirements management tools such as Rational Requisite Pro and Caliber RM.
CO5	Explore and assess advanced requirement engineering techniques.

S. NO	Contents	Contact Hours
UNIT 1	**Software Requirements:** Essential of Software requirements, Different Dimensions of Software Requirements, Good practices for requirements engineering, improving requirements processes, and risk management.	8
UNIT 2	**Requirements Engineering:** Review of various activities of Requirements Engineering like requirements elicitation, requirements analysis, documentation & review. Discussion on current trends in requirements elicitation, requirements analysis models and verifying requirements, requirements specification & requirements prioritization.	8
UNIT 3	**Requirements Management (RM):** Principles and practices of RM, Requirements attributes, Change Management Process, Requirements Traceability Matrix, Links in requirements chain.	8
UNIT 4	**RM Tools:** Rational Requisite pro, Caliber RM, benefits of using a RM tool.	5
UNIT 5	**Advances in Requirement Engineering:** Commercial requirements management techniques & tools, implementing requirements management automation.	7
UNIT 6	**Application:** Latest trends in requirements engineering such as aspect-oriented requirement engineering, agent-based requirement engineering.	6
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Swapna Kishore, Rajesh Naik, "Software Requirements and Estimation", McGraw Hill Education.	2017
2	Karl Wiegers, Joy Beatty, "Software Requirements (Microsoft Press)", Wiley, 3rd Edition.	2013
3	Ellen Gottesdiener, "Requirements by Collaboration: Workshops for Defining Needs", Addison-Wesley Educational Publishers Inc, 1st Edition.	2002

4	Ian Graham, "Requirements Engineering and Rapid Development: An object-oriented approach", Addison Wesley.	**1998**
5	Ivy F. Hooks, Kristin A. Farry, "Customer-Centered Products: Creating Successful Products Through Smart Requirements Management", Amacom.	**2000**
6	Dean Leffingwell, Don Widrig, "Managing Software Requirements: A Unified Approach", Addison Wesley, 1st Edition.	**1999**

Course code: Course Title	Course Structure			Pre-Requisite
SE309: Computer Graphics	L	T	P	NIL
	3	0	2	

Course Objective: The objective of the course is to help students learn broad introduction to the theory and practice of computer graphics.

S. NO	Course Outcomes (CO)
CO1	Explain the fundamentals of computer graphics, applications, and graphic pipeline.
CO2	Apply and compare the algorithms for drawing 2D images also explain aliasing, anti-aliasing and half toning techniques.
CO3	Apply 2D and 3D transformations, including translation, scaling, rotation, reflection, shearing, affine transformation, and coordinate system conversions.
CO4	Analyze and apply clipping algorithms and transformation on 2D images.
CO5	Explain basic ray tracing algorithm, shading, shadows, curves and surfaces and also solve the problems of curves.

S. NO	Contents	Contact Hours
UNIT 1	**Overview of Computer Graphics:** Usage of Graphics and their applications, Over view of Graphics systems: Refreshing display devices, Random and raster scan display devices, Colour Models: RGB, HSV etc., Tablets, Joysticks, Track balls, Mouse and light pens, plotters, printers, digitizers.	6
UNIT 2	**Output Primitives:** DDA Line drawing algorithm, Bresenham's Line Drawing Algorithm, Mid-point circle algorithm, Mid-point Ellipse algorithms, filling algorithms, boundary fill and flood fill algorithms, scan- line filling, character generation, line attributes, fill styles, anti-aliasing.	8
UNIT 3	**Transformations:** Basic 2D Transformations, Matrix representations & Homogeneous Coordinates, Matrix Representations for basic 2D and 3D transformations, Composite Transformations, reflection and shear transformations, affine transformation, transformations between coordinate systems.	6
UNIT 4	**Two dimensional viewing**: The viewing Pipeline, Viewing Coordinate Reference Frame, Window-to-Viewport Coordinate Transformation, Two Dimensional Viewing Functions, Barky line clipping algorithm, Algorithm for polygon clipping, Sutherland-Hodgeman polygon clipping, Wailer-Atherton polygon clipping, curve clipping, Text clipping.	8
UNIT 5	**Curves and Surfaces:** Representation of surfaces, polygon meshes, plane equations, parametric cubic curves, Hermite Curves, Bezier Curves, 4 point and 5 point Bezier curves using Bernstein Polynomials, Conditions for smoothly joining curve segments, Bezier bi-cubic surface patch, B-Spline Curves, Cubic B-Spline curves using uniform knot vectors, Testing for first and second order continuities.	6
UNIT 6	**Shading and Hidden Surface Removal:** Shading, Illumination Model for diffused Reflection, Effect of ambient lighting, distances, Specular Reflection Model, Computing Reflection Vector, Curved Surfaces, Polygonal Approximations, Guard Shading, Phong Model, Hidden Surface Removal, Back Face Detection, Depth Buffer (Z-Buffer, A-Buffer) Method, Scan Line Method, Depth Sorting Method, Area Subdivision Method.	8
	TOTAL	**42**

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Donald Hearn, M. Baker, Warren Carithers, "Computer Graphics with OpenGL", Pearson, 4th Edition.	**2011**
2	Z. Xiang, R. Plastock "Computer Graphics", Schaum's Series, McGraw Hill Education.	**2006**
3	David F. Rogers, "Procedural Elements for Computer Graphics", McGraw Hill Education, 2nd Edition.	**2017**
4	D. Rogers and J. Adams, "Mathematical Elements for Computer Graphics", MacGraw- Hill, 2nd Edition.	**1989**
5	James D. Foley, Andries van Dam, Steven K. Feiner, John F. Hughes, "Computer Graphics Principles & practice", Addison-Wesley Professional, 2nd Edition.	**1996**

Course code: Course Title	Course Structure			Pre-Requisite
SE311: Information Theory and Coding	L	T	P	NIL
	3	1	0	

Course Objective: To introduce fundamentals of coding and information theory.

S. NO	Course Outcomes (CO)
CO1	Introduce the principles and applications of information theory.
CO2	Comprehend various communication channel and error control code properties.
CO3	Apply linear block codes for error detection and correction.
CO4	Apply cyclic codes and parity generator for performance analysis & cyclic codes for error detection and correction.
CO5	Apply information theory and coding concepts to solved real-world problems.

S. NO	Contents	Contact Hours
UNIT 1	Introduction to Probability, Sample space and events, The axioms of probability Elementary theorems - Conditional Probability and Independence, Baye's theorem. Random variables, discrete probability distribution, discrete functions for random and discrete random variables, continuous random variables.	6
UNIT 2	Uncertainty and Information, Shannon Entropy, Joint and conditional Entropies Mutual Information, Uniquely decipherable and Instantaneous codes, Noiseless coding problem. Source coding Theorem, Block coding, construction of Optimal codes, Huffman's & Shannon – Fano methods.	8
UNIT 3	Discrete memory less channel, channel capacity BSC and other channels	6
UNIT 4	Information measure for continuous ensembles capacity of AWGN channel. Error control coding. The channel coding Theorem, Application to BSC, Source Coding with fidelity criteria. Types of codes, error and error control strategies, Linear block codes, syndrome and error detection, Minimum distance, Error detecting and correcting capabilities of a block code, Syndrome decoding, Hamming codes.	8
UNIT 5	Cyclic codes, Generator and parity – check matrices, encoding, syndrome computation and error detection and decoding .BCH codes, decoding, of the BCH codes Introduction to RS codes. Convolution codes, Maximum likelihood decoding The Viterbi algorithm. Introduction to Turbo codes.	8
UNIT 6	Blind Deconvolution Using Convex Programming, Asynchronous code-division random access using convex optimization.	6
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Robert B. Ash, "Information Theory", Dover Science Publications, 2nd Edition.	1998
2	Joy A. Thomas, Thomas M. Cover, "Element of Information Theory", John Wiley & Sons, 2nd Edition.	2013
3	Shu Lin, Daniel J. Costello, "Error Control Coding: Fundamentals and Applications", Pearson, 1st Edition.	1982

4	C. E. Shannon, “A Mathematical Theory of Communication”, The Bell System Technical Journal.	**1948**
5	C. E. Shannon, “Communications in the presence of noise”, Proceedings of the IRE.	**1949**
6	Simon Haykin, “Communication Systems”, Wiley, 5th Edition.	**2017**

Course code: Course Title	Course Structure			Pre-Requisite
SE313: Digital Signal Processing	L	T	P	NIL
	3	1	0	

Course Objective: The objective of the course is to understand and learn the basics of digital signal processing.

S. NO	Course Outcomes (CO)
CO1	Understand and classify the signal continuous time and discrete time signals and systems, and describe the characteristics.
CO2	Define and describe the frequency domain representation of discrete time signals and systems, and different properties.
CO3	Demonstrate the concepts, representation, and properties of discrete Fourier transform, fast Fourier transform, and Z- transform.
CO4	Understand and evaluate the difference equations of digital systems.
CO5	Analyze the finite impulse response (FIR) systems and infinite impulse response (IIR) systems and evaluate the different methods in IIR filter design and FIR filter design.

S. NO	Contents	Contact Hours
UNIT 1	**Introduction:** Introduction to Signal-continuous time and Discrete time signals and systems, characteristics of discrete time sinusoidal signals. **Discrete–time description of signals and systems:** Representation of elementary sequences, signal classification, basic operations, classification of discrete time systems. Linear convolution.	6
UNIT 2	**Frequency Domain Representation of Discrete - Time Signal and Systems:** Discrete time Fourier transform (DTFT). Different properties of DTFT. Frequency domain representation of linear time invariant system.	6
UNIT 3	**Discrete Fourier Transform (DFT):** Introduction, Fourier representation of periodic signal DFT, properties of DFT. Linear convolution using the DFT. **Fast Fourier Transform (FFT):** Decimation- in- time and Decimation- in-frequency FFT Algorithms (Radix 2 only).	10
UNIT 4	**Z-Transform:** Introduction, region of convergence for the Z-transform. The Inverse Z-transform. The Inverse Z-transform. One sided Z-transform. Solution of difference equation using Z-transform. System function.	6
UNIT 5	**Realization of Digital Systems:** System describe by difference equation, recursive and non-recursive systems, linear constant coefficient difference equation, Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) systems, Direct, cascaded and parallel form structure for IIR system. Direct and cascaded form structure for FIR system	6
UNIT 6	**IIR Filter Design:** Impulse invariance, Bilinear transform method, Butterworth filter. **FIR FILTER DESIGN:** FIR versus IIR, Linear phase FIR filter, FIR filter design by Rectangular, Hanning and Hamming window.	8
	TOTAL	42

REFERENCES		
S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint

1	Alan V. Oppenheim, Ronald W. Schafer, "Digital Signal Processing", PHI.	**1988**
2	B. P. Lathi, "Principles of Linear Systems and Signals", Oxford, 2nd Edition.	**2009**
3	A. K. Mitra, "Digital Signal Processing", PHI.	**2009**
4	John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", Pearson, 5th Edition.	**2021**

Course code: Course Title	Course Structure			Pre-Requisite
SE315: Advanced Data Structures	L	T	P	NIL
	3	1	0	

Course Objective: To study concepts of some advanced data structures like advanced trees and heaps.

S. NO	Course Outcomes (CO)
CO1	Understand advanced tree structures and their applications.
CO2	Apply mergeable heaps (Binomial, Fibonacci, 2-3-4 Heaps) for efficient data management.
CO3	Understand graph theory concepts.
CO4	Implement graph theory algorithms for efficient utilization of resources.
CO5	Create efficient techniques for searching and indexing to solve real world problems.

S. NO	Contents	Contact Hours
UNIT 1	**Advanced Trees:** Definitions Operations on Weight Balanced Trees (Huffman Trees), Height balanced trees- B trees, B+ trees, 2-3 Trees and Red-Black Trees. Augmenting Red-Black Trees to Dynamic Order Statics and Interval Tree and Applications. Operations on Disjoint sets and its union find problem Implementing Sets. Dictionaries, Priority Queues and Concatenable Queues using 2-3 Trees.	8
UNIT 2	**Mergeable Heaps:** Mergeable Heap Operations, Binomial Trees Implementing Binomial Heaps and its Operations, 2-3-4. Trees and 2-3-4 Heaps. Structure and Potential Function of Fibonacci Heap Implementing Fibonacci Heap.	9
UNIT 3	**Graph Theory Definitions:** Definitions of Isomorphism Components. Circuits, Fundamental Circuits, Cut-sets. Cut-Vertices Planer and Dual graphs, Spanning Trees, Kuratovski's two Graphs.	8
UNIT 4	**Graph Theory Algorithms:** Algorithms for Connectedness, Finding all Spanning Trees in a Weighted Graph and Planarity Testing, all pair shortest path algorithms. Min-Cut Max-Flow theorem of Network Flows. Ford-Fulkerson Max Flow Algorithms.	9
UNIT 5	Tries/digital search trees, Multiway tries, Suffix trees and applications, Quadtrees and Octrees and R-trees.	8
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Narsingh Deo, "Graph Theory with Application to Engineering and Computer Science", Reprint Edition, Dover Pubns.	2016
2	Sara Baase, Allen Van Gelder, "Computer Algorithms: Introduction to Design & Analysis", 3rd Edition, Pearson Education India.	2002
3	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, "Introduction to Algorithms", 4th Edition, Mit Pr.	2022
4	Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, "The Design and	2002

	Analysis of Computer Algorithms", 1st Edition, Pearson India.	
5	Ellis Horowitz, Sartaj Sahni, "Fundamentals of Data Structures", 5th Edition, Computer Science Press.	**1976**

Course code: Course Title	Course Structure			Pre-Requisite
SE317: Discrete Structures	L	T	P	NIL
	3	1	0	

Course Objective: The objective of the course is to give basic knowledge of combinatorial problems, algebraic structures and graph theory.

S. NO	Course Outcomes (CO)
CO1	Understand and remember the symbols and properties of predicators, propositional logic, logic programming, and quantifiers.
CO2	Analyze and apply various theorem-proving techniques, principles of induction, and recurrence relation solutions.
CO3	Apply and understand set theory, combinatorial principles, and relational algebra.
CO4	Analyze and understand the concepts of lattices and boolean algebra and evaluate the operations.
CO5	Understand the concepts of graph theory and evaluate depth first search, breadth first search, in order, pre order, and post order traversal algorithms.

S. NO	Contents	Contact Hours
UNIT 1	**Formal Logic:** Statement, Symbolic Representation and Tautologies, Quantifiers, Predicator and validity, Normal form, Prepositional Logic, Predicate Logic, Logic Programming and Proof of correctors.	4
UNIT 2	**Proof, Relation and Analysis of Algorithm:** Technique for theorem proving: Direct Proof, Proof by Contra position, proof by exhausting cares and proof by contradiction, Principle of mathematical induction, principle of complete induction, recursive definition, solution methods for linear, first-order recurrence relations with constant coefficients, analysis of algorithms involving recurrence rotations-recursive selection sort, binary search, quick sort, solution method for a divide-and-conquer recurrence relation.	8
UNIT 3	**Sets and Combinations:** Sets, Subtracts, powersets, binary and unary operations on a set, set operations/set identities, fundamental country principles, principle of inclusion, exclusion and pigeonhole, permutation and combination, pascal's triangles, binomial theorem, representation of discrete structures.	8
UNIT 4	**Relation/function and matrices:** Rotation, properties of binary rotation, operation on binary rotation, closures, partial ordering, equivalence relation, properties of function, composition of function, inverse, binary and n-ary operations, characteristics for, permutation function, composition of cycles, Boolean matrices, Boolean matrices multiplication.	7
UNIT 5	**Lattices:** Lattices: Definition, sublattices, direct product, homomorphism **Boolean Algebra**: Definition, properties, isomorphic structures (in particulars, structures with binary operations) subs algebra, direct product and homomorphism, Boolean function, Boolean expression, representation & minimization of Boolean function.	7
UNIT 6	**Graph Theory:** Terminology, isomorphic graphs, Euler's formula (Proof) four color problem and the chromatic number of a graph, five color theorem. Trees terminology, directed graphs, Computer representation of graphs, Warshall's algorithms, Decision Trees, Euler path & Hamiltonian circuits, shortest path & minimal spanning trees, Depth-first and breadth first searches, analysis of research algorithm, trees associated with DFS & BFS Connected components,	8

	in order, preorder & post order trees traversal algorithms.	
	TOTAL	**42**

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	J. P. Trembly, P. Manohar, "Discrete Mathematical Structures with Applications to Computer Science", McGraw Hill.	**1997**
2	Narsingh Deo, "Graph Theory with Application to Engineering and Computer Science", PHI.	**2004**
3	Kenneth H. Rosen, K. Krithivasan, "Discrete Mathematics and Its Applications", McGraw Hill, 8th Edition.	**2021**
4	C. L. Liu, D. P. Mohapatra, "Elements of Discrete Mathematics: A Computer Oriented Approach", McGraw Hill, 4th Edition.	**2017**
5	Bernard Kolman, Robert Busby, and Sharon C. Ross, "Discrete Mathematical Structures", Pearson, 6th Edition.	**2015**

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
SE319: Distributed Systems	3	0	2	Computer Networks, Operating Systems

Course Objective: The objective of the course is to help students understand the fundamental goals of Distributed Systems and concepts communication, synchronization, resource allocation, file systems, fault tolerance and security.

S. NO	Course Outcomes (CO)
CO1	Understand and remember the architectures, design principles, and communication mechanisms of distributed systems.
CO2	Understand the concepts of synchronization and evaluate the various synchronization algorithms.
CO3	Evaluate replication strategies and consistency models to design efficient data management solutions and apply consistency protocols.
CO4	Create and analyze fault tolerance mechanisms, including failure models, process resilience.
CO5	Analyze security mechanisms and naming strategies to ensure data integrity, authenticity, and confidentiality.

