National Institute of Technology Srinagar

Hazratbal, Srinagar, Kashmir, 190006 India

COURSES & SYLLABI
(Batch 2023 onwards)

Department of Computer Science and Engineering

Department of Computer Science & Engineering

The Department of Computer Science & Engineering started functioning from 2007. It offers four year B.Tech degree course in Computer Science & Engineering. The initial intake in 2007 was 40 and has now increased to 90.

The degree is awarded after completion of a minimum of 160 credits. Common courses for 42 credits are offered to students of all branches in a common first year spread over 2 semesters. Courses for the remaining credits are offered to students during a span of three years spread over 6 semesters. Students need to complete 180 credits (Including Honors Electives) to get B.TECH Honors in Computer Science and Engineering,

The scheme of courses has been designed as per the required credit breakup (see page no. 11), such that at least 50% of the courses are offered by Department of Computer Science & Engineering. The remaining 50% courses are interdisciplinary and are offered by Departments of Information Technology, Department of Electronics & Communication Engineering, Electrical Engineering, Physics, Chemistry Mathematics and Humanities Departments.

Other main features of the scheme are:-

1. Courses offered are 1 credit , 2 credits, and or 3 credits
2. One hour lecture/tutorial has been assigned 1 credit weightage.
3. Two hour laboratory per week has also been assigned 1 credit weightage.
4. A continuous evaluation scheme is used to evaluate the students for each course. The evaluation is as under:

Midterm	26marks
Assignment	8 marks
Quiz	8 marks
Attendance	8 marks
Major Exam	50 marks

5. Grades are allotted to the students as per the following scheme:

Marks	Grades	Points
0 to 39	F	4
40 to 50	C	5
51 to 60	C^+	6
61 to 70	B	7
71 to 80	B^+	8
81 to 90	A	9
91 to 100	A^+	10

6. At the end of each semester a cumulative grade point average (CGPA) is calculatedfor the courses taken by a student.

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PROPOSED SCHEME OF COURSES FOR FIRST SEMESTER

S. No	Course Code	Course Title	Department Offering	Credit	Contact Hours			
					L	T	P	Total
B11	HST101	Basic English and Communication Skills	Humanities	3	2	1	0	3
B12	MAT101	Mathematics I	Mathematics	3	2	1	0	3
B13	MET101	Elements of Mechanical Engineering	Mechanical	3	2	1	0	3
B14	PHT101	Engineering Physics	Physics	3	2	1	0	3
B15	CHT102	Environmental Studies	Chemistry	3	2	1	0	3
B16	CVT102	Engineering Mechanics	Civil	3	2	1	0	3
B17	HSL101	English Language Laboratory	Humanities	1	0	0	2	2
B18	PHL101	Engineering & Applied Physics Laboratory	Physics	1	0	0	2	2
B19	WSL101	Workshop Practice	Workshop	2	0	0	4	4
		Total		**22**	**12**	**6**	**8**	**26**

PROPOSED SCHEME OF COURSES FOR 2ND SEMESTER

S. No	Course Code	Course Title	Department Offering	Credit	Contact Hours			
					L	T	P	Total
B21	HST102	Advanced English and Comm. Skills	Humanities	3	2	1	0	3
B22	MAT102	Mathematics II	Mathematics	3	2	1	0	3
AB23	EET101	Basic Electrical Engineering	Electrical	3	2	1	0	3
B24	ITT101	Computer Programming	Information Technology	3	2	1	0	3
B25	CHT101	Engineering Chemistry	Chemistry	3	2	1	0	3
B26	CVT102	Engineering Drawing	Civil	3	1	0	4	5
B27	CHL101	Chemistry Laboratory	Chemistry	1	0	0	2	2
B28	ITL101	Computer Programming Laboratory	Information Technology	1	0	0	2	2
A10	**NBA101**	**Fundamental Knowledge of Accreditation****	**NBA Instt. Cell**	**0**	**2**	**0**	**0**	**2**
		Total		**20**	**13**	**5**	**8**	**26**

**** Compulsory Audit Course**

PROPOSED SCHEME OF COURSES FOR 3RD SEMESTER

S. No.	Course Code	Course Title	Department Offering	Credit	Contact Hours			
					L	T	P	Total
1	CST201	Object Oriented Programming	CSE	3	2	1	0	3
2	CSL202	Object Oriented Programming -Lab	CSE	1	0	0	2	2
4	CST203	Database Management Systems	CSE	3	2	1	0	3
5	CSL204	Database Management Systems - Lab	CSE	1	0	0	2	2
6	CST205	Software Engineering	CSE	3	2	1	0	3
7	ECT205	Electronic Devices and Circuits	ECE	3	2	1	0	3
8	ECL206	Electronic Devices and Circuits Lab	ECE	1	0	0	2	2
9	MAT207	Discrete Mathematics	Mathematics	3	2	1	0	3
10	HST006	Entrepreneurship Development	Humanities	3	3	0	0	3
		Total		**21**				**24**

PROPOSED SCHEME OF COURSES FOR 4TH SEMESTER

S. No.	Course Code	Course Title	Department Offering	Credit	Contact Hours			
					L	T	P	Total
1	CST250	Data Structures	CSE	3	2	1	0	3
2	CSL251	Data Structures – Lab	CSE	1	0	0	2	2
3	CST252	Internet & Web Technologies	CSE	3	1	1	2	4
4	CST253	Theory of Computation	CSE	3	3	0	0	3
5	ECT251	Digital Electronics & Logic Design	ECE	3	2	1	0	3
6	ECL255	Digital Electronics & Logic Design – Lab	ECE	1	0	0	2	2
7	MAT217	Probability & Statistics	Mathematics	3	3	0	0	3
8	HST058	Project Management	Humanities	3	2	1	0	3
		Total		**20**				**23**

PROPOSED SCHEME OF COURSES FOR 5TH SEMESTER

S. No.	Course Code	Course Title	Department Offering	Credit	Contact Hours			
					L	T	P	Total
1	CST306	Design & Analysis of Algorithms	CSE	3	2	1	0	3
2	CST307	Microprocessor	CSE	3	3	0	0	3
3	CSL308	Microprocessor - Lab	CSE	1	0	0	2	2
4	CST309	Operating Systems	CSE	3	2	1	0	3
5	CST310	Python Programming	CSE	3	2	1	0	3
6	CSL311	Python Programming - Lab	CSE	1	0	0	2	2
7	CST312	Compiler Design	CSE	3	2	1	0	3
9	ECT307	Communication Systems	ECE	3	2	1	0	3
10	ECL308	Communication Systems Lab	ECE	1	0	0	2	2
		Total		**21**				**24**
10	-	Honors Elective I	-	3	3	0	0	3

