दिल्ली प्रौद्योगिकी विश्वविद्यालय

DELHI TECHNOLOGICAL UNIVERSITY

(Formerly Delhi College of Engineering)

(Estd. By Govt. of NCT of Delhi vide Act 6 of 2009)

Bachelor of Technology (B.Tech)

Discipline: Computer Science and Engineering (CSE)

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

(w.e.f. 2023-24)

Delhi Technological University
Computer Science and Engineering Department
Schemes of Teaching and Examination
B.Tech. (Computer Science and Engineering) Program
(Effective from session 2023-24)

B. Tech. Computer Science and 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	CO101	Programming Fundamentals	ESC	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	ME105	Computer Aided Engineering Graphics-II	ESC	4	3	0	2	3	0	15	25	20	40	-
5	CS103	Web Designing	SEC	2	1	0	2	0	3	-	50	-	-	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				**20**										

I Year: Second Semester

1	AM102	Mathematics-II	BSC	4	3	1	0	3	0	25	-	25	50	-
2	AP102	Physics	BSC	4	3	0	2	3	0	15	25	20	40	-
3	CS102	Discrete Structure	ESC	4	3	1	0	3	0	25	-	25	50	-
4	CS104	Data Structures	DCC	4	3	0	2	3	0	15	25	20	40	-
5	CS106	Basics of Machine Learning & Application	SEC	2	1	0	2	0	3	-	50	-	-	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				**20**										

B. Tech. Computer Science and 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	CS201	Digital Logic Design	ESC	4	3	1	0	3	0	25	-	25	50	-
2	CS203	Object Oriented Programming Concepts	DCC	4	3	0	2	3	0	15	25	20	40	-
3	CS205	Design and Analysis of Algorithms	DCC	4	3	1	0	3	0	25	-	25	50	-
4	CS207	Operating Systems Design	DCC	4	3	0	2	3	0	15	25	20	40	-
5	CS209	Software Engineering	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
7	MS299	Community Engagement Course	Mandatory	2										
Total				**24**										
II Year: Fourth Semester														
1	CS202	Probability and Statistics	ESC	4	3	1	0	3	0	25	-	25	50	-
2	CS204	Theory of Computation	DCC	4	3	1	0	3	0	25	-	25	50	-
3	CS206	Computer System Architecture and Organization	DCC	4	3	1	0	3	0	25	-	25	50	-
4	CS208	Computer Networks	DCC	4	3	0	2	3	0	15	25	20	40	-
5	CS210	Database Management Systems	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
Total				**22**										

B. Tech. Computer Science and 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	CS301	Compiler Design	DCC	4	3	0	2	3	0	15	25	20	40	-
2	CS303	Machine Learning	DCC	4	3	0	2	3	0	15	25	20	40	-
3	CS305	Parallel Computer Architecture	DCC	4	3	1	0	3	0	25	-	25	50	-
4	HU301	Engineering Economics	SEC	3	3	1	0	3	0	25	0	25	50	-
5	CS3xx	Department Elective Course -1	DEC	4	3	0/1	2/0	3	0	15/ 25	25/ -	20/25	40/50	-
6		Generic Elective Course-1	GEC	4	3	0/1	2/0	3	0	15/ 25	25/ -	20/25	40/50	-
Total				**23**										

III Year: Sixth Semester

1	CS302	Information and Network Security	DCC	4	3	0	2	3	0	15	25	20	40	-
2	CS304	Data Warehousing and Data Mining	DCC	4	3	0	2	3	0	15	25	20	40	-
3	MG301	Fundamentals of Management	SEC	3	3	0	0	3	0	25	-	25	50	-
4	CS3xx	Department Elective Course -2	DEC	4	3	0/1	2/0	3	0	15/ 25	25/ -	20/25	40/50	-
5	CS3xx	Department Elective Course -3	DEC	4	3	0/1	2/0	3	0	15/ 25	25/ -	20/25	40/50	-
6		Generic Elective Course-2	GEC	4	3	0/1	2/0	3	0	15/ 25	25/ -	20/25	40/50	-
Total				**23**										

B. Tech. Computer Science and 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	CS401	B.Tech Project-I	DCC	4	-	-	-	-	-	-	-	-	-	-
2	CS403	Internship	DCC	2	-	-	-	-	-	-	-	-	-	-
5	CS4xx	Department Elective Course -4	DEC	4	3	0/1	2/0	3	0	15/ 25	15/ -	20/25	40/50	-
6	CS4xx	Department Elective Course -5	DEC	4	3	0/1	2/0	3	0	15/ 25	15/ -	20/25	40/50	-
7		Generic Elective Course-3	GEC	4	3	0/1	2/0	3	0	15/ 25	15/ -	20/25	40/50	-
8		Indian Knowledge System	VAC	Non-Credit										
Total				**18**										
IV Year: Eighth Semester														
1	CS402	B.Tech Project-II	DCC	8	-	-	-	-	-	-	-	-	-	-
2	CS4xx	Department Elective Course -6	DEC	4	3	0/1	2/0	3	0	15/ 25	25/ -	20/25	40/50	-
3		Generic Elective Course-4	GEC	4										-
Total				**16**										
Cumulative Total				**164***										

B. Tech. Computer Science and Engineering

III Year: Fifth Semester Department Elective Course-1

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	CS307	Modelling and Simulation	DEC	4	3	1	0	3	0	25	-	25	50	-
2	CS309	Distributed System	DEC	4	3	1	0	3	0	25	-	25	50	-
3	CS311	Information Theory and coding	DEC	4	3	1	0	3	0	25	-	25	50	-
4	CS313	Quantum Computing	DEC	4	3	1	0	3	0	25	-	25	50	-
5	CS315	Advanced Data Structures	DEC	4	3	1	0	3	0	25	-	25	50	-
6	CS317	Microprocessors and Interfacing	DEC	4	3	1	0	3	0	25	-	25	50	-
7	CS319	Computer Graphics	DEC	4	3	0	2	3	0	15	25	20	40	-
III Year: Sixth Semester Department Elective Course-2,3														
1	CS306	Optimization Techniques	DEC	4	3	1	0	3	0	25	-	25	50	-
2	CS308	Soft Computing	DEC	4	3	0	2	3	0	15	25	20	40	-
3	CS310	Enterprise Java programming	DEC	4	3	0	2	3	0	15	25	20	40	-
4	CS312	Embedded Systems	DEC	4	3	1	0	3	0	25	-	25	50	-
5	CS314	Data Compression	DEC	4	3	1	0	3	0	25	-	25	50	-
6	CS316	Parallel Algorithms	DEC	4	3	1	0	3	0	25	-	25	50	-
7	CS318	Deep Learning	DEC	4	3	0	2	3	0	15	25	20	40	-
8	CS320	Blockchain and Applications	DEC	4	3	1	0	3	0	25	-	25	50	-
9	CS322	Optical Networks	DEC	4	3	1	0	3	0	25	-	25	50	-
10	CS324	High Speed Networks	DEC	4	3	1	0	3	0	25	-	25	50	-
11	CS326	Advanced Database Management Systems	DEC	4	3	1	0	3	0	25	-	25	50	-
12	CS328	Multimedia System Design	DEC	4	3	1	0	3	0	25	-	25	50	-

B. Tech. Computer Science and Engineering

IV Year: Seventh Semester
Department Elective Course-4,5

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	CS405	Real Time System	DEC	4	3	1	0	3	0	25	-	25	50	-
2	CS407	Pattern Recognition	DEC	4	3	1	0	3	0	25	-	25	50	-
3	CS409	Reinforcement Learning	DEC	4	3	1	0	3	0	25	-	25	50	-
4	CS411	Cyber vulnerability and Ethical hacking	DEC	4	3	1	0	3	0	25	-	25	50	-
5	CS413	Computer Vision	DEC	4	3	1	0	3	0	25	-	25	50	-
6	CS415	Data Visualization	DEC	4	3	0	2	3	0	15	25	20	40	-
7	CS417	Wireless and Mobile Computing	DEC	4	3	1	0	3	0	25	-	25	50	-
8	CS419	Business Analytics	DEC	4	3	1	0	3	0	25	-	25	50	-
9	CS421	Advance Web Technology	DEC	4	3	0	2	3	0	15	25	20	40	-
10	CS423	Big Data Analytics	DEC	4	3	0	2	3	0	15	25	20	40	-
11	CS425	Cloud Computing	DEC	4	3	1	0	3	0	25	-	25	50	-
12	CS427	Natural Language Processing	DEC	4	3	0	2	3	0	15	25	20	40	-
IV Year: Eighth Semester **Department Elective Course-6**														
1	CS404	High Performance Computing	DEC	4	3	1	0	3	0	25	-	25	50	-
2	CS406	Grid and Cluster Computing	DEC	4	3	1	0	3	0	25	-	25	50	-
3	CS408	Swarm & Evolutionary Computing	DEC	4	3	1	0	3	0	25	-	25	50	-
4	CS410	Digital Image Processing	DEC	4	3	0	2	3	0	15	25	20	40	-
5	CS412	Intellectual Property Rights	DEC	4	3	1	0	3	0	25	-	25	50	-
6	CS414	Cyber Forensics	DEC	4	3	1	0	3	0	25	-	25	50	-
7	CS416	Semantic Web and Web Mining	DEC	4	3	1	0	3	0	25	-	25	50	-

Delhi Technological University
Computer Science and Engineering Department
Syllabus
B.Tech. (Computer Science and Engineering) Program
(Effective from session 2023-24)

B. Tech . Computer Science and Engineering				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CS101: Programming Fundamentals	**L**	**T**	**P**	**NIL**
	3	**0**	**2**	

Course Objective: To understand the basic principles of programming languages. To provide design & development basic programming skills. To introduce problem solving methods and program development.

S. No	Course Outcomes (CO)
CO1	Ability to develop algorithmic solutions for use on computers. Approach the programming task using procedural and Object Oriented Programming techniques
CO2	Ability to perform console input and output, utilize basic operators, and perform sequential Processing, utilize the basic control
CO3	Ability to use decision structures, loops, storage class and functions
CO4	Ability to process data in arrays, pointers and data files
CO5	Ability to Develop effective programs in C and C++.

S. No	Contents	Contact Hours
UNIT 1	Introduction: Concepts of algorithm, flow chart, Basics of Computer Languages, Compilers, Interpreter, Programming Environments and Debugging: types of errors and debugging techniques. Program design techniques: Structured, modular, Bottom-up, top-down, procedural, OOP Programming features: Data types, Expressions and Operators-Arithmetic, unary, logical, bitwise, relational, assignment, comma operators. Data conversions. Input/Output statements.	**10**
UNIT 2	Control statements: While, do-while, for statements, nested loops, if else, switch, break, Continue, and goto statements, Iterations. Concept of subprograms. Functions: Storage class -Scope and extent of variables, Argument types-actual, formal, dummy. Function definition, declaration, prototype. Recursion.	**8**
UNIT 3	Pre-processor directives: headers and library functions, macros. Array: Array representation, Operations on array elements, using arrays, multidimensional arrays. Strings, operations on strings. Structures & Unions: Declaration and usage of structures and Unions.	**8**
UNIT 4	Pointers: Pointer and address arithmetic, pointer operations and declarations, pointer and arrays, pointer to structure. Call by value, call by reference. Dynamic memory allocation. Sorting and searching algorithms: selection sort, bubble sort, insertion sort, and linear and binary search.	**8**

UNIT 5	File Handling: Declaration of files, types of files File pointer. File input/ output and usage, File operation Introduction to Object Oriented Programming: OOPS concepts, OOP languages- C++, Python etc.	**8**
Total		**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	C Programming Language (Ed 2) by Brian W. Kernighan and Dennis M. Ritchie, Prentice Hall	-
2	C Programming for Beginners - The C Guru , 2016	2016
3	Kanetkar, Y (2016): Let us C, 15thed .BPB Publications.	2016
4	Modern C by Jens Gustedt - ICube , 2015	2015
5	C Programming :: The Ultimate Way to Learn The Fundamentals of The C Language by Harry. H. Chaudhary.	-
6	Mastering C, Venugopal K R, Sudeep R Prasad, Edition 1,McGraw Hill Education.	-
7	Programming in ANSI C , Sixth Edition, McGraw Hill Education (India) Private Limited E Balagurusamy	-
8	Conceptive C by Harry McGeough - Smashwords , 2011	2011

Course code: Course Title	Course Structure			Pre-Requisite
CS102: Discrete Structure	**L**	**T**	**P**	**NIL**
	3	**1**	**0**	

Course Objective:
To provide knowledge of combinatorial problems, algebraic structures and graph theory required for building mathematical foundation of computer science.

S. No.	Course Outcomes (CO)
CO1	Understand the fundamentals of lattices, sublattices, and Boolean algebra, including their properties and homomorphisms.
CO2	Learn to represent and minimize Boolean functions and expressions.
CO3	Explore key concepts in graph theory, including isomorphic graphs, Euler's formula, and chromatic numbers.
CO4	Analyze tree structures and search algorithms like depth-first and breadth-first, with their associated trees.
CO5	Apply Warshall's algorithm, Euler paths, Hamiltonian circuits, and minimal spanning trees in problem-solving.

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	**6**
UNIT 2	Proof, Relation and Analysis of Algorithm: Technique for theorem proving : Direct Proof, Proof by Contra position, proof by exhausting cases 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.	**10**
UNIT 3	Sets and Combinations:Sets, Subsets, powersets, binary and unary operations on a set, set operations/set identities, fundamental counting 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:Rotations, properties of binary rotations, operation on binary rotation, closures, partial ordering, equivalence relation, properties of function, composition of function, inverse, binary and n-ary operations, characteristics of permutation function, composition of cycles, Boolean matrices, Boolean matrices multiplication.	**8**
UNIT 5	Lattices & Boolean Algebra: Lattices: definition, sublattices, direct product, homomorphism Boolean algebra: Definition, properties, isomorphic structures (in particular, structures with binary operations) subs algebra, direct product and homomorphism, Boolean function, Boolean expression, representation & minimization of Boolean function.	**8**
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 search algorithm, trees associated with DFS & BFS Connected components, in order, preorder & post order tree traversal algorithms	**8**
Total		**48**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Kenneth H. Rosen, "Discrete Mathematics and Its Applications", TMH ISBN: 9780070681880),1999	1999
2	C.L. Liu, "Elements of Discrete Mathematics", TMH (ISBN: 9780007043477),2000	2000
3	Kolman, Busby & Ross, "Discrete Mathematical Structures", PHI (ISBN-9780132297516),1996	1996

4	J. P. Trembly& P. Manohar, “Discrete Mathematical Structures with Applications to Computer Science”, McGraw Hill (ISBN:0070651426),1997	1997
5	NarsinghDeo, “Graph Theory With Application to Engineering and Computer Science”, PHI (ISBN: 9788120301450), 2004	2004

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
CS103: Web Designing	1	0	2	NIL

Course Objective:
1. Develop the skill & knowledge of Web page design.
2. Students will understand the knowhow and can function either as an entrepreneur or can take up jobs in the multimedia and Web site development studio and other information technology sectors

S. No.	Course Outcomes (CO)
CO1	Define the principle of Web page design
CO2	Visualize the basic concept of HTML.
CO3	Recognize the elements of HTML.
CO4	Apply basics concept of CSS for styling the pages.
CO5	Develop the concept of web publishing.