S. NO	Contents	Contact Hours
UNIT 1	**Introduction:** Distributed Systems, Design Goals, Types of Distributed Systems, System Architectures and Fundamental Models, Middleware, Threads, Virtualization, Client-Server Model, Code Migration.	7
UNIT 2	**Communication:** Communication Fundamentals, Remote Procedure Call, Message Oriented Communication, and Stream Oriented Communication, Multicast Communication.	7
UNIT 3	**Synchronization:** Clock Synchronization, Logical Clocks, Mutual Exclusion Algorithms: Centralized, Decentralized, Distributed and Token Ring Algorithms, Election Algorithms.	6
UNIT 4	**Replication Management:** Need for Replication, Consistency Models: Data Centric and Client Centric Consistency Models, Replica Management, Consistency Protocols: Continuous, Primary-Based, Replicated-Write and Cache Coherence Protocols.	8
UNIT 5	**Fault Tolerance:** Basic Concepts and Failure Models, Process Resilience, Reliable Client-Server and Group Communication, Distributed Commit Recovery Mechanisms.	6
UNIT 6	Security in Distributed Systems, Secure Channels, Authentication, Integrity and Confidentiality, Access Control, Security Management. **Naming:** Flat Naming Approaches, Structured Naming, Name Space and Resolution, Attribute- Based Naming, Directory Services, LDAP, Decentralized Implementations.	8
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Andrew S Tanenbaum, Maarten Ven Steen, "Distributed Systems: Principles and Paradigms", Pearson, 2nd Edition.	**2013**
2	George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair, "Distributed Systems: Concepts and Design", Pearson, 5th Edition.	**2013**
3	Ajay D. Kshemkalyani, Mukesh Singhal, "Distributed Computing: Principles, Algorithms and Systems", Cambridge University Press.	**2010**

Course code: Course Title	Course Structure			Pre-Requisite
SE321: Soft Computing	L	T	P	Discrete Mathematics
	3	1	0	

Course Objective: The course integrates the concepts of fuzzy logic, neural networks, and optimization techniques for understanding the complex nature of decisions taken by human beings which incorporates partial understanding of the truth with past experience. At the end of this course the student should be able to understand the basic techniques used in soft computing and apply them to solve real world problems.

S. NO	Course Outcomes (CO)
CO1	Understand the basic concepts of artificial neural networks and apply artificial neural network models and learning algorithms.
CO2	Analyze fuzzy logic principles and creation of fuzzy rules, and also evaluates membership function to solve problems.
CO3	Understand and evaluate various operations on fuzzy sets such as compliment, intersections, unions, and aggregation.
CO4	Apply and analyze evolutionary computing algorithms.
CO5	Analyze the architecture and evaluate the functioning of neuro-fuzzy systems.

S. NO	Contents	Contact Hours
UNIT 1	**Neural Networks:** History, Overview of Biological Neuro-System, Mathematical Models of Neurons, ANN Architecture, Learning Rules, Learning Paradigms-Supervised, Unsupervised and Reinforcement Learning, ANN Training Algorithms-Perceptrons, Training Rules, Delta, Back Propagation Algorithm, Multilayer Perceptron Model, Hopfield Networks, Associative Memories, Applications of Artificial Neural Networks.	8
UNIT 2	**Fuzzy Logic:** Introduction to Fuzzy Logic, Classical and Fuzzy Sets: Overview of Classical Sets, Membership Function, Fuzzy rule generation.	7
UNIT 3	**Operations on Fuzzy Sets:** Compliment, Intersections, Unions, Combinations of Operations, Aggregation Operations. Nonspecificity of Fuzzy & Crisp Sets, Fuzziness of Fuzzy Sets	6
UNIT 4	**Fuzzy Arithmetic:** Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals & Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations.	6
UNIT 5	**Evolutionary Computing:** Introduction, Evolutionary Techniques, Swarm Intelligence, Bacterial Foraging, Ant Colony Optimization, and Genetic Algorithm.	8
UNIT 6	**Introduction of Neuro-Fuzzy Systems:** Architecture of Neuro Fuzzy Networks.	7
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	J. A. Anderson, "An Introduction to Neural Networks", PHI.	1995
2	John A. Hertz, Anders S. Krogh, Richard G. Palmer, "Introduction to the Theory of Neural Computation", CRC Press, 1st Edition.	1991

3	George J. Klir and B. Yuan, "Fuzzy Sets & Fuzzy Logic – Theory and Applications", Pearson, 2nd Edition.	**2015**
4	Melanie Mitchell, "An Introduction to Genetic Algorithms", PHI, 1st Edition.	**1998**
5	S V Kartalopoulos, "Understanding Neural Networks and Fuzzy Logic – Basic Concepts and Applications", IEEE Press, PHI, 1st Edition.	**1995**
6	S. Rajasekaran, G. A. Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis and Application", PHI, 1st Edition.	**2003**

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	Discrete mathematics, Programming, Probability & Graph Theory
SE323: Artificial Intelligence	3	0	2	

Course Objective: To introduce basic Knowledge representation, problem solving, and learning methods of Artificial Intelligence and understand the role of knowledge representation, problem solving, and learning in intelligent system engineering.

S. NO	Course Outcomes (CO)
CO1	Understand the foundation and scope of Artificial Intelligence (AI).
CO2	Apply problem-solving methods, heuristic search techniques, and evolutionary algorithms to address AI-related challenges.
CO3	Explore and implement game playing algorithms, predicate logic and its applications to understand knowledge representation.
CO4	Implement reasoning techniques and neural network based systems.
CO5	Analyze AI applications such as expert systems, natural language processing, robotics, and computer vision using appropriate AI techniques.

S. NO	Contents	Contact Hours
UNIT 1	**Introduction**: AI Problems, Task Domains of AI, AI Techniques: search knowledge, abstraction. Introduction to Intelligent program and Intelligent agents. Problem Solving: Basic Problem solving Method: state space search, problem characteristics, Production systems characteristics, issues in design of Intelligent search algorithm.	6
UNIT 2	**Heuristic search Techniques**: Hill climbing techniques, Best First search, A* Search, Problem Reduction: AO* Search, Constraint Satisfaction, Means-End Analysis. **Game Playing**: Game Tree, Searching procedure Minimax, alpha-beta pruning.	7
UNIT 3	**Knowledge Representation**: Knowledge Representation issues. Knowledge Representation using Predicate Logic: Unification, resolution. **Rule based Systems:** Forward versus backward reasoning, conflict resolution. **Structured Knowledge Representation**: Semantic Nets, Frames, conceptual dependency, scripts.	7
UNIT 4	**Programming Languages**: Fundamental and concepts of Programming languages like Prolog or Lisp. Relationship of languages with Knowledge representation and inferences.	6
UNIT 5	**Reasoning**: Handling uncertainty Non-Monotonic Reasoning, Probabilistic reasoning, use of certainty factors, fuzzy logic. Learning Concept of learning, learning automation, genetic algorithm, learning by inductions, neural nets.	8
UNIT 6	**Applications:** Expert Systems: Architecture, Domain Knowledge, Knowledge Acquisition, Case Studies: MYCIN, RI, Natural language Processing: Syntactic, Semantic and Pragmatic Analysis, Robotics etc.	8

	TOTAL	42

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Elaine Rich, Kevin Knight, Shivashankar B. Nair, "Artificial Intelligence", McGraw Hill Education, 3rd Edition.	**2017**
2	Nils J. Nilsson, "Principles of Artificial Intelligence", Reprint edition, Morgan Kaufmann Publishers In.	**1993**
3	LiMin Fu, "Neural Networks in Computer Intelligence", McGraw Hill Education, 1st Edition.	**2003**
4	George Luger, "Artificial Intelligence: Structures and Strategies for Complex Problem Solving", Pearson, 6th Edition.	**2008**
5	Michael Negnevitsky, "Artificial Intelligence: A Guide to Intelligent Systems", Pearson Education, 3rd Edition.	**2020**
6	Dan W. Patterson, "Introduction to Artificial Intelligence and Expert Systems", Pearson Education India, 1st Edition.	**2015**

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	Elementary set theory, Relations, Mappings, and some abstract algebra
SE325: Theory of Computation	3	1	0	

Course Objective: To provide knowledge and skills in theoretical foundations of computing that are needed to study and practice computer science.

S. NO	Course Outcomes (CO)
CO1	Understand basic concepts of formal languages, automata, and different types of finite automata.
CO2	Classify programming languages using Chomsky's hierarchy.
CO3	Demonstrate the concepts, representations, and limitations of regular languages.
CO4	Construct context free grammars and evaluate their characteristics.
CO5	Demonstrate deep understanding of pushdown automata and Turing machines to solve computational problems.

S. NO	Contents	Contact Hours
UNIT 1	**Introduction:** Alphabets, Strings and Languages; Automata and Grammars, Deterministic finite Automata (DFA)-Formal Definition, Simplified notation: State transition graph, Transition table, Language of DFA, Nondeterministic finite Automata (NFA), NFA with epsilon transition, Language of NFA, Equivalence of NFA and DFA, Minimization of Finite Automata, Distinguishing one string from other, Myhill-Nerode Theorem.	8
UNIT 2	**Regular expression (RE):** Definition, Operators of regular expression and their precedence, Algebraic laws for Regular expressions, Kleen's Theorem, Regular expression to FA, DFA to Regular expression, Arden Theorem, Non Regular Languages, Pumping Lemma for regular Languages. Application of Pumping Lemma, Closure properties of Regular Languages, Decision properties of Regular Languages, FA with output: Moore and Mealy machine, Equivalence of Moore and Mealy Machine, Applications and Limitation of FA.	8
UNIT 3	**Context free grammar (CFG):** Definition, Examples, Derivation , Derivation trees, Ambiguity in Grammar, Inherent ambiguity, Ambiguous to Unambiguous CFG, Useless symbols, Simplification of CFGs, Normal forms for CFGs: CNF and GNF.	6
UNIT 4	**Context Free Languages (CFL):** Closure properties of CFLs, Decision Properties of CFLs: Emptiness, Finiteness and Membership, Pumping lemma for CFLs.	6
UNIT 5	**Push Down Automata (PDA):** Description and definition, Instantaneous Description, Language of PDA, Acceptance by Final state, Acceptance by empty stack, Deterministic PDA, Equivalence of PDA and CFG, CFG to PDA and PDA to CFG, Two stack PDA.	6

UNIT 6	**Turing machines (TM):** Basic model, definition and representation, Instantaneous Description, Language acceptance by TM, Variants of Turing Machine, TM as Computer of Integer functions, Universal TM, Church's Thesis, Recursive and recursively enumerable languages, Halting problem, Introduction to undecidability, Undecidable problems about TMs. Post correspondence problem (PCP), Modified PCP, Introduction to recursive function theory.	**8**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, "Introduction to Automata Theory, Languages and Computation", Pearson Education India, 3rd Edition.	**2008**
2	K.L.P. Mishra, N. Chandrasekaran, "Theory of Computer Science: Automata, Languages and Computation", Prentice Hall India Learning Private Limited, 3rd Edition.	**2006**
3	John C. Martin, "Introduction to Languages and the Theory of Computation", McGraw-Hill Education, 4th Edition.	**2010**
4	Harry R. Lewis, Christos H. Papadimitriou "Elements of the Theory of Computation", Pearson Education India, 2nd Edition.	**2015**
5	Peter Linz, "An Introduction to Formal Language and Automata", Jones and Bartlett Publishers, Inc, 6th Edition.	**2016**
6	Kamala Krithivasan, R. Rama, "Introduction to Formal Languages, Automata Theory and Computation", Pearson, 1st Edition.	**2009**

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
SE327: Web Technology	3	0	2	Fundamentals of Programming

Course Objective: To understand the Internet & the Web phenomena. Comprehend the evolution, development and research in the area of Web.

S. NO	Course Outcomes (CO)
CO1	Understand the concept of internet, history of internet and the terminology of internet, and also describes how the internet works.
CO2	Understand and evaluate the use of various internet applications.
CO3	Describe the evolution, applications, and technologies of web 1.0, web 2.0, and web 3.0.
CO4	Understand client side and server-side technologies and create dynamic and interactive web applications.
CO5	Apply and evaluate web search and mining techniques, search optimization techniques, web mining, and text mining.

S.No.	Contents	Contact Hours
UNIT 1	**Inter-Networking:** Internet, Growth of Internet, Owners of the Internet, Anatomy of Internet, APRANET and Internet history of the World Web, Basic Internet Terminology, Net etiquette. Working of Internet: Packet switching technology, Internet Protocols: TCP/IP, Router. Internet Addressing Scheme: Machine Addressing (IP address), E-mail Address, and Resource Addresses.	6
UNIT 2	**Internet Applications:** E-mail, file transfer (FTP), telnet, usenet, Internet chat, Web.	4
UNIT 3	**Evolution of Web:** Web 1.0: Hypertext & linking documents, HTTP, Client-Server, peer-to-peer; Web Browser (Lynx, Mosiac, Netscape, Internet Explorer, Firefox, and Safari, the mobile web); Impact: Opportunities & Challenges. **Web 2.0:** From 1.0 to 2.0; Framework; Technologies: Client-side & server-side; Web 2.0 development technologies; Examples: social networking sites, blogs, wikis, video sharing sites, hosted services (web services, location-based services), web applications, mashups & folksonomies; Practical Usage. **Web 3.0:** From 2.0 to 3.0; Semantic Web: What, How, Why; From Web 3.0 to Web 4.0	10
UNIT 4	**Web Development:** Phases; Web Page, Website, and Web Application: Example, Technology Framework for development. Client-side technology: HTML (HTML 5). Client-side scripting: JavaScript. **Server-side technology:** PHP. Server-side scripting: Server-side JavaScript. Web application development frameworks: Django & Ruby on Rails. Web Database: Database Connectivity: JDBC, ODBC; Database-to-web connectivity.	14
UNIT 5	**Web Search and Mining:** Web IR System: Search Engines, Web Crawling, Search Engine Optimization, Web Analytics, Web Mining Taxonomy; Web Mining Framework; Social Web Mining. Text Mining: Opinion Mining, Recommendation System, Topic Detection and Tracking.	8
	TOTAL	42

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1.	Raj Kamal, "Internet and Web Technologies", Tata McGraw Hill edition.	**2002**
2.	Mark Levene, "An Introduction to Search Engines and Web Navigation", Pearson Education.	**2010**
3.	Pierre Baldi, Paolo Frasconi, and Padhraic Smyth, "Modeling the Internet and the Web", John Wiley and Sons Ltd.	**2003**
4.	Wendy Willard, "HTML: A Beginner's Guide", Tata McGraw-Hill.	**2009**
5.	Larry Ulman, "PHP and MySQL for Dynamic Web Sites", Peachpit Press, 5th Edition.	**2017**

Course code: Course Title	Course Structure			Pre-Requisite
SE329: Methods for Data Analysis	L	T	P	NIL
	3	0	2	

Course Objective: To make one understand the methods for data preparation and analysis.

S. NO	Course Outcomes (CO)
CO1	Understand the principles and importance of data analysis, including effective data collection strategies and mining software repositories.
CO2	Identify different types of variables, and classify data using appropriate measurement scales.
CO3	Apply descriptive statistics techniques to summarize data and inferential statistics methods to draw meaningful conclusions.
CO4	Implement data preparation techniques such as feature selection, and feature extraction in order to have quality data for model development.
CO5	Apply various data analysis techniques, including statistical and machine learning methods, to analyze data effectively and solve real-world problems.

S. NO	Contents	Contact Hours
UNIT 1	**Introduction:** Data Collection Strategies, Data Collection from Repositories, Mining Data from Software Repositories: Configuration Management Systems, Importance of Mining Software Repositories. Common Types of Software Repositories, Version Control Systems, Bug Tracking Systems, Open Source Repositories.	6
UNIT 2	**Types of Variables:** Independent and Dependent Variables, Categorical vs Numerical, Nominal Variables, Ordinal Variables, Interval Variables, Ratio Variables; Identifying the dependent and independent variables, Confidence levels.	8
UNIT 3	**Data Preparation-I:** Descriptive Statistics: Summarizing and describing a collection of data, Univariate and bivariate analysis, Mean, mode and standard deviation, Percentages and Ratios, Histograms, Identifying randomness and uncertainty in data inferential Statistics: Drawing inference from data, Modeling assumptions, Identifying Patterns, Regression analysis, T-test, Analysis of Variance, Correlations, Chi-square Measures of central tendency, measures of dispersion, data distribution, histogram analysis, normalization, outlier analysis, correlation analysis.	6
UNIT 4	**Data Preparation-II**: Attribute Reduction Methods: Univariate Analysis, Correlation-based Feature Selection, Attribute Extraction: Principal Component Analysis.	6
UNIT 5	**Data Analysis:** Data Analysis Techniques: Introduction to Statistical and Machine Learning techniques, Tools for analyzing Data.	8
UNIT 6	**Applications:** Case studies for data preparation and analysis.	8
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Max Kuhn, Kjell Johnson, "Applied Predictive Modelling", Springer, 2nd Edition.	**2018**
2	Ruchika Malhotra, "Empirical Research in Software Engineering: Concepts, Analysis & Applications", CRC press, 1st Edition.	**2016**
3	Kattamuri S. Sarma, "Predictive Modeling with SAS Enterprise Miner: Practical Solutions for Business Applications", SAS Institute, 3rd Edition.	**2017**
4	Jeffrey Strickland, "Predictive Modeling and Analytics", Lulu.com.	**2014**

Course code: Course Title	Course Structure			Pre-Requisite
SE331: Predictive Analytics	L	T	P	NIL
	3	1	0	

Course Objective: To make one understand the correct framework of predictive modelling process which involves data preparation, model development, hypothesis testing and model evaluation.

S. NO	Course Outcomes (CO)
CO1	Understand the concepts of classification, prediction, and regression models.
CO2	Analyzing the data and apply attribute reduction, attribute extraction, and statistical tests.
CO3	Create the predictive model and evaluate using hypothesis testing and performance evaluation measures.
CO4	Understand and apply linear regression and logistic regression technique.
CO5	Analyze and methods to resolve the problem of overfitting, class imbalance problems, and model hyperparameter tuning.