PROPOSED SCHEME OF COURSES FOR 6TH SEMESTER

S. No.	Course Code	Course Title	Department Offering	Credit	Contact Hours			
					L	T	P	Total
1	CST354	Artificial Intelligence	CSE	3	2	1	0	3
2	CSL355	Artificial Intelligence - Lab	CSE	1	0	0	2	2
3	CST356	Computer Networks	CSE	3	2	1	0	3
4	CSL357	Computer Networks - Lab	CSE	1	0	0	2	2
5	CST358	Computer Organization & Architecture	CSE	3	3	0	0	3
6	CST359	Java Programming	CSE	3	3	0	0	3
7	CSL360	Java Programming Lab	CSE	1	0	0	2	2
8	-	Open Elective-I	-	3	3	0	0	3
9	CSI361	Industrial Training or internship	CSE	1	0	0	0	0
10	CST0XX	Elective-I	CSE	3	3	0	0	3
		Total		**22**				**24**
11	-	Honors Elective II	-	3	3	0	0	3

PROPOSED SCHEME OF COURSES FOR 7TH SEMESTER

S. No.	Course Code	Course Title	Department Offering	Credit	Contact Hours			
					L	T	P	Total
1	CST414	Network Security	CSE	3	2	1	0	3
2	CSL415	Network Security - Lab	CSE	1	0	0	2	2
3	CSP416	Pre-Project	CSE	2	0	0	4	4
4	CSS417	Seminar	CSE	1	0	0	2	2
5	-	Open Elective-II	-	3	3	0	0	3
6	CST0XX	Elective-II	CSE	3	3	0	0	3
7	CST0XX	Elective-III	CSE	3	2	1	0	3
8	CST0XX	Elective-IV	CSE	3	2	1	0	3
		Total		**19**				**25**
9	-	Honors Elective III	-	3	3	0	0	3
9	-	Honors Elective IV	-	3	3	0	0	3

PROPOSED SCHEME OF COURSES FOR 8TH SEMESTER

S. No.	Course Code	Course Title	Department Offering	Credit	Contact Hours			
					L	T	P	Total
1	CST0XX	Elective V*	CSE	3	3	0	0	3
2	CST0XX	Elective VI*	CSE	3	3	0	0	3
3	CST0XX	Elective VII*	CSE	3	3	0	0	3
4	CSP464	Project	CSE	6	0	0	6	6
		Total		**15**				**15**
5	-	Honors Elective V*	-	3	3	0	0	3
9	-	Honors Elective VI*	-	3	3	0	0	3
7	-	Honors Comprehensive Viva*	-	2	2	0	0	2

*Electives can be taken as swayam/self-study/ online/ hybrid courses from the list of Electives, anytime during the final year.

COURSES OFFERED TO OTHER DEPARTMENTS AS OPEN ELECTIVES

S. No.	Course Code	Course Title	Credit	Contact Hours			
				L	T	P	Total
1.	CST203	Database Management Systems	3	2	1	0	3
2.	CST250	Data Structures	3	2	1	0	3
3.	CST306	Design & Analysis of Algorithms	3	2	1	0	3
4.	CST414	Network Security	3	2	1	0	3
5.	CST051	Machine Learning	3	2	1	0	3

LIST OF ELECTIVES

S.No.	Subject	Code	L-T-P-Credits
1.	Simulation & Modeling	CST001	3-0-0-3
2.	Graph Theory	CST002	3-0-0-3
3.	Digital Signal Processing	CST003	3-0-0-3
4.	Multimedia Technology	CST004	3-0-0-3
5.	Logic Programming	CST005	3-0-0-3
6.	Embedded Systems	CST006	3-0-0-3
7.	Advanced Java & Android Programming	CST007	3-0-0-3
8.	System on Chip (SoC)	CST008	3-0-0-3
9.	Advanced Internet Technologies	CST009	3-0-0-3
10.	Wireless Communication	CST010	3-0-0-3
11.	Fault Tolerant Computing	CST011	3-0-0-3
12.	Image Processing	CST012	3-0-0-3
13.	System Design using HDL	CST013	3-0-0-3
14.	Real Time Systems	CST014	3-0-0-3
15.	Unix & Shell Programming	CST015	3-0-0-3
16.	High Speed Networks	CST016	3-0-0-3
17.	Advanced Algorithms	CST017	3-0-0-3
18.	Reconfigurable Computing	CST018	3-0-0-3
19.	Computer Vision	CST019	3-0-0-3
20.	Advanced Computer Networks	CST020	3-0-0-3
21.	Advanced Computer Graphics	CST021	3-0-0-3
22.	Advanced DBMS	CST022	3-0-0-3
23.	Advanced Computer Architecture	CST023	3-0-0-3
24.	Advanced Compilation Techniques	CST024	3-0-0-3
25.	Principles of Cryptography	CST025	3-0-0-3
26.	Neural Networks	CST026	3-0-0-3
27.	Pervasive Computing	CST027	3-0-0-3
28.	Distributed and Parallel Computing	CST028	3-0-0-3
29.	Cloud Computing	CST029	3-0-0-3
30.	Software Project Management	CST030	3-0-0-3
31.	Big Data	CST031	3-0-0-3
32.	Cyber laws and Forensics	CST032	3-0-0-3
33.	Expert Systems	CST033	3-0-0-3
34.	Mobile Computing	CST034	3-0-0-3
35.	Green Computing	CST035	3-0-0-3
36.	Introduction to Robotics	CST036	3-0-0-3
37.	Data Analytics	CST037	3-0-0-3
38.	Computational Biology	CST038	3-0-0-3
39.	Special topics in Computer Science	CST039	3-0-0-3
40.	System & Network Administration	CST040	3-0-0-3