S. No	Contents	Contact Hours
UNIT 1	Introduction to Internet and HTML: WWW, Browser, URL, Web server, Web site, Domain Name, Basic principles involved in developing a web site, designing a web page, Page Layout, HTML Documents, Basic structure of an HTML document, Creating an HTML document, Mark up Tags, Heading-Paragraphs, Line Breaks, HTML Tags.	4
UNIT 2	Elements of HTML: Introduction, Working with Text, Working with Lists, Tables and Frames, Working with Hyperlinks, Images and Multimedia, Working with Forms and controls.	4
UNIT 3	Introduction to Cascading Style Sheets: Concept of CSS, Creating Style Sheet, CSS Properties, CSS Styling, Working with block elements and objects, Working with Lists and Tables, CSS Id and Class, CSS Colour, Creating page Layout and Site Designs.	3
UNIT 4	Introduction to Web Publishing or Hosting: Creating the Web Site, Saving the site, working on the web site, creating web site structure, Creating Titles for web pages, Themes-Publishing web sites.	3
Total		14

REFERENCES

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

1	HTML 5 in simple steps, Kogent Learning Solutions Inc, Dreamtech Press	2010
2	Beginner's Guide to HTML, Michael Gabriel	-
3	Beginning HTML, XHTML, CSS, and JavaScript, John Duckett, Wiley India	2009
4	Beginning CSS: Cascading Style Sheets for Web Design, Ian Pouncey, Richard York, Wiley India	2011
5	HTML, XHTML, and CSS Bible, 5ed, Steven M. Schafer, Wiley India	2010

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
CS106: Basics of Machine Learning & Applications	1	0	2	NIL

Course Objective: The objective of the course is to develop the skill & knowledge of Machine Learning and understand the knowhow and can function either as an entrepreneur or can take up jobs in the data science.

S. No	Course Outcomes (CO)
CO1	Descibe the basic concepts of machine learning.
CO2	learn Preprocessing of data.
CO3	Apply supervised algorithms on Real-world data.
CO4	Apply unsupervised algorithms on Real-world data.

S. No	Contents	Contact Hours
UNIT 1	Introduction to Machine Learning: Machine Learning, Supervised vs Unsupervised Learning, Classification, Regression, Clustering.	4
UNIT 2	Data Pre-processing: Introduction, Working with CSV files, Handling missing values and outliers, Feature scaling and normalization, Encoding categorical variables, Splitting data into training and testing sets, Cross-validation techniques for model evaluation.	4
UNIT 3	SkLearn for Supervised Learning: Model Initialization, Model Training, Model prediction, Model evaluation, Model selection, Model Persistence, Feature selection, performance metrics, Ensemble methods, House-price prediction, Sentiment Analysis.	4
UNIT 4	SkLearn for Unupervised Learning: Clustering Algorithms, Anomaly Detection, Document Clustering.	2
Total		14

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Pattern Recognition and Machine Learning by Christopher M. Bishop	2006

2	The Elements of Statistical Learning: Data Mining, Inference, and Prediction by Trevor Hastie, Robert Tibshirani, and Jerome Friedman	2009
3	Machine Learning: A Probabilistic Perspective by Kevin P. Murphy	2012
4	Machine Learning by Andrew Ng	2018
5	Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow by Aurélien Géron	2019

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Modern Digital Electronics by R. P. Jain (TMH)	2009
2	Digital Principles and Application by Malvino & Leach (TMH).	2014
3	Mano, M. Morris, Michael D. Ciletti, Digital Design, Pearson Education	2018
4	Introduction To System Design Using Integrated Circuits by B.S.Sonde (New Age International)	1992
5	Switching And Finite Automata Theory by Z. Kohavi (TMH).	2017
6	Barry B. Brey, The Intel Microprocessors, Architecture, Programming and Interfacing, Pearson Education	2008

Course code: Course Title	**Course Structure**			**Pre-Requisite**
CS203: Object Oriented Programming Concepts	**L**	**T**	**P**	**C Programming**
	3	**0**	**2**	

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

S. No	**Course Outcomes (CO)**
CO1	To understand the need of object oriented programming.
CO2	Describe the concept of function overloading, operator overloading, virtual functions and polymorphism.
CO3	To implement relationships between classes.
CO4	Classify inheritance with the understanding of early and late binding, usage of exception handling, generic programming
CO5	To demonstrate programs on exceptions, multithreading and applets.

S. No	**Contents**	**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.	**8**
UNIT 3	Introduction to byte code, security and portability, Data Types, variables, operators, arrays, type conversion and casting, type promotion, Control statements, standard 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.	**8**
UNIT 4	Exception Handling: exception types, nested try-catch, throw, throws and finally statements, Multithread Programming: thread creation, synchronization and priorities.	**6**
UNIT 5	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.	**6**
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.	**6**
	Total	**42**

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Patrick Naughton, Herbert Schildt: "The Complete Reference: Java 2", TMH. ISBN 13 9780070495432	2017
2	C Thomas Wu : "An Introduction to OO programming with Java", TMH,ISBN-10: 0073523305	2009
3	Balaguruswami, "Object oriented with C++", TMH. SBN 0070669074, 9780070669079	2008
4	Budd, "Object Oriented Programming", Addison Wesley	2002

Course code: Course Title	**Course Structure**			**Pre-Requisite**
CS205: Design and Analysis of Algorithms	**L**	**T**	**P**	**Data Structures**
	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 detail about Greedy Paradigm, Principle of Dynamic Programming, Back Tracking, Branch and Bound, and Computational Complexity.

S. No	Course Outcomes (CO)
CO1	To evaluate time and space complexity of recursive and non-recursive algorithms.
CO2	To analyze various divide and conquer algorithms and construct recurrence relations.
CO3	To design and analyze greedy algorithm to solve real life problems.
CO4	To analyze different algorithms to find minimum spanning tree and shortest path algorithm.
CO5	To apply dynamic programming techniques to solve numerous optimization problems
CO6	To design backtracking and branch and bound techniques for solving specific problems.
CO7	To be able to classify problems as P, NP, NP complete and compose approximate.

S. No	Contents	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, Strassen Matrix Multiplication; merge sort, heap sort and Analysis of divide and conquer run time recurrence relations, Application of graph theory concepts- connected components, Cut vertex, Bridge	**8**
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.	**10**
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, Back tracking: Overview, 8-queen problem, and Knapsack problem, Edit Distance Problem, Rod cutting problem.	**10**
UNIT 5	Branch and bound: LC searching Bounding, FIFO branch and bound, LC branch and bound application: 0/1 Knapsack problem.	**8**
UNIT 6	Computational Complexity: Complexity measures, Polynomial Vs non-polynomial time complexity; NP-hard and NP-complete classes, examples: Circuit Satisfiability, Vertex cover, Subset Sum problem	**6**
	Total	**48**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	T .H . Cormen, C . E . Leiserson, R .L . Rivest "Introduction to Algorithms", 4th Ed.	2022
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

Course code: Course Title	Course Structure			Pre-Requisite
CS207: Operating Systems Design	L	T	P	NIL
	3	0	2	

Course Objective: To familiar 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

S. No	Course Outcomes (CO)
CO1	Understand the basic concepts, types of operating system and functions of operating systems.
CO2	Analyze the basic concept of process and to analyze different CPU scheduling algorithms
CO3	Understand the basic concept of deadlock and characteristics, analyze various measures taken to prevent deadlock and for its recovery.
CO4	Analyze various memory management schemes and its associated concepts like paging, segmentation, virtual memory concept.
CO5	Understand and evaluate I/O management and File systems including basic concept of disk scheduling and Implementation Issues.
CO6	Understand and analyze case studies of linux, unix and windows.

S. No	Contents	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.	6
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 of Scheduling Algorithm, Evolution, Multiprocessor Scheduling.	8
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 replacement algorithms, Allocation of frames, Thrashing, Cache memory organization, Impact on performance.	8
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.	8
UNIT 6	Case Studies: Windows, Linux and Unix.	4
	Total	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Silbersachatz and Galvin, “Operating System Concepts”, Pearson, 10th Ed	2018
2	Tannenbaum, “Operating Systems”, PHI, 4th Edition.	2015
3	Milenekovic, “Operating System Concepts”, McGraw Hill	1992

4	Dietel, “An introduction to operating system”, Addison Wesley	1995

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
CS209: Software Engineering	3	1	0	NIL

Course Objective: To introduce fundamentals of software engineering including requirement specifications, software design, testing and maintenance

S. No	Course Outcomes (CO)
CO1	A general understanding of software process models such as the waterfall and evolutionary models.
CO2	To be able to decompose the given project in various phases of a lifecycle.
CO3	Understanding of software requirements and the SRS documents.
CO4	To perform various life cycle activities like Analysis, Design, Implementation, Testing and Maintenance
CO4	To apply the knowledge, techniques, and skills in the development of a software product.

S. No	Contents	Contact Hours
UNIT 1	Introduction: Introduction to software Engineering, Software characteristics, Software components, Software applications, Software Engineering Principles, Software metrics and measurement, monitoring and control. Software development life-cycle, Water fall model, prototyping model, Incremental model, Iterative enhancement Model, Spiral model, Agile Model.	8
UNIT 2	Software Requirement Specification: Requirements Elicitation Techniques, Requirements analysis, Models for Requirements analysis, Requirements specification, and requirements validation.	8
UNIT 3	System Design: Design Principles: Problem partitioning, abstraction. Top down and bottom up – design, structured approach. Functional versus object oriented approach of design, design specification, Cohesiveness and Coupling. Overview of SA/SD Methodology, structured analysis, data flow diagrams, extending DFD to structure chart, Entity-Relationship diagram, Use case diagrams.	8
UNIT 4	Software project Management: Project planning and Project scheduling and Resource Management including Gantt charts and critical path method (CPM). Software Metrics: Size Metrics like LOC, Token Count, and 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, Agile Project Management	10
UNIT 5	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.	8
UNIT 6	Software Maintenance: Structured Vs unstructured maintenance, Maintenance Models, Configuration Management, Reverse Engineering, Software Re-engineering.	6
	Total	**48**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	R. S. Pressman, “Software Engineering – A practitioner’s approach”, 3rd ed., McGraw Hill Int. Ed.	1992
2	K. K. Aggarwal & Yogesh Singh, “Software Engineering”, 2ndEd., New Age International.	2005
3	Sommerville, “Software Engineering”, Addison Wesley.	2001
4	Schach, Stephen R. "Object-Oriented and Classical Software Engineering," Latest Edition, McGraw-Hill Education.	2010

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
CS202: Probability and Statistics	3	1	0	Engineering Mathematics and Fundamental of Programming.

Course Objective: The aim of this course is to provide students with a detailed understanding of probability and statistical methods. It focuses on enabling students to develop models, perform analyses, and deep knowledge based on data in real-world contexts.

S. No	Course Outcomes (CO)
CO1	Apply foundational principles of probability theory to solve problems in various contexts, demonstrating a solid understanding of experiments, sample spaces, events, and probability axioms.
CO2	Analyze and characterize random variables using their distribution and density functions, and apply key probability distributions to real-world scenarios.
CO3	Understand and apply the Central Limit Theorem in the context of sampling distributions, and develop competency in descriptive statistics and estimation techniques to analyze data.
CO4	Visualize the drawing details of public buildings viz school, hostel, and hospital.
CO5	Design and execute hypothesis tests for different statistical models, interpret the results, and understand their applications in testing theories and making predictions.

S. No	Contents	Contact Hours
UNIT 1	Probability Theory and Foundations: Introduction to Probability Theory: Set theory, experiments, sample spaces (discrete, continuous, and mixed), events, and axioms of probability. Probability as Relative Frequency: Understanding probability through the lens of relative frequency. Joint, Conditional Probability, and Bayes’ Theorem: Deep dive into joint probability, conditional probability, total probability, Bayes’ theorem, and their applications. Independent Events: Analysis of independence for two events, multiple events, and properties of independent events.	10
UNIT 2	Random Variables and Distribution Functions: Concept and Classification of Random Variables: Definition, discrete, continuous, and mixed random variables. Distribution and Density Functions: Exploration of existence, properties, Gaussian random variables, and examples including Binomial, Poisson, Uniform, Exponential, Rayleigh. Conditional Distributions and Densities: Conditional distribution, properties, conditional density, and their implications.	10

UNIT 3	Operations on Random Variables and Multiple Random Variables: Expectation and Moments: Expected value, moments about the origin, central moments, and understanding variance and skewness. Key Inequalities: Chebychev's, Markov's, Chernoff's inequalities and their significance. Introduction to Multiple and Vector Random Variables: Joint distribution, properties, joint density functions, marginal distribution and density functions.	**10**
UNIT 4	Sampling Distributions, Descriptive Statistics, and Estimation: The Central Limit Theorem: Its importance and implications for sampling distributions. Descriptive Statistics: Graphical representation, measures of location and variability. Estimation Methods: Unbiasedness, consistency, method of moments, maximum likelihood estimation. Confidence Intervals: Construction for parameters in one and two sample problems, including proportions.	**10**
UNIT 5	Hypothesis Testing and Advanced Topics: Testing of Hypotheses: Null and alternative hypotheses, types of error, power of the test, Neyman-Pearson Lemma. Tests for Normal Populations: One and two sample problems, tests for proportions. Chi-Square Goodness of Fit Test: Applications and problems. Introduction to Advanced Statistical Methods: Brief overview of regression analysis, ANOVA, and non-parametric tests to bridge students to further studies in statistics.	**8**
	Total	**48**

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Jay L. Devore, "Probability and Statistics for Engineering and the Sciences," 10th ed, Cengage Learning.	2020
2	Sheldon M. Ross, "A First Course in Probability," 10th ed, Pearson.	2019
3	Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, and Keying Ye, "Probability & Statistics for Engineers & Scientists," 10th ed, Pearson.	2021
4	Allan G. Bluman, "Elementary Statistics: A Step By Step Approach," 10th ed, McGraw Hill.	2020
5	Douglas C. Montgomery and George C. Runger, "Applied Statistics and Probability for Engineers," 7th ed, Wiley.	2020

Course code: Course Title	**Course Structure**			**Pre-Requisite**
CS204: Theory of Computation	**L**	**T**	**P**	**Elementary set theory, Relations, Mappings, and some abstract algebra**
	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	Construct, analyze and interpret Regular languages, Expression and finite automata (FA) with and without output
CO2	Design, analyze and interpret Context Free languages, Expression and Grammars
CO3	Design and analyze different types of Push down Automata (PDA) as Simple Parser.
CO4	Design different types of Turing Machines as Acceptor, Verifier, Translator and Basic computing machines and Apply to propose computation solutions.

CO5	Compare and analyze different languages, grammars, automata and machines and appreciate their power and convert automata to programs and functions

S. No	Contents	Contact Hours
UNIT 1	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.	**10**
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	**10**
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, Context Free Languages (CFL): Closure properties of CFLs, Decision Properties of CFLs: Emptiness, Finiteness and Membership, Pumping lemma for CFLs.	**8**
UNIT 4	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.	**8**
UNIT 5	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.	**10**
	Total	**48**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Hopcroft, Ullman, "Introduction to Automata Theory, Languages and Computation", Pearson Education.ISBN-13: 978-0321455369	2006
2	K.L.P. Mishra and N.Chandrasekaran, "Theory of Computer Science Automata, Languages and Computation", PHI, ISBN-10: 8120329686	2007
3	Martin J. C., "Introduction to Languages and Theory of Computations", TMH ,ISBN 978–0–07–319146–1	2010
4	Papadimitrou, C. and Lewis, C.L., "Elements of the Theory of Computation", PHI , ISBN-13: 978-0132624787	1997
5	Peter Linz, "An Introduction to Formal Language and Automata", Third Edition, Narosa Publishers, New Delhi , ISBN 0-7637-142	2011

Course code: Course Title	Course Structure	Pre-Requisite

CS206: Computer System Architecture and Organization	L	T	P	Digital Logic Design
	3	1	0	

Course Objective: To provide in depth knowledge of Computer system architecture and organization covering design of processor, memory and I/O systems**.**

S. No	Course Outcomes (CO)
CO1	To get familiar with basic architecture of computer systems, its sub-systems and concept of register based architecture.
CO2	To understand design of various types of control units and design of instructions.
CO3	To understand design of CPU and arithmetic and logic unit (ALU)
CO4	To understand concept of main memory and its interaction with cache memory
CO5	To understand architecture of Input and Output, and various data transfer modes and techniques.