S. No	Content	Contact Hours
UNIT 1	**Introduction:** Classification & prediction, Key ingredients of predictive models, Goals of a regression analysis. Regression models, Data in a regression analysis.	6
UNIT 2	**Data Preparation & Statistical Tests:** Analyzing the metric data: Measures of central tendency, measures of dispersion, data distribution, histogram analysis, outlier analysis, correlation analysis. Attribute Reduction Methods: Univariate Analysis, Correlation-based Feature Selection, Attribute Extraction: Principal Component Analysis. Overview of statistical tests: Categories, one-tail and two-tail, Type I and Type II errors, interpreting significance results.	8
UNIT 3	**Model Development:** Model Development: Data partition, Attribute reduction, model construction, model validation, hypothesis testing, results interpretation, cross-validation.	6
UNIT 4	**Hypothesis Testing & Model Evaluation:** Steps in Hypothesis Testing, Statistical testing, model-comparison tests. Performance measures for categorical and continuous dependent variables, ROC analysis.	6
UNIT 5	**Linear and Logistic Regression Model Estimation:** Simple Linear Regression: Ordinary Least Squares Estimation, Least Squares Method, Estimating σ, Properties of Least Squares Estimates, Estimated Variances, Comparing Models: The Analysis of Variance, The Coefficient of Determination, R^2, DW Test, Confidence Intervals and Tests, The Residuals, Multiple Regression: Adding a Term to a Simple Linear Regression Model, Explaining Variability, The Multiple Linear Regression Model, Terms and Predictors, Ordinary Least Squares, The Analysis of Variance, Predictions and Fitted Values. Logistic Regression: Binomial Regression, Fitting Logistic Regression, Binomial Random Variables.	8
UNIT 6	**Overfitting, Model Tuning & Class Imbalance:** Concerns in model prediction, The Problem of Over-Fitting; Model Tuning; Data Splitting; Resampling Techniques; Choosing Final Tuning Parameters; Data Splitting Recommendations; Choosing Between Models; Computing. Remedies for Severe Class Imbalance: The Effect of Class Imbalance; Model Tuning; Alternate Cutoffs; Adjusting Prior Probabilities; Unequal Case Weights; Sampling Methods; Cost-Sensitive Training.	8
	TOTAL	**42**

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1.	Max Kuhn and Kjell Johnson, "Applied Predictive Modelling", Springer Verlag.	**2013**
2.	Sanford Weisberg, "Applied Linear Regression", Wiley, Fourth Edition.	**2014**
3.	Ruchika Malhotra, "Empirical Research in Software Engineering: Concepts, Analysis & Applications", CRC press.	**2016**
4.	Samprit Chatterjee, Ali S. Hadi, "Regression Analysis by Example", John Wiley, Fifth Edition.	**2012**
5	Edward W. Frees, Richard A. Derrig, Glenn Meyers, "Predictive Modeling Techniques in Actuarial Science", Vol. I: Predictive Modeling Techniques. Cambridge University Press.	**2014**
6.	Kattamuri S. Sarma, "Predictive Modeling with SAS Enterprise Miner: Practical Solutions for Business Applications", SAS Institute, Second Edition.	**2013**
7.	Jeffrey Strickland, "Predictive Modeling and Analytics", Lulu.com.	**2012**

Course code: Course Title	Course Structure			Pre-Requisite
SE333: Artificial Intelligence for Sports	L	T	P	NIL
	3	0	2	

Course Objective: The course will discuss the theory, development and application of Artificial Intelligence (AI) in sports.

S. NO	Course Outcomes (CO)
CO1	Understand the basic applications of AI in sports industry.
CO2	Apply AI-driven techniques to track and enhance athlete rehabilitation and performance management.
CO3	Analyze different game strategies for demonstrating AI's role in optimizing performance.
CO4	Design and develop innovative solutions for fan engagement.
CO5	Evaluate the latest trends of AI for sports analytics.

S. NO	Contents	Contact Hours
UNIT 1	**Foundations of AI in Sports:** The foundational and advanced applications of AI in the sports industry, with a strong emphasis on practical, real-world applications, their historical and evolving roles in sports, followed by modules on data collection.	7
UNIT 2	**AI for Recovery Monitoring:** AI-driven recovery monitoring, a practical application that is increasingly important in the sports industry.	7
UNIT 3	**Tactical AI in Sports:** Explore game strategy analysis and tactical decision-making using reinforcement learning and real-time game analytics, demonstrating the immediate relevance of AI in sports.	9
UNIT 4	**AI in Fan Engagement and Ethics:** Fan engagement and innovations such as AI-powered broadcasting, personalized recommendations, and Augmented Reality/ Virtual Reality experiences. Ethical considerations, including data privacy and AI fairness, hands-on training in AI tools like TensorFlow, OpenCV, and specialized sports analytics software.	9
UNIT 5	**AI Trends and Innovations:** Applications of AI in sports analytics. Latest trends in Artificial Intelligence in Olympics Sports. Overview of use of AI in sports equipments and wearables.	10
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Duarte Araujo, Micael Couceiro, Ludovic Seifert, Hugo Sarmento, Keith Davids, "Artificial Intelligence in Sport Performance Analysis", Routledge, 1st Edition.	2021
2	Rajalingappaa Shanmugamani, "Deep Learning for Computer Vision: Expert techniques to train advanced neural networks using TensorFlow and Keras", Packt Publishing.	2018
3	Ulf Brefeld, Jesse Davis, Jan Van Haaren, Albrecht Zimmermann, "Machine Learning and Data Mining for Sports Analytics", Springer Cham, 1st Edition.	2018

4	Jan Van Haaren, Albrecht Zimmermann, Joris Renkens, Guy Van den Broeck, Tim Op De Beéck, Wannes Meert, and Jesse Davis, “Machine learning and data mining for sports analytics”.	**2013**

Course code: Course Title	Course Structure			Pre-Requisite
SE302: Empirical Software Engineering	L	T	P	Software Engineering
	3	0	2	

Course Objective: The objective is to study the collection and analysis of data and experience that can be used to characterize, evaluate and reveal relationships between software development deliverables, practices, and technologies.

S. NO	Course Outcomes (CO)
CO1	Demonstrate deep understanding of fundamentals of empirical study.
CO2	Apply software metrics and experimental design principles to measure software quality and conduct empirical studies.
CO3	Extract and analyze data collected from software repositories to derive insights using historical analysis techniques.
CO4	Develop predictive models, evaluate their performance and validate models using statistical testing.
CO5	Identify and mitigate threats to validity, report findings ethically, and utilize empirical tools.

S. NO	Contents	Contact Hours
UNIT 1	**Introduction:** What Is Empirical Software Engineering?; Overview of Empirical Studies; Types of Empirical Studies; Empirical Study Process; Ethics of Empirical Research; Importance of Empirical Research; Basic Elements of Empirical Research; Some Terminologies. **Systematic Literature Reviews:** Basic Concepts; Case Study; Planning the Review; Methods for Presenting Results; Conducting the Review; Reporting the Review.	6
UNIT 2	**Software Metrics**: Introduction; Measurement Basics; Measuring Size; Measuring Software Quality; Object-Oriented Metrics; Dynamic Software Metrics; System Evolution and Evolutionary Metrics; Validation of Metrics; Practical Relevance and Use of Software Metrics in Research; Industrial Relevance of Software Metrics. **Experimental Design:** Overview of Experimental Design; Case Study: Fault Prediction Systems; Research Questions; Reviewing the Literature; Research Variables; Terminology Used in Study Types; Hypothesis Formulation; Data Collection; Selection of Data Analysis Methods.	8
UNIT 3	**Mining Data from Software Repositories:** Configuration Management Systems; Importance of Mining Software Repositories; Common Types of Software Repositories; Version Control Systems; Bug Tracking Systems; Extracting Data from Software Repositories; Static Source Code Analysis; Software Historical Analysis; Software Engineering Repositories and Open Research Data Sets; Case Study: Defect Collection and Reporting System for Git Repository.	6
UNIT 4	**Data Analysis and Statistical Testing:** Analyzing the Metric Data; Attribute Reduction Methods; Hypothesis Testing; Statistical Testing; Example—Univariate Analysis Results for Fault Prediction System. **Model Development and Interpretation:** Model Development; Statistical Multiple Regression Techniques; Machine Learning Techniques; Concerns in Model Prediction; Performance Measures for Categorical Dependent Variable; Performance Measures for Continuous Dependent Variable; Cross-Validation;	6

	Model Comparison Tests; Interpreting the Results; Example—Comparing ML Techniques for Fault Prediction.	
UNIT 5	**Validity Threats:** Categories of Threats to Validity; Example—Threats to Validity in Fault Prediction System; Threats and Their Countermeasures. **Reporting Results:** Reporting and Presenting Results; Guidelines for Masters and Doctoral Students; Research Ethics and Misconduct.	**8**
UNIT 6	**Mining Unstructured Data: Introduction;** Steps in Text Mining; Applications of Text Mining in Software Engineering; Example—Automated Severity Assessment of Software Defect Reports. **Case Study & Tools:** Demonstrating Empirical Procedures**;** WEKA; KEEL; SPSS; MATLAB; R; Comparison of Tools.	**8**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Ruchika Malhotra, "Empirical Research in Software Engineering: Concepts, Analysis & Applications", CRC press, 1st Edition.	**2016**
2	B. Boehm, H. D. Rombach, M. V. Zelkowitz, "Foundations of Empirical Software Engineering: The Legacy of Victor R. Basili, Springer.	**2010**

Course code: Course Title	Course Structure			Pre-Requisite
SE304: Compiler Design	L	T	P	Theory of Computation
	3	1	0	

Course Objective: To study the design of all the phases of compiler in detail.

S. NO	Course Outcomes (CO)
CO1	Demonstrate basic concepts of compiler and compilation of different phases.
CO2	Represent language tokens using regular expressions, context free grammar and finite automata and design lexical analyzer for a language.
CO3	Design syntax directed translation schemes for a given context free grammar.
CO4	Evaluate symbol table structures, runtime memory management strategies, and error detection & recovery methods to enhance compiler efficiency.
CO5	Apply optimization techniques to intermediate code and generate machine code for high level language program.

S. NO	Contents	Contact Hours
UNIT 1	**Introduction:** Definition, Phases and Passes, FSM & RE's and their application to Lexical Analysis, Implementation of Lexical Analyzers, Lexical- Analyzer Generator, Lex – Compiler.	6
UNIT 2	**Syntax Analysis:** Formal Grammar and their application to Syntax Analysis, BNF Notation,. The Syntactic specification of Languages: CFG, Derivation and Parse Trees, Shift Reduce Parsing, Operator precedence parsing, top down Parsing, Predictive Parsers. LR Parsers, the canonical collection of LR(0)items, constructing SLR Parsing Tables, Constructing canonical LR Parsing tables and LALR parsing tables, An Automatic Parser Generator, YACC.	12
UNIT 3	**Syntax Directed Translation:** Syntax directed Translation Schemes, Implementation of Syntax directed translators, Intermediate Code, Postfix notation, Parse Trees and Syntax Trees, Three address Code, Quadruple & Triples, Translation of Assignment Statements, Boolean expressions, Control Statements, Array references in Arithmetic expressions , Procedure Calls , Declarations and Case statements Translations.	10
UNIT 4	**Symbol Tables:** Data Structure for Symbol Tables, representing scope information. Run Time Administration: Implementation of simple Stack allocation scheme, storage allocation in block structured language.	4
UNIT 5	**Error detection and Recovery:** Lexical phase errors, syntax phase errors, semantic errors and Error recovery techniques.	4
UNIT 6	**Code Optimization**: Loop optimization, the DAG representation of basic blocks, value numbers and Algebraic Laws, Global Data – Flow Analysis and Code generation.	6
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman, "Compilers Principles, Techniques, & Tools", 2nd Edition, Pearson Addison Wesley.	**2007**

Course code: Course Title	Course Structure			Pre-Requisite
SE306: Software Reliability	L	T	P	Software Engineering
	3	1	0	

Course Objective: To appreciate and understand scientific concepts of Software and Hardware Reliability, to apply Software Reliability Growth Models in Software Development and to emphasize the Application of Software Reliability Models.

S. NO	Course Outcomes (CO)
CO1	Remember and understand the reliability mathematics.
CO2	Understand software and hardware reliability concepts and terminologies.
CO3	Apply non homogeneous poisson process models to access software reliability
CO4	Analyze, compare, and evaluate software reliability growth models.
CO5	Analyze and apply methods to prepare test case and executing those test cases.

S.No.	Contents	Contact Hours
UNIT 1	**Introduction to System Reliability**: Review of Reliability Mathematics – Random Experiment, Probability distributions- Binomial, Poisson, Exponential, Weibull, and Generalized Exponential distributions; System Reliability -Reliability Block diagram — Repairable and Non-Repairable systems; Maintainability and Availability — MTBF — MTTF, MDT – MTTR; Designing for higher reliability — Redundancy— k out of n systems	8
UNIT 2	**System Reliability Concepts**: Software and hardware reliability; Basic Concepts – Errors, faults and Failures; Reliability Model classification – Operational Reliability, Testing Reliability; Introduction to Software Reliability Growth Models (SRGMs) - General Model Characteristic – Historical Development of models – Model Classification scheme –white box and black box models; Markovian models – Jelinski –Moranda model	9
UNIT 3	**Non-Homogenous Poisson Process Models:** NHPP models- Musa models- Basic Execution time, Logarithmic Poisson Execution time models- Goel – Okumoto model, Yamada delayed S-shaped model, Imperfect debugging models –Kapur- Garg model, Subburaj-Gopal model for the learning phenomenon, Subburaj-Gopap-Kapur versatile debugging model	9
UNIT 4	**Comparison of Software Reliability Models:** Bayesian models- Littlewood – Verall model; Discrete models; Efforts based models; Execution time, Testing time and Calendar Time modeling; Comparison Criteria – Goodness of fit - Predictive Validity of Models – short term and long term	8
UNIT 5	**Advanced Topics in Software Reliability:** Engineering "just right reliability"- Test case generation-operational profile; setting system failure intensity objectives; preparing, executing and guiding test; Release Time determination – criteria – cost, failure intensity, reliability.	8
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1.	John D. Musa, Anthony Iannino, Kazuhira Okumoto, "Software Reliability – Measurement, Prediction, Application, Series in Software Engineering and	1987

	Technology", McGraw Hill.	
2.	Michael Lyu, "Handbook of Software Reliability Engineering", IEEE Computer Society Press, ISBN: 0-07-039400-8.	**1996**
3.	John D. Musa, "Software Reliability Engineering", Tata McGraw Hill, 1999.	**1999**
4.	Patric D. T.O'Connor, "Practical Reliability Engineering", 4th Edition, John Wesley & sons, 2003.	**2003**
5.	M. Xie, "Software Reliability Modelling", World Scientific, Singapore, 1991.	**1991**

Course code: Course Title	Course Structure			Pre-Requisite
SE308: Multimedia Systems	L	T	P	NIL
	3	1	0	

Course Objective: To study the concepts of multimedia data, algorithms and compression

S. NO	Course Outcomes (CO)
CO1	Understand the basic concepts of multimedia, stages of multimedia projects, tools, and techniques.
CO2	Apply multimedia building blocks in order to create multimedia digital content.
CO3	Understand and apply data compression algorithms and evaluate compression ratio
CO4	Analyze, understand, and evaluate speech compression techniques, synthesis techniques, and image processing methods.
CO5	Apply multimedia database techniques, video compression standards, and streaming technologies

S.No.	Contents	Contact Hours
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.	9
UNIT 2	**Multimedia Building Blocks:** Text, Sound MIDI, Digital Audio, audio file formats, MIDI under windows environment, Audio & Video Capture.	6
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 loss less & lossy compression.	9
UNIT 4	**Speech Compression & Synthesis:** Digital Audio concepts, Sampling Variables, Loss less compression of sound, loss compression & silence compression.	6
UNIT 5	**Images:** Multiple monitors, bitmaps, Vector drawing, lossy graphic compression, image file formats, animations, Images standards, JPEG Compression, Zigzag Coding	5
UNIT 6	**Multimedia Database. Content based retrieval for text and images, Video:** Video representation, Colors, Video Compression, MPEG standards, MHEG Standard Video Streaming on net, Video Conferencing, Multimedia Broadcast Services, Indexing and retrieval of Video Database, recent developments in Multimedia.	7
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1.	Tay Vaughan, "Multimedia, Making IT Work" Osborne McGraw Hill, 9th	2014

	Edition.	
2.	John F. Koegel Buford, "Multimedia Systems", Addison Wesley.	**2000**
3.	Rajneesh Agarwal, Bharat Tiwari, "Multimedia Systems", Excel Books.	**2002**
4.	Mark Nelson, Jean – Loup - Gailly, "Data Compression Book" BPB.	**2013**
5.	David Hillman, "Multimedia technology and Applications", Galgotia Publication.	**2008**

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
SE310: Parallel Computer Architecture	3	1	0	Computer Architecture

	Course Objective: To introduce fundamentals of parallel, pipelines and superscalar architecture.