41.	Pattern Recognition	CST041	3-0-0-3
42.	Natural Language Processing	CST042	3-0-0-3
43.	Quantum Computing	CST043	3-0-0-3
44.	Deep Learning	CST044	3-0-0-3
45.	Introduction to Data Science	CST045	3-0-0-3
46.	Internet of Things	CST046	3-0-0-3
47.	Advanced Cryptography	CST047	3-0-0-3
48.	Data Mining	CST048	3-0-0-3
49.	Advanced Graph Algorithms	CST049	3-0-0-3
50.	Advanced Java	CST050	3-0-0-3
51.	Machine Learning	CST051	3-0-0-3
52.	Computer Graphics	CST052	3-0-0-3
53.	Advanced Data Structures	CST053	3-0-0-3
54.	Numerical Methods	MTH707	3-0-0-3
55.	Operations Research	MAT-02	3-0-0-3

REQUIRED CREDIT BREAKUP

S. No.	Category	Credits		Courses/ Subjects
		Minimum	Maximum	
1	Humanities, Social Science and Management courses	13		Theory = 04 Lab =. 01
2	Basic Science Courses including Mathematics	23	29	Maths Theory = 4-6 Chemistry : T=2, L=01 Physics: T=01, L=01
		Mathematics. 12 – 18 Chemistry. 4 Physics. 4 Environmental Studies. 3		
3	Basic Engineering Courses	18		Theory =05 Workshop =01 Lab =01
		Engineering Drawing. 3 Elements of Mechanical Engineering. 3 Basic Electrical Engineering 3 Engineering Mechanics 3 Workshop Practice 2 Computer Programming 4 (3+1)		
4	Institute Open Electives (Compulsory for all students)	06		Theory = 02
5	Professional Electives relevant to branch	21	45	Theory = 07-15
6	Professional core courses relevant to branch	63	69	Theory = 17-19; Lab = 9-12
7	Project (8^{th} semester) Pre-project (7^{th} semester) Seminar (6^{th} semester) Compulsory industrial training/ internship 8 weeks to be done after 5^{th} semester (6^{th} semester)	Project. = 06 Pre-Project = 02 Seminar = 01 Industrial Training or internship = 01 Sub-total of credits = 10		4
Total Minimum		B.Tech. Requirements = 160 credits B.Tech. with Honors = 180 credits		

CREDIT BREAKUP FOR CSE

S. No.	Category	Course Name (Credits)		Semester	Credits Covered
1	Humanities, Social Science and Management	Basic English and Communication Skills (3)		First	13
		English Language Laboratory (1)		First	
		Advanced English Communication Skills & Organisational Behaviour (3)		2nd	
		Entrepreneurship Development (3)		3rd	
		Project Management (3)		4th	
2	Basic Science Courses including Mathematics	Mathematics (12)	Mathematics-I (3)	First	23
			Mathematics-II (3)	2nd	
			Discrete Mathematics (3)	3rd	
			Probability & Statistics (3)	4th	
		Engineering Chemistry (3)		2nd	
		Chemistry Laboratory (1)			
		Engineering Physics (3)		First	
		Engineering & Applied Physics Laboratory (1)			
		Environmental Studies (3)		First	
3	Basic Engineering Courses	Engineering Drawing (3)		2nd	18
		Elements of Mechanical Engineering (3)		First	
		Basic Electrical Engineering (3)		2nd	
		Engineering Mechanics (3)		First	
		Workshop Practice (2)		First	
		Computer Programming (3)		2nd	
		Computer Programming Laboratory (1)		2nd	
4	Institute Open Electives (Compulsory for all students)	Open Elective-I (3), Preferably Signals and Systems taught by the Department of Electronics and Communications		6th	6
		Open Elective-II (3), Preferably Control Systems taught by the Department of Electrical Engineering		7th	
5	Professional Electives relevant to branch	Elective-I		6th	21
		Elective-II		7th	
		Elective-III		7th	
		Elective-IV		7th	
		Elective-V		8th	
		Elective-VI		8th	
		Elective-VII		8th	
6	Professional core courses relevant	Object Oriented Programming (3)		3rd	69
		Electronic Devices and Circuits (3)		3rd	
		Database Management Systems (3)		3rd	
		Software Engineering (3)		3rd	

	to branch (63-69)	Internet & Web Technologies (3)	4th	
		Data Structures (3)	4th	
		Digital Electronics and Logic Design (3)	4th	
		Theory of Computation (3)	4th	
		Compiler Design (3)	5th	
		Design Analysis and Algorithms (3)	5th	
		Microprocessor (3)	5th	
		Operating Systems (3)	5th	
		Communication Systems (3)	4th	
		Python Programming (3)	5th	
		Artificial Intelligence (3)	6th	
		Computer Networks (3)	6th	
		Computer Organization and Architecture (3)	6th	
		Java Programming (3)	6th	
		Network Security (3)	7th	
		Object Oriented Programming Lab (1)	3rd	
		Electronic Devices and Circuits Lab (1)	3rd	
		Database Management Systems Lab (1)	3rd	
		Data Structures Lab (1)	4th	
		Digital Electronics and Logic Design Lab (1)	4th	
		Communication Systems Lab (1)	5th	
		Microprocessor Lab (1)	5th	
		Python Programming Lab (1)	5th	
		Artificial Intelligence Lab (1)	6th	
		Computer Networks Lab (1)	6th	
		Java Programming Lab (1)	6th	
		Network Security Lab (1)	7th	
7	Project (8th semester) Pre-project (7th semester) Seminar (6th semester) Compulsory industrial training/ internship 8 weeks to be done after 5th semester (6th semester)	Project (06)	8th	10
		Pre-Project (2)	7th	
		Seminar (1)	7th	
		Industrial Training or internship (1)	6th	
Total Credits			160	
Total Minimum Required	B.Tech. Requirements = 160 credits B.Tech. with Honors = 180 credits			

National Institute of Technology Srinagar

SEMESTER 3RD

Department of Computer Science and Engineering

Department of Computer Science & Engineering

National Institute of Technology Srinagar

Year (Semester)	Course Title	Course Code	L-T-P-Credits
2nd Year (3rd Semester)	Object Oriented Programming	CST201	2-1-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: Computer Programming (ITT101)

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Use C++ basic primitives to solve programming problems.	3
CO2	Translate real-world constructs into object-oriented solutions using abstraction and encapsulation, implementing these designs in C++.	4
CO3	Design software applications using object-oriented design principles with polymorphism and inheritance.	5
CO4	Handle file operations and demonstrate problem-solving skills using standard template library.	5