S. No	Contents	Contact Hours
UNIT 1	Introduction: REGISTER TRANSFER LANGUAGE: Data movement around registers. Data movement from/to memory, arithmetic and logic micro operations. Concept of bus and timing in register transfer. Functional units and their interconnections, bus architecture, types of buses and bus arbitration. Register, bus and memory transfer.	6
UNIT 2	Control Unit: Instruction types, formats, instruction cycles and sub-cycles (fetch and execute etc), micro-operations, execution of a complete instruction. Hardwired and microprogrammed control: microprogramme sequencing, wide branch addressing, and micro-instruction with next address field, pre-fetching microinstructions, concept of horizontal and vertical microprogramming	10
UNIT 3	Central Processing Unit: Computer Arithmetic: Addition and subtraction of signed numbers look ahead carry adders. Multiplication: Signed operand multiplication, Booths algorithm and array multiplier. Division and logic operations. Floating point arithmetic operation, Processor organization, general register organization, stack organization and addressing modes.	10
UNIT 4	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
UNIT 5	Input/Output organization: Peripheral devices, I/O interface, I/O ports, Interrupts: interrupt hardware, types of interrupts and exceptions.	6
UNIT 6	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.	8
	Total	**48**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Patterson, Computer Organisation and Design, Elsevier Pub.	2009
2	Morris Mano, Computer System Architecture, PHI	2017
3	William Stalling, Computer Organization, PHI	2013

4	Vravice,Hamacher & Zaky, Computer Organization, TMH	2011
5	Tannenbaum, Structured Computer Organization, PHI	2016

Course code: Course Title	Course Structure			Pre-Requisite
CS208: Computer Networks	L	T	P	Fundamentals of Computer Science and Design and Analysis of Algorithms
	3	0	2	

Course Objective: The course aims to provide students with a thorough understanding of computer network principles, architectures, protocols, and technologies, enabling them to design, implement, and manage efficient, secure, and scalable computer networks.

S. No	Course Outcomes (CO)
CO1	Understand the foundational aspects of computer networks, including network topologies, OSI and TCP/IP models, to design and analyze network structures effectively.
CO2	Master error detection and correction, data link control, and IP addressing, enabling efficient data communication across networks.
CO3	Learn advanced routing protocols, Quality of Service (QoS) principles, and basic network security to manage high-performance, secure networks.
CO4	Acquire a deep understanding of transport protocols like UDP and TCP, focusing on reliable data transfer and congestion control.
CO5	Develop expertise in application layer protocols and network management, preparing for effective management of networked applications.

S. No	Contents	Contact Hours
UNIT 1	Foundations of Computer Networks: Evolution of computer networks, Basic principles of network design, Network topologies: Star, Mesh, Bus, Ring, Hybrid, OSI and TCP/IP models, and Physical layer fundamentals: Data and signals, bandwidth utilization, transmission techniques and media, signal encoding, multiplexing.	8
UNIT 2	Data Link and Network Layer Protocols: Error detection and correction mechanisms, Data link control protocols, Multiple access protocols and LAN technologies, Network layer functions and services, Routing algorithms: Link-State, Dijkstra's algorithm; IP addressing, subnetting, super netting (CIDR), IPv4, IPv6, and Address resolution protocols: ARP, RARP, BOOTP, DHCP.	10
UNIT 3	Advanced Networking and Routing Protocols: Advanced IP addressing and routing protocols: RIP, OSPF, BGP; Multicast routing and protocols; Quality of Service (QoS) concepts and protocols; and Network security fundamentals.	8
UNIT 4	Transport Layer and End-to-End Protocols: Transport layer services: UDP, TCP; Flow control, congestion control, TCP congestion avoidance algorithms; Session management: Establishment, and synchronization; Presentation layer roles: Data formatting, encryption, decryption	8
UNIT 5	Application Layer Protocols and Network Management: Naming and addressing mechanisms: DNS, URIs; Communication and data transfer protocols: HTTP, SSH, Telnet, SMTP, POP3, IMAP, FTP, SFTP, FTPS; World Wide Web fundamentals; Network management with SNMP, Modern application-layer protocols: WebSockets, MQTT.	8
	Total	**42**

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Behrouz A. Forouzan, “Data Communications and Networking,” 6th ed, McGraw Hill	2022
2	William Stallings, “Data and Computer Communications,” 10th ed, Pearson Education	2022
3	Andrew S. Tanenbaum, “Computer Networks”, 6th ed., Pearson Education India	2022
4	JF Kurose, KW Ross, “Computer Networking: A Top-Down Approach”, 8th Ed., Addison-Wesley	2020

Course code: Course Title	**Course Structure**			**Pre-Requisite**
CS210: Database Management System	**L**	**T**	**P**	**Data Structures**
	3	**0**	**2**	

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

S. No.	**Course Outcomes (CO)**
CO1	Ability to differentiate database systems from traditional file systems and compare their functionality and benefits.
CO2	Transform information model into a relational database schema and define the schema using data definition language in DBMS.
CO3	Formulate SQL, relational algebra and TRC query for broad range of query problems.
CO4	Able to use a DBMS software to create, populate, maintain, and query a database.
CO5	Ability to analyze functional dependencies and design of database.
CO6	Describe normalization theory and apply such knowledge to the normalization of a database.
CO7	List basic database storage structures and access techniques: file and page organizations, including B-tree and hashing.
CO8	Pursue advance courses and acquire knowledge of new technologies, skills in the field of DBMS.
CO9	Generate and integrate databases for real life projects.

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. 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.	**10**
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.	**8**

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 approaches to database design.	**8**
UNIT 4	File Organization, Indexing and Hashing: Overview of file organization techniques, 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 Management: Transaction concept, schedule and recoverability, Serializability of schedules, conflict & view serializable schedule, Testing of serializability.	**8**
UNIT 5	Concurrency Control: Lock-based protocols for concurrency control, Timestamp-based protocols for concurrency control, concurrency control in distributed systems. multiple granularities and multi-version schemes, deadlock handling. Recovery System: Failure Classification, Log-based recovery, Recovery with concurrent transactions, Buffer management Case Studies: Commercial databases, Oracle, Postgres, MySQL, NoSQL	**8**
	Total	**42**

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	"Data base concepts" by Korth, Silbertz, Sudarshan, McGraw-Hill.	2010
2	"Fundamentals of Database systems" by Elmasri, Navathe, Pearson	2017
3	"An Introduction to Database Systems" by C J Date, Kannan, Pearson	2003

Course code: Course Title	**Course Structure**			**Pre-Requisite**
CS301: Compiler Design	**L**	**T**	**P**	**Theory of Computation**
	3	**0**	**2**	

Course Objective: To study the various stages of compiler designing.

S. No.	**Course Outcomes (CO)**
CO1	Explain the fundamental concepts of compiler design, including the phases like lexical analysis, syntax analysis, and the role of finite state machines (FSM) and regular expressions in lexical analysis.
CO2	Implement lexical analyzers using tools like Lex and apply formal grammar techniques such as BNF, CFG, and various parsing methods like LR, SLR, and LALR parsers, utilizing parser generators like YACC.
CO3	Design and implement syntax-directed translation schemes for generating intermediate code, including three-address code, quadruples, and triples, and handle translations of complex constructs like arrays, control statements, and procedure calls.
CO4	Construct and manage symbol tables, implement runtime administration using stack allocation, and handle scope information in block-structured languages.
CO5	Perform code optimization using techniques like loop optimization, DAG representation, and algebraic laws, and understand error detection and recovery strategies for handling lexical, syntax, and semantic errors.

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 4	Error detection and Recovery: Lexical phase errors, syntax phase errors, semantic errors and Error recovery techniques.	4
UNIT 5	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	Aho,Ullman & Sethi, "Compiler Design", Addison Wesley	2004
2	D.M.Dhamdhere, "Compiler Construction – Principles & Practice" Macmillan India	2000

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
CS303: Machine Learning	3	0	2	Engineering Mathematics

Course Objective: The student should be able to understand the different supervised, unsupervised and reinforcement learning algorithms and choose the appropriate machine learning tool for different real world examples.

S. No	Course Outcomes (CO)
CO1	Design and implement supervised learning algorithms, including linear regression and classification models, and evaluate their performance using appropriate metrics.
CO2	Apply unsupervised learning techniques, such as k-means and hierarchical clustering, to real-world datasets and interpret the results.
CO3	Develop and train neural network models, including convolutional neural networks (CNNs) and recurrent neural networks (RNNs), for complex pattern recognition tasks.

CO4	Apply reinforcement learning algorithms, such as Q-learning and policy gradient methods, to create agents capable of solving decision-making problems in simulated environments.
CO5	Critically evaluate the ethical implications of AI technologies and apply principles of responsible AI in the development and deployment of machine learning models.

S. No	Contents	Contact Hours
UNIT 1	Review of Probability Theory: Definitions, independent events, joint probability, marginal probability, conditional probability, sum rule, product rule, Bayes' theorem, concept of probability distribution, likelihood. Random process and random variable: Definitions, continuous and discrete random variables, expectation, variance, covariance. Classification and Regression: curve fitting, model selection, curse of dimensionality, loss function. Evaluation of ML models: The train/test/validation split, under-fitting, overfitting, generalization, Bias vs Variance, validation curves. Metrics: Confusion matrix, Accuracy, Precision, Recall, Specificity, F1 score Precision-Recall or PR curve, ROC (Receiver Operating Characteristics) curve, PR vs ROC curve.	**8**
UNIT 2	Information Theory: Concept of information, Entropy, Information gain, relative and mutual information. Classification using Decision Trees: Iterative Dichotomiser 3 (ID3), Greedy decision tree learning, selecting best feature for split, classification error, prediction with decision trees. Decision trees with real valued features, threshold split in 1-D, threshold split in 2-D, finding optimal threshold split. Overfitting in decision tress: Principle of Occam's Razor, complex and simpler decision trees, early stopping, Decision tree pruning. CART, C4.5. Kn –nearest neighbor density estimation, K-nearest neighbor classifier (K-NN). Naïve-Bayes Classifier. Linear discriminant functions, logistic discrimination, Linear separability, generalized linear discriminants. Least-square techniques, gradient descent algorithms. Supervise Learning-Linear Regression, linear regression with one variable, Derivative of cost function, gradient descent algorithm. Logistic regression: Classification, learning parameters, cost function for logistic regression, gradient descent algorithm in logistic regression. Support Vector Machine (SVM).	**13**
UNIT 3	Artificial Neural Network (ANN): Introduction, Perceptron model, applications of linear model. Perceptron learning, perceptron convergence theorem, limitations of perceptron. Fisher's linear Discriminant-Linear discriminant analysis (LDA). Multi-layer perceptron: Error back-propagation	**7**
UNIT 4	Unsupervised Learning: similarity measures, k-means clustering, k-means as coordinate descent algorithm, k-mean++. Convergence of k-means algorithm, limitations: uncertainty in cluster assignment, failure modes of k-means, mixture models. Gaussian mixture models (GMM), Maximum likelihood estimation (MLE), Expectation Maximization, Inferring soft assignments with expectation maximization (EM), Convergence and overfitting of MLE. Hierarchal Clustering. Data representation and Dimension Reduction: change of basis vectors, principle component analysis (PCA). Factor analysis, Manifold Learning	**7**
UNIT 5	Reinforcement learning: Introduction, difference with supervised learning, Evaluative feedback: n-armed bandit problem, action-value methods, softmax action selection. The reinforcement learning problem: Agent-Environment interface, goals and rewards, returns, unified notation for episodic and continuing tasks, Markov property, Markov decision processes, value functions, optimal value functions. Dynamic programming: policy evaluation, policy improvement, policy iteration. Temporal-Difference Learning: TD prediction and advantages, Optimality of TD(0), Sarsa: On-Policy TD Control. Q-Learning: Off-Policy TD Control, Actor-Critic Methods.	**7**
	Total	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Bishop, C. M. (2006). Pattern Recognition and Machine Learning (1st ed.). Springer.	2006
2	Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep Learning (1st ed.). MIT Press.	2016
3	Géron, A. (2022). Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow (3rd ed.). O'Reilly Media.	2022
4	Sutton, R. S., & Barto, A. G. (2018). Reinforcement Learning: An Introduction (2nd ed.). MIT Press.	2018
5	Murphy, K. P. (2012). Machine Learning: A Probabilistic Perspective (1st ed.). MIT Press.	2012
6	Russell, S., & Norvig, P. (2021). Artificial Intelligence: A Modern Approach (4th ed.). Pearson.	2021

Course code: Course	Course Structure			Pre-Requisite
CS305: Parallel Computer Architecture	L	T	P	Computer Architecture
	3	1	0	

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

S. No.	Course Outcomes (CO)
CO1	Define the fundamental concepts and classification schemes in parallel computing architectures.
CO2	Explain the principles of multi-core and multi-threaded architectures, including their performance issues and optimization techniques.
CO3	Apply program optimization techniques and parallelization strategies in the development of parallel programs.
CO4	Analyze different parallel computer architectures and evaluate their performance, including memory hierarchy and communication latency.
CO5	Evaluate compiler optimization issues and operating system techniques for efficient multiprocessing and parallel program execution.
CO6	Design and implement parallel computing solutions for real-world applications in areas such as digital signal processing and image processing.

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**
	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.	**10**
UNIT 4	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	**10**
UNIT 5	Applications: Case studies from Applications: Digital Signal Processing, Image processing, Speech processing.	**6**
	Total	**48**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Kai Hwang, "Advanced computer architecture"; TMH, 2000	2000
2	J .P.Hayes, "computer Architecture and organization", MGH, 1998	1998
3	M.J Flynn, "Computer Architecture, Pipelined and Parallel Processor Design", Narosa Publishing, 1998	1998
4	D.A.Patterson, J.L.Hennessy, "Computer Architecture :A quantitative approach", Morgan Kauffmann, 2002	2002
5	Hwang and Briggs, "Computer Architecture and Parallel Processing", MGH, 2000	2000

Course code: Course Title	Course Structure			Pre-Requisite
CS302: Information and Network Security	**L**	**T**	**P**	**Nil**
	3	**0**	**2**	

Course Objective: To study concepts of information and network security using cryptographic algorithms and network security protocols.

S. No	Course Outcomes (CO)
CO1	Identify and explain various security attacks and basic cryptographic techniques. [Understanding, Applying]
CO2	Analyze the principles and methods of modern block ciphers for e.g. DES, IDEA etc. [Remembering, Undrstanding]

CO3	Apply mathematical concepts such as modular arithmetic and discrete logarithms to understand and implement public key cryptography systems like RSA, Elgamal etc. [Applying, Evaluating]
CO4	Understand message authentication codes, hash functions, and digital signatures, emphasizing their role in securing communications. [Understanding]
CO5	Evaluate authentication applications and protocols, such as Kerberos and assess their effectiveness in securing electronic communications. [Understanding,Evaluate]

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, Elgamal 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.	2017
2	Atul Kahate, "Cryptography and Network Security", TMH.	2017
3	Behrouz A. Forouzan, "Cryptography and Network Security", TMH.	2007
4	Johannes A. Buchmann, "Introduction to Cryptography", Springer-Verlag.	2001
5	BruceSchiener, "Applied Cryptography".	1995

Course code: Course Title	Course Structure			Pre-Requisite
	L	**T**	**P**	
CS304: Data Warehousing and Data Mining	**3**	**0**	**2**	**Database Management System**

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	Understand the concepts and architecture of data warehousing, including OLAP and web integration.
CO2	Comprehend the principles of data mining, its query languages, and system architectures.
CO3	Apply association rule mining techniques to large transactional and relational databases.
CO4	Utilize classification and prediction models to analyze and predict data patterns effectively.
CO5	Implement clustering methods and mine complex data types like spatial, multimedia, and time-series data.