S. NO	Course Outcomes (CO)
CO1	Understand the fundamentals of parallel computing, architectural classifications, and performance evaluation techniques.
CO2	Apply multi-core programming techniques, optimization strategies, and parallel processing libraries.
CO3	Analyze and understand multi-threaded architectures, cache coherence mechanisms, and memory consistency models.
CO4	Understand and analyze compiler optimization and operating system issues for multiprocessing and approaches to resolve these issues.
CO5	Analyze and implement parallel computing techniques in real-world applications

S.No.	Contents	Contact Hours
UNIT 1	**Introduction**: Introduction to parallel computing, need for parallel computing, parallel architectural classification schemes, Flynn's, Fang'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.	6
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, Open MP and other message passing libraries, threads, mutex etc.	6
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	10
UNIT 4	**Compiler Optimization Issues:** Introduction to optimization, overview of parallelization; Shared memory programming, introduction to Open MP; 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.	8

UNIT 5		**Operating System Issues:** 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; Open MP, MPI and case studies	**8**
UNIT 6		**Applications** Case studies from Applications: Digital Signal Processing, Image processing, Speech processing.	**4**
		TOTAL	**42**

REFERENCES

S.No.		Name of Books/Authors/Publishers	Year of Publication / Reprint
1.		Kai Hwang, Naresh Jotwani, "Advanced Computer Architecture: Parallelism, Scalability, Programmability", TMH, 3rd Edition.	**2003**
2.		John P. Hayes, "Computer Architecture and Organization", McGraw Hill, 3rd Edition.	**2017**
3.		Michael. J. Flynn, "Computer Architecture, Pipelined and Parallel Processor Design", Narosa Publishing.	**1998**
4.		John L. Hennessy, David A. Patterson, "Computer Architecture: A Quantitative approach", Morgan Kauffmann, 6th Edition	**2017**
5.		Kai Hwang, Faye A. Briggs, "Computer Architecture and Parallel Processing", MGH.	**2000**

Course code: Course Title	Course Structure			Pre-Requisite
SE312: Introduction to Health Care Analytics	L	T	P	NIL
	3	1	0	

Course Objective: To describe how data-based healthcare can help in improving outcomes for patient health and to use data analytics to find health concerns and solutions to the problem faced by a patient.

S. NO	Course Outcomes (CO)
CO1	Understand the fundamentals of healthcare data analytics, healthcare policies, and standardized clinical data handling.
CO2	Apply machine learning techniques to preprocess, analyze, and model healthcare data for predictive analytics and evaluate the model performance.
CO3	Analyze and apply IoT, encryption techniques, and visual analytics to enhance healthcare management and decision support systems
CO4	Apply and evaluate deep learning techniques for healthcare analytics to analyze clinical data, biomedical images.
CO5	Apply descriptive, predictive, and prescriptive analytics techniques to analyze and improve healthcare decision-making.

S. NO	Contents	Contact Hours
UNIT 1	**Introduction to Healthcare Data Analytics:** History of Healthcare Analysis, Parameters on Medical Care Systems, Healthcare Policy, Need for Healthcare Analytics, Examples of Healthcare Analytics, Healthcare policy – Handling Patient data: the journey from patient to computer - Standardized clinical codesets - Breaking down healthcare analytics: population, medical task, data format, disease.	8
UNIT 2	**Machine Learning for Healthcare Analytics:** Machine Learning Foundations: Tree-like reasoning, Probabilistic reasoning weighted sum approach, Machine learning pipeline: Loading the data, Cleaning and preprocessing the data, Exploring and visualizing the data, Selecting features, Training the model parameters, Evaluating model performance	8
UNIT 3	**Health Care Management:** IOT – Smart Sensors – Migration of Healthcare Relational Database to NoSQL Cloud Database, Decision Support System, Matrix Block Cipher System, Semantic Framework Analysis, Histogram Bin Shifting and Rc6 Encryption, Visual Analytics for Healthcare	8
UNIT 4	**Deep Learning for Healthcare Analytics:** Introduction on Deep Learning, DFF network, CNN-RNN for Sequences, Biomedical Image and Signal Analysis, Natural Language Processing and Data Mining for Clinical Data, Mobile Imaging and Analytics, Clinical Decision Support System.	10
UNIT 5	**Healthcare Analytics Applications:** Introduction - Descriptive Analytics Applications - Predictive Analytics Applications - Prescriptive Analytics Application.	8
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1.	Vikas (Vik) Kumar, "Healthcare Analytics Made Simple: Techniques in	2018

	Healthcare Computing Using Machine Learning and Python", Packt Publishing Ltd.	
2.	Christo El Morr, Hossam Ali-Hassan, "Analytics in Healthcare: A Practical Introduction", Springer	**2019**
3.	Ivo D. Dinov, "Data Science and Predictive Analytics", Springer, Ann Arbor, MI, USA	**2018**
4.	Hui Yang, Eva K. Lee, "Healthcare Analytics: From Data to Knowledge to Healthcare Improvement", John Wiley & Sons.	**2016**

Course code: Course Title	Course Structure			Pre-Requisite
SE314: Natural Language Processing	L	T	P	Theory of Automata
	3	1	0	

Course Objective: The goal of natural language processing (NLP) is to design and build computer systems that are able to analyze natural languages like German or English, and that generate their outputs in a natural language.

S. NO	Course Outcomes (CO)
CO1	Demonstrate understanding of fundamental concepts of natural language processing, including language structures, and finite-state automata.
CO2	Utilize various parsing techniques such as top-down, bottom-up, and feature-based parsing to analyse natural language structures.
CO3	Demonstrate grammars for natural language processing.
CO4	Implement probabilistic and statistical models, dependency parsing, and ambiguity resolution techniques in NLP applications.
CO5	Develop and demonstrate real-world NLP applications such as machine translation, speech recognition, and intelligent interfaces using advanced NLP techniques.

S. NO	Contents	Contact Hours
UNIT 1	**Introduction:** The study of Language, Introduction to NLP, Regular Expression, Finite State Automata, Evaluating Language Understanding Systems, Different levels of Language Analysis, Representations and Understanding, Linguistic Background.	6
UNIT 2	**Grammars and Parsing:** Top-Down and Bottom-Up Parsers, Transition Network Grammars, Top-Down Chart Parsing, Feature Systems and Augmented Grammars, Morphological Analysis and the Lexicon, Parsing with Features, Augmented Transition Networks.	7
UNIT 3	**Grammars for Natural Language:** Auxiliary Verbs and Verb Phrases, Movement Phenomenon in Language, Handling questions in Context-Free Grammars, Hold mechanisms in ATNs, Human preferences in Parsing, Encoding uncertainty, Deterministic Parser.	6
UNIT 4	**Ambiguity Resolution:** Statistical Methods, Probabilistic Language Processing, Estimating Probabilities, Part-of-Speech tagging, Obtaining Lexical Probabilities, Probabilistic Context-Free Grammars, Dependency Parsing, Best First Parsing, Semantics and Logical Form, Word senses and Ambiguity, Encoding Ambiguity in Logical Form.	7
UNIT 5	**Advanced Features and Syntax, Features and Unification:** Feature structures – Unification of feature structures – Features structures in the grammar – Implementing unification – Parsing with unification constraints – Types and Inheritance. Lexicalized and Probabilistic Parsing: Probabilistic context-free grammar – problems with PCFGs – Probabilistic lexicalized CFGs – Dependency Grammars – Human parsing.	8
UNIT 6	**Application of NLP:** Intelligent Work Processors, Machine Translation, User Interfaces, Man-Machine Interfaces, Natural language Querying Tutoring and Authoring Systems, Speech Recognition Commercial use of NLP, Semantic Interpretation, Information Retrieval.	8
	TOTAL	**42**

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	James Allen, "Natural Language Understanding", Pearson Education, 2nd Edition.	**2002**
2	Christopher D. Manning, Hinrich Schutze, "Foundation of Statistical Natural Language Processing, The MIT Press.	**1999**
3	Daniel Jurafsky, James H. Martin, "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", Pearson Education India, 2nd Edition.	**2013**
4	Akshar Bharati, Vineet Chaitanya, Rajeev Sangal, "Natural Language Processing: A Paninian Perspective", Prentice Hall India Learning Private Limited.	**1995**
5	J. G. Carbonell, K.W. Church, W. Dilger, T. W. Finin, P.J. Hayes, W.A. Martin, J. G. Neal, R. S. Patil, J. Pitrat, A. Sagvall Hein, S.C. Shapiro, S. L. Small, M. Stone Palmer, M. Thiel, Leonard Bolc, "Natural Language Parsing Systems (Artificial Intelligence)", Springer-Verlag Berlin and Heidelberg GmbH & Co. K, 1st Edition.	**2011**

Course code: Course Title	Course Structure			Pre-Requisite
SE316: Advanced Database Management Systems	L	T	P	Database Management Systems
	3	1	0	

Course Objective: To highlight the features of advanced SQL, parallel and distributed databases and architecture of modern database systems.

S. NO	Course Outcomes (CO)
CO1	Demonstrate deep understanding of advanced SQL features, object-based databases, and XML.
CO2	Apply query processing and optimization techniques to improve database performance.
CO3	Analyze various recovery mechanisms to ensure data integrity and consistency in database systems.
CO4	Evaluate various database system architecture with parallel and distributed database.
CO5	Design and implement advanced database applications using real-time transaction systems, and distributed transaction processing techniques.

S. NO	Contents	Contact Hours
UNIT 1	**Advanced SQL**: SQL Data Types and Schemas, Integrity Constraints, Authorization, Embedded SQL, Dynamic SQL, Functions and Procedural Constructs, Recursive Queries, Advanced SQL Features. **Object-Based Databases and XML:** Complex Data Types, Structured Types and Inheritance in SQL, Table Inheritance, Array and Multiset Types in SQL, Object-Identity and Reference Types in SQL, Implementing O-R Features, Persistent Programming Languages, Object-Oriented versus Object-Relational, Structure of XML Data, XML Document Schema, Querying and Transformation, Application Program Interfaces to XML, Storage of XML Data, XML Applications.	8
UNIT 2	**Query Processing and Query Optimization:** Measures of Query Cost, Selection Operation, Sorting, Join Operation, Other Operations, Evaluation of Expressions, Transformation of Relational Expressions, Estimating Statistics of Expression Results, Choice of Evaluation Plans, Materialized Views.	6
UNIT 3	**Recovery System:** Failure Classification, Storage Structure, Recovery and Atomicity, Log-Based Recovery, Recovery with Concurrent Transactions, Buffer Management, Failure with Loss of Nonvolatile Storage, Advanced Recovery Techniques, Remote Backup Systems.	6
UNIT 4	**Database-System Architectures:** Centralized and Client –Server Architectures, Server System Architectures, Parallel Systems, Distributed Systems, Network Types, Parallel Databases, I/O Parallelism, Interquery Parallelism, Intraquery Parallelism, Intraoperation Parallelism, Interoperation Parallelism, Design of Parallel Systems.	8
UNIT 5	**Distributed Databases:** Homogeneous and Heterogeneous Databases, Distributed Data Storage, Distributed Transactions, Commit Protocols, Concurrency Control in Distributed Databases, Availability, Distributed Query Processing, Heterogeneous Distributed Databases.	6
UNIT 6	**Advanced Transaction Processing**: Transaction-Processing Monitors, Transactional Workflows, E-Commerce, Main-Memory Databases, Real-Time Transaction Systems, Long-Duration Transactions, Transaction Management in Multi-databases.	8

	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Abraham Silberschatz, Henry F. Korth, "Database System Concepts", MCGRAWHILL, 7th Edition.	**2021**
2	Elmasri Ramez, Navathe Shamkant, "Fundamentals of Database System", Pearson Education, 7th Edition.	**2017**
3	Raghu Ramakrishnan, Johannes Gehrke, "Database Management Systems", McGraw Hill Education, 3rd Edition.	**2002**
4	M. Tamer Ozsu, Patrick Valduriez, "Principles of Distributed Database Systems", Pearson Education, 2nd Edition.	**2005**

Course code: Course Title	Course Structure			Pre-Requisite
SE318: Data Compression	L	T	P	NIL
	3	1	0	

Course Objective: To study various data/image compression techniques in detail.

S. NO	Course Outcomes (CO)
CO1	Understand compression techniques, modelling approaches, and coding methods
CO2	Apply Huffman coding and its variants for efficient lossless compression in image, text, and audio processing
CO3	Apply arithmetic coding and dictionary-based compression techniques to optimize image and file compression.
CO4	Analyze image compression techniques, including GIF, predictive coding, and JPEG-LS.
CO5	Analyze lossy coding techniques, including scalar and vector quantization, to optimize data compression and signal representation.

S.No.	Contents	Contact Hours
UNIT 1	**Introduction:** Compression Techniques: Loss less compression, Lossy Compression, Measures of performance, Modelling and coding, Mathematical *Preliminaries* for Lossless compression: A brief introduction to information theory, Models: Physical models, Probability models, Markov models, composite source model, Coding: uniquely decodable codes, Prefix codes.	6
UNIT 2	**Huffman coding:** The Huffman coding algorithm: Minimum variance Huffman codes, Adaptive Huffman coding: Update procedure, encoding procedure, decoding procedure. Golomb codes, Rice codes, Tunstall codes, Applications of Hoffman coding: Loss less image compression, Text compression, Audio Compression.	8
UNIT 3	**Arithmetic Coding:** Coding a sequence, Generating a binary code, Comparison of Binary and Huffman coding, Applications: Bi-level image compression-The JBIG standard, JBIG2, Image compression. Dictionary Techniques: Introduction, Static Dictionary: Diagram Coding, Adaptive Dictionary. The LZ77 Approach, The LZ78 Approach, Applications: File Compression-UNIX compress.	12
UNIT 4	**Image Compression:** The Graphics Interchange Format (GIF), Compression over Modems: V.42 bits, Predictive Coding: Prediction with Partial match (ppm): The basic algorithm, The ESCAPE SYMBOL, length of context, The Exclusion Principle, The Burrows- Wheeler Transform: Move-to-front coding, CALIC, JPEG-LS, Multi-resolution Approaches, Facsimile Encoding, Dynamic Markoy Compression.	8
UNIT 5	**Mathematical Preliminaries for Lossy Coding:** Distortion criteria, Models, Scalar Quantization: The Quantization problem, Uniform Quantizer, Adaptive Quantization, Non uniform Quantization.	4
UNIT 6	**Vector Quantization:** Advantages of Vector Quantization *over* Scalar Quantization, The Linde-Buzo- Gray Algorithm, Tree structured Vector Quantizers. Structured *Vector* Quantizers.	4
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1.	Khalid Sayood, "Introduction to Data Compression", Morgan Kaufmann Publishers.	**2000**
2.	David Salomon, "Data Compression: The Complete Reference", Springer, 4th Edition.	**2007**

Course code: Course Title	Course Structure			Pre-Requisite
SE320: Real Time Systems	L	T	P	Data Structures and Algorithms
	3	1	0	

Course Objective: The course addresses basic concepts of real-time systems, presents examples of real-time systems, covers real-time systems analysis and design, and gives an in-depth treatment of timing analysis and scheduling.

S. NO	Course Outcomes (CO)
CO1	Understand real-time system fundamentals, including timing constraints, task models, and application domains.
CO2	Analyze real-time scheduling approaches and algorithms to optimize task execution in dynamic and time-constrained systems.
CO3	Analyze resource access control mechanisms, including priority-based protocols.
CO4	Analyze multiprocessor system environments, scheduling algorithms, and task schedulability to optimize performance.
CO5	Analyze real-time communication models, protocols, and scheduling techniques.

S.No.	Contents	Contact Hours
UNIT 1	**Introduction:** Definition, Typical Real Time Applications; Digital Control, High Level Controls, Signal Processing etc., 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, Precedence Constraints and Data Dependency.	8
UNIT 2	**Real Time Scheduling:** Common Approaches to Real Time Scheduling: Clock Driven Approach, Weighted Round Robin Approach, Priority Driven Approach, Dynamic Versus Static Systems, Optimality of Effective-Deadline-First (EDF) and Least-Slack-Time-First (LST) Algorithms, Offline Versus Online Scheduling, Scheduling A periodic and Sporadic jobs in Priority Driven and Clock Driven Systems.	10
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, Stack Based Priority-Ceiling Protocol, Use of Priority-Ceiling Protocol in Dynamic Priority Systems, Pre-emption Ceiling Protocol, Access Control in Multiple-Unit Resources, Controlling Concurrent Accesses to Data Objects	8
UNIT 4	**Multiprocessor System Environment:** Multiprocessor and Distributed System Model, Multiprocessor Priority-Ceiling Protocol, Schedulability of Fixed-Priority End-to-End Periodic Tasks, Scheduling Algorithms for End-to-End Periodic Tasks, End-to-End Tasks in Heterogeneous Systems, Predictability and Validation of Dynamic Multiprocessor Systems, Scheduling of Tasks with Temporal Distance Constraints.	8
UNIT 5	**Real Time Communication:** Model of Real Time Communication, Priority-Based Service and Weighted Round-Robin Service Disciplines for Switched Networks, Medium Access Control Protocols for Broadcast Networks, Internet and Resource Reservation Protocols, Real Time Protocols, Communication in Multicomputer System, An Overview of Real Time Operating Systems.	8
	TOTAL	42

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1.	Jane W. S. Liu, "Real Time Systems", Pearson Education Publication.	**2000**
2.	Hermann Kopetz, Wilfried Steiner, "Real Time Systems: Design Principle for Distributed Embedded Applications", Kluwer Academic, 3rd Edition.	**2022**
3.	Bruce Powel Douglass, "Real Time UML: Advances in the UML for Real-Time Systems", Addison-Wesley, 3rd Edition.	**2013**

Course code: Course Title	Course Structure			Pre-Requisite
SE322: Parallel Algorithms	L	T	P	Data Structures and Algorithms
	3	1	0	

Course Objective: To introduce parallel algorithms and compare it with its sequential equivalent.

S. NO	Course Outcomes (CO)
CO1	Analyze and implement parallel algorithms for dense matrix computations to enhance computational efficiency.
CO2	Analyze decomposition and mapping techniques
CO3	Understand and apply parallel sorting algorithms for efficient data processing.
CO4	Understand and apply parallel searching and selection algorithms to optimize data retrieval and processing.
CO5	Apply graph algorithms such as graph coloring, minimum spanning tree, and shortest path algorithms.