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Tokens, Expressions and Control Structures**: Tokens, Keywords, Identifiers & Constants, Basic Data types, User-defined Data types, Derived Data Types, Manipulators, Expressions, Control Structures, storage classes (auto, static, extern, register). **Functions in C++:** Main function, function prototyping, call by reference, inline functions, default parameters, function overloading. **Pointers**: Declare a pointer, Passing pointers to function, Pointer arithmetic, function pointer, Dynamic memory allocation. **Arrays:** Initialization of Arrays, 1-D, 2-D arrays, passing array to a function, pointers to arrays, Use of *new* and *delete* operator. **Strings:** Creating and manipulating string objects, accessing characters in strings, comparing and swapping, in-built string functions.	**10**
Module 2	**Introduction**: Object Oriented thinking: Need for OOP Paradigm, Procedural oriented programming vs Object Oriented Programming, object oriented concepts - abstraction, encapsulation, polymorphism, inheritance. Benefits, Languages and Applications of OOPs. **Abstraction & Encapsulation:** Specifying a class, defining member functions, static members, Access Specifiers, memory allocation for	**12**

	objects, arrays of objects, scope resolution operator, objects as function arguments, returning objects, pointers to members, nested classes, Friend class and friend functions, const member functions, *mutable* storage class, Pointer to class members of class. **Constructors & Destructors:** Type of constructors: default, parameterized and copy constructor, constructor overloading, constructor with default parameter, *this* pointer, dynamic initialization of objects, destructor.	
Module 3	**Static Polymorphism:** Definition & Rules of overloading Operators, Overloading Unary and Binary Operators, Function call operator, type conversion. **Inheritance:** Base and derived classes, visibility modes. Types of Inheritance: single, multiple, multilevel, hierarchical and hybrid inheritance. **Runtime Polymorphism:** Method overriding, Pointers to Objects and derived classes, Early vs. late binding, virtual functions, pure virtual functions, Virtual base class and abstract class, Virtual Table and Virtual pointer, Virtual destructors, Object slicing. **Exception Handling:** Exceptions, handling various types of Exceptions (*try*, *throw*, *catch)*, User defined exception.	**10**
Module 4	**File and Stream Handling:** Classes for file stream operations, opening and closing files, File opening modes, file Pointers, Error handling during file operations, File I/O with Member Functions, Overloading the Extraction and Insertion Operators, memory as a Stream Object command line arguments. **Templates:** Class templates, function templates. **Standard Template Library (STL):** Overview of STL, Containers, Algorithms, Container classes, General Theory of Operation, Other STL Elements: Vectors, Iterators, Lists, Stacks, Queues, Pairs, Sets, Maps. **Other STL**: Count, find, unique, reverse and transform.	**10**

References Books:

1. Stroustrup, Bjarne (2013), "Programming: Principles and Practice Using C++", Addison-Wesley Professional.
2. Lafore, Robert (2008), "Object-Oriented Programming in C++" , Sams Publishing.
3. Schildt, Herbert (2011), "C++: The Complete Reference", McGraw-Hill Education.
4. Horton, Ivor (2018), "Beginning C++ 17: From Novice to Professional", 5th Edition, Apress.
5. Balagurusamy (2020), “Object Oriented programming with C++”, Tata McGraw Hill.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
2nd Year (3rd Semester)	Object Oriented Programming Lab	CSL202	0-0-2-1
Evaluation Policy	**Continuous Assessment**		**End Term**
	60 Marks		40 Marks

Pre-requisites: ITL101

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Use C++ basic primitives to solve programming problems.	3
CO2	Model real-world problems into object-oriented solutions using abstraction and encapsulation in C++.	4
CO3	Design software applications in C++ using object-oriented design principles with polymorphism and inheritance.	5
CO4	Implement file operations and demonstrate problem-solving skills using standard template library in C++.	6

Lab details:

S. No	Particulars
1	Switching from C to C++ Programming - C++ Programs to print various patterns –
2	C++ Programs using I/O, variables, data types, operators, and control flow statements.
3	C++ Programs using scope and lifetime, functions, recursion, arrays, Math library <*cmath*>, strings <*string*>, and string manipulations.
4	Function Overloading, default arguments in C++
5	Simple class design and object creations in C++
6	Use of Constructors, default copying, Array of Objects, passing/returning objects, and static members
7	Use of friend class, friend function, const object & member function, and mutable storage class
8	Use of Inheritance Concept in C++
9	Exception Handling and Operator Overloading in C++
10	Runtime Polymorphism in C++
11	Use of Templates and Standard Template Library (STL) in C++
12	File Handling in C++

Department of Computer Science & Engineering

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
2nd Year (3rd Semester)	Database Management Systems	CST203	2-1-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Design robust conceptual database systems using entity-relationship modeling.	3
CO2	Use relational algebra, SQL, PL/SQL, query optimization, and database normalization, ensuring efficient database design and management.	5
CO3	Handle crucial database operations using indexing methods, transaction management, concurrency control,	4
CO4	Practice effective data management using database recovery, security, data transformation, and emerging technologies in data mining and warehouse modeling.	4

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Conceptual Database Design:** Characteristics of the Database, DBMS Architecture & Data Independence, Database Languages & Interfaces. Data Models - Hierarchical model, Network Model, CODD Rules, Relational Database Management Systems (RDBMS). **Data Modelling:** Entity-Relationship Model – Entities, Attributes and Relationships, Cardinality of Relationships, Strong and Weak Entity Sets, Generalization, Specialization, and Aggregation, Converting ER Model into Relational Model, Integrity constraints over relationship. **Relational Database Model:** Terminologies: relation, tuple, attribute, domain, relational schema, degree of relation. Relational constraints: Domain constraints, Key constraints, Entity integrity constraints, Referential integrity constraints.	**12**
Module 2	**Relational Algebra:** Basic relational algebra, tuple calculus **Normalization**: Functional Dependencies (FDs), Closure set of attributes, Determining candidate keys, Equivalence of FDs, Lossless	**10**