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	Data Warehousing Fundamentals, P. Ponnian, John Wiley,	2001
2	Data Mining Introductory & Advanced Topics, M.H. Dunham, Pearson Education.	2012
3	Data Mining Concepts & Techniques, Han Kamber, M. Kaufman.	2011
4	The Data Warehouse Lifecycle Tool Kit, Ralph Kimball, John Wiley	2007
5	Master in Data Mining, M. Berry , G. Linoff, John Wiley	2008
6	Building the Data Ware houses, W.H. Inmon, Wiley Dreamtech	2005

Course code: Course Title	Course Structure			Pre-Requisite
CS307: Modelling and Simulation	L	T	P	Nil
	3	1	0	

Course Objective: To introduce different types of Simulation models, discrete event simulation modeling with example, uses of different simulation modeling software like GPSS, SIMSCRIPT, SLAM, GASP, and SIMULA and different evaluation methods for the simulation software output.

S. No.	Course Outcomes (CO)
CO1	To understand and classify various simulation modelling techniques.[Understanding].
CO2	To outline steps in a simulation study and illustrate Discrete event simulation.[Understanding]
CO3	To construct a model for complex systems and experiment with simulation language. [Applying]
CO4	To analyze random numbers generation using different statistical techniques.[Analysing]
CO5	To evaluate simulation output and validate the system.[Evaluating]

S. No	Contents	Contact Hours
UNIT 1	Definition of System, types of system: continuous and discrete, modelling process and definition of a model.The nature of simulation: simulation model - static, dynamic, deterministic stochastic continuous, discrete models.	12
UNIT 2	Discrete event simulation: Time Advance Mechanism, Components and Organization of a Discrete Event Simulation Model, Selected Illustrative Examples of Simulation Application Models.	12
UNIT 3	Simulation software: Modelling of Complex Systems, Use of a Simulation Language such as GPSS, SIMSCRIPT, SLAM, GASP, and SIMULA.	12
UNIT 4	Evaluation of simulation output :Random Variables and their properties Estimation Methods, Goodness of Fit, Confidence Intervals, Variance Reduction Techniques, Validation of Simulation Models.	12
	Total	48

REFERENCES		
S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Simulation Modeling and Analysis, Kelton W.D. and Law A.M, II Edition, McGraw Hill.	1982
2	Interactive Dynamic System Simulation, G. A. Korn, McGraw Hill.	1988
3	Theory of Modeling and Simulation: Integrating Discrete Event and Continuous Complex Dynamic Systems, Bernard P. Zeigler, Herbert Praehofer, Tag Gon Kim, Academic Press.	2000
4	Modelling and simulation : Exploring dynamic system behavior, Birta, publisher : Yesdee.	2013

Course code: Course Title	Course Structure			Pre-Requisite
CS309: Distributed System	L	T	P	Computer Networks, Operating System
	3	1	0	

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	Apply knowledge of computer networks and operating system to perform of various (DS) algorithms and techniques related to communication, synchronization, resource allocation, file systems, fault tolerance and security.
CO2	Demonstrate limitations and applicability of various DS concepts in real life problems.
CO3	Investigate real life problems and formulate as computer engineering (DS) problems.
CO4	Design, select and apply appropriate DS concepts to solve computer engineering problems.
CO5	Compose and provide solution through computer program for DS concepts using modern computer languages such as C, Java and Python.

S. No	Contents	Contact Hours
UNIT 1	Introduction to Distributed Systems, Design Goals, Types of Distributed systems, system architectures and fundamental models, middleware, Threads, virtualization, client-Server Model, Code migration.	8
UNIT 2	Communication fundamentals, Remote Procedure Call, message oriented communication, and stream oriented communication, multicast communication.	8
UNIT 3	Synchronization: clock synchronization, logical clocks, mutual exclusion algorithms: centralized, decentralized, distributed and token ring algorithms, election algorithms.	8
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.	8
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	**48**

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Distributed Systems, Principles and Paradigms, 2nd edition by Andrew S. Tanenbaum and Maarteen Van Steen, Pearson Education.	2013
2	Distributed System: Concepts and Design, 5th edition by Coulouris, Dollimore, Kindberg,Pearson Ed.	2013
3	Distributed Algorithms: Principles, Algorithms, and Systems by A. D. Kshemkalyani and M. Singhal.	2013

Course code: Course Title	Course Structure			Pre-Requisite
CS311: Information Theory and coding	L	T	P	Nil
	3	1	0	

Course Objective: To introduce fundamentals of Information theory and various coding techniques.

S. No.	Course Outcomes (CO)

CO1	Apply fundamental probability concepts to analyze and solve problems involving random variables.
CO2	Compute and analyze information measures like entropy and mutual information, and design optimal source codes.
CO3	Evaluate channel capacity and apply error control coding techniques to ensure reliable communication.
CO4	Design and implement various error-correcting codes, including cyclic and BCH codes, for effective error detection and correction.
CO5	Apply advanced information theory techniques, such as convex optimization, to solve complex coding and decoding 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.	**10**
UNIT 3	Discrete memory less channel, channel capacity BSC and other channels	**8**
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.	**10**
UNIT 5	Cyclic codes, Generator and parity – check matrices, encoding, syndrome computation, 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	**48**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Information Theory by R Ash, Dover Science Publications	1990
2	Element of Information Theory by Cover and Thomas, John Wiley & Sons	2006
3	Error Control coding: Fundamental & Application by Shulin & Daniel J. Costello Jr, Prentice Hall	2004
4	A Mathematical Theory of Communication. By C. E. SHANNON	1948

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
CS313: Quantum Computing	**3**	**1**	**0**	**Algorithms**

Course Objective: To provide a comprehensive understanding of quantum computing, covering qubits, quantum circuits, quantum cryptography, algorithms, error correction, and practical implementations.

S. No	Course Outcomes (CO)
CO1	Demonstrate a clear understanding of qubits, their representation, and the Bloch sphere for visualizing quantum states.
CO2	Design and analyze quantum circuits using various quantum gates and architectures.
CO3	Apply principles of quantum cryptography and information theory to real-world cryptographic protocols such as quantum key distribution and quantum teleportation.
CO4	Implement and compare quantum algorithms like Deutsch's, Shor's, and Grover's for solving complex computational problems.
CO5	Analyze and apply quantum error correction techniques and evaluate different quantum computing implementations (e.g., NMR, ion traps, optical methods).

S. No	Contents	Contact Hours
UNIT 1	Introduction to Quantum Computing : Qubits and their representation, multiple qubits, entanglement, Bloch sphere representation of a qubit.	10
UNIT 2	Quantum Logic Elements and Circuits : Quantum logic gates (Hadamard, Pauli-X, CNOT, etc.), design of quantum circuits, architectures of quantum computers, quantum circuit operations.	10
UNIT 3	Quantum Information and Cryptography : Quantum Key Distribution (QKD), quantum teleportation, single photons, EPR pairs, Bell states, quantum cryptography, no cloning theorem.	10
UNIT 4	Quantum Algorithms : Introduction to quantum algorithms, Deutsch's algorithm, Deutsch-Jozsa algorithm, Shor's factorization algorithm, Grover's search algorithm.	10
UNIT 5	Error Correction and Implementations: Quantum error correction, fault-tolerant computation, graph states and quantum codes, implementations of quantum computers (NMR, Ion trap, optical implementations).	8
	Total	48

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication
1	Introduction to Quantum Computing, Philip Kaye etal., Oxford University Press.	2006
2	Introduction to Quantum Computers, Gennady Berman, World Scientific.	1998
3	Quantum Computation and Quantum Information, M. Nielsen and I. Chuang, Cambridge University Press, Cambridge.	2010
4	Classical and Quantum Computation, A. Yu. Kitaev, A.H. Shen, and M.N. Vyalyi, American Mathematical Society, Providence.	2002
5	Problems & Solutions in Quantum Computing & Information, W.H. Steeb and Y. Hardy World Scientific, River Edge, NJ, 2004.	2017

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
CS315: Advanced Data Structures	3	1	0	Data Structures

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

S. No.	Course Outcomes (CO)
CO1	Understand and perform operations on advanced tree structures such as B-trees and Red-Black trees.
CO2	Implement and analyze mergeable heaps, including binomial and Fibonacci heaps, and their operations.

CO3	Apply fundamental graph theory concepts and definitions to analyze graph properties and components.
CO4	Implement and evaluate graph algorithms for connectivity, shortest paths, and network flows.
CO5	Design and utilize advanced data structures like tries, suffix trees, and spatial trees for efficient data handling.

S. No	Contents	Contact Hours
UNIT 1	Review of Elementary data structures- Binary Trees, Binary Heap, Sorting & Searching Technique Sparse matrices- Properties of Sparse Matrices, Linked List representation of Sparse Matrices, Analysing Algorithm ,Hashing ,Universal Hashing ,Perfect Hashing	**6**
UNIT 2	Advanced Data Structures: data structures for combinatorial Optimization – Binomial Heap, Fibonacci Heaps, Red -Black Trees, Augmenting Red – Black Trees to Dynamic order Statics and Interval Applications. Operations on Disjoint Sets –find union problem , Implementing Sets, Dictionaries, Self-Adjusting Trees, Skip lists.	**8**
UNIT 3	Divide and Conquer approach- Application of Divide and Conquer- Finding Maximum and Minimum, Finding K-th Smallest element order statistics, Finding K-th Smallest element, Merge Sort, Randomized Quick Sort.	**8**
UNIT 4	Graph Algorithms: Definitions for Graph, Algorithms for connectedness, Finding All Spanning Trees in a Weighted Graph and Planarity Testing, Breadth First and Depth First Search, Articulation Point, Cut Edge, Topological Sort, Strongly Connected Components and Single Source Shortest Path and All pair shortest path algorithms, Planer graphs.	**10**
UNIT 5	Greedy Method and Dynamic Programming: General method, knapsack problem, Single Source Shortest path, Job Sequencing with deadline, Scheduling problems. Dynamic Programming: General method,0/1 knapsack problem, All Pair Shortest Path.	**8**
UNIT 6	Advanced Algorithms: NP Complete problems, Approximation algorithms for NP complete problem (vertex cover, traveling salesman), Algorithms for matching, Flow and circular problems, Bio Inspired Algorithm- Genetic Algorithm, Particle Swam, Artificial Bee Colony, Firefly Algorithm, Bat Algorithm.	**8**
	Total	**48**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	NarsinghDeo-Graph Theory with Application to Engineering and Computer Science, Prentice Hall of India.	2004
2	Baase-Computer Algorithms, Pearson Education.	2000
3	Cormen-Introduction to Algorithms, Prentice Hall of India.	2022
4	Aho A.V.,Hoperptt J.E. and Ullman J.D.-The Design and Analysis of Computer	1974
5	Horowitz and Sawhni-Fundamentals of Data Structures Galgotia Book Source.	2004

Course code: Course Title	Course Structure			Pre-Requisite
CS317: Microprocessor and Interfacing	**L**	**T**	**P**	**Nil**
	3	**1**	**0**	

Course Objective: To introduce fundamentals of microprocessor architecture, programming and system design.

S. No.	Course Outcomes (CO)

CO1	Understand microprocessor evolution, architecture, and the operation of its components, including addressing modes and interrupts.
CO2	Analyze and utilize the architecture and instruction set of the 8085 microprocessor, including data transfer, arithmetic, and logical operations.
CO3	Comprehend the architecture of the 8086 microprocessor, including memory segmentation, operating modes, and interrupts.
CO4	Develop and debug assembly language programs for Intel 8085/8086, focusing on instructions, data transfer, and control flow.
CO5	Interface and configure peripheral devices using components such as DMA controllers, programmable interfaces, timers, and USART.

S. No	Contents	Contact Hours
UNIT 1	Introduction: Microprocessor evolution and types, microprocessor architecture and operation of its components, addressing modes, interrupts, and data transfer schemes, instruction and data flow, timer and timing diagram. Interfacing devices. Architectural advancement of microprocessor	**8**
UNIT 2	8-bit Microprocessors: Pin diagram and internal architecture of 8085 microprocessor, registers, ALU, interrupt and machine cycle. Instruction sets. Addressing modes. Instruction formats Instruction Classification: data transfer, arithmetic operations, logical operations, branching operations, machine control and assembler directives. Counters and Time Delays.	**10**
UNIT 3	16-bit Microprocessor: Architecture of 8086 microprocessor: register organization, bus interface unit, execution unit, memory addressing, memory segmentation. Operating modes. Instruction sets, instruction format, Types of instructions. Interrupts: hardware and software interrupts.	**10**
UNIT 4	Programming: Assembly language programming based on Intel 8085/8086. Instructions, data transfer, arithmetic, logic, branch operations, looping, counting, indexing, programming techniques, counters and time delays, stacks and subroutines, conditional call and return instructions	**10**
UNIT 5	Peripheral Interfacing: Peripheral Devices: 8237/8257 DMA Controller, 8255 programmable peripheral interface, 8253/8254programmable timer/counter, 8259 programmable interrupt controller, 8251 USART and RS232C.	**10**
	Total	**48**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Gaonkar Ramesh S, "Microprocessor Architecture, Programming and Applications with 8085", Penram International Publishing.	2020
2	Ray A K , Bhurchandi K M , "Advanced Microprocessors and Peripherals, TMH	2023
3	Hall D V, "Microprocessor Interfacing", TMH.	2016
4	Liu and Gibson G A , Microcomputer System: The 8086/8088 family,PHI	2006
5	Aditya P Mathur, Introduction to Microprocessor, TMH	2019
6	Brey, Barry B, INTEL Microprocessors, PHI	2018
7	Renu Sigh & B.P.Sigh, Microprocessor, Interfacing and Application	2018

Course code: Course Title	Course Structure			Pre-Requisite
CS319: 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	
S. No.	**Course Outcomes (CO)**
CO1	Understand the components and applications of computer graphics systems, including display devices and color models.
CO2	Implement and analyze output primitive algorithms for rendering lines, shapes, and fills.
CO3	Apply 2D and 3D transformation techniques using matrix representations and homogeneous coordinates.
CO4	Utilize 2D viewing and clipping techniques for managing and displaying graphical content.
CO5	Design and manipulate curves and surfaces using Bezier and B-Spline techniques.
CO6	Apply projection and shading methods for realistic image rendering and hidden surface removal.

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	Projection: Parallel Projection, Oblique Projection on XY plane, Isometric Projection, Perspective Projection, One Vanishing Point (V.P.) projection, Generation of 2 V.P. Projection, planar geometric projections. 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	D. Hearn , P. Baker& W. Carithers, "Computer Graphics with OpenGL", Pearson.	2015

2	Z. Xiang & R. Plastock “Computer Graphics”, Schaum’s Series, McGraw Hill.	2007
3	David F. Rogers, “Procedural Elements for Computer Graphics”, Tata McGraw Hill Book Company.	2002
4	D. Rogers and J. Adams, “Mathematical Elements for Computer Graphics”, MacGraw- Hill International Edition.	2002
5	Foley et al., “Computer Graphics Principles & practice”, Addison Wesley.	1999

Course code: Course Title	**Course Structure**			**Pre-Requisite**
CS306: Optimization Techniques	**L**	**T**	**P**	**Nil**
	3	**1**	**0**	

Course Objective: To familiarize with various optimization techniques and their applications.

S. No.	**Course Outcomes (CO)**
CO1	Apply linear programming methods, including the Simplex method and post-optimality analysis.
CO2	Understand duality theory and solve linear programming problems using various algorithms.
CO3	Utilize dynamic programming for deterministic and probabilistic optimization problems.
CO4	Implement integer programming techniques, including branch-and-bound for binary and mixed integer problems.
CO5	Apply nonlinear programming methods, including KKT conditions and various optimization techniques.
CO6	Analyze and model queuing systems using queuing theory and associated processes.