S.No.	Contents	Contact Hours
UNIT 1	Introduction: Need for parallel computers, Models of computation, Analyzing parallel algorithms, Expressing parallel algorithms	3
UNIT 2	Dense Matrix algorithms: Matrix vector Multiplication, Matrix matrix multiplication	4
UNIT 3	Decomposition & Mapping techniques: Database query processing, 15 puzzle problem, Parallel discrete event simulation, Image dithering, Dense LU factorization	5
UNIT 4	Sorting: Hyper quick sort, Merge sort, Bitonic merge sort, odd even transposition, Enumeration sort (sorting on the CRCW model, CREW model and EREW model)	10
UNIT 5	Searching and selection: Searching on a sorted sequence (EREW, CREW, CRCW), Searching on a random sequence (EREW, CREW, CRCW, Tree and Mesh), Sequential selection algorithm, Parallel selection algorithm (EREW parallel solution)	10
UNIT 6	Graph Algorithm: Graph coloring, Minimal spanning tree, Shortest path algorithm	10
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1.	Ananth Grama, Anshul Gupta, George Karypis, and Vipin Kumar, "Introduction to Parallel Computing", Addison Wesley, 2nd Edition.	2003
2.	S.G. Akl, "The Design and Analysis of Parallel Algorithms", PHI.	1989
3.	F.T. Leighton, "Introduction to Parallel Algorithms and Architectures: Arrays, Trees, Hypercubes", MK Publishers, San Mateo California.	1992
4.	Barry Wilkinson, Michael Allen, "Parallel Programming Techniques and Applications using Networked Workstations and Parallel Computers", Prentice Hall, 2nd Edition.	2004

5.	Michael J. Quinn, "Parallel Computer Theory and Practice", McGraw Hill, 2nd Edition.	**1994**

Course code: Course Title	Course Structure			Pre-Requisite
SE324: Probability and Statistics	L	T	P	NIL
	3	1	0	

Course Objective: To learn the language and core concepts of probability theory and understand basic principles of statistical inference.

S. NO	Course Outcomes (CO)
CO1	Elucidate the basic principles of probability and statistics.
CO2	Compute marginal and conditional distributions from joint distributions.
CO3	Perform operations on random variables.
CO4	Explain probability distribution function, probability density function and solve problems.
CO5	Understand sampling, error and perform hypothesis testing.

S. NO	Contents	Contact Hours
UNIT 1	**Introduction to Probability theory:** Through set and Relative Frequency: Experiments and Sample Spaces, Discrete and Continuous Sample Spaces, Events, Probability and Axioms, Probability as a Relative Frequency, Joint and Conditional Probability: Joint Probability, Conditional Probability, Total Probability, Bayes' Theorem. Independent Events: Two Events, Multiple Events, Properties of Independent Events.	6
UNIT 2	**Random Variables:** Random Variable Concept, Definition of a Random Variable, Conditions for a Function to be a Random Variable, Discrete and Continuous Random Variables, Mixed Random Variable. Distribution Function, Density Function: Existence, Properties of Density Functions. Gaussian Random Variable: Other Distribution and Density Examples: Binomial, Poisson, Uniform, Exponential, Rayleigh. Conditional Distribution and Density Functions: Conditional Distribution, Properties of Conditional Distribution, Conditional Density, Properties of Conditional Density.	8
UNIT 3	**Operations on Random Variables:** Expectation, Expected Value of a Random Variable, Expected Value of a Function of a Random Variable, Conditional Expected Value, Moments, Moments about the Origin, Central Moments, Variance and Skew / Chebychev's Inequality / Markov's Inequality, Chernoff's Inequality and Bound.	6
UNIT 4	Multiple Random Variables, Vector Random Variables, Joint Distribution and Its Properties, Joint Distribution Function, Properties of the Joint Distribution, Marginal Distribution Functions, Joint Density and Its Properties, Joint Density Function, Properties of the Joint Density, Marginal Density Functions, Conditional Distribution and Density, Statistical Independence, Distribution and Density of a Sum of Random Variables.	6
UNIT 5	**Sampling Distributions:** The Central Limit Theorem, distributions of the sample mean and the sample variance for a normal population, Chi-Square, t and F-distributions. Descriptive Statistics: Graphical representation, measures of locations and variability. Estimation: Unbiasedness, consistency, the method of moments and the method of maximum likelihood estimation, confidence intervals for parameters in one sample and two sample problems of normal populations, confidence intervals for proportions, problems.	8

UNIT 6	**Testing of Hypotheses**: Null and alternative hypotheses, the critical and 8 acceptance regions, two types of error, power of the test, the most powerful test and Neyman-Pearson Fundamental Lemma, tests for one sample and two sample problems for normal populations, tests for proportions, Chi-square goodness of fit test and its applications, problems.	**8**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Peyton Peebles, "Probability, Random Variables and Random Signal Principles", McGraw Hill Education, 4th Edition.	**2017**
2	Athanasios Papoulis, S Pillai, "Probability - Random Variables and Stochastic Processes", McGraw Hill Education, 4th Edition.	**2017**
3	Douglas Lind, William Marchal, Samuel Wathen, "Statistical Technics in Business and Economics", McGraw-Hill Education, 13th Edition.	**2007**
4	Roy D. Yates, David J. Goodman, "Probability and Stochastic Processes", Wiley, 3rd Edition.	**2014**
5	Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, Keying Ye, "Probability and Statistics for Engineers and Scientists", Pearson, 9th Edition.	**2024**

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
SE326: Artificial Intelligence for Sports Surfaces and Equipment	3	0	2	NIL

Course Objective: The course will focus on the application of Artificial intelligence in sports infrastructure, wearable technologies and equipment.

S. NO	Course Outcomes (CO)
CO1	Understand the role of artificial intelligence in sports surfaces, wearable technologies, and preventive equipment.
CO2	Illustrate sports surfaces with an emphasis on future innovations and maintenance solutions.
CO3	Analyze use of internal sensors to assess an athlete's physiological and psychological response.
CO4	Demonstrate usage of wearable technology such as GPS tracking, video processing, and sensors to improve the design, analysis, and performance in various sports.
CO5	Develop data-driven applications to track player movement, and analyze the impact of surfaces.

S. NO	Contents	Contact Hours
UNIT 1	**Introduction:** Applicability of artificial intelligence for sports surfaces, wearable technologies, preventive & protective equipment. Different types of wearable devices to improve training loads, performance and recovery. Types of sensors used within the wearable devices and methods to collate the data coming from sensors to provide insights, such as training intensity and physiologic "readiness", for optimum performance and external measures of "load" and "effort".	8
UNIT 2	**Sports Surfaces:** Future of Sports Surfaces. Different types of artificial sport pitch surfaces. Synthetic vs. Natural Surfaces. Factors to consider specific surface. Sustainability at the core. Multi-Sport Versatility.	8
UNIT 3	**Wearable Technology - 1:** Internal sensors to provide a glimpse of how individual athlete responds to the physiological and psychological stress induced by training and competition. Internal measures to evaluate individual's innate potential and methodic used on team training and recovery.	10
UNIT 4	**Wearable Technology - 2:** Wearable technology, including GPS tracking, sensors, and video processing, to enhance the design, analysis, and application of surfaces and equipment across various sports like athletics, swimming, racket sports (e.g., Badminton/Tennis etc.), and field games (e.g., hockey/football etc.), and combat sports (e.g., Wrestling/Boxing etc.).	10
UNIT 5	**Applications:** Track player's movement, monitoring impact of surfaces, analyzing strokes and training techniques, and assessing environmental conditions affecting sports performance.	6
	TOTAL	42

REFERENCES		
S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint

1	Sharon Dixon, Paul Fleming, Iain James, Matt Carre, "The Science and Engineering of Sport Surfaces", Routledge, 1st Edition.	**2016**
2	Daniel Memmert, Dominik Raabe, "Data Analytics in Football", Routledge, 1st Edition.	**2018**
3	International Olympics Committee official website (https://olympics.com/ioc/overview).	**2024**

Course code: Course Title	Course Structure			Pre-Requisite
SE328: Sports Business Analytics	L	T	P	NIL
	3	0	2	

Course Objective: This course provides a comprehensive overview on the use of statistics in sports team administration & development, business management, marketing and communication. The course covers the application of analytics in sports team management, revenue generation, ticketing, sponsorship, customer relationship development, media management and tournament organization. The course is case study and project-based involving sports team data analysis and assessment.

S. NO	Course Outcomes (CO)
CO1	Understand the infrastructure and technologies required for processing large scale, real-time sports data.
CO2	Develop advanced skills for data engineering and creating insightful, dynamic visualizations.
CO3	Build advanced models to predict outcomes and recommend optimal decisions in sports scenarios.
CO4	Apply advanced analytics techniques to understand and influence fan behaviour effectively.
CO5	Use advanced financial models and analytics to optimize sports business revenue streams.
CO6	Leverage AI techniques to provide actionable insights and innovations in sports.

S. NO	Contents	Contact Hours
UNIT 1	**Data Architectures in Sports Analytics:** Big Data Ecosystems in Sports: Tools and Technologies (Hadoop, Spark), Real-Time Data Streaming and Processing in Sports (Kafka, Flink), Building and Managing Sports Data Warehouses, Integrating IoT Data from Wearables and Sensors.	8
UNIT 2	**Data Engineering and Visualization:** Advanced Data Cleaning and Transformation Techniques, Building Interactive Dashboards for Sports Management Using Tableau, Power BI, and D3.js, Time Series Analysis for Sports Data (Player Performance, Match Metrics), Spatial Analysis: Heatmap, Zone Control in Team Sports.	8
UNIT 3	**Fan and Social Media Analytics:** Advanced Sentiment Analysis and Natural Language Processing (NLP) for social media data, Building recommendation systems for fan engagement and personalization, measuring and enhancing fan loyalty through multi channel data integration.	6
UNIT 4	**Revenue Optimization and Financial Modeling in Sports:** Dynamic Pricing Models for Tickets and Merchandise, Player Contract Valuation Using Predictive Analytics, Building ROI Models for Sponsorship and Advertisement Campaigns, Optimization for Sports Investments.	8
UNIT 5	**Artificial Intelligence in Sports Analytics:** Deep Learning for Sports Video Analysis: Pose Estimation and Action Recognition, Computer Vision for Player and Ball Tracking Systems, AI Models for Injury Prediction and Recovery Monitoring, Building AI-Driven Virtual Coaching Systems.	6
UNIT 6	**Ethical, Legal, and Strategic Aspects of Sports Analytics:** Ethical Concerns in Player Monitoring and Data Privacy, Legal Framework for Data Usage in Sports Analytics, Strategies for Integrating Analytics into Sports, Organizations' Decision-Making Processes, Building Analytics-Driven Cultures in Teams and Businesses.	6
	TOTAL	42

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Jim Albert, Mark E. Glickman, Tim B. Swartz, Ruud H. Koning, "Handbook of Statistical Methods and Analyses in Sports", Routledge publication, Chapman and Hall/CRC, 1st Edition.	**2017**
2	C. Keith Harrison, Scott Bukstein, "Sport Business Analytics: Using Data to Increase Revenue and Improve Operational Efficiency (Data Analytics Applications)", Auerbach Publications, 1st Edition.	**2016**
3	Benjamin C. Alamar, "Sports Analytics - A Guide for Coaches, Managers, and Other Decision Makers", Columbia University Press.	**2013**

DELHI TECHNOLOGICAL UNIVERSITY

DEPARTMENT OF SOFTWARE ENGINEERING

B.Tech. 4th YEAR SYLLABUS

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
SE405: Software Maintenance	3	1	0	Software Engineering

Course Objective: To study about reverse engineering, configuration management, software maintenance tools, software administration and performance.

S. NO	Course Outcomes (CO)
CO1	Understand software maintenance fundamentals, process models, and program comprehension strategies.
CO2	Analyze and understand reverse engineering techniques and software reuse strategies.
CO3	Understand configuration management principles, change control processes, and organizational strategies.
CO4	Analyze software maintenance strategies, tools, and quality assurance techniques.
CO5	Apply software administration techniques, including system monitoring, backups, updates, and performance tuning.

S.No.	Contents	Contact Hours
S.No.	Contents	Contact Hours
UNIT 1	**Fundamentals of Software Maintenance:** Meaning of software maintenance, software change, ongoing support, economic implications of modifying software, the nomenclature and image problem, software maintenance framework, potential solutions to maintenance problem. Maintenance process models: Definition of critical appraisal of traditional process models, maintenance process models. Program understanding: Aims of program comprehension, maintainers and their information needs comprehension process models, mental models, program comprehension strategies, factors that affect understanding, implications of comprehension theories and studies	9
UNIT 2	**Reverse Engineering**: Definition, purposes and objectives, levels of reverse Engineering, supports techniques, benefits. Reuse and reusability: Definitions, objective and benefit of reuse, approach to reuse, domain Analysis, COMPONENTS engineering, reuse process model, factors that impact upon reuse. Maintenance measures, Definitions, objectives of software measurement, example measures, and guidelines for selecting maintenance measures.	9
UNIT 3	**Configuration Management**: Definition for configuration management, change control, documentation. Management and organizational issues, Management responsibilities, enhancing maintenance productivity, maintenance teams, personnel Education and Training, organization modes.	8
UNIT 4	**Building and Sustaining Maintainability**: Quality Assurance, fourth generation languages, object-oriented paradigms. Maintenance tools: Criteria for selecting tools, taxonomy of tools, program understanding and reverse	8

	engineering testing, configuration management, and other tasks. Past, present and future of software maintenance.	
UNIT 5	**Software Administration**: Analyzing system logs, operating system updates, patches, and configuration changes, Performing backups. Installing and configuring new hardware and software. Adding, removing, or updating user account information, resetting passwords, System performance tuning. Performing routine audits of systems and software.	**8**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1.	Armstrong A Takang, Penny A. Grubb, "Software Maintenance: concepts and Practice", World Scientific, River Edge, N. J., 2nd Edition.	**2003**
2.	Roger S. Pressman, "Software Engineering: A Practitioner's Approach", Tata McGraw-Hill, 6th Edition.	**2004**

Course code: Course Title	Course Structure			Pre-Requisite
SE407: Deep Learning	L	T	P	NIL
	3	0	2	

Course Objective: To make one understand concepts and application of reinforcement learning.

S. NO	Course Outcomes (CO)
CO1	Demonstrate deep understanding of reinforcement learning fundamentals and apply action-value methods to optimize k-armed bandit problems.
CO2	Analyze Markov Decision Processes and evaluate policies, value functions, and optimality in sequential decision-making.
CO3	Implement dynamic programming techniques for policy evaluation, policy iteration, and value iteration.
CO4	Apply and analyze temporal-difference in reinforcement learning.
CO5	Evaluate N-step bootstrapping techniques for improving reinforcement learning algorithms.

S. NO	Contents	Contact Hours
UNIT 1	**Introduction:** Elements of Reinforcement Learning, Episodic vs Continuous Tasks, The Rewards Hypothesis, Cumulative Reward, Multi-armed Bandits: A k -armed Bandit Problem, Action-value Methods, The 10-armed Testbed, Optimistic Initial Values, Gradient Bandit Algorithms.	8
UNIT 2	**Markov Decision Process:** The Agent–Environment Interface, Returns and Episodes, Episodic vs Continuous Tasks, Policies and Value Functions, Optimal Policies and Optimal Value Functions.	8
UNIT 3	**Dynamic Programming:** Policy Evaluation, Policy Improvement, Policy Iteration, Value Iteration, Asynchronous, Dynamic Programming, Generalized Policy Iteration .	8
UNIT 4	Temporal-Difference Methods, TD Prediction, Advantages of TD Prediction Methods, TD control – Sarsa, TD control- Q-Learning, TD control- Expected Sarsa, Maximization Bias and Double Learning.	9
UNIT 5	N-step Bootstrapping, N-step TD prediction, N-step Sarsa, N-step Off-policy Learning.	9
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Richard S. Sultton, Andrew G. Barto, "Reinforcement Learning", MIT Press, 2nd Edition.	2018
2	Marco Wiering (Editor), Martijn van Otterlo, "Reinforcement Learning: State-of-the-Art: 12 (Adaptation, Learning, and Optimization)", Springer-Verlag Berlin and Heidelberg GmbH & Co. K.	2012

3	Csaba Szepesvari, "Algorithms for Reinforcement Learning", Morgan & Claypool.	2010

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
SE409: Grid and Cluster Computing	3	1	0	Operating Systems, Data Structures and Algorithms

Course Objective: The course will provide an insight for achieving cost efficient high performance system and how to deal with design and architecture of grid and cluster computing.

S. NO	Course Outcomes (CO)
CO1	Understand the fundamental concepts of hardware, and software architectures used in cluster computing.
CO2	Apply different programming models and paradigms for efficient parallel computing.
CO3	Illustrate resource management and scheduling techniques, and parallel file systems to optimize computing performance in distributed environments.
CO4	Demonstrate grid computing models, security infrastructure, and deployment techniques for set up and execution of grid-based applications.
CO5	Examine standard tools and paradigms for performance measurement.

S. NO	Contents	Contact Hours
UNIT 1	**Cluster Computing:** Introduction to concepts in Cluster based distributed computing Hardware technologies for cluster computing and software for cluster computing, and different Software Architecture for Cluster Computing.	6
UNIT 2	**Programming:** Programming Models and Paradigms, features and performance of standard MPI variants, Derived data types, communicators.	8
UNIT 3	**Resource management and scheduling:** Managing, cluster resources: single system images, system level middleware, distributed task scheduling, monitoring and administering system resources. Parallel I/O and Parallel Virtual File System. Scheduling: Condor, Maui Scheduler, Portable Batch System (PBS).	7
UNIT 4	**Grid Computing:** Grids and Grid Technologies, Programming models and Parallelization Techniques, Grid Security Infrastructure, Setting up Grid, deployment of Grid software and tools, and application execution.	9
UNIT 5	**Standard application development tools and paradigms:** Performance evaluation tools, HINT, netperf, netpipe, ttcp, Iperf message.	8
UNIT 6	**Data Management Application Case Study:** Molecular Modeling for Drug Design and Brain Activity Analysis, Resource management and scheduling.	4
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint

1	C. S. R. Prabhu, "Grid and Cluster Computing", PHI.	**2008**
2	B. Jacob, M. Brown, K. Fukul, N. Trivedi, "Introduction to grid computing", IBM.	**2005**
3	Barry Wilkinson, "Grid Computing: Techniques and Applications", CRC Press, 1st Edition.	**2009**
4	Rajkumar Buyya, "High Performance Cluster Computing: Architectures and Systems", Volume I, Pearson Education.	**2008**
5	D. Janakiram, "Grid Computing", McGraw Hill Education.	**2005**

Course code: Course Title	Course Structure			Pre-Requisite
SE411: Pattern Recognition	**L**	**T**	**P**	**Linear Algebra, Probability Theory**
	3	**1**	**0**	

Course Objective: To equip with basic mathematical and statistical techniques commonly used in pattern recognition. Also provide with an adequate background on probability theory, statistics, and optimization theory to tackle a wide spectrum of engineering problems.