	Join, Dependency preserving Decomposition, Normal forms - 1NF, 2NF, 3NF, BCNF. **Structured Query Language (SQL)** - Creating a table and constraints, Referential triggered actions, Aliasing, Data Definition Language (DDL), Data Manipulation Language (DML), set operations, ORDER BY, IN, ANY, ALL, SOME clauses. Nested correlated queries: EXISTS, NOT EXISTS, JOINS, and aggregate functions. PL/SQL: Cursors, Triggers. **Query Processing and Optimization:** Overview of Query Evaluation, operator evaluation, Algorithms for relational operations.	
Module 3	**File Organisation & Indexing:** File organization, Types of Indexing: primary, secondary and clustered indexing, multi-level indexing. Introduction to B trees and B+ trees, Database properties of B trees, Insertion and deletion on B tree. **Transaction and Concurrency Control:** ACID properties, transactions, schedules and concurrent execution of transactions, Concurrency control-lock based protocol, Serializability, recoverability, dealing with deadlocks and Concurrency control without locking. **Transaction Control Language (TCL)**: Commit, Save point, Roll back, Set transaction, Data Control Language (DCL): grant and revoke.	**10**
Module 4	**Database Recovery:** Failure classification, Recovery and atomicity, Log-based recovery shadow paging and Advanced Recovery Techniques. Security and Authorization, Access control, Direct access control and Mandatory access control, Role of DBA. **Data transformation techniques:** Normalization, Discretization, Sampling, Compression. **Emerging Technologies:** Datamining, Knowledge Discovery in Database, Data Warehouse Modelling: Schema for multidimensional data models, Concept hierarchies, Measures: Categorization and Computations.	**10**

Reference Books:

1. Silberschatz, A., Korth, H. F., & Sudarshan, S. (2011). *Database system concepts*. McGraw-Hill.
2. Ramez Elmasri, S. B. N., Navathe, D. V. L. N., & Somayajulu, S. G. (2010). *Fundamentals of Database Systems.* Pearson Education.
3. Ramakrishnan, R., Gehrke, J., (2003). *Database management systems* (Vol. 3). New York: McGraw-Hill.

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Year (Semester)	**Course Title**	**Course Code**	**L-T-P-Credits**
2nd Year (3rd Semester)	Database Management Systems Lab	CST204	0-0-2-1
Evaluation Policy	**Continuous Assessment**		**End Term**
	60 Marks		40 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	**Course Outcomes**	**Bloom's Taxonomy Level**
CO1	Understand RDBMS Architecture and learn about different data types supported by SQL and their practical implementation.	4
CO2	Implement creating, managing SQL tables using Data Definition Language (DDL) and relational and logical operators in SQL queries.	5
CO3	Understand Data Manipulation Language (DML) commands, implement various constraints and perform various types of joins.	4
CO4	Implement security by assigning privileges to database users using Data Control Language (DCL) commands and understand the implementation of Transaction Control Language (TCL) commands.	6

Lab Details:

S. No.	**Particulars**
1	Introduction to SQL, RDBMS. Visualizing the architecture of RDBMS. Different data types and its implementation.
2	SQL commands: Implementation of Creating and managing SQL tables. DDL (Data definition language): Implementation of Create, Alter, drop, rename, truncate, comment.
3	Basic Parts of speech in SQL Implementation of Relational operators. Implementation of Logical operators (ALL, AND, ANY, BETWEEN, EXISTS, IN, LIKE, NOT, OR, SUM) SQL functions: (SUM, MAX, AVERAGE, LIKE)
4	Changing of Data in tables DML (Data manipulation Language): Understanding the implementation of Select, Insert, Update, Delete, and merge.

	Retrieval of data from the table: Understanding implementation of simple queries on single table only.
5	Implementation of constraints: Not null, Primary Key, Unique, Check, Foreign key) Combining Tables and execution of queries on such tables: o Perform Join, inner join, outer join, natural join and subtypes of each. o Implementation of Advanced queries, sub query and grouping (Group by and having clause).
6	Understanding the dependence in queries, correlated queries using Existential quantifiers Understanding the difference in replacing IN with OUTER JOIN, EXISTS and NOT EXISTS.
7	Implementation of Security by assigning Privileges to database users DCL: (Data control Language): Understanding the implementation of Grant, Revoke and views. TCL: (Transaction control Language): Understanding the implementation of Begin, Commit, Rollback and Save point in transaction.
8	Lab Project: Students are required to submit a case study

Books Recommended:

1. Oppel, A. J., Groff, J. R., & Weinberg, P. N. (2010). *SQL: The Complete Reference*. McGraw-Hill.
2. McLaughlin, M., & Harper, J. (2010). *Oracle Database 11g PL/SQL Programming Workbook*. McGraw-Hill, Inc.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
2nd Year (3rd Semester)	Software Engineering	CST205	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	To understand diverse software process models: Waterfall, Incremental, RAD, Evolutionary, Unified, Agile (SCRUM and KANBAN methodologies).	3
CO2	To learn requirements engineering tasks: feasibility studies, elicitation techniques, use case development, and requirement analysis.	4
CO3	To understand software design concepts: modularity, architectural design, user interface design, and project planning aspects.	4
CO4	To acquire software testing strategies, validation techniques, debugging methodologies, maintenance models, and quality management practices.	5

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Software Process:** The Evolving role of Software, Defining Software, Software Myths, Legacy software, A generic view of process, A layered Technology, Process Framework, Capability Maturity Model Integration (CMMI), Process Assessment, Personal and Team Process Models, Product and Process, Process Models – Build and fix model, The Waterfall Model, Incremental Process Model, RAD Model, Evolutionary Process Models, Unified Process **Agile Methodology:** Agile Manifesto, Waterfall model vs Agile, Problems solved by Agile, Introduction to SCRUM and Kanban, What is a Sprint, SCRUM Events (Sprint Planning, Stand-ups, Sprint Review and Sprint Retrospective and their differences), SCRUM Roles (Scrum master, Product Owner, Engineering Team, Engineering Manager, Service Manager, Service Owner), Commonly used Terminologies (Issues and their types, Project, Workflows, Versions), Estimation (How	**14**