S. No	**Contents**	**Contact Hours**
UNIT 1	Linear Programming Models, Prototype, Examples, Assumptions of Linear Programming, Additional Examples, Some Classic Case Studies. Graphical method, The Simplex Method: The Essence of the Simplex Method, Setting up the Simplex Method, The Algebra of the Simplex Method, The Simplex Method in Tabular Form, Tie Breaking in the Simplex Method, Adapting to Other Model Forms, Post optimality Analysis.	**8**
UNIT 2	Duality theory and Essence of Duality Theory, Economic Interpretation of Duality, Primal-Dual relationships, Adapting to Other Primal Forms, The Role of Duality Theory in Sensitivity Analysis. Algorithms for Linear Programming:The Dual Simplex Method, Parametric Linear Programming, the Upper Bound Techniques, An Interior-Point Algorithm.	**8**
UNIT 3	Dynamic programming, prototype example for Dynamic Programming, Characteristics of Dynamic Programming Problems, Deterministic Dynamic Programming, Probabilistic Dynamic Programming.	**8**
UNIT 4	Integer Programmingand Prototype Example, Some BIP Applications, Innovative Uses of Binary Variables in Model Formulation, Some Formulation examples, Some Perspectives on Solving Integer Programming Problems, The Branch-and-Bound Technique and Its application to Binary Integer Programming, A Branch-and-Bound Algorithm for Mixed Integer.	**8**
UNIT 5	Nonlinear Programming and Sample Applications, Graphical Illustration of Nonlinear Programming Problems, Types of Nonlinear Programming Problems, One-Variable Unconstrained Optimization, Multivariable Unconstrained Optimization, The Karush-Kuhn-Tucker (KKT) Conditions for Constrained Optimization, Quadratic Programming, Separable Programming , Convex Programming.	**8**
UNIT 6	Discussion about the Queuing Theory and Prototype Example, Basic Structure of queuing Models, Examples of Real Queuing Systems, The role of the Exponential Distribution, The Birth-and-Death Process, Queuing Models Based on the Birth-and Death Process, Queuing Models involving non exponential distributions.	**8**

	Total	**48**

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	H.A.Taha – Operations Research, Pearson Education , New Delhi	2017
2	J.K. Sharma – Operations Research, Mcmillan , India Ltd	2020
3	S. Hiller & G.J. Lieberman – Operations Research, TMH, New Delhi	2017
4	Kanti Swarup, Gupta Pk, Man Mohan, Operations Research, Sultan Chand &	2017

Course code: Course Title	**Course Structure**			**Pre-Requisite**
CS308: Soft Computing	**L**	**T**	**P**	**Discrete Mathematics**
	3	**0**	**2**	

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 basics of soft computing and its applications in artificial intelligence.
CO2	Implement and analyze neural network models and learning algorithms.
CO3	Apply fuzzy logic principles, including fuzzy sets and rule generation.
CO4	Perform arithmetic operations on fuzzy numbers and solve fuzzy equations.
CO5	Develop and apply neuro-fuzzy models and data clustering techniques.
CO6	Utilize genetic algorithms and swarm optimization methods for solving complex problems.

S. No	**Contents**	**Contact Hours**
UNIT 1	Soft Computing & Artificial Intelligence: Soft Computing Introduction, Hard Computing, Types of Soft Computing Techniques, Applications of Soft Computing, Al Search Algorithm, Predicate Calculus, Rules of Interference, Semantic Networks, Frames, Objects, Hybrid Models Artificial.	**8**
UNIT 2	Neural Networks: History, overview of biological Neuro-system, Neuron Model, Neural Network Architecture, Learning Rules, Perceptrons, Single Layer Perceptrons, Multilayer Perceptrons, Back propagation Networks: Kohnen'sself organizing networks, Hopfield network, Applications of NN.	**6**
UNIT 3	Fuzzy Logic and Fuzzy Sets: Introduction to Fuzzy Logic, Classical and Fuzzy Sets: Compliment, Intersections, Unions, Combinations of Operations, Aggregation Operations, Overview of Classical Sets, Membership Function, Fuzzy rule generation.	**8**
UNIT 4	Fuzzy Arithmetic: Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals & Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations.	**6**
UNIT 5	Neuro-Fuzzy Modeling: Neuro Fuzzy Controls Adaptive Networks Based Fuzzy Interface Systems, Classification and Regression Trees, Data Clustering Algorithms, Rule Based Structure Identification, Evolutionary Computation.	**6**
UNIT 6	Genetic Algorithms and Swarm Optimizations: Introduction to Genetic Algorithm, Fitness Computations, Evolutionary Programming, Genetic Programming Parse Trees, Variants of GA, Applications, Ant Colony Optimization, Particle Swarm Optimization, Artificial Bee Colony Optimization.	**8**
	Total	**42**

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	"An Introduction to Neural Networks", Anderson J.A., PHI.	1995
2	Srikanta Patnaik, Baojiang Zhong, Soft Computing Techniques in Engineering	2014
3	"Introduction to the Theory of Neural Computation", Hertz J. Krogh, R.G.	1991
4	"Fuzzy Sets & Fuzzy Logic", G.J. Klir & B. Yuan, PHI.	2005
5	"An Introduction to Genetic Algorithm", Melanie Mitchell, PHI.	1998
6	Saroj Kaushik, Artificial Intelligence, Cengage Learning.	2020

Course code: Course Title	**Course Structure**			**Pre-Requisite**
CS310: Enterprise Java Programming	**L**	**T**	**P**	**Core Java**
	3	**0**	**2**	

Course Objective: To introduce fundamentals of Enterprise Java Programming, concepts of program development using beans.

S. No.	**Course Outcomes (CO)**
CO1	Implement and utilize Java collections and multithreading concepts for effective data management and concurrent processing.
CO2	Understand and apply relational data models and SQL for database design and querying.
CO3	Use JDBC to connect to databases, execute queries, and manage data types and result sets.
CO4	Develop and manage servlets for handling HTTP requests and responses, including state and session management.
CO5	Create and use Java Beans, applying concepts like reflection, introspection, and customizers for component-based development.
CO6	Design and develop enterprise JavaBeans, including session, entity, and message-driven beans, for distributed multitiered applications.

S. No	**Contents**	**Contact Hours**
UNIT 1	Collections : Collection Interfaces, Concrete Collections, Collections Framework. Multithreading : Creating and running thread, Multiple thread synchronization, Thread communication, Thread group, Thread priorities, Daemon Thread, Life Cycle of Thread.	**5**
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.	**6**
UNIT 3	JDBC Package: JDBC – JDBC versus ODBC – Types of JDBC drivers – Connection – Statement – PreparedStatement. ResultSet: Fields of ResultSet – Methods of ResultSet – Executing a query - ResultSetMetaData – DatabaseMetaData. Datatypes in JDBC : Basic datatypes in JDBC – Advanced datatypes in JDBC – fields of Statement – methods of Statement – CallableStatement Interface – BatchUpdates	**6**

UNIT 4	Servlets : Using Servlets - Servlet Package - Servlet lifecycle - init() method - service() method , doGet() method, doPost() method and destroy() method . Classes and interfaces of Servlet: Servlet - GenericServlet - ServletConfig - ServletContext - ServletException - ServletInputStream - ServletOutputStream - ServletRequest – ServletResponse. Classes and interfaces of HttpServlet: HttpServlet - HttpServletRequest - HttpServletResponse - Reading HTML form data from Servlets - Response Headers - Response Redirection. Handling Servlets : Servlet Chaining - HttpUtils - Database access with JDBC inside servlet. State and Session management : Cookies - HttpSession - Server Side includes - Request forwarding – RequestDispatcher.	**7**
UNIT 5	Concepts of Java Beans: Java Beans - Advantage of Java Beans - Reflection and Introspection - Customizers – Persistence. Developing Java Beans : Bean Developer Kit (BDK) - Creating a Java Bean - Creating a Bean Manifest file - Creating a Bean JAR file. Controls and Properties of a Bean : Adding controls to Beans - Giving Bean Properties - BeanInfo interface - SimpleBeanInfo class. Types of Properties: Design pattern for Properties: Simple properties - Indexed Properties; Descriptor Classes - Giving Bean methods - Bound and Constrained Properties - Property Editors.	**9**
UNIT 6	Components of EntrepriseBeans : Distributed Multitiered Applications -J2EE components: J2EE clients, Web components, J2EE containers. Developing an Enterprise Bean : Packaging - Enterprise JavaBeans Technology - Enterprise Bean - Contents of an Enterprise Bean. Session Bean : Stateful session bean – life cycle of stateful session bean - Stateless session bean – life cycle of stateless session – ejbCreate methods – Business methods – Home interface – Remote interface – Running the session bean. Entity Bean: Persistence - Bean managed Persistence - Container Managed Persistance - Shared Access - Primary key – Relationships. Message Driven Bean: life cycle of message driven bean – onMessage method.	**9**
	Total	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Java2 Programming Black Book - Steven Holzner	2006
2	JavaBeans Programming from the GroundUp - Joseph O'Neil, TMGH, New	1998
3	Head first EJB-O'Reilly	2005
4	"Beginning Java EE 6 Platform with GlassFish 3 From Novice to	2010

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
CS312: Embedded Systems	**3**	**1**	**0**	

Course Objective: To introduce fundamentals of embedded systems and programming fundamentals and microcontroller, concepts of program development and object Oriented Programming and Field programmable gate array (FPGA) using digital circuits and systems.

S. No.	Course Outcomes (CO)
CO1	Understand the evolution, applications, and architectural diversity of embedded systems.
CO2	Apply embedded programming principles and instruction set architectures for effective software development.
CO3	Implement interrupt systems, I/O programming, and memory management using high-level programming languages.
CO4	Utilize FPGA technology for reconfigurable computing and address related hardware-software development issues.

CO5	Design and develop digital systems on FPGAs with a focus on fault tolerance and re-targetable compilation.
CO6	Explore specific applications and emerging trends in embedded systems.

S. No	Contents	Contact Hours
UNIT 1	Introduction Evolution of embedded systems &their applications, architectural diversity for embedded system development.	**6**
UNIT 2	Techniques and tools for embedded software development Embedded Programming principles, Instruction Set Architectures for embedded software development: arithmetic and logical, program control, string instructions, special or privileged instructions.	**10**
UNIT 3	Interrupt system, Input-output programming, Memory management, Using High level languages for embedded programming, structured and Object Oriented Programming.	**8**
UNIT 4	Re-configurable FPGA for embedded computing R-FPGA and hardware software development, issues in Reconfigurable computing, placement and scheduling techniques.	**8**
UNIT 5	Design of digital systems on FPGAs, fault tolerant design on FPGAs, Re-targetable assembling and compilation.	**8**
UNIT 6	Applications Specific applications,Emerging trends.	**8**
	Total	**48**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Advanced FPGA Design: Architecture, Implementation, and Optimization by Steve Kilts, Wiley	2007
2	Practical FPGA Programming in C by David Pellerin, Prentice Hall.	2005
3	Synthesis of Arithmetic Circuits: FPGA, ASIC and Embedded Systems, by Jean- Pierre Deschamps, Gery J.A. Bioul, Gustavo D. Sutter, Wiley.	2008
4	Rapid Prototyping of Digital Systems Hamblen, James O., Hall, Tyson S., Furman, Michael D. Springer.	2012
5	Embedded Software Development with eCos (Bruce Perens' Open Source Series), Anthony J. Massa.	2004
6	Embedded systems Architecture programming and design-Rajkamal, TataMcGrewHill	2022
7	Computer Architecture: A Quantitative Approach - Wayne Wolf, Elsevier	2022

Course code: Course Title	Course Structure			Pre-Requisite
CS314: 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	Apply lossless and lossy compression techniques and understand performance measures.
CO2	Implement Huffman coding and its applications in various compression scenarios.
CO3	Utilize arithmetic coding and dictionary techniques for effective data compression.
CO4	Apply image compression methods and standards for efficient image and modem compression.
CO5	Understand distortion criteria and quantization techniques for lossy compression.
CO6	Implement vector quantization methods for improved compression efficiency.

S. No	Contents	Contact Hours
UNIT 1	Introduction: Compression Techniques: Loss less compression, Lossy Compression, Measures of performance, Modeling 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.	8
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.	10
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 Ouantization: The Quantization problem, Uniform Quantizer, Adaptive Quantization, Non uniform Quantization.	6
UNIT 6	Vector Quantization: Advantages of Vector Quantization over Scalar	4
	Total	48

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Khalid Sayood, Introduction to Data Compression, Morgan Kaufmann	2017
2	Data Compression The Complete Reference, David Salomon.	2007

Course code: Course Title				Pre-Requisite
CS316: Parallel Algorithms	L	T	P	Data Structures, Algorithms
	3	1	0	

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

S. No.	Course Outcomes (CO)
CO1	Understand parallel computing models and analyze parallel algorithms.
CO2	Implement dense matrix multiplication algorithms.
CO3	Apply decomposition and mapping techniques to various problems.
CO4	Use parallel sorting algorithms like Hyper Quick Sort and Merge Sort.
CO5	Implement parallel searching and selection algorithms.
CO6	Apply parallel algorithms to graph problems such as coloring and shortest paths.

S. No	Contents	Contact Hours

UNIT 1	Introduction: Need for parallel computers ,Models of computation,Analyzing parallel algorithms, Expressing parallel algorithms	**4**
UNIT 2	Dense matrix multiplication algorithms: Matrix vector Multiplication, Matrix multiplication.	**6**
UNIT 3	Decomposition & Mapping techniques: Database query processing, 15 puzzle problem, Parallel discrete event simulation, Image dithering, Dense LU factorization	**8**
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	**48**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar "Introduction to Parallel Computing", Addison Wesley	2003
2	S.G. Akl, "The Design and Analysis of Parallel Algorithms"	1997
3	F.T. Leighton, "Introduction to Parallel Algorithms and Architectures: Arrays, Trees, Hypercubes", MK Publishers, San Mateo California	1992
4	Wilkinson, M. Allen, "Parallel Programming Techniques and Applications using networked workstations and parallel computers", Prentice Hall.	2005
5	Michael J. Quinn, "Parallel computer theory and practice", McGraw Hill, Second Edition.	2004

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
CS318: Deep Learning	**3**	**0**	**2**	**Artificial Intelligence and Neural Networks**

Course Objective: Become an expert in neural networks, and learn to implement them in Keras and Tensor flow

S. No.	Course Outcomes (CO)
CO1	Explain Deep Learning Foundations and Architecture
CO2	Design and Implement Deep Learning Models
CO3	Analyse and Optimize Model Performance
CO4	Implement and Evaluate Generative Models
CO5	Apply Ethical Principles in Deep Learning Practice

S. No	Contents	Contact Hours
UNIT 1	Machine Learning Basics: Learning Algorithms, Capacity, Overfitting and Underfitting, Hyperparameters and Validation Sets, Estimators, Bias and Variance, Maximum Likelihood Estimation, Bayesian Statistics, Supervised Learning Algorithms, Unsupervised Learning Algorithms, Stochastic Gradient Descent	**7**
UNIT 2	Architecture of Neural Network, Hidden Units, Gradient-Based Learning, Back-Propagation	**6**

UNIT 3	Regularization for Deep Learning, Train / Dev / Test sets, Bias / Variance, Regularization, Dropout Regularization, Understanding Dropout, Other regularization methods, Normalizing inputs, Vanishing / Exploding gradients, Weight Initialization for Deep Networks	**6**
UNIT 4	Optimization for Training Deep Models, Mini-batch gradient descent, Exponentially weighted averages, Bias correction in exponentially weighted averages, Gradient descent with momentum, RMSprop, Adam optimization algorithm, Learning rate decay	**6**
UNIT 5	Convolutional Networks, Convolution operation, Motivation, Padding, Stride Convolutions, Convolutions Over Volume, One Layer of a Convolutional Network, Simple Convolutional Network, Pooling Layers CNN Example architectures	**8**
UNIT 6	Sequence Modeling: Why sequence models? Notation, Recurrent Neural, Network Model, Backpropagation through time, Different types of RNN, Vanishing gradients with RNNs, Gated Recurrent Unit (GRU), Long Short Term Memory (LSTM), Optimization for Long-Term Dependencies, Bidirectional RNN, Deep RNNs	**9**
	Total	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Deep Learning by Ian Goodfellow, Yoshua Begio, and Aron Courville	2016
2	Deep Learning with Python. By Francois Chollet, Google AI	2017
3	Neural Networks and Deep Learning by Michael Nielsen.	2019

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
CS320: Blockchain and Applications	**3**	**1**	**0**	**Algorithms and Data Structures**

Course Objective: To provide an understanding of blockchain technology, distributed ledger systems, consensus mechanisms, and their real-world applications.