S. NO	Course Outcomes (CO)
CO1	Understand fundamental principles, and methodologies of pattern recognition, including real-world applications and models.
CO2	Implement bayesian classifier, discriminant functions, to address issues like missing and noisy features using Bayesian networks.
CO3	Utilize Maximum Likelihood and Bayesian parameter estimation methods, including PCA, Fisher Discriminant Analysis, and Expectation-Maximization for dimensionality reduction.
CO4	Develop models using hidden markov models, dynamic bayesian networks, perceptron, and other non-parametric density estimation techniques.
CO5	Apply clustering techniques like K-means, Mixture Modeling, Hidden Markov Models, and Kalman Filtering for pattern recognition tasks.

S. NO	Contents	Contact Hours
UNIT 1	**Pattern recognition fundamentals:** Basic concepts of pattern recognition, fundamental problems in pattern recognition system, design concepts and methodologies, example of automatic pattern recognition systems, a simple automatic pattern recognition model.	**7**
UNIT 2	**Bayesian decision theory:** Minimum-error-rate classification, Classifiers, Discriminant functions, Decision surfaces, Normal density and Discriminant functions, Discrete features, Missing and noisy features.	**7**
UNIT 3	**Maximum-likelihood and Bayesian parameter estimation:** Maximum-Likelihood estimation: Gaussian case, Maximum a Posteriori estimation, Bayesian estimation: Gaussian case, Problems of dimensionality, Dimensionality reduction: Principle component analysis.	**6**
UNIT 4	**Non-parametric techniques for density estimation:** Parzen-window method, K-Nearest Neighbour method, Fuzzy classifications. **Unsupervised learning and Clustering:** k-mean clustering, fuzzy k-mean clustering, similarity measures, criterion functions for clustering, hierarchical clustering.	**8**
UNIT 5	**Neural Network Classifiers:** Single and Multilayer Perceptron, Feed forward operations and classifications, network learning, training protocols, Back Propagation Learning, Bayes discriminants and neural networks.	**6**
UNIT 6	**Stochastic Methods:** Stochastic search, Boltzmann factor, simulated annealing algorithm, deterministic simulated annealing, Boltzmann learning. **Evolutionary Methods:** Genetic algorithms, genetic programming, particle swarm optimization.	**8**

	TOTAL	42

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Richard Duda, Peter Hart, David Stork, "Pattern Classification", Wiley, 2nd Edition.	**2007**
2	Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 1st Edition.	**2009**
3	Sergios Theodoridis, Konstantinos Koutroumbas, "Pattern Recognition", Academic Press, 4th Edition.	**2008**
4	Christopher M. Bishop, "Neural Networks for Pattern Recognition", Clarendon Press, 1995.	**1995**
5	Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Second Edition (Springer Series in Statistics)", Springer, 2nd Edition.	**2009**

Course code: Course Title	Course Structure			Pre-Requisite
SE413: Agile Software Process	L	T	P	Software Engineering
	3	1	0	

Course Objective: To understand the basic concepts of agile software process, to gain knowledge in the area of various Agile Methodologies, to develop Agile Software Process and to know the principles of agile testing.

S. NO	Course Outcomes (CO)
CO1	Understand iterative and evolutionary software development approaches to manage risks and ensure efficient incremental delivery.
CO2	Analyze and understand agile methodologies, iterative development principles, and software quality models.
CO3	Understand agile methodology, its lifecycle, roles, practices, and adoption strategies.
CO4	Analyze and apply agile methodologies, including Scrum, Extreme Programming, and Unified Process.
CO5	Apply and evaluate agile project management and testing principles.

S.No.	Contents	Contact Hours
UNIT 1	**INTRODUCTION** Software is new product development – Iterative development – Risk-Driven and Client-Driven iterative planning – Time boxed iterative development – During the iteration, No changes from external stakeholders – Evolutionary and adaptive development - Evolutionary requirements analysis – Early "Top Ten" high-level requirements and skilful analysis – Evolutionary and adaptive planning – Incremental delivery – Evolutionary delivery – The most common mistake – Specific iterative and Evolutionary methods.	9
UNIT 2	**AGILE AND ITS SIGNIFICANCE** Agile development – Classification of methods – The agile manifesto and principles – Agile project management – Embrace communication and feedback – Simple practices and project tools – Empirical Vs defined and prescriptive process – Principle-based versus Rule-Based – Sustainable discipline: The human touch – Team as a complex adaptive system – Agile hype – Specific agile methods. The facts of change on software projects – Key motivations for iterative development – Meeting the requirements challenge iteratively – Problems with the waterfall. Research evidence – Early historical project evidence – Standards-Body evidence – Expert and thought leader evidence – A Business case for iterative development – The historical accident of waterfall validity. MI, PCMM, Malcolm Balridge, 3 Sigma, 6 Sigma, Software Quality Models.	9
UNIT 3	**AGILE METHODOLOGY**: Method overview – Lifecycle – Work products, Roles and Practices values – Common mistakes and misunderstandings – Sample projects – Process mixtures – Adoption strategies – Fact versus fantasy – Strengths versus "Other" history.	9
UNIT 4	**CASE STUDY** Agile – Motivation – Evidence – Scrum – Extreme Programming – Unified Process – Evo – Practice Tips.	7

UNIT 5	**AGILE PRACTICING AND TESTING** Project management – Environment – Requirements – Test – The agile alliances – The manifesto – Supporting the values – Agile testing – Nine principles and six concrete practices for testing on agile teams.	**8**
	TOTAL	**42**

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1.	Craig Larman, "Agile and Iterative Development – A Manager's Guide", Pearson Education, 1st Edition.	**2004**
2.	Elisabeth Hendrickson, "Agile Testing", Quality Tree Software Inc.	**2008**
3.	Alistair Cockburn, "Agile Software Development Series", Addison Wesley.	**2001**

Course code: Course Title	Course Structure			Pre-Requisite
SE415: Cyber Forensics	L	T	P	NIL
	3	1	0	

Course Objective: To introduce various techniques related to Cyber Forensics.

S. NO	Course Outcomes (CO)
CO1	Understand the fundamentals of cyber security, cyber-attacks, and digital forensics techniques.
CO2	Apply forensic techniques and data collection methods using built-in and freeware tools.
CO3	Analyze live data collection and forensic investigation techniques in Unix/Linux environments.
CO4	Utilize forensic tools and techniques to recover deleted files, analyze network traffic, and assess vulnerabilities

S.No.	Contents	Contact Hours
UNIT 1	**Introduction**: Review of TCP/IP and TCP, IP Header analysis, Introduction to Cyber World, Cyber-attacks and cyber security, Information warfare and cyber terrorism, Types of cyber-attacks, Cyber Crime and Digital Fraud, Overview of Types of computer forensics i.e. Media Forensics, Network forensics (internet forensics), Machine forensic, Email forensic (e-mail tracing and investigations)	10
UNIT 2	**Live Data collection and investigating windows environment**: windows Registry analysis, Gathering Tools to create a response toolkit (Built in tools like netstat, cmd.exe, nbtstat, arp, md5sum, regdmpetc and tools available as freeware like Fport, Pslistetc), Obtaining volatile Data (tools like coffee, Helix can be used) Computer forensics in windows environment, Log analysis and event viewer, File auditing, identifying rogue machines, hidden files and unauthorized access points	12
UNIT 3	**Live Data collection and investigating Unix/Linux environment** : /Proc file system overview , Gathering Tools to create a response toolkit (Built in tools like losetup , Vnode , netstat , df , md5sum , straceetc and tools available as freeware like Encase , Carboniteetc) Handling Investigations in Unix/Linux Environment: Log Analysis (Network, host, user logging details), Recording incident time/date stamps, Identifying rogue processes, unauthorized access points, unauthorized user/group accounts	10
UNIT 4	**Forensic tools and report generation**: Recovery of Deleted files in windows and Unix, Analyzing network traffic, sniffers, Ethical Hacking, Hardware forensic tools like Port scanning and vulnerability assessment tools like Nmap, Netscan etc. Password recovery (tools like John the ripper, L0phtcrack, and THC-Hydra), Mobile forensic tools and analysis of called data record Template for computer forensic reports	10
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1.	Kevin Mandia, Chris Prosise, Matt Pepe, “Incident Response & Computer	2003

	Forensics", McGraw-Hill Osborne Media.	
2.	Bill Nelson, Amelia Phillips, Frank Enfinger, Christopher Steuart, "Guide to Computer Forensics and Investigations", Thomson Course Technology.	**2008**
3.	Eoghan Casey, "Digital Evidence and Computer Crime: Forensic Science, Computers, and the Internet", Academic Press, 3rd Edition.	**2011**
4.	"File System Forensic Analysis", Brian Carrier , addition Wesley	**2005**

Course code: Course Title	Course Structure			Pre-Requisite
SE417: Robotics	L	T	P	NIL
	3	1	0	

Course Objective: To study Robot anatomy arm geometry, robot sensing and range proximity, manipulation and its programming language.

S. NO	Course Outcomes (CO)
CO1	Analyze and understand robot arm kinematics, dynamics, and trajectory planning
CO2	Apply control techniques such as computed torque, sequencing, and adaptive control.
CO3	Analyze robot sensing techniques, imaging geometry, and vision-based segmentation.
CO4	Analyze and apply robot programming languages, task planning, and intelligence techniques.

S.No.	Contents	Contact Hours
UNIT 1	Robot Anatomy Arm Geometry-Direct & Inverse Kinematics Problem, Arm Dynamics, D Alembert Equations of Motion, Synthesis of elements with movalulity constraints, manipulations-trajectory planning, joint interpolated trajectories.	12
UNIT 2	Control of Robot Manipulation-computed torque technique sequencing & adaptive control, resolved motion control Moluie Robots.	10
UNIT 3	Robot sensing-Range & Proximity & Higher-Level vision, illumination techniques, Imaging Geometry, Segmentation Recognition & Interpretation.	10
UNIT 4	Robot Programming Language Characteristics of Robot Level & Task Level languages. Robot intelligence-State Space search, Robot learning, Robot Task Planning, Knowledge Engineering.	10
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1.	K. S. Fu, R. C. Gonzalez, and C. S. G. Lee, "Robotics: Control, Sensing, Vision & Intelligence", McGraw-Hill.	1997
2.	Mikell P. Groover, Mitchel Weiss, Roger N Nagel, Nicholas G Odrey and Ashish Dutta, "Industrial Robotics: Technology Programming and Applications", McGraw Hill, 2nd Edition.	2017
3.	Andrew C. Straugaard, Jr., "Robotics and AI: An Introduction to Applied Machine Intelligence", PHI.	1987
4.	S. Sitharama Iyengar, Alberto Elefes, "Autonomous Mobile Robots: Control, Planning and Architecture", IEEE Computer Society Press.	2013

Course code: Course Title	Course Structure			Pre-Requisite
SE419: Wireless and Mobile Computing	L	T	P	Computer Networks
	3	0	2	

Course Objective: To understand the concept of wireless communication, mobile computing paradigm, its novel applications and limitations.

S. NO	Course Outcomes (CO)
CO1	Describe fundamental concepts of mobile computing, and wireless telephony technologies.
CO2	Apply wireless networking protocols, and WAP technologies to develop efficient mobile communication applications.
CO3	Illustrate data management techniques, replication strategies, and mobile agent security mechanisms in wireless environments.
CO4	Analyze and implement different adhoc routing protocols, QoS considerations, and security algorithms for enhancing wireless network performance.
CO5	Design optimized mobile computing solutions for real-world applications.

S. NO	Contents	Contact Hours
UNIT 1	**Introduction, issues in mobile computing, overview of wireless telephony:** cellular concept, GSM: air-interface, channel structure, location management: HLR, VLR, hierarchical, handoffs, channel allocation in cellular systems, Cellular telephone, Digital Cellular Standards, Call Routing in GSM, Satellite Technology, FDMA, TDMA, CDMA and GPRS.	5
UNIT 2	**Wireless Networking, Wireless LAN Overview:** MAC issues, PCF, DCF , Frame types, addressing, IEEE 802.11 standards, Blue Tooth: Architecture , Layers and protocols, Wireless multiple access protocols, TCP over wireless, Wireless applications, data broadcasting, Mobile IP, WAP: Architecture, protocol stack, application environment, applications, WAP application environment(WAE), WML, WSP, WTP and WTLS.	9
UNIT 3	**Data management and data replication:** Data management issues, data replication for mobile computers, Replication through data allocation, User profile replication scheme, optimistic replication and active replication, adaptive clustering for mobile wireless networks, File system, Disconnected operations.	6
UNIT 4	**Mobile Agents computing**: Introduction, Advantages, Application Domains; security and fault tolerance: Protecting server, code signaling, Firewall approach; security techniques and algorithms: DES, 3DES, AES, Diffie Hellman, RSA: transaction processing in mobile computing environment: Structure, properties, Data consistency, Transaction relation, Recovery and wireless data Dissemination.	9
UNIT 5	Ad Hoc networks, localization, Routing protocols: Global state routing (GSR), Destination sequenced distance vector routing (DSDV), Fisheye state routing (FSR), Dynamic source routing (DSR), ABR, Route Discovery, Route Repair/Reconstruction, Establishment, Maintenance; Ad Hoc on demand distance vector routing (AODV). File Directories, File Sharing, Implementation Issues.	9
UNIT 6	Temporary ordered routing algorithm (TORA), Quality of Service in Ad Hoc Networks, and applications.	4

	TOTAL	42

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Jochen Schiller, "Mobile Communications", Pearson Education India, 2nd Edition.	**2008**
2	Dharma Prakash Agarwal, Qing-An Zeng, "Introduction to Wireless and Mobile Systems", CL Engineering, 2nd Edition.	**2007**
3	Raj Pandya, "Mobile and Personal Communication Systems and Services", IEEE.	**1999**
4	Asoke K Talukder, Hasan Ahmed, Roopa Yavagal, "Mobile Computing-Technology, Applications and Service Creation", McGraw Hill Education, 2nd Edition.	**2017**

Course code: Course Title	Course Structure			Pre-Requisite
SE421: Intellectual Property Rights and Cyber Laws	L	T	P	NIL
	3	1	0	

Course Objective: To familiarize the students with basic concepts in each type of IPR together with historical developments in the subject & its importance in modern times.

S. NO	Course Outcomes (CO)
CO1	Understand and remember the fundamental concepts, types, and significance and role of Intellectual Property Rights.
CO2	Understand the fundamentals of patent laws, procedures, and rights related to inventions.
CO3	Understand and remember the principles, registration process, and legal aspects of trademarks, including rights, infringement, and licensing.
CO4	Understand and remember copyright laws, ownership rights, infringement issues, and legal remedies.
CO5	Understand industrial design laws, international IPR frameworks, and dispute resolution mechanisms.

S.No.	Contents	Contact Hours
UNIT 1	**Introduction:** Concept of IPR, Historical development, kinds of IPR, brief description of patent, trademark, copyright, industrial design, importance of IPR, IPR authorities.	5
UNIT 2	**Patents:** Introduction, Indian Patent Act 1970 &2002, Protectable subject matter--patentable invention, Procedure for obtaining patent, Provisional and complete specification Rights conferred on a patentee, transfer of patent, Revocation and surrender of patents, Infringement of patents, Action for infringement, Patent agents, Patent in computer programs.	8
UNIT 3	**Trademark:** Introduction, Statutory authorities, principles of registration of trademarks, rights conferred by registration of trademarks, Infringement of trademarks and action against infringement, procedure of registration and duration, licensing in trademark	7
UNIT 4	**Copyright:** Introduction, Author and ownership of copyright, rights conferred by copyright, term of copyright, assignment/licence of copyright, Infringement of copyright, remedies against infringement of copyright, registration of copyright, copyright enforcement and societies	7
UNIT 5	**Industrial design:** The design act-200 0, register ability of a design, procedure of registration of a design, piracy of a registered design, Case law on designs	6
UNIT 6	**International IPR & case laws:** World intellectual property organization, WCT, WPPT, TRIPS, Copyright societies, international IPR dispute resolution mechanism. Case laws.	9
	TOTAL	42

REFERENCES		
S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint

1.	B. L. Wadehra, "Law Relating to Intellectual Property", Universal Law Publishing Co. Pvt. Ltd, 4th Edition.	**2007**
2.	William Cornish, David Llewelyn, "Intellectual Property: Patents, Copyright, Trademarks and Allied Rights", Sweet & Maxwell Publisher, 5th Edition.	**2003**
3.	Vikas Vashishth, "Law and Practice of Intellectual Property in India" Bharat Law House.	**2006**
4.	B. L. Wadehra, "Law Relating to Patents, Trade Marks, Copyright, Design, and Geographical Indications", Universal Law Publishing Co Ltd.	**2014**
5.	B. L. Wadhera, "Intellectual Property Law Handbook", Universal Law Publishing Co Ltd.	**2002**

Course code: Course Title	Course Structure			Pre-Requisite
SE423: Software Project Management	L	T	P	NIL
	3	0	2	

Course Objective: To introduce concepts of software planning, estimation, and time scheduling.