	to estimate story points), Sprint Backlog, Sprint Velocity Calculation, Intro to Jira and Confluence	
Module 2	**Requirements and Tools:** Software Engineering Practice, Requirements Engineering tasks, Types of requirements, Feasibility studies, Initiating the requirements engineering process, Eliciting Requirements, Developing Use cases, Requirement Analysis, Documentation and validation, Building the Analysis Model, Elements of the Analysis Model	**9**
Module 3	**Analysis Modeling And Project Planning**: Requirements Analysis, Analysis Modeling approaches, data modeling concepts, Object oriented Analysis, Scenario based modeling, Flow oriented Modeling, Class based modeling, creating a behavior model. Planning: Size estimation, Cost estimation, COCOMO, Software risk management. **Design & Implementation:** Design Engineering, Design Concepts, Modularity, Strategy of Design, Function oriented Design, Architectural Design, Detailed Design, Design process, Design Quality, Design model, User interface Design, Implementation, issues in implementation. Software metrics, SCM.	**10**
Module 4	**Testing & Maintenance**: Testing strategies, Testing Tactics and terminologies, functional testing, structural testing, levels of testing, validation testing, system testing, Art of debugging. Software maintenance, maintenance models, Regression testing, Reverse Engineering, ReEngineering, evolution, Quality Management, Process Improvement, Risk Management.	**9**

Books Recommended:

1. Pressman R., "Software Engineering", 7th Ed., McGraw-Hill. 2000
2. Sommerville, I., " Software E ngineering", 6 th Ed., P earson 2007 Education.
3. Dfleeger, S. L., "Software Engineering", Pearson Education.

References:

1. Richard Fairley, "Software Engineering Concepts", McGraw Hill.
2. Stephan Schach, "Software Engineering", Tata McGraw Hill.
3. Pfleeger and Lawrence,"Software Engineering: Theory and Practice", Pearson Education.

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Year (Semester)	**Course Title**	**Course Code**	**L-T-P-Credits**
2nd Year (3rd Semester)	Electronic Devices and Circuits	ECT206	2-1-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Objectives: To understand basics of semiconductors, Diodes, Transistors, Operational amplifiers and their application.**Course Outcomes:** At the end of the course, the student will be able to:

CO No.	**Course Outcomes**	**Bloom's Taxonomy Level**
CO1	Understand the basics of semiconductor physics, PN junction diode and list of diode applications.	I
CO2	Explain the construction, basics of operation and performance analysis of the devices like BJT, MOSFET.	II
CO3	Develop knowledge of OPAMP and its negative feedback applications	III
CO4	Analyze various feedback amplifiers and positive feedback applications of OPAMP such as oscillators.	IV

Details of the Syllabus:

Module No.	**Particulars**	**Hours**
Module 1	**Introduction to Semiconductors and P-N junction diode:** Band theory of Insulators, semiconductors and metals, Intrinsic and extrinsic semiconductors, Current components and IV characteristics of diode, Breakdown, diode circuits: half wave, full wave rectifiers, Filter and regulator circuits, clipping and clamping circuits.	10
Module 2	**Transistors:** Construction and characteristics of bipolar junction transistors (BJTs)- Common Base, Common emitter, Common Collector configuration, DC load line, Transistor as a switch and Amplifier. Low frequency, h-parameter model, Analysis and design of transistor amplifier circuits using h-parameters., Biasing and stability techniques, MOSFET construction and characteristics.	12
Module 3	**Operational Amplifiers:** Introduction to Op-amp, Inverting and non-inverting configuration, Applications–adder, subtractor, integrator, differentiator.	10
Module 4	**Amplifiers And Oscillators:** Classification of amplifiers, concept of feedback, types of feedback, general characteristics of feedback amplifiers, Single stage RC coupled amplifier. Oscillators – Criterion for Oscillation, type of oscillators, Power amplifiers.	10

Recommended Books:

1. Semiconductor Physics and Devices by Donald A. Neamen
2. Microelectronics by Sedra & Smith
3. Millman's Electronic Devices and Circuits by Millman Halkias Satiyabrata Jit

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Year (Semester)	**Course Title**	**Course Code**	**L-T-P-Credits**
2nd Year (3rd Semester)	Electronic devices and circuits Lab	ECL207	0-0-2-1
Evaluation Policy	**Internal Assessment**	**External Assessment**	
	60 Marks	40 Marks	

Pre-requisites: Electronic devices and circuits.

Objectives: To acquire knowledge and become familiar with the different characterization techniques to analyse, synthesize basic electronic networks to get desired output.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	**Course Outcomes**	**Bloom's Taxonomy Level**
CO1	Select and explain the working of different electronic equipment used in Electronics laboratories.	1,2
CO2	Experimental measures on different types of electronic circuit and analyse their operation under different operating conditions.	4,5
CO3	Classify relevant information to supplement the Electronic devices and circuits course.	2
CO4	Examine the characterization of diodes, BJT, and OP-AMP for different applications.	2,3

Details of the Syllabus:

Exp. No.	**Particulars**
1	Study of CRO-Measurement of voltage frequency and phase of a given waveform.
2	To obtain V-I characteristics of PN Junction diodes.
3	To assemble a half wave and a full wave rectifier and to study their performance.
4	To study Clipping and Clamping circuits with some examples.
5	Comparison of Zener diode and Avalanche diode characteristics and to use Zener diode as a voltage regulator.
6	To obtain transistor characteristics in the following configurations. a) Common base b) Common emitter.
7	To assemble a CE amplifier and observe its performance.
8	Study characteristics of OP-AMP as inverting and non-inverting amplifier.
9	Study applications of OP-AMP as integrator and differentiator.
10	To measure the following parameters of a typical OP-AMP. a. I/P Impedance. b. O/P Impedance. c. Slew rate. d. CMRR.
11	Feedback a. To assemble current series feedback amplifier and study its performance. b. To assemble a voltage shunt feedback amplifier and study its performance.
12	To assemble an RC phase shift oscillator.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
2nd Year (3rd Semester)	Discrete Mathematics	MAT207	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: A student should have basic knowledge of Set Theory.