S. No	Course Outcomes (CO)
CO1	Describe the fundamental concepts of distributed databases and cryptographic principles used in blockchain technology[Remembering]
CO2	Explain the advantages of blockchain over conventional distributed databases and identify blockchain networks' key components and mechanisms.[Understanding]
CO3	Apply cryptographic techniques such as hash functions and digital signatures to secure transactions within a blockchain network.[Applying]
CO4	Analyze various consensus algorithms and evaluate their effectiveness in maintaining the security and integrity of blockchain networks.[Analysing]
CO5	Develop a simple blockchain application and design smart contracts using Ethereum, addressing potential vulnerabilities and ensuring secure transactions.[Creating]

S. No	Contents	Contact Hours
UNIT 1	Need for Distributed Record Keeping and Consensus algorithms: Modeling faults and adversaries, Byzantine Generals problem, Consensus algorithms and their scalability problems, Why Nakamoto Came up with Blockchain based cryptocurrency.	**10**

UNIT 2	Blockchain Technologies: Technologies Borrowed in Blockchain — hash pointers, consensus, byzantine fault-tolerant distributed computing, digital cash, Atomic Broadcast, Consensus, Byzantine Models of fault tolerance.	**8**
UNIT 3	Cryptographic Foundations of Blockchain: Hash functions, Puzzle friendly Hash, Collision-resistant hash, digital signatures, public key crypto, verifiable random functions, Zero-knowledge systems.	**8**
UNIT 4	Bitcoin Blockchain and Alternatives: Bitcoin blockchain, the challenges, and solutions, proof of work, Proof of stake, alternatives to Bitcoin consensus, Bitcoin scripting language and their use.	**10**
UNIT 5	Ethereum, Smart Contracts, and Advanced Blockchain Concepts: Ethereum and Smart Contracts, The Turing Completeness of Smart Contract Languages, Verification challenges, Using smart contracts to enforce legal contracts, Comparing Bitcoin scripting vs. Ethereum Smart Contracts, Hyperledger Fabric, Pseudo-anonymity vs. anonymity, Zcash and Zk-SNARKS for anonymity preservation, Attacks on Blockchains: Sybil attacks, selfish mining, 51% attacks, Advent of Algorand, Sharding-based consensus algorithms	**12**
	Total	**48**

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	"Blockchain: Blueprint for a New Economy", by Melanie Swan	2015
2	Blockchain: The blockchain for beginners guide to blockchain technology and	2017
3	Draft version of "S. Shukla, M. Dhawan, S. Sharma, S. Venkatesan,	2019
4	Josh Thompson, 'Blockchain: The Blockchain for Beginnings, Guild to	2017

Course code: Course Title	**Course Structure**			**Pre-Requisite**
CS322: Optical Networks	**L**	**T**	**P**	**Physics, Mathematics**
	3	**1**	**0**	

Course Objective: To introduce the concepts of digital logic, functioning and design of digital devices, logic families, electronic memory and related devices.

S. No.	**Course Outcomes (CO)**
CO1	Understand SONET/SDH and Dense Wavelength-Division Multiplexing (DWDM).
CO2	Explain Time-Division Multiplexing (TDM) and its network elements.
CO3	Describe fiber-optic technologies and their applications.
CO4	Implement and analyze Wavelength-Division Multiplexing (WDM) systems.
CO5	Understand SONET architectures and protection strategies.
CO6	Explain SDH architectures and protection methods.

S. No	**Contents**	**Contact Hours**
UNIT 1	Introduction to Optical Networking: Introduction to SONET/SDH, SONET/SDH, Dense Wavelength-Division Multiplexing,The Future of SONET/SDH and DWDM.	**8**
UNIT 2	Time-Division Multiplexing: Introduction to Time-Division Multiplexing, Analog Signal Processing, Circuit-Switched Networks, The T-Carrier, The E-Carrier, ISDN, TDM, Network Elements	**8**

UNIT 3	Fiber-Optic Technologies: A Brief History of Fiber-Optic Communications, Fiber-Optic Applications, The Physics Behind Fiber Optics, Optical-Cable Construction, Propagation Modes, Fiber-Optic Characteristics, Fiber Types, Fiber-Optic Cable Termination, Splicing, Physical-Design Considerations, Fiber-Optic Communications System, Fiber Span Analysis.	**8**
UNIT 4	Wavelength-Division Multiplexing: The Need for Wavelength-Division Multiplexing, Wavelength-Division Multiplexing, Coarse Wavelength-Division Multiplexing, Dense Wavelength-Division Multiplexing, The ITU Grid, Wavelength-Division Multiplexing Systems, WDM Characteristics and Impairments to Transmission, Dispersion and Compensation in WDM.	**8**
UNIT 5	SONET Architectures: SONET Integration of TDM Signals, SONET Electrical and Optical Signals, SONET Layers, SONET Framing, SONET Transport Overhead, SONET Alarms, Virtual Tributaries, SONET Multiplexing, SONET Network Elements, SONET Topologies, SONET Protection Architectures, SONET Ring Architectures, SONET Network Management.	**8**
UNIT 6	SDH Architectures:SDH Integration of TDM Signals, SDH Layers, SDH Multiplexing, SDH Framing, SDH Transport Overhead, SDH Alarms, SDH Higher-Level Framing, SDH Network Elements, SDH Topologies, SDH Protection Architectures, SDH Ring Architectures, SDH Network Management.	**8**
	Total	**48**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Optical Network Design and Implementation, Vivek Alwayn	2005

Course code: Course Title	Course Structure			Pre-Requisite
CS324: High Speed Networks	**L**	**T**	**P**	**Computer Networks**
	3	**1**	**0**	

Course Objective: To highlight the features of different technologies involved in high speed networking and their performance

S. No.	Course Outcomes (CO)
CO1	Understand ATM and high-speed LAN technologies.
CO2	Analyze queuing models and congestion management.
CO3	Explain TCP and ATM congestion control mechanisms.
CO4	Understand Integrated and Differential Services.
CO5	Describe QoS support protocols: RSVP, MPLS, RTP.
CO6	Explore internetworking, BGP, IPv6, and security systems.

S. No	Contents	Contact Hours
UNIT 1	High Speed networks: Asynchronous transfer mode – ATM Protocol Architecture,ATM logical Connection, ATM Cell – ATM Service Categories – AAL, High Speed LANs:Fast Ethernet, Gigabit Ethernet, Fiber Channel – Wireless LANs: applications,requirements – Architecture of 802.11	**8**
UNIT 2	Congestion And Traffic Management: Queuing Analysis- Queuing Models – Single Server Queues – Effects of Congestion – Congestion Control – Traffic Management – Congestion Control in Packet Switching Networks	**8**

UNIT 3	TCP And ATM Congestion Control: TCP Flow control – TCP Congestion Control – Retransmission – Timer Management – Exponential RTO backoff – KARN's Algorithm – Window management - Performance ofTCP over ATM. Traffic and Congestion control in ATM – Requirements – Attributes –Traffic Management Frame work, Traffic Control – ABR traffic Management – ABR ratecontrol, RM cell formats, ABR Capacity allocations – GFR traffic management	**8**
UNIT 4	INTEGRATED AND DIFFERENTIAL SERVICES Integrated Services Architecture - Approach, Components, Services- Queuing Discipline, FQ, PS, BRFQ, GPS, WFQ - Random Early Detection, Differentiated Services	**8**
UNIT 5	PROTOCOLS FOR QOS SUPPORT RSVP - Goals & Characteristics, Data Flow, RSVP operations, Protocol Mechanisms - Multiprotocol Label Switching - Operations, Label Stacking, Protocol details - RTP - Protocol Architecture, Data Transfer Protocol, RTCP.	**8**
UNIT 6	Internetworking: Inter-domain Routing, BGP, IPv6, Multicast Routing Protocols, Applications and Other Networking Technologies: RTP, RTSP, SIP, VoIP, Security Systems, SSH, PGP, TLS, IPSEC, DDoS Attack	**8**
	Total	**48**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	HIGH SPEED NETWORKS AND INTERNET, William Stallings, Pearson	2002
2	HIGH PERFORMANCE COMMUNICATION NETWORKS, Warland &	2001
3	MPLS and VPN architecture by Irvan Pepelnjk, Jin Guichard and Jeff Apcar,	2003
4	Behrouz A. Forouzan, Data Communications and Networking, Tata McGraw	2017

Course code: Course Title	Course Structure			Pre-Requisite
CS326: Advanced Database Management System	**L**	**T**	**P**	**Database Management System**
	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	Apply advanced concepts like integrity constraints, ER diagrams, relational algebra, and functional dependencies for data normalization.
CO2	Implement complex transaction techniques, including nested and multilevel transactions, focusing on workflows and serializability.
CO3	Use advanced strategies for query transformation, size estimation, and indexing to enhance query performance and database operations.
CO4	Design Parallel and Distributed Databases, focusing on data storage, fragmentation, replication, and concurrency control.
CO5	Design and manage active databases with real-time constraints, including triggers, event constraints, and concurrency control.
CO6	Assess and apply advanced security measures for databases, including access control, encryption, and secure transaction processing, to protect data integrity and privacy.

S. No	Contents	Contact Hours
UNIT 1	This course covers topics of Relational Databases Integrity Constraints, Extended ER diagram, Relational Algebra & Calculus, Functional, Multivalued and Join Dependency, Normal Forms, Rules about functional dependencies.	**8**

UNIT 2	Advanced Transaction Processing; Nested and multilevel transaction, Compensating Transaction & Saga, Long Duration Transaction ,Weak Level of Consistency, Transaction Work flows, Transaction Processing Monitors, Schedules, Serializability- Conflict & View	**8**
UNIT 3	Query Processing ; General Strategy for Query Processing ,Transformations ,Expected size ,Statistics in Estimation ,Query improvement ,View Processing ,Query Processor	**8**
UNIT 4	Query Optimization: Indexing and Query Optimization, Limitations of Relational Data Model ,Null Values & Partial Information	**8**
UNIT 5	Parallel and Distributed Databases: Distributed Data Storage – Fragmentation & Replication, Location and Fragment Transparency, Distributed Query Processing and Optimization, Distributed Transaction Modelling & Concurrency Control, Distributed Deadlock ,Commit Protocol, Design of Parallel Databases ,Parallel Query Evaluation	**8**
UNIT 6	Active Database and Real Time Databases: Triggers in SQL, Event Constraint and Action-ECA rules ,Query Processing & Concurrency Control ,Compensation & Databases Recovery	**8**
	Total	**48**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Elmarsi, Navathe, Somayajulu, Gupta, "Fundamentals of Database Systems", Pearson Education	2007
2	Garcia, Ullman, Widom, "Database Systems, The complete book", Pearson	2008
3	Date, Kannan, Swaminathan, "An Introduction to Database Systems", Pearson Education,	2007
4	Silberscatz, Korth, Sudarshan, "Database System Concepts", Mcgraw Hill	2006

Course code: Course Title	Course Structure			Pre-Requisite
CS328: Multimedia System Design	**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 multimedia systems and tools, including hardware, software, and authoring techniques.
CO2	Apply multimedia building blocks such as text, audio, and video in various formats.
CO3	Implement data compression techniques for efficient multimedia storage and transmission.
CO4	Apply concepts of digital audio and speech compression for multimedia sound optimization.
CO5	Utilize image formats, standards, and compression techniques for multimedia applications.
CO6	Manage multimedia databases, video compression, and retrieval systems in modern multimedia services.

S. No	Contents	Contact Hours
UNIT 1	Introduction to Multimedia, Multimedia Information, Multimedia Objects, Multimedia inbusiness and work. Convergence of Computer, Communication and EntertainmentProducts ,Stages of Multimedia Projects:Multimedia hardware, Memory & storage devices, Communication devices, Multimedia softwares, presentation tools, tools for object generations, video, sound, image capturing,authoring tools, card and page based authoring tools.	**10**

UNIT 2	Multimedia Building Blocks: Text, Sound MIDI, Digital Audio, audio file formats, MIDI under windows environment, Audio & Video Capture.	**8**
UNIT 3	Data Compression: Huffman Coding, Shannon Fano Algorithm, Huffman Algorithms, Adaptive Coding,Arithmetic Coding Higher Order Modeling. Finite Context Modeling, Dictionary basedCompression, Sliding Window Compression, LZ77, LZW compression, Compression,Compression ratio loss less & lossy compression.	**10**
UNIT 4	Speech Compression & Synthesis : Digital Audio concepts, Sampling Variables, Loss less compression of sound, lossy compression & silence compression.	**6**
UNIT 5	Images: Multiple monitors, bitmaps, Vector drawing, lossy graphic compression, image fileformats, animations, Images standards, JPEG Compression, Zigzag Coding.	**6**
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, VideoConferencing, Multimedia Broadcast Services, Indexing and retrieval of Video Database,recent developments in Multimedia.	**8**
	Total	**48**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Tay Vaughan "Multimedia, Making IT Work" Osborne McGraw Hill.	2010
2	Buford "Multimedia Systems" Addison Wesley	2000
3	Agarwal & Tiwari "Multimedia Systems" Excel	2002
4	Mark Nelson "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	
CS405: Real Time System	**3**	**1**	**0**	**Data Structures, Algorithms**

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	Define real-time systems and their key concepts, including deadlines and timing constraints.
CO2	Compare scheduling approaches and evaluate EDF and LST algorithms.
CO3	Apply resource access control protocols for managing contention and data access.
CO4	Develop and analyze scheduling strategies for multiprocessor systems.
CO5	Describe real-time communication models, protocols, and real-time operating systems.

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.	**10**

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,mStack 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	**10**
UNIT 4	Multiprocessor System Environment : Multiprocessor and Distributed System Model, Multiprocessor Priority-CeilingProtocol, 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, RealTime Protocols, Communication in Multicomputer System, An Overview of Real Time Operating Systems.	**10**
	Total	**48**

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Real Time Systems by Jane W. S. Liu, Pearson Education Publication	2000
2	H. Kopetz, Real time systems for distributed embedded applications, Kluwer Academic	2011
3	Douglass, Real Time UML: Advances in the UML for Real-Time Systems, Addison-Wesley	2013

Course code: Course Title	**Course Structure**			**Pre-Requisite**
CS407: 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	Learn various data pre-processing techniques.
CO2	Understand feature selection methodologies.
CO3	Apply different learning approaches in pattern recognition
CO4	Implement performance evaluation of models.

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.	**8**

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.	**8**
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.	**8**
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, Feedforward operations and classifications, network learning, training protocols,Back Propagation Learning, Bayes discriminants and neural networks.	**8**
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	**48**

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	R. O. Duda, P. Hart, D. Stork, Pattern Classification, Wiley	2000
2	Bishop, C. M., Pattern Recognition and Machine Learning. Springer	2007
3	Bishop, C. M., Neural Networks for Pattern Recognition, Oxford University	1995
4	Theodoridis, S. and Koutroumbas, K., Pattern Recognition	2008
5	Hastie, T., Tibshirani, R. and Friedman, J., The Elements of Statistical	2009

Course code: Course Title	**Course Structure**			**Pre-Requisite**
CS409: Reinforcement Learning	**L**	**T**	**P**	**Linear algebra, Theory of Probability, Calculus**
	3	**1**	**0**	

Course Objective: To develop a robust understanding of reinforcement learning principles with emphasis on real-world application.