S. NO	Course Outcomes (CO)
CO1	Understand project management concepts, process frameworks, and software life cycle models.
CO2	Apply cost and scheduling estimation models, including COCOMO II and Putnam.
CO3	Apply and analyze project management techniques, including risk management, tracking, and quality control.
CO4	Evaluate project closure processes and software management methodologies.
CO5	Evaluate advanced software project management practices and emerging trends.

S.No.	Contents	Contact Hours
UNIT 1	**Introduction:** Project Management concepts, Process Framework, Project Planning Software Life Cycle Models, Artifacts of the Project Management Process.	6
UNIT 2	**Cost and Scheduling Estimation Models:** Various Levels of COCOMO for Cost, Effort, Schedule and Productivity Estimation. Approaches to Effort, Cost Estimation, and Schedule Estimation factors through COCOMO II, Putnam Estimation Model, Algorithmic models.	8
UNIT 3	**Project Management Techniques**: Project Organizations and Responsibilities, Establishing Project Environment, Risk Management Process, Project Tracking and Control Defect Tracking Concepts such as Process monitoring and audit, Reviews, Inspections and Walkthroughs.	8
UNIT 4	**Project Closure:** Project Closure Analysis, Role of Closure Analysis in a project, Performing Closure Analysis, Closure Analysis Report.	6
UNIT 5	**Software Project Management Renaissance:** Conventional Software Management, Evolution of Software Economics, Improving Software Economics, The old way and the new way.	6
UNIT 6	**Advance Topics in Software Project Management:** Discussion on future Software Project Management Practices & Modern Project Profiles, Next Generation Software Economics, Modern Process Transitions.	8
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1.	Watts S. Humphrey, "Managing the Software Process", Pearson Education.	1989
2.	Bob Hughes, Mike Cotterell, "Software Project Management", Tata McGraw Hill, 5th Edition.	2009
3.	Ian Sommerville, "Software Engineering", Addison Wesley, 10th Edition.	2017

Course code: Course Title	Course Structure			Pre-Requisite
SE425: Data Warehouse and Data Mining	L	T	P	Database Management System
	3	0	2	

Course Objective: To introduce the concept of Data Warehousing and Data Mining, respective techniques and applications in real world scenario.

S. NO	Course Outcomes (CO)
CO1	Describe fundamental concepts, architecture, and OLAP techniques.
CO2	Apply data mining concepts, and association rule mining techniques to extract useful patterns from large datasets.
CO3	Compare and contrast various classification, prediction, and clustering techniques to categorize and predict data patterns.
CO4	Implement advanced data mining techniques for mining complex data types, including spatial, multimedia, and time-series data.
CO5	Design solutions to solve real-world problems.

S. NO	Contents	Contact Hours
UNIT 1	**Data Warehousing:** Basic concepts in data warehousing, Collecting the requirements of data warehouse, Data Warehouse Architecture, Design, Implementation & Maintenance, OLAP in data warehouse, Data warehousing and the web, Data Cube Technology, From Data Warehousing to Data Mining.	8
UNIT 2	**Data Mining Concepts:** Data mining primitives, Basics of data mining, Query language, Architectures of data mining systems.	6
UNIT 3	**Mining Association Rules in Large Databases:** Association Rule Mining, Mining Single Dimensional Boolean Association Rules from Transactional Databases, Mining Multilevel Association Rules from Transaction Databases, Mining Multidimensional Association Rules from Relational Databases and Data Warehouses, From Association Mining to Correlation Analysis, Constraint Based Association Mining.	8
UNIT 4	**Classification and Prediction:** Issues Regarding Classification and Prediction, Classification by Decision Tree Induction, Bayesian Classification, Classification by Back propagation, Classification Based on Concepts from Association Rule Mining, Other Classification Methods, Prediction, Classifier Accuracy.	8
UNIT 5	**Cluster Analysis in Data Mining:** Types of Data in Cluster Analysis. A Categorization of Major Clustering Methods, Partitioning Methods, Density Based Methods, Grid Based Methods; Model Based Clustering Methods, Outlier Analysis.	6
UNIT 6	**Mining Complex Types of Data:** Multidimensional Analysis and Descriptive Mining of Complex Data Objects, Mining Spatial Databases, Mining Multimedia Databases, Mining Time Series and Sequence Data, Mining Text Databases. **Applications and trends in Data Mining: -** Applications, Systems products and research prototypes, Additional themes in data mining, Trends in Data mining, spatial mining, and Web Mining.	6

	TOTAL	42

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	P. Ponnian, "Data Warehousing Fundamentals for IT Professionals", John Wiley & Sons Inc, 2nd Edition.	**2010**
2	Margaret H. Dunham, "Data Mining Introductory and Advanced Topics", Pearson Education India.	**2006**
3	Jiawei Han, Micheline Kamber, "Data Mining: Concepts & Techniques", 2nd Edition.	**2010**
4	Ralph Kimball, Margy Ross, "The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling", John Wiley & Sons, 3rd Edition.	**2013**
5	Michael J. A. Berry, Gordon S. Linoff, "Mastering Data Mining: The Art and Science of Customer Relationship Management", Wiley, 3rd Edition.	**2008**
6	W. H. Inmon, "Building the Data Warehouse", Wiley, 3rd Edition.	**2008**

Course code: Course Title	Course Structure			Pre-Requisite
SE427: Data Management and Ethics	L	T	P	NIL
	3	1	0	

Course Objective: To make one understand the data management basics and publication ethics in academia.

S. NO	Course Outcomes (CO)
CO1	Understand database system concepts, architectures, and data modelling techniques.
CO2	Apply relational data modelling concepts and normalization techniques.
CO3	Analyze transaction processing concepts and concurrency control techniques to ensure database consistency, recoverability, and security.
CO4	Evaluate ethical principles and responsibilities in data management.
CO5	Analyze and remember ethical challenges in data usage, privacy, and algorithmic decision-making through real-world case studies.

S.No.	Contents	Contact Hours
UNIT 1	**Introduction:** Database system concepts and its architecture, Data models schema and instances, Data independence and database language and interface, Data definition languages, DML. **Data modeling using Entity Relationship Model:** E.R. model concept, notation for ER diagrams mapping constraints, Keys, Concept of super key, candidate key, primary key generalizations, Aggregation	8
UNIT 2	**Relational Data Model and Language:** Relational data model concepts, integrity constraints, Keys domain constraints, referential integrity, assertions, triggers, foreign key relational algebra, SQL data definition queries and updates in SQL. **Data Base Design:** Functional dependencies, normal forms, 1NF, 2NF, 3NF and BCNF, multi-valued dependencies fourth normal form, join dependencies and fifth normal form. Inclusion dependencies, lossless join decompositions, normalization using FD	8
UNIT 3	**Transaction processing concepts:** Transaction processing system, schedule and recoverability, Testing of serializability, Serializability of schedules, conflict & view serializable schedule, recovery from transaction failures, deadlock handling. **Concurrency Control Techniques:** Locking Techniques for concurrency control, time stamping protocols for concurrency control, Database Security Issues.	8
UNIT 4	**Ethics and Data Management:** Data ethics, Need for Data ethics, Data ownership, The Five Cs(Consent, Clarity Consistency and Trust, Control and Transparency, Consequences), Implementing 5Cs, Ethics and Security Training, Developing Guiding Principles, Building Ethics into a Data-Driven Culture.	8
UNIT 5	**Ethical issues related to data collection and storage:** ethical responsibilities of a company to its customers. Ethical responsibilities of employees to the company and its customers, Ethical responsibilities of customers to the	3

	company. **Database Administrator's Code of Ethics:** Database Administrator, Need of Database Administrator, Existing DBA Code of Ethics, Areas of improvistion in existing code of ethics.	
UNIT 6	**Data Ethics Case studies:** The Ethics of Using Hacked Data: Patreon's Data Hack and Academic Data Standards, "It Was A Matter of Life and Death": A YouTube Engineer's Decision to Alter Data in the 'It Gets Better Project', No Encore for Encore? Ethical questions for web-based censorship measurement Dynamic Sound Identification, Optimizing Schools Law Enforcement Chatbots	**7**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1.	Elmasri Ramez, Navathe Shamkant, "Fundamentals of Database systems", Pearson, 7th Edition.	**2017**
2.	Abraham Silberschatz, Henry F. Korth, S. Sudarshan, "Data Base System Concepts", McGraw-Hill, 7th Edition.	**2021**
3.	Mike Loukides, Hilary Mason, DJ Patil, "Ethics and Data Science", O'Reilly Media, Inc.	**2018**
4.	Leslie Turner and Andrea Weickgenannt, "Accounting Information Systems: The Processes and Controls", Wiley, 2nd Edition.	**2013**

Course code: Course Title	Course Structure			Pre-Requisite
SE429: GPU Computing	L	T	P	NIL
	3	0	2	

Course Objective: To learn parallel programming with Graphics Processing Units (GPUs).

S. NO	Course Outcomes (CO)
CO1	Demonstrate deep understanding of basic concepts of Graphics Processing Units (GPUs), parallel programming models like CUDA and OpenCL.
CO2	Utilize various memory types (global, shared, constant) and synchronization mechanisms to optimize memory allocation.
CO3	Demonstrate the use of device and host functions for efficient GPU programming.
CO4	Identify and resolve parallel programming challenges such as error handling, synchronization issues, and algorithmic efficiency in GPU computing.
CO5	Develop optimized GPU-based solutions for real-world applications.

S. NO	Contents	Contact Hours
UNIT 1	**Introduction:** History, Graphics Processors, Graphics Processing Units, GPGPUs. Clock speeds, CPU / GPU comparisons, Heterogeneity, Accelerators, Parallel programming, CUDA OpenCL / OpenACC, Hello World Computation Kernels, Launch parameters, Thread hierarchy, Warps/ Wavefronts, Thread blocks / Workgroups, Streaming multiprocessors, 1D / 2D / 3D thread mapping, Device properties, Simple Programs.	10
UNIT 2	**Memory:** Memory hierarchy, DRAM / global, local / shared, private / local, textures, Constant Memory, Pointers, Parameter Passing, Arrays and dynamic Memory, Multi-dimensional Arrays, Memory Allocation, Memory copying across devices, Programs with matrices, Performance evaluation with different memories.	8
UNIT 3	**Synchronization:** Memory Consistency, Barriers (local versus global), Atomics, Memory fence. Prefix sum, Reduction. Programs for concurrent Data Structures such as Worklists, Linked-lists. Synchronization across CPU and GPU. Functions: Device functions, Host functions, Kernels functions, Using libraries (such as Thrust), and developing libraries.	9
UNIT 4	**Support:** Debugging GPU Programs. Profiling, Profile tools, Performance aspects. Streams: Asynchronous processing, tasks, Task-dependence, Overlapped data transfers, Default Stream, Synchronization with streams. Events, Event-based-Synchronization - Overlapping data transfer and kernel execution, pitfalls.	8
UNIT 5	**Advanced topics:** Dynamic parallelism, Unified Virtual Memory, Multi-GPU processing, Peer access, Heterogeneous processing. Case Studies: Image Processing, Graph algorithms, Simulations, Deep Learning.	7
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Wen-mei W. Hwu, David B. Kirk, Izzat El Hajj, "Programming Massively Parallel Processors: A Hands-on Approach", Morgan Kaufmann, 4th Edition.	**2022**
2	Shane Cook, "CUDA Programming: A Developer's Guide to Parallel Computing with GPUs (Applications of Gpu Computing)", Morgan Kaufmann Publishers In, Illustrated edition.	**2012**

Course code: Course Title	Course Structure			Pre-Requisite
SE431: Data Security and Privacy	L	T	P	NIL
	3	1	0	

Course Objective: To become familiar with the fundamental concepts of data security and privacy mechanisms along with an understanding of hiding data in text and images.

S. NO	Course Outcomes (CO)
CO1	Understand and remember the basic concepts related to data security and different types of symmetric key ciphers.
CO2	Understand and apply the concepts of encryption standards.
CO3	Understand hash functions and to learn the basic concepts of hiding data in text and images.
CO4	Understand the concepts of privacy, authentication, web and email security.

S. NO	Contents	Contact Hours
UNIT 1	**Introduction to Security and Ciphers:** Introduction: Security goals, Cryptographic Attacks, Services and Mechanism, Techniques. Traditional Symmetric Key Ciphers: Introduction, Substitution Ciphers, Transposition Ciphers, Stream and Block Ciphers. Introduction to Modern Symmetric-Key Ciphers: Modern Block Ciphers, Modern Stream Ciphers.	10
UNIT 2	**Symmetric and Asymmetric Encryption Algorithms:** Data Encryption Standard (DES): Introduction, DES Structure, DES Analysis, Multiple DES, Security of DES. Advanced Encryption Standard (AES): Introduction, Transformations, Key Expansion, AES Ciphers, Analysis of AES. Asymmetric-Key Cryptography: Introduction, RSA Cryptosystem, Rabin Cryptosystem, Elgamal Cryptosystem, Elliptic Curve Crypto systems.	10
UNIT 3	**Hash Functions, Digital Signature and Data Hiding:** Cryptographic Hash Functions: Introduction, Iterated Hash function, SHA-512, WHIRLPOOL. Digital Signature: Comparison, Process, Services, Attacks on Digital Signature, Digital Signature Standard. Data Hiding in Text: Basic Features, Applications of Data Hiding, Watermarking, Intuitive Methods, Simple Digital Methods, Data Hiding in Text, Innocuous Text, Mimic Functions. Data Hiding in Images: LSB Encoding, BPCS Steganography, Lossless Data Hiding, Spread Spectrum Steganography, Data Hiding by Quantization, Patchwork, Signature Casting in Images, Transform Domain Methods, Robust Data Hiding in JPEG Images, Robust Frequency Domain Watermarking, Detecting Malicious Tampering.	12
UNIT 4	**Privacy, Legal and Ethical Issues:** Privacy Concepts, Privacy Principles and Policies, Authentication and Privacy, Data Mining, Privacy on the Web, E-Mail Security, Impacts on Emerging Technologies. Legal and Ethical Issues in Computer Security: Protecting Programs and Data, Information and the Law, Rights of Employees and employers, Redress for Software Failures, Computer Crime, Ethical Issues in Computer Security.	10
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1.	Behrouz A. Forouzan, Dedeep Mukhopadhyay, "Cryptography and Network Security", TMH, 2nd Edition.	**2013**
2.	Charles P. Pfleeger, Shari Lawrence Pfleeger, Jonathan Margulies, "Security in Computing", PHI, 5th Edition.	**2015**
3.	Mark Stamp, "Information Security: Principles and Practice", Wiley Inter Science.	**2011**
4.	Matt Bishop, "Computer Security: Art and Science", Addison Wesley, 1st Edition.	**2002**
5.	William Stallings, "Cryptography and Network Security", Pearson Education, 7th Edition.	**2017**

Course code: Course Title	Course Structure			Pre-Requisite
SE433: Quantum Computing	L	T	P	NIL
	3	1	0	

Course Objective: The course explores quantum computation and quantum information covering aspects of quantum entanglement, quantum algorithms, quantum channels, quantum information theory.

S. NO	Course Outcomes (CO)
CO1	Understand the fundamental concepts of qubits, quantum gates, entanglement, and quantum circuit design
CO2	Analyze and evaluate quantum algorithms, including Shor's Algorithm and Quantum Fourier Transform.
CO3	Analyze quantum simulation techniques and the impact of hardware noise on simulation results.
CO4	Understand the fundamentals of quantum computing, quantum circuits, and probabilistic differences from classical computing.
CO5	Analyze quantum error correction techniques and their applications in cryptography, optimization, and machine learning.

S. NO	Contents	Contact Hours
UNIT 1	**Introduction to Quantum Computation:** Representing Qubit States, Single Qubit Gates, Multiple Qubits and Entangled States, More Circuit Identities, Design of Quantum Circuits, Measurements in Bases other than Computational Basis.	8
UNIT 2	**Quantum Algorithms:** Shor's Algorithm, Bernstein-Vazirani Algorithm, Quantum Fourier Transform, Quantum Phase Estimation, Variational Quantum Eigensolver (VQE), SWAP Test, Linear Combination of Unitaries (LCU).	8
UNIT 3	**Quantum Simulation of Many-Body Hamiltonian:** Encodings and Transformations (Jordan-Wigner transformation, Gray code encoding), Many-body Hamiltonian, VQE and suitable Ansatz, Simulation results in the presence of hardware noise.	8
UNIT 4	**Basics of Quantum Computing and Circuits:** Introduction to Hilbert Spaces (basic understanding), Quantum vs Classical probability (with simple examples), Basic Quantum Circuits (single and multi-qubit operations), Concept of Quantum Universality, Introduction to Grover's Algorithm.	8
UNIT 5	**Quantum Error Correction and Applications:** Need for Quantum Error Correction, Introduction to simple Quantum Error Correcting Codes, Stabilizer Codes (basic concepts), Real-world Applications of Quantum Computing (cryptography, optimization, and machine learning).	10
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1.	M. A. Nielsen, I. L. Chuang, "Quantum Computation and Quantum Information", Cambridge University Press.	2010
2.	D. J. Griffiths, "Introduction to Quantum Mechanics", Prentice Hall.	2016

3.	N. D. Mermin, "Quantum Computer Science: An Introduction", Cambridge University Press.	**2007**
4.	R. M. Roth, "Introduction to Coding Theory", Cambridge University Press.	**2006**

Course code: Course Title	Course Structure			Pre-Requisite
SE404: Advances in Software Engineering	L	T	P	Software Engineering
	3	1	0	

Course Objective: To study about formal specification, cleanroom software engineering, component-based software engineering, client-server software engineering and web engineering.

S. NO	Course Outcomes (CO)
CO1	Understand, remember, and apply formal methods and mathematical notation.
CO2	Apply Cleanroom software engineering principles to develop high-reliability software systems.
CO3	Analyze component-based software engineering processes, including component qualification, adaptation, and reuse.
CO4	Design and develop client-server and web-based applications.
CO5	Analyze software reengineering concepts, including reverse engineering, restructuring, and forward engineering.