Course Outcomes: At the end of the course, a student should be able to:

CO No.	Course Outcome	Bloom's Taxonomy Level
CO1	Apply the concepts of mathematical logic and counting in engineering problems	3
CO2	Determine ordered sets and lattices	5
CO3	Apply concepts of graph theory in computer science and engineering	3
CO4	Apply concepts of group theory in engineering problems	3

Syllabus:

Module No.	Contents	Hours
Module 1	Mathematical Logic and Combinatorics: Fundamentals of Mathematical Logic, Propositions and compound propositions, Basic Logical operations, truth tables, Tautologies and contradictions, Conditional and biconditional statements. Basic counting principles, Permutations and Combinations, Pigeon hole principle with applications, Inclusion-exclusion principle, Homogenous and non-homogenous recurrence relations.	**15**
Module 2	Ordered sets, Lattices: Ordered sets, Diagram of Partially ordered sets, Supremum and Infimum, well-ordered sets, Lattices, Bounded and complemented lattice, Distributive Lattice.	**10**
Module 3	Graph Theory: Introduction to graphs, Basic concepts, Isomorphism, Operations in graphs, Degree sequences, Trees and their properties, Matrices associated to graphs and matrix tree theorem.	**10**

Module 4	Algebra: Groups, semi group, order of a group, Abelian group, subgroup, Cosets, Lagrange's Theorem, order of an element of a group, cyclic groups.	**7**

Recommended Books:

1. J. A. Gallian, *Contemporary Abstract Algebra*, 9th Edition, Cengage India Private Limited, (2019).

2. K. H. Rosen, *Discrete Mathematics and its Applications*, 8th Edition, Mc-Graw Hill Publication, (2007).

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
2nd Year (3rd Semester)	Entrepreneurship Development	HST006	2-1-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

COURSE OUTCOMES:

After completing this course, the student must demonstrate the knowledge and ability to:

CO1	Apply the concepts of entrepreneurship and innovation.	BTL 3
CO2	Analyze entrepreneurship considering various theories and models.	BTL4
CO3	Appraise Training Programme to inculcate Entrepreneurial acumen.	BTL5
CO4	Develop Entrepreneurship Development Skills.	BTL6

Detailed Syllabus:

Module-1	Entrepreneurship: Importance and growth, Characteristics of entrepreneurs, Ethical and social responsibilities of entrepreneurs, Challenges and opportunities of different forms of entrepreneurship, Entrepreneurial motivation.	10 Hrs
Module-2	Theories of entrepreneurship, Schumpeter's Theory of Innovation, Economic Theory of Entrepreneurship, Resource based, Opportunity based, psychological and Sociological theories of entrepreneurship.	10 Hrs

Module-3	Designing Appropriate Training Programme to inculcate Entrepreneurial Spirit, Training for New and Existing Entrepreneurs, Feedback and Performance of Trainees, Training entrepreneurs for creative problem solving.	10 Hrs
Module-4	Entrepreneurship Development Skills: Meaning of Entrepreneurship skill, Types of Entrepreneurship Skills: Business managementskills, Teamwork and leadership skills,Time management and organizational skills	10 Hrs

Books Recommended:

1. Kumar, A. (2012). *Entrepreneurship: Creating and Leading an Entrepreneurial Organization.* Pearson Education India.
2. Rao, T., & Kuratko, D. (2012). *Entrepreneurship*. Cengage learning India.
3. Ramachandran, K. (2012). *Entrepreneurship Development*. McGraw Hill Education India.
4. Roy, R. (2020). *Entrepreneurship (Ed. 3rd).* Oxford University Press India.
5. Chole, R. R., Kapse, P. S., & Deshmukh, P. R. (2012*). Entrepreneurship Development and Communication Skills.* Scientific Publisher.

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SEMESTER 4TH

Department of Computer Science and Engineering

Department of Computer Science & Engineering

National Institute of Technology Srinagar

Year (Semester)	Course Title	Course Code	L-T-P-Credits
2nd Year (4th Semester)	Data Structures	CST250	2-1-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: Computer Programming (ITT101)

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Apply the concept of Abstract Data Types and implement suitable algorithms to solve problems of searching and sorting	3
CO2	Design stack and queue data structures using linear and linked representation for various applications	4
CO3	Construct tree data structures using linear and linked representation for various applications	4
CO4	Apply hash tables and graph data structure to solve computational problems efficiently	5

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Introduction:** **Primitive Structures:** Arrays, Structures, Self-Referential Structures Strings, Pointers, Dynamic Memory Allocation. **Searching Techniques:** Linear and Binary Search **Sorting Algorithms:** Stability and In Place Properties, Insertion Sort, Merge Sort, Quick Sort, Lower Bound for Comparison Based Sorting Algorithms, Counting Sort, Radix Sort, Bucket Sort **Recursion**: Recursion, Recursion and Stacks. Expression evaluation using stacks. **Other:** Kadane's Algorithm	**11**
Module 2	**Linear Data Structures and Abstract Data Types (ADTs):** **Stacks:** Array/Static implementation of Stacks. Prefix, Postfix and Infix Expressions. Infix to postfix conversion. Expression evaluation and expression trees, Applications of Stacks. **Queues:** Array/Static implementation of Queues, Applications of Queues, Types of Queues.	**11**

	Linked Lists: Linked List vs Arrays, Types of Linked lists: Singly, Doubly, Circular, Multiple Linked Lists. Linked List basic operations: Insertion, Deletion, Searching, and Traversing. Applications and Limitations of Linked lists, Dynamic Implementation of Stacks and Queues. Floyd's Tortoise and Hare Algorithm and its Applications.	
Module 3	**Non-Linear Data Structures:** **Trees:** Introduction to Trees, Implementation of Trees, Binary Trees, Tree Traversals with an Application, Binary Search Trees (BSTs), Operations on BST: Traversal, Insert, delete, and search. Static and dynamic implementation. Balanced BST: AVL Trees, Red Black Trees. **Heaps:** Definition and Implementation of Max and Min Heap. Priority Queue, Binary Heap Implementation and Applications of Priority Queues. Heap Sort.	**10**
Module 4	**Hash Tables**: Hashing, Direct Address Table, Hash Function, Collisions resolution techniques in Hashing: Chaining, Open Addressing - linear probing, quadratic probing, double hashing. **Graph Algorithms**: Graphs and their Representations, Graph Traversal Techniques: Breadth First Search (BFS) and Depth First Search (DFS), Applications of BFS and DFS, Search vs. Traversal, BFT and DFT. Minimum Spanning Trees (MST): Prim's and Kruskal's algorithms. Dijkstra's Algorithm for Single Source Shortest Paths.	**10**