S. No.	**Course Outcomes (CO)**
CO1	Explain Core Concepts of Reinforcement Learning
CO2	Implement and Analyze Reinforcement Learning Algorithms
CO3	Design Reinforcement Learning Solutions for Defined Scenarios
CO4	Assess Reinforcement Learning Systems Using Performance Metrics
CO5	Identify and Mitigate Ethical Risks in Reinforcement Learning Applications

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	**10**

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 Dynamic Programming: Policy Evaluation, Policy Improvement, Policy Iteration, Value Iteration, Asynchronous, Dynamic Programming, Generalized Policy Iteration	**10**
UNIT 3	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 N-step Bootstrapping, N-step TD prediction, N-step Sarsa, N-step Off-policy Learning	**8**
UNIT 4	RL in Continuous Space, Discrete vs Continuous space, Discretization, Functions Approximation, Linear Function Approximation- kernel, Non-Linear Function Approximation	**10**
UNIT 5	Value-Based Network, Deep Q networks, From RL to Deep RL, Deep Q Networks Architectures(DQN), Experience Replay, Fixed Q-Targets, Other Networks- Double DQN, Prioritized Experience Replay, Dueling DQN(Introduction)	**10**
	Total	**48**

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Reinforcement Learning by Richard S. Sulfton and Andrew G. Barto, MIT Press	2018
2	Reinforcement Learning: State-of-the-Art. By Wiering, M. and van Otterlo, M., Springer	2012
3	Algorithms for Reinforcement Learning by Morgan & Claypool	2010

Course code: Course Title	**Course Structure**			**Pre-Requisite**
CS411: Cyber Vulnerability and Ethical hacking	**L**	**T**	**P**	**Web Technology**
	3	**1**	**0**	

Course Objective: To provide comprehensive knowledge and practical skills in ethical hacking, including methodologies for system, web server, and wireless network penetration testing, and to understand the legal and technical aspects of cybersecurity.

S. No	**Course Outcomes (CO)**
CO1	Describe the fundamental concepts of ethical hacking, including terminology, types of hacking technologies, and phases of ethical hacking. [Remembering]
CO2	Explain various system hacking techniques, such as password hacking, rootkits, trojans, and denial of service attacks, and understand their impact on system security. [Understanding]
CO3	Apply techniques for hacking web servers, identifying web application vulnerabilities, and exploiting security weaknesses in wireless networks. [Applying]
CO4	Analyze penetration testing methodologies, cryptographic principles, and legal frameworks for ethical hacking and evaluate their effectiveness in maintaining security. [Analyzing]
CO5	Develop and implement penetration testing tools, understand firewall types, and address physical security factors and honeypots to enhance overall cybersecurity measures. [Creating]

S. No	**Contents**	**Contact Hours**

UNIT 1	Introduction to Ethical Hacking: Introduction to Ethical Hacking, Ethical Hacking Terminology, Types of Hacking Technologies, Phases of Ethical Hacking, Footprinting, Social Engineering, Scanning and Enumeration	**10**
UNIT 2	System Hacking : Understanding the Password Hacking Techniques, Rootkits, Trojans, Backdoors, Viruses and Worms, Sniffers, Denial of Service, Session Hijacking	**10**
UNIT 3	Web Server Hacking : Hacking Web Servers, Web Application Vulnerabilities, Buffer Overflow, Wireless Hacking, Physical Security	**8**
UNIT 4	Wireless Hacking : WEP, WPA Authentication Mechanism, Wireless Sniffers, Physical Security, Factors Affecting Physical Security, Honeypots, Firewall Types	**10**
UNIT 5	Penetration Testing : Cryptography overview of MD5, SHA, RC4, Penetration Testing Methodologies and Steps, Pen Test Legal Framework, Penetration Testing Tools	**10**
	Total	**48**

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Patrick Engebretson, The Basics of Hacking and Penetration Testing, Elsevier, 2013.	2013
2	Network Security and Ethical Hacking, Rajat Khare, Luniver Press, 2006.	2006
3	Hands-On Ethical Hacking and Network Defense – By Michael T. Simpson,	2010

Course code: Course Title	**Course Structure**			**Pre-Requisite**
CS413: Computer Vision	**L**	**T**	**P**	
	3	**1**	**0**	

Course Objective: To introduce fundamentals of computer vision so that students will understand to program a computer for understanding a scene or features in an image development.

S. No.	**Course Outcomes (CO)**
CO1	Describe the role of AI and image processing in computer vision and its applications.
CO2	Explain image formation, transformations, and sensor fundamentals, and perform calibration.
CO3	Extract features using various detectors and descriptors, and apply scale-space techniques.
CO4	Apply image representation and segmentation techniques for object detection.
CO5	Analyze patterns and motion with clustering, classification, and tracking algorithms.

S. No	**Contents**	**Contact Hours**
UNIT 1	Introduction to Computer Vision: Role of Artificial Intelligence and Image processing in Computer Vision, Industrial Machine Vision Applications, System Architecture, Stages of Computer Vision, State of the art.	**8**
UNIT 2	Visual Sensors: Camera sensors, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc.; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing, 2D/3D Geometric transformations, Homography, Feature descriptors- SIFT, Ransac, Camera Calibration: Interior and Exterior Calibration.	**8**

UNIT 3	Feature Extraction: Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.	**8**
UNIT 4	Image Representation: Adaptive basis- Principal Component Analysis (PCA) and Independent Component Analysis (ICA), Image Segmentation: Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFS, Texture Segmentation; Object detection.	**8**
UNIT 5	Pattern Analysis: Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non- parametric methods.	**8**
UNIT 6	Motion and Tracking: Detection and tracking of point features, Optical flow, Tracking-Lucas Kanade & Tomasi method (LK Tracker), Motion Analysis: Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation.	**8**
	Total	**48**

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson	2003
2	Milan Sonka, VaclavHlavac, Roger Boyle, "Image Processing, Analysis, and Machine Vision" Cengage Learning.	2008
3	Richard Hartley and Andrew Zisserman, Multiple View Geometry in	2004
4	Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-	2011
5	K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition,	1990

Course code: Course Title	**Course Structure**			**Pre-Requisite**
CS415: Data Visualisation	**L**	**T**	**P**	**NIL**
	3	**0**	**2**	

Course Objective: The objective of this course is to introduce the principles and techniques of data visualization. It covers effective methods for visual data representation, understanding the impact of visual perception on data interpretation, and applying various visualization techniques to analyze and evaluate data.

S. No	**Course Outcomes (CO)**
CO1	Identify and recognize visual perception and representation of data.
CO2	Illustrate about projections of different views of objects.
CO3	Apply various Interaction and visualization techniques.
CO4	Analyze various groups for visualization.
CO5	Evaluate visualizations

S. No	**Contents**	**Contact Hours**
UNIT 1	Introduction to Data Science and Data Visualization: Concepts, lifecycle, applications of Data Science; Role of Data Visualization in Analysis and Decision Making; Basics of R Programming including variables, data types, operators; Fundamentals of Data Visualization covering principles and types.	**8**

UNIT 2	Data Preprocessing and EDA with R: Data Collection and Sources such as structured, unstructured, and web scraping; Data Cleaning techniques like handling missing data and outliers; Data Transformation Techniques including normalization, standardization, encoding; Exploratory Data Analysis (EDA) covering univariate, bivariate, and multivariate analysis; Advanced EDA Plotting using ggplot2 for customized visualizations, faceting, and distributions.	**9**
UNIT 3	Advanced Data Analysis and Visualization with R: Statistical Analysis including descriptive stats and hypothesis testing; Data Visualization Libraries in R, specifically ggplot2; Machine Learning Concepts introducing ML and basic models in R; R Shiny for building interactive web applications.	**8**
UNIT 4	Power BI for Data Visualization and Dashboard Creation: Introduction to Power BI including interface and data connection; Creating Basic Visualizations such as bar charts, line charts, and scatter plots; Building Interactive Dashboards focusing on design principles and combining visualizations; Effective Data Storytelling using Power BI.	**9**
UNIT 5	Advanced Data Visualization and Integration: Advanced Visualization Techniques in R; Integrating R with Power BI using R scripts and calculations; Data Visualization Ethics and Best Practices; Project applying skills using R and Power BI, including a Capstone project.	**8**
	Total	**42**

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Ward, Grinstein, Keim, Interactive Data Visualization: Foundations, Techniques, and Applications. Natick, 2nd edition,A K Peters, Ltd 2015.	2015
2	Tamara Munzner,Visualization Analysis & Design ,1st edition,AK Peters Visualization Series 2014	2014
3	Scott Murray,Interactive Data Visualization for the Web ,2nd Edition, 2017	2017
4	Wickham, H., Çetinkaya-Rundel, M., & Grolemund, G. (2023). R for data science. " O'Reilly Media, Inc.".	2023

Course code: Course Title	**Course Structure**			**Pre-Requisite**
CS417: Wireless and Mobile Computing	**L**	**T**	**P**	
	3	**1**	**0**	

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

S. No.	**Course Outcomes (CO)**
CO1	Explain GSM, cellular systems, and digital cellular standards.
CO2	Understand wireless networking, IEEE 802.11, Bluetooth, and mobile IP.
CO3	Analyze data management, replication, and clustering in mobile networks.
CO4	Explore mobile agents, security techniques, and transaction processing.
CO5	Discuss ad hoc network routing protocols, localization, and quality of service.

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.	**6**

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	**10**
UNIT 3	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.	**8**
UNIT 4	Mobile Agents computing: Introduction, Advantages, Application Domains; security and fault tolerance: Protecting server, code signalling, 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.	**10**
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	**10**
UNIT 6	Temporary ordered routing algorithm (TORA), Quality of Service in Ad Hoc Networks, and applications.	**4**
	Total	**48**

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Jochen Schiller, “Mobile Communications”, Addison-Wesley	2004
2	Dharma Prakash Agarwal & Zeng, “Introduction to Wireless and Mobile Systems”, Cengage Learning India Private Limited.	2006
3	Raj Pandya, “Mobile and Personal Communication systems and services”, Prentice Hall of India.	2001
4	A.K.Talukder and R.R.Yavagal, Mobile Computing, TMH.	2006
5	Raj Kamal, “Mobile Computing”, Oxford University Press.	2007

Course code: Course Title	**Course Structure**			**Pre-Requisite**
CS-419: Business Analytics	**L**	**T**	**P**	**NIL**
	3	**1**	**0**	

Course Objective: To provide an understanding of Business Intelligence (BI) principles, techniques, and models that enable effective and timely decision-making. The course explores the development and application of BI systems, ethical considerations, and emerging trends, including machine learning and advanced visualization.

S. No	**Course Outcomes (CO)**
CO1	Identify and explain the components of Business Intelligence systems and architectures.
CO2	Develop and implement Business Intelligence solutions for decision-making processes.
CO3	Apply various models for pattern matching, cluster analysis, and outlier analysis.
CO4	Analyze the use of Business Intelligence in marketing, logistics, and production through case studies.
CO4	Evaluate emerging BI trends, such as machine learning and predictive analytics.

S. No	Contents	Contact Hours
UNIT 1	Introduction to Business Intelligence: Business Intelligence: Effective and timely decisions, data, information, and knowledge, Role of mathematical models in decision-making, Overview of Business Intelligence architectures and the cycle of Business Intelligence analysis, Enabling factors in Business Intelligence projects, Development and ethics in Business Intelligence systems.	10
UNIT 2	Knowledge Delivery and Visualization: Types of Business Intelligence users, Standard reports, interactive analysis, ad hoc querying, and parameterized reports, Self-service reporting and dimensional analysis, Alerts and notifications, Visualization techniques: Charts, graphs, widgets, scorecards, dashboards, geographic visualization, Integrated analytics and optimizing presentation for the right message.	8
UNIT 3	Efficiency in Business Intelligence: Efficiency measures and the CCR (Charnes, Cooper, Rhodes) model, Definition of target objectives and peer groups, Identification of good operating practices, Cross-efficiency analysis, Virtual inputs and outputs, Other efficiency models, Pattern matching, Cluster analysis, Outlier analysis in BI.	10
UNIT 4	Business Intelligence Applications: Marketing models: McKinsey 7S, the 7Ps of the marketing mix, AIDA, Ansoff Matrix, BCG Matrix, Diffusion of Innovation, DRIP model, Porter's Five Forces, Logistic and production models, Case studies demonstrating the use of BI in various domains.	10
UNIT 5	Future of Business Intelligence: Future trends in Business Intelligence and emerging technologies, Role of machine learning in BI, Predictive analytics, BI search and text analytics, Advanced visualization techniques, Rich reporting and the future of Business Intelligence beyond technology.	10
	Total	**48**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Efraim Turban, Ramesh Sharda, Dursun Delen, "Decision Support And Business Intelligence Systems", 9th Edition, Pearson 2013.	2013
2	Carlo Vercellis, "Business Intelligence: Data Mining And Optimization For Decision Making", Wiley Publications, 2009.	2009
3	Cindi Howson, "Successful Business Intelligence: Secrets To Making BI A Killer App", McGraw-Hill, 2007.	2007
4	Larissa T. Moss, S. Atre, "Business Intelligence Roadmap: The Complete Project Lifecycle Of Decision Making", Addison Wesley, 2003	2003
4	Ralph Kimball , Margy Ross , Warren Thornthwaite, Joy Mundy, Bob Becker, "The Data Warehouse Lifecycle Toolkit", Wiley Publication Inc.,2007.	2007

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
CS421: Advance Web Technology	3	0	2	

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	This course describe the World Wide Web as a platform for interactive applications, content publishing and social services. Demonstrate competency using FTP to transfer web pages to a server.

CO2	Construct dynamic websites with good aesthetic sense of designing and latest technical skills. Understand the user as well as client point of view of the system.
CO3	List a Good grounding of Web Application Terminologies, Internet Tools, E – Commerce and other web services.
CO4	Identify fundamental skills to maintain web server services required to host a website.
CO5	Describe markup languages for processing, identifying, and presenting of information in web pages using markup languages such as: HTML, XHTML and XML language.
CO6	Design websites using appropriate security principles, focusing specifically on the vulnerabilities inherent in common web implementations.

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, 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.cClient-side technology: HTML (HTML5). 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	Internet and Web Technologies by Raj Kamal, Tata McGraw Hill.	2002
2	An Introduction to Search Engines and Web Navigation, Mark Levene, Pearson Education.	2010
3	Modeling the Internet and the Web,PierreBaldi,PaoloFrasconi, Padhraic Smyth, John Wiley and Sons Ltd.	2003
4	HTML: A Beginner's Guide by Wendy Willard, Tata McGraw-Hill	2009
5	PHP and MySQL for Dynamic Web Sites, Ullman, Larry, Peachpit Press.	2012

Course code: Course Title	Course Structure			Pre-Requisite
CS423: Big Data Analytics	L	T	P	Mathematics, aptitude.
	3	0	2	

Course Objective: Be Exposed With the Basic Rudiments of Business Intelligence System. Understand The Modeling Aspects Behind Business Intelligence. Understand Of the Business Intelligence Life Cycle and the Techniques Used In It.

S. No.	Course Outcomes (CO)
CO1	Understand big data characteristics, storage, and high-performance architectures like HDFS and MapReduce.
CO2	Apply clustering (K-means) and classification methods (decision trees, Naïve Bayes) and evaluate their effectiveness.
CO3	Implement association rules and recommendation systems using algorithms like Apriori and various recommendation approaches.
CO4	Analyze stream data, real-time analytics, and apply graph analytics.
CO5	Utilize NoSQL databases and visualization tools for big data management and analysis.