S.No.	Contents	Contact Hours
UNIT 1	**Formal Methods:** Deficiencies of Less Formal Approaches, Mathematics in Software Development, Mathematical Preliminaries, Sets and Constructive Specification, Set Operators, Logic Operators, Sequences, Applying Mathematical Notation for Formal Specification, Formal Specification Languages, Using Z to Represent an Example Software Component.	8
UNIT 2	**Cleanroom Software Engineering:** The Cleanroom Approach, The Cleanroom, Functional Specification, Black-Box Specification, State-Box Specification, Clear-Box Specification, Cleanroom Design, Design Refinement and Verification, Advantages of Design Verification, Cleanroom Testing, Statistical Use Testing.	6
UNIT 3	**Component-Based Software Engineering:** Engineering of Component-Based Systems, The CBSE Process, Domain Engineering, The Domain Analysis Process, Characterization Functions, Structural Modeling and Structure Points, Component-Based Development, Component Qualification, Adaptation, and Composition, Component Engineering, Analysis and Design for Reuse, Classifying and Retrieving Components , Economics of CBSE.	10
UNIT 4	**Client/Server Software Engineering:** The Structure of Client/Server Systems, Software Engineering for c/s Systems, Analysis Modeling Issues, Design for c/s Systems, Architectural Design for Client/Server Systems, Conventional Design Approaches for Application Software, Database Design, An Overview of a Design Approach, Process Design Iteration, Testing Issues, Overall c/s Testing Strategy, Testing Tactics.	6
UNIT 5	**Web Engineering**: The Attributes of Web-Based Applications, Quality Attributes, The Technologies, The WebE Process, Framework for WebE, Formulating/Analyzing Web-Based Systems, Formulation Analysis, Design for Web-Based Applications, Architectural Design, Navigation Design, Interface Design, Testing Web-Based Applications, Management Issues, The WebE Team, Project Management, SCM Issues for WebE.	6
UNIT 6	Reengineering: Business Process Reengineering, Software Reengineering, Reverse Engineering, Restructuring, Forward Engineering for Client/Server Architectures, Object-Oriented and for User Interfaces, The Economics of Reengineering.	6
	TOTAL	42

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1.	Roger S. Pressman, Bruce R. Maxim, "Software Engineering – A Practitioner's Approach", McGraw Hill, 8th Edition.	**2014**

Course code: Course Title	Course Structure			Pre-Requisite
SE406: Information and Network Security	L	T	P	NIL
	3	1	0	

Course Objective: To study various cryptographic algorithms and network security protocols.

S. NO	Course Outcomes (CO)
CO1	Understand security threats, cryptographic techniques, and encryption methods.
CO2	Analyze and understand modern block cipher principles, encryption techniques, and cryptanalysis methods.
CO3	Apply number theory concepts and cryptographic algorithms, including RSA, Diffie-Hellman, and elliptic curve cryptography.
CO4	Analyze message authentication techniques, hash functions, and digital signature protocols.
CO5	Analyze authentication mechanisms, IP security protocols, and web security technologies.

S.No.	Contents	Contact Hours
UNIT 1	**Introduction:** Need for security, 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, Intruders, Viruses and related threads.	8
UNIT 2	**Modern Block Ciphers:** Block ciphers principals, Shannon's theory of confusion and diffusion, fiestal structure, data encryption standard(DES), strength of DES, crypt analysis of DES, block cipher modes of operations, triple DES, IDEA encryption and decryption, strength of IDEA, key distribution.	6
UNIT 3	Introduction to graph, ring and field, prime and relative prime numbers, modular arithmetic, Fermat's and Euler's theorem, primarily testing, Euclid's Algorithm, Chinese Remainder theorem, discrete logarithms, Principals of public key crypto systems, RSA algorithm, security of RSA, key management, Diffle-Hellman key exchange algorithm, introductory idea of Elliptic curve cryptography, Elganel encryption.	10
UNIT 4	**Message Authentication and Hash Function:** Authentication requirements, authentication functions, message authentication code (MAC), hash functions, security of hash functions and MACS, MD5 message digest algorithm, Secure hash algorithm (SHA), Public Key Infrastructure (PKI): Digital Certificate, private key management, Digital Signatures: Digital Signatures, authentication protocols, digital signature standards (DSS), proof of digital signature algorithm.	6
UNIT 5	**Authentication Applications:** Kerberos and X.509, directory authentication service, password, challenge-response, biometric authentication, electronic mail security-pretty good privacy (PGP), S/MIME.	6
UNIT 6	**IP Security:** Architecture, Authentication header, Encapsulating security payloads, combining security associations, key management. **Web Security:** Secure Socket Layer (SSL) and transport layer security, TSP, Secure Electronic Transaction (SET), Electronic money, WAP security, firewall design principals, Virtual Private Network (VPN) security.	6
	TOTAL	42

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1.	William Stallings, "Cryptography and Network Security: Principals and Practice", Prentice Hall, New Jersy.	**2005**
2.	Atul Kahate, "Cryptography and Network Security", TMH.	**2006**
3.	Behrouz A. Forouzan, "Cryptography and Network Security", TMH.	**2008**
4.	Johannes A. Buchmann, "Introduction to Cryptography", Springer-Verlag.	**2004**
5.	BruceSchiener, "Applied Cryptography".	**1996**

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
SE408: Swarm and Evolutionary Computing	3	1	0	Discrete Mathematics, Artificial Intelligence

Course Objective: The course explores a variety of evolutionary algorithms and their application for problem solving. The student should be able to understand the bio-inspired algorithms and apply them to optimize parameters in real-world problems.

S. NO	Course Outcomes (CO)
CO1	Understand and apply evolutionary computing and swarm intelligence techniques to solve optimization problems.
CO2	Analyze and apply genetic algorithms to solve optimization problems by utilizing concepts of selection, crossover, mutation, and fitness evaluation.
CO3	Analyze and develop hybrid multi-objective optimization algorithms.
CO4	Apply and understand nature-inspired evolutionary algorithms such as Cuckoo Search, Artificial Bee Colony, and Ant Colony Optimization.
CO5	Apply optimization techniques to real-world problems in machine learning, robotics, image processing, etc.

S.No.	Contents	Contact Hours
UNIT 1	**Introduction to Evolutionary Computing:** Global Optimization, Components of an evolutionary algorithm, Evolution strategies, Fitness Functions, Learning Classifier systems, Parameter Control, Multi-modal Problems.	8
UNIT 2	**Swarm Intelligence:** Introduction to Swarm Intelligence and its application to optimization problems, Particle Swarm Optimization algorithm, position and velocity updation.	8
UNIT 3	**Genetic Algorithm:** Genetic algorithm basics: Population and generation of chromosomes, Fitness function, survival of the fittest, reproduction, cross-over and mutation, Genetic algorithm convergence, Genetic programming.	8
UNIT 4	**Hybrid Methods and Multi-objective Evolutionary Algorithms:** Variants of Particle Swarm optimization and Genetic Algorithm, Hybridization of Particle Swarm and Genetic based optimizations, Hybrid Multi-objective Optimization algorithms.	6
UNIT 5	**Recent nature-inspired evolutionary algorithms:** Cuckoo search algorithm, Artificial Bee Colony Optimization, Ant Colony Optimization, Fire-fly algorithm, Bacterial Foraging, Application to the travelling salesman problem.	6
UNIT 6	**Application to real world optimization problems:** Optimization examples from Machine Learning, Robotics, Image Processing and Computer Vision, Web and data mining, network traffic routing.	6
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1.	Andries P. Engelbrech, "Computational Intelligence: An Introduction", John	2008

	Wiley & Sons, 2nd Edition.	
2.	Melanie Mitchell, "An Introduction to Genetic Algorithm", MIT Press.	**1996**
3.	David E. Goldberg, "Genetic Algorithms in Search, Optimization, and Machine Learning", Addison-Wesley.	**1989**
4.	A.E Eiben, J.E. Smith, "Introduction to Evolutionary Computing", Springer Nature, 2nd Edition.	**2007**
5.	D. Dumitrescu, B. Lazzerini, L. C. Jain, A. Dumitrescu, "Evolutionary Computation", CRC Press.	**2000**
6.	Kenneth A. De Jong, "Evolutionary Computation: A Unified Approach", MIT Press.	**2006**
7.	D. Dasgupta, Z. Michalewicz, "Evolutionary Algorithms in Engineering Applications", Springer Science & Business Media.	**2013**

Course code: Course Title	Course Structure			Pre-Requisite
SE410: Semantic Web and Web Mining	L	T	P	NIL
	3	1	0	

Course Objective: To introduce concepts of semantic web and various techniques of Web Mining

S. NO	Course Outcomes (CO)
CO1	Understand the evolution of web documents and semantic search techniques to enhance information retrieval.
CO2	Apply XML languages in web-based development to structure, store, and transport data efficiently.
CO3	Create and apply ontologies, RDF, and OWL to effectively describe and annotate web resources.
CO4	Analyze, apply, and evaluate advanced semantic web technologies, their applications, and future directions.

S.No.	Contents	Contact Hours
UNIT 1	**Introduction:** The Semantic Web Roadmap, evolution of Web Documents, Semantic Search Techniques.	10
UNIT 2	**XML Languages:** Detailed study of XML language & application to Web based developments.	10
UNIT 3	**Describing Web Resources**: Resource Description Framework (RDF), Taxonomies, Ontologies, Web Ontology Language (OWL), Design process of ontology, Annotation.	12
UNIT 4	**Advanced Topics:** Semantic Applications & Power, Latest on Semantic Web, Future Directions, W3C Consortium, Case studies in different application.	10
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1.	Grigoris Antoniou, Frank Van Harmelen, "A Semantic Web Primer", MIT Press, 2nd Edition.	2008
2.	Dieter Fensel, James A. Hendler, Henry Lieberman, and Wolfgang Wahlster, "Spinning the Semantic Web - Bringing the World Wide Web to Its Full Potential", MIT Press.	2005
3.	Michael C. Daconta, Leo J. Obrst , Kevin T. Smith, "The Semantic Web: A Guide to the Future of XML, Web Services and Knowledge Management", Wiley Publishing.	2007
4.	John F. Sowa, "Principles of Semantic Networks: Explorations in the Representation of Knowledge", Morgan Kaufmann.	1990
5.	Stuart Russell, Peter Norvig, "Artificial Intelligence: A Modern Approach", Prentice Hall.	2022
6.	Han Reichgelt, "Knowledge Representation: An AI Perspective", Ablex Publishing.	1991

Course code: Course Title	Course Structure			Pre-Requisite
SE412: Cloud Computing	L	T	P	NIL
	3	1	0	

Course Objective: To study the concepts, architecture, models of a cloud and its security issues and service management parameters.

S. NO	Course Outcomes (CO)
CO1	Explain fundamental concepts of cloud computing, its evolution, computing paradigms, and service providers.
CO2	Illustrate cloud computing architectures, service models (IaaS, PaaS, SaaS), and deployment models for various applications.
CO3	Apply virtualization techniques, resource provisioning, and storage management to optimize cloud infrastructure.
CO4	Formulate cloud service management techniques, scalability, SLAs, and economic considerations for efficient cloud solutions.
CO5	Design secure cloud environments by implementing data security, access control, and identity management mechanisms.

S. NO	Contents	Contact Hours
UNIT 1	**Introduction:** Overview of Computing Paradigm and introduction to cloud computing: Recent trends in Computing (Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing), Evolution of cloud computing(Business driver for adopting cloud computing), Cloud Computing (NIST Model) , Cloud service providers, Properties, Characteristics & Disadvantages, Cloud computing vs. Cluster computing vs. Grid computing, Role of Open Standards	8
UNIT 2	**Cloud Computing Architecture:** Cloud computing stack: Comparison with traditional computing architecture (client/server), Services provided at various levels, How Cloud Computing Works, Role of Networks in Cloud computing, protocols used, Role of Web services, Service Models (XaaS) :Infrastructure as a Service(IaaS), Platform as a Service(PaaS), Software as a Service(SaaS), Deployment Models(Public cloud, Private cloud, Hybrid cloud, Community cloud)	6
UNIT 3	**Infrastructure as a Service(IaaS):** Introduction to IaaS ,IaaS definition, Introduction to virtualization, Different approaches to virtualization, Hypervisors, Machine Image, Virtual Machine(VM),Resource Virtualization(Server, Storage, Network), Virtual Machine(resource) provisioning and manageability, storage as a service, Data storage in cloud computing(storage as a service)	6
UNIT 4	**Platform as a Service(PaaS):** Introduction to PaaS, Service Oriented Architecture (SOA), Cloud Platform and Management (Computation,Storage) Examples: Google App Engine ,Microsoft Azure, SalesForce.com Software as a Service(SaaS): Introduction to SaaS, Web services, Web 2.0, Web OS,Case Study on SaaS	8
UNIT 5	**Service Management in Cloud Computing:** Service Level Agreements(SLAs) (Billing & Accounting, Comparing Scaling Hardware: Traditional vs. Cloud , Economics of scaling: Benefitting enormously,	8

	Managing Data, Looking at Data, Scalability & Cloud Services, Database & Data Stores in Cloud, Large Scale Data Processing	
UNIT 6	**Cloud Security:** Infrastructure Security(Network level security, Host level security, Application level security), Data security and Storage (Data privacy and security Issues, Jurisdictional issues raised by Data location), Identity & Access Management, Access Control, Trust, Reputation, Risk, Authentication in cloud computing, Client access in cloud, Cloud contracting Model, Commercial and business considerations	**6**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Barrie Sosinsky, "Cloud Computing Bible", Wiley, 1st Edition.	**2011**
2	Rajkumar Buyya, James Broberg, Andrzej Gos'cinski, "Cloud Computing: Principles and Paradigms", Wiley, 1st Edition.	**2013**
3	Nikos Antonopoulos, Lee Gillam, "Cloud Computing: Principles, Systems and Applications (Computer Communications and Networks)", Springer London Ltd, 1st Edition.	**2012**
4	Ronald L. Krutz, Russell Dean Vines, "Cloud Security: A Comprehensive Guide to Secure Cloud Computing", Wiley, 1st Edition.	**2010**

Course code: Course Title	Course Structure			Pre-Requisite
SE414: Big Data Analytics	L	T	P	Database Management Systems
	3	1	0	

Course Objective: Understand the fundamentals of various big data analysis techniques, Hadoop structure, environment and framework.

S. NO	Course Outcomes (CO)
CO1	Understand basic concepts of Big Data, its challenges, and modern data analytic tools to analyze large datasets.
CO2	Apply data stream mining techniques such as filtering, sampling, and real-time analytics for applications like sentiment analysis and stock market predictions.
CO3	Implement MapReduce programs using Hadoop Distributed File System (HDFS) and analyze the execution of MapReduce jobs.
CO4	Configure and manage a Hadoop cluster by handling security, monitoring, maintenance, and cloud integration for efficient big data processing.
CO5	Demonstrate big data frameworks like Pig, Hive, HBase, and ZooKeeper to process, query, and visualize large-scale datasets effectively.

S. NO	Contents	Contact Hours
UNIT 1	**Introduction to Big Data:** Introduction to Big Data Platform – Challenges of Conventional Systems - Intelligent data analysis – Nature of Data - Analytic Processes and Tools - Analysis vs Reporting - Modern Data Analytic Tools - Statistical Concepts: Sampling Distributions - Re-Sampling - Statistical Inference - Prediction Error.	8
UNIT 2	**Mining Data Streams:** Introduction To Streams Concepts – Stream Data Model and Architecture - Stream Computing - Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Decaying Window - Real time Analytics Platform(RTAP) Applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions.	8
UNIT 3	**Hadoop:** History of Hadoop- The Hadoop Distributed File System – Components of Hadoop- Analyzing the Data with Hadoop- Scaling Out- Hadoop Streaming- Design of HDFS-Java interfaces to HDFS- Basics- Developing a Map Reduce Application-How Map Reduce Works-Anatomy of a Map Reduce Job run-Failures-Job Scheduling-Shuffle and Sort – Task execution - Map Reduce Types and Formats- Map Reduce Features.	10
UNIT 4	**Hadoop Environment:** Setting up a Hadoop Cluster - Cluster specification - Cluster Setup and Installation - Hadoop Configuration-Security in Hadoop - Administering Hadoop – HDFS - Monitoring-Maintenance-Hadoop benchmarks- Hadoop in the cloud.	8
UNIT 5	**Frameworks:** Applications on Big Data Using Pig and Hive – Data processing operators in Pig – Hive services – HiveQL – Querying Data in Hive - fundamentals of HBase and ZooKeeper - IBM InfoSphere BigInsights and Streams. Visualizations - Visual data analysis techniques, interaction techniques; Systems and applications.	8
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.	**2007**
2	Tom White "Hadoop: The Definitive Guide", O'Reilly, 3rd Edition.	**2012**
3	Paul Zikopoulos, Chris Eaton, Dirk Deroos, Tom Deutsch, George Lapis, "Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data", McGraw Hill Education, 1st Edition.	**2017**
4	Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 2nd Edition.	**2014**
5	Bill Franks, Thomas H. Davenport, "Taming the Big Data Tidal Wave", Wiley, 1st Edition.	**2012**
6	Glenn J. Myatt, "Making Sense of Data: A Practical Guide to Exploratory Data Analysis and Data Mining", Wiley–Blackwell.	**2006**
7	Pete Warden, "Big Data Glossary: A Guide to the New Generation of Data Tools", Shroff/O'Reilly, 1st Edition.	**2011**
8	Jiawei Han, Micheline Kamber, "Data Mining: Concepts & Techniques", 2nd Edition.	**2010**
9	Da Ruan, Guoquing Chen, Etienne E. Kerre, Geert Wets, "Intelligent Data Mining", Springer.	**2007**
10	Paul Zikopoulos, Dirk deRoos, Krishnan Parasuraman, Thomas Deutsch, James Giles, David Corrigan, "Harness the Power of Big Data The IBM Big Data Platform", McGraw Hill Publications.	**2012**
11	Michael Minelli, Michele Chambers, Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's", Wiley.	**2013**