S. No	Contents	Contact Hours
UNIT 1	Introduction to Big Data: Evolution of Big data, Best Practices for Big data Analytics – Big data characteristics, Validating, The Promotion of the Value of Big Data, Big Data Use Cases- Characteristics of Big Data Applications, Perception and Quantification of Value, Understanding Big Data Storage, A General Overview of High-Performance Architecture, HDFS – MapReduce and YARN, Map Reduce Programming Model.	8
UNIT 2	Clustering and Classification: Advanced Analytical Theory and Methods: Overview of Clustering ,K-means, Use Cases – Overview of the Method, Determining the Number of Clusters, Diagnostics, Reasons to Choose and Cautions, Classification: Decision Trees Overview of a Decision Tree, The General Algorithm, Decision Tree Algorithms Evaluating a Decision Tree, Decision Trees in R, Naïve Bayes, Bayes‘ Theorem, Naïve Bayes Classifier.	6
UNIT 3	Association and Recommendation System: Advanced Analytical Theory and Methods-Association Rules, Overview – Apriori Algorithm, Evaluation of Candidate Rules, Applications of Association Rules, Finding Association& finding similarity, Recommendation System: Collaborative Recommendation-Content Based Recommendation, Knowledge Based Recommendation, Hybrid Recommendation Approaches.	8
UNIT 4	Classification :Classification: Decision Trees, Overview of a Decision Tree, The General Algorithm, Decision Tree Algorithms, Evaluating a Decision Tree, Decision Trees in R, Naïve Bayes, Bayes' Theorem, Naïve Bayes Classifier.	6
UNIT 5	Stream Memory: 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. Using Graph Analytics for Big Data: Graph Analytics.	8
UNIT 6	NoSQL Data Management For Big Data And Visualization: NoSQL Databases: Schema-less Models: Increasing Flexibility for Data Manipulation-Key Value Stores- Document Stores, Tabular Stores, Object Data Stores, Graph Databases Hive, Sharding, Hbase, Analyzing big data with twitter, Big data for E-Commerce Big data for blogs, Review of Basic Data Analytic Methods using R.	6
	Total	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Chris Eaton, Dirk deroos et al., “Understanding Big data ”, McGraw Hill, 2012.	2012
2	Anand Rajaraman and Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 2012.	2012
3	Boris lublinsky, Kevin t. Smith, Alexey Yakubovich, “Professional Hadoop Solutions”, Wiley, 2015.	2015
4	Tom White, “HADOOP: The definitive Guide” , O Reilly 2012	2012

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
CS425: Cloud Computing	3	1	0	Nil

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	Understand cloud computing evolution, characteristics, and its comparison with grid and cluster computing.
CO2	Describe cloud architecture, service models (IaaS, PaaS, SaaS), and deployment models.
CO3	Explain IaaS, virtualization, and resource provisioning, including managing virtual machines and storage.
CO4	Identify PaaS components and examples like Google App Engine and Microsoft Azure.
CO5	Analyze cloud service management, SLAs, scaling economics, and data management.
CO6	Evaluate cloud security issues, including network, host, and data security, and identity management.

S. No	Contents	Contact Hours
UNIT 1	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)	8
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).	8
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, Managing Data, Looking at Data, Scalability & Cloud Services, Database & Data Stores in Cloud, Large Scale Data Processing	**8**
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	**8**
	Total	**48**

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Cloud Computing Bible, Barrie Sosinsky, Wiley-India	2010
2	Cloud Computing: Principles and Paradigms, Editors: Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Wile	2011
3	Cloud Computing: Principles, Systems and Applications, Editors: Nikos Antonopoulos, Lee Gillam, Springer	2012
4	Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines, Wiley-India	2010

Course code: Course Title	**Course Structure**			**Pre-Requisite**
CS427: Natural Language Processing	**L**	**T**	**P**	
	3	**0**	**2**	

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	Understand NLP basics and language analysis.
CO2	Describe parsing techniques and feature-based parsing.
CO3	Resolve ambiguity using statistical methods and probabilistic processing.
CO4	Apply advanced parsing techniques like feature unification and probabilistic parsing.
CO5	Implement NLP applications including machine translation and speech recognition.

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	2003
2	Foundation of Statistical Natural Language Processing, Manning and Schutze	1998
3	D. Jurafsky, J. H. Martin, Speech and Language Processing, Pearson	2008
4	Bharati, Chaitanya and Sangal: Natural Language Processing- a Paninian	1995

Course code: Course Title	**Course Structure**			**Pre-Requisite**
CS404: High Performance	**L**	**T**	**P**	**Computer Architecture**
	3	**1**	**0**	

Course Objective: To introduce the concept of advanced computer architectures with Parallel algorithms and Parallel programming with high end computer systems and methods for achieving high performance.

S. No.	**Course Outcomes (CO)**
CO1	Explain key characteristics of advanced computing architectures and their impact on performance.
CO2	Analyze computational complexity and performance using case studies from engineering applications.
CO3	Identify and compare memory hierarchies and processor models in HPC systems.
CO4	Implement and optimize parallel algorithms for both regular and irregular problems.
CO5	Apply parallel programming techniques and performance optimization methods to improve application efficiency.

S. No	**Contents**	**Contact Hours**
UNIT 1	Introduction to advanced computer architectures, parallel algorithms, parallel languages, and performance oriented computing, discussing about the key characteristics of highend computing architectures .	**6**
UNIT 2	Introduction to Computational Science and Engineering Applications, their characteristics and requirements, Review of Computational Complexity, Performance: metrics and measurements, Granularity and Partitioning, temporal/spatial/stream/kernel, Basic methods for parallel programming, Real-world case studies which are drawn from multiscale, multidiscipline applications .	**8**

UNIT 3	Memory Hierarchies, Multi core Processors, Homogeneous and Heterogeneous, Sharedmemory Symmetric Multiprocessors, Vector Computers, Distributed Memory Computers, Super computers and Petascale Systems, Application Accelerators / Reconfigurable Computing, Novel computers: Stream, multithreaded, and purposebuilt.	**8**
UNIT 4	Discussion about Parallel algorithms with Parallel models including ideal and real frameworks, Basic Techniques including Balanced Trees, Pointer Jumping, Divide and Conquer, Partitioning, Regular Algorithms: Matrix operations and Linear Algebra,Irregular Algorithms: Lists, Trees, Graphs, Randomization: Parallel PseudoRandom Number Generators, Sorting, Monte Carlo techniques.	**8**
UNIT 5	Parallel Programming involving Revealing concurrency in applications ,Task and Functional parallelism, Task Scheduling, Synchronization Methods, Parallel Primitives (collective operations), SPMD Programming (threads, OpenMP, MPI), I/O and File Systems, Parallel Matlabs (Parallel Matlab, StarP, Matlab MPI) Partitioning Global Address Space (PGAS) languages (UPC, Titanium, Global Arrays).	**10**
UNIT 6	Discussion about high performance methods with Achieving Measuring performance, Identifying performance bottlenecks, Restructuring applications for deep memory hierarchies, Partitioning applications for heterogeneous resources, Using existing libraries, tools, and frameworks	**8**
	Total	**48**

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Introduction to Parallel Computing, Ananth Grama, Anshul Gupta, George Karypis, and Vipin Kumar, AddisonWelsey	2003
2	Petascale Computing: Algorithms and Applications, David A. Bader (Ed.), Chapman & Hall/CRC Computational Science Series	2007
3	Grama, A. Gupta, G. Karypis, V. Kumar, An Introduction to Parallel Computing, Design and Analysis of Algorithms, AddisonWesley	2003
4	G.E. Karniadakis, R.M. Kirby II, Parallel Scientific Computing in C++ and MPI: A Seamless Approach to Parallel Algorithms and their Implementation, Cambridge University Press	2003

Course code: Course Title	**Course Structure**			**Pre-Requisite**
CS406: Grid and Cluster Computing	**L**	**T**	**P**	**Operating Systems**
	3	**1**	**0**	

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	Describe the fundamental concepts, hardware technologies, and software architectures used in cluster computing.
CO2	Implement and analyze standard MPI variants, derived data types, and communicators for parallel programming.
CO3	Demonstrate skills in resource management, distributed task scheduling, and system administration using tools like Condor, Maui, and PBS.
CO4	Set up and deploy grid computing environments, apply programming models, and ensure grid security.
CO5	Use performance evaluation tools and apply data management techniques to case studies such as molecular modeling and brain activity analysis.

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).	8
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.	10
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.	6
	Total	**48**

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Grid and Cluster Computing by C.S.R. Prabhu, PHI	2008
2	Introduction to grid computing - Bart Jacob, Michael Brown	2005
3	B. Wilkinson, Grid Computing: Techniques and Applications, CRC Press	2009
4	R. Buyya, High Performance Cluster Computing: Architectures and Systems	2008
5	D. Janakiram, Grid Computing, Tata McGraw-Hill	2005

Course code: Course Title	Course Structure			Pre-Requisite
CS408: Swarm and Evolutionary Computing	L	T	P	Discrete Mathematics, Artificial Intelligence
	3	1	0	

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	Describe components, strategies, and fitness functions in evolutionary computing.
CO2	Implement and analyze the Particle Swarm Optimization algorithm and its update mechanisms.
CO3	Develop and apply genetic algorithms, including chromosome generation, fitness evaluation, and evolutionary operations.
CO4	Analyze and implement hybrid approaches combining Particle Swarm and Genetic Algorithms for multi-objective optimization.
CO5	Utilize nature-inspired algorithms like Cuckoo Search and Ant Colony Optimization for real-world optimization challenges.

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: Population and generation of chromosomes, Fitness function, survival of the fittest, reproduction, cross-over and mutation, Genetic algorithm convergence, Genetic programming	**10**
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	**8**
UNIT 5	Recent nature-inspired evolutionary algorithms: Cockoo search algorithm, Artificial Bee Colony Optimization, Ant Colony Optimization, Fire-fly algorithm, Bacterial Foraging, Application to the travelling salesman problem	**8**
UNIT 6	Application to real world optimization problems	**6**
	Total	**48**

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Computational Intelligence, Andries P. Engelbrech, John Wiley & Sons	2008
2	An Introduction to Genetic Algorithm, Melanie Mitchell, MIT Press	1996
3	Genetic Algorithms in Search, Optimization, and Machine Learning, David Goldberg	1989
4	Introduction to Evolutionary Computing", A.E Eiben and J.E. Smith, Springer	2007
5	Evolutionary Computation, A "Unified Approach, K. DeJong. MIT Press	2006

Course code: Course Title	**Course Structure**			**Pre-Requisite**
CS410: Digital Image Processing	**L**	**T**	**P**	**Nil**
	3	**0**	**2**	

Course Objective: To introduce to the concepts of digital image processing. The students will learn image transforms, image enhancement, restoration, morphological operations, edge detection,and segmentation algorithms.

S. No.	**Course Outcomes (CO)**
CO1	Describe digital image representation and basic processing concepts.
CO2	Apply gray level transforms, histogram techniques, and spatial filtering.
CO3	Implement Fourier Transform and frequency domain filtering for enhancement.
CO4	Apply noise removal algorithms and perform color model conversions.
CO5	Execute dilation, erosion, and image segmentation techniques.

S. No	**Contents**	**Contact Hours**
UNIT 1	Introduction And Digital Image Fundamentals: Digital Image Representation, Fundamental Steps in Image Processing, Elements of Digital image processing systems, Sampling and quantization, some basic relationships like neighbours, connectivity, Distance measure between pixels, Imaging Geometry.	**6**
UNIT 2	Image Enhancement (Spatial Domain): Gray level transforms, histogram equalization, histogram specification, basics of the spatial filtering, smoothing operators, image gradients, sharpening operators Fuzzy logic: basic definitions, fuzzy operations, fuzzy inference, application of fuzzy logic in image processing.	**7**
UNIT 3	Image Enhancement (Frequency domain): Two-Dimensional Fourier transform and its properties, basics of frequency domain filtering, smoothing and sharpening in frequency domain.	**7**

UNIT 4	Image Restoration: modelling of image degradations, noise models, noise removal algorithms for impulse and Gaussian noise, Adaptive filtering, estimation of degradation function, inverse filtering. Color Image Processing: Color models, conversion between different models, color transforms, color smoothing and sharpening	**8**
UNIT 5	Morphological Image Processing: Dilation, Erosion, opening and closing, hit and miss transform, boundary extraction, region filling, thinning, thickening, skeletons, pruning, Gray scale image dilation and erosion.	**6**
UNIT 6	Discontinuity Detection: point, line and edge detection, Sobel, Canny, and LoG edge detectors, edge linking. Image Segmentation: Thresholding, optimal and global thresholding, multiple thresholding, region growing, region splitting and merging, dam construction watershed segmentation algorithm, spatial techniques, frequency domain techniques	**8**
	Total	**42**

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, Pearson	2008
2	Anil K. Jain, Fundamentals of Digital Image Processing, Pearson	2002
3	William K. Pratt, Digital Image Processing, John Wiley	2002
4	Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, Digital Image Processing using MATLAB	2004

Course code: Course Title	**Course Structure**			**Pre-Requisite**
CS412: Intellectual Property Rights	**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 the fundamental principles of Intellectual Property Rights (IPR) and their pivotal role in fostering innovation and research.
CO2	Analyze patent, design, copyright and trademark laws, encompassing filing procedures, prosecution steps, and infringement actions, with reference to relevant case laws.
CO3	To apply the concepts of patentability, including conditions and subject matter, to hypothetical scenarios.
CO4	Examine case laws such as Alice Corp. v. CLS Bank and understand their impact on patent law and practices.
CO5	To conduct Prior-art, validity/invalidity, state-of-the-art, freedom to operate, and landscape analysis searches.

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.	**6**
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,	**8**
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.	**8**
UNIT 5	Industrial design: The design act-2000, registerability of a design, procedure of registration of a design, piracy of a registered design, Case law on designs.	**8**
UNIT 6	International IPR & case laws: World intellectual property organization, WCT, WPPT, TRIPS, Copyright societies, international IPR dispute resolution mechanism. Case laws.	**10**
	Total	**48**

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Law Relating to Intellectual property, B.L.Wadehra	2007
2	Intellectual property: Patents, copyright ,trademarks and allied rights, W.R. Cornish. Sweet & Maxwell publisher	2003
3	Law and practice of intellectual property in India by Vikas Vashishth	2006
4	Patents ,copyrights, trade marks and design by B L Wadhera	2014
5	Dr. B. L. Wadhera, “Intellectual Property Law Handbook”. Universal Law Publishing	2002

Course code: Course Title	**Course Structure**			**Pre-Requisite**
CS414: 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	Describe TCP/IP, cyber attacks, cyber security, and types of cyber forensics.
CO2	Use tools and techniques for live data collection, registry analysis, and file auditing in Windows.
CO3	Apply tools and methods for data collection, log analysis, and process management in Unix/Linux systems.
CO4	Recover deleted files, analyze network traffic, and use forensic and ethical hacking tools.
CO5	Create detailed reports on forensic investigations, including evidence recovery and analysis using various tools.

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)	**12**

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	**12**
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	**12**
	Total	**48**

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	"Incident Response & Computer Forensics", Mandia, k., Prosise, c., Pepe, m., TMH.	2003
2	"Guide to Computer Forensics and Investigations", Bill Nelson, Amelia Phillips, Frank Enfinger, and Chris Steuart , Thomson Learning.	2009
3	"Digital Evidence and Computer Crime", Eoghan Casey, Academic Press	2011
4	"File System Forensic Analysis", Brian Carrier , addition Wesley	2005
5	"Windows Forensic Analysis DVD Toolkit", Harlan Carvey, Syngress	2009
6	"EnCE: The Official EnCase Certified Examiner Study Guide", Steve Bunting, Sybex Publication	2012

Course code: Course Title	**Course Structure**			**Pre-Requisite**
CS416: Semantice 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	Describe the evolution of web documents and semantic search techniques.
CO2	Apply XML languages in web-based development.
CO3	Analyze semantic applications, latest developments, and future directions in the Semantic Web.
CO4	Evaluate case studies involving semantic web applications and W3C consortium standards.

S. No	**Contents**	**Contact Hours**
UNIT 1	Introduction: The Semantic Web Roadmap, evolution of Web Documents, Semantic Search Techniques.	**12**
UNIT 2	XML Languages: Detailed study of XML language & application to Web based developments.	**12**

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.	**12**
	Total	**48**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	"A Semantic Web Primer", Grigoris Antoniou and Frank van Harmelen, MIT	2012
2	"Spinning the Semantic Web - Bringing the World Wide Web to Its Full	2005
3	"The Semantic Web: A guide to the future of XML, Web Services and	2003
4	"Principles of Semantic Networks: Explorations in the representation of	1991
5	Russell and Norvig, "Artificial Intelligence: A Modern Approach", Prentice	2020
6	Han Reichgelt, "Knowledge Representation: An AI Perspective", Ablex	1991