Books and References:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein (2009), Introduction to Algorithms, Third Edition, MIT Press.
2. Bhagat Singh, Thomas L. Naps (1985). Introduction to Data Structures. Thomson Learning
3. Sartaj Sahni (1998), "Data structures, Algorithms and Applications in C++ ", McGraw Hill.
4. E. Horowitz, S. Sahni (2008), "Fundamentals of Data Structures", Computer Science Press
5. Narasimha Karumanchi (2016), Data Structures and Algorithms Made Easy: Data Structure and Algorithmic Puzzles, Second Edition, Career Monk publisher.
6. Seymour Lipschutz (2017), "Data Structures with C", (Schaum's Outline Series), McGraw Hill.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
2nd Year (4th Semester)	Data Structures Lab	CSL251	0-0-2-1
Evaluation Policy	**Continuous Assessment**		**End Term**
	60 Marks		40 Marks

Pre-requisites: ITL101

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Apply the concept of Abstract Data Types (ADTs) and implement suitable algorithms to solve problems of searching and sorting	3
CO2	Design stack and queue ADTs using linear and linked representation for various applications	4
CO3	Construct tree data structures using linear and linked representation for various applications	4
CO4	Apply hash tables and graph data structure to solve computational problems efficiently	5

Lab Programming Exercises:

S. No	List of Experiments
1	Use of Arrays and Structures
2	Implementation of Searching Algorithms
3	Implementation of Sorting Algorithms – Part 1 • Bubble Sort • Insertion Sort • Selection Sort • Counting Sort • Radix Sort
4	Implementation of Sorting Algorithms – Part 2 • Merge Sort • Quick Sort
5	Implementation of operations on Single Linked List.
6	Implementation of operations on Stack and Queue ADTs.
7	Implementation of various applications of Stack data structures.
8	Implementation of various applications of Queue data structures.
9	Implementation of tree traversals. • Pre-order • In-order

	• Post-order
10	Implementation of Binary Search Tree operations. • Insert • Delete • Search
11	Implementation of Priority queue using Heap.
12	Implementation of Hashing Techniques. • Chaining • Linear Probing
13	Implementation of Breadth First Search (BFS) and Depth First Search (DFS) on a graph.
14	Solve the single-source shortest path problem using Dijkstra's algorithm.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
2nd Year (4th Semester)	Internet & Web Technologies	CSL252	1-1-2-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	To understand the basics of the Internet, World Wide Web, and modern web technologies.	3
CO2	To learn HTML and CSS, for creating structured and styled web pages.	4
CO3	To acquire proficiency in JavaScript programming, including advanced form validation and jQuery usage.	4
CO4	To gain expertise in server-side scripting with Node.JS	5

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Web Basics and Overview:** Introduction to Internet, World Wide Web, Web Browsers, URL, MIME, HTTP, Web Programmers Toolbox. **Web 2.0**: Concepts, technologies, and trends shaping the modern web.	**4**
Module 2	**HTML (Hypertext Markup Language)**: Basics of HTML, including tags, attributes, and document structure. **CSS (Cascading Style Sheets)**: Fundamentals of CSS for styling HTML elements and web pages.	**8**
Module 3	**Introduction to Javascript Programming**: Basics of JavaScript syntax and variables, Data types and operators in JavaScript, Control structures: if-else statements, switch statements, loops, Functions in JavaScript: declaration, invocation, parameters, return values, JavaScript events: handling user interactions and browser events, DOM manipulation with JavaScript: accessing and modifying HTML elements, Error handling and debugging in JavaScript, Introduction to ES6 features: let and const, arrow functions, template literals, Advanced Form Validation, jQuery for DOM manipulation and event handling	**15**

Module 4	**Introduction to Server-Side Scripting with Node.js**: Understanding the Node.js environment, event-driven architecture, and non-blocking I/O model. Exploring the Node.js event loop and its role in asynchronous programming. **Basics of Node.js**: Familiarizing with Node.js syntax, variables, data types, control structures, and error handling. Understanding the use of require for module importing. **Functions in Node.js**: Deep dive into Node.js callback functions, promises, and async/await for handling asynchronous operations. Understanding closures and higher-order functions in JavaScript. **Node.js Modules and Package Management**: Understanding built-in and custom modules in Node.js. Learning to manage third-party packages with npm (Node Package Manager). **Creating Dynamic Web Pages with Node.js**: Learning to use the Express.js framework to set up a server, define routes, and render dynamic views. **Data Exchange between Client and Server**: Learning to handle HTTP requests and responses. Understanding RESTful APIs and building one using Express.js. Working with form data and file uploads. **Connecting Node.js to Databases**: Understanding how to connect Node.js to relational databases (like MySQL or PostgreSQL) using an ORM like Sequelize. Learning to connect to non-relational databases (like MongoDB) using Mongoose. Performing CRUD operations and understanding data modeling in both types of databases.	**15**

Books Recommended:

1. Dietel & Dietel "Internet & Web Designing".
2. John Duckett. "JavaScript and Jquery: Interactive Front-end Web Development".

References:

1. Greenlaw R and Hepp E "Fundamentals of Internet and www".
2. B. Underdahle and K.Underdahle, "Internet and Web Page / WebSite Design", IDG Books India (P) Ltd.
3. D. Comer, "The Internet Book", Prentice Hall of India.
4. David Flanagan. "JavaScript: The Definitive Guide".

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
2nd Year (4th Semester)	Theory of Computation	CST253	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Classify machines by their power to recognize languages.	5
CO2	Employ finite state machines to solve problems in computing.	4
CO3	Design grammars and recognizers for different formal languages	6
CO4	Comprehend the hierarchy of computing problems arising in the theoretical computer science.	4

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Introduction and Deterministic Finite Automata:** Complexity of computations, Automata, Mathematical notations and terminology, Definitions, Theorems and proofs, Types of proofs, Families of Formal Languages, Deterministic Finite Automata (DFA), Construction of minimal DFA, Union, Concatenation, Cross product, Complementation, Reversal of DFA, Minimization of DFA - Myhill–Nerode theorem.	**12**
Module 2	**Non-Deterministic Finite Automata and Regular Languages:** Introduction to NFA, Examples of NFA, Conversion of NFA to DFA, Complementation of NFA, Epsilon-NFA and conversion of epsilon-NFA to NFA, Regular expressions, Regular language, Regular Grammar, Moore Machine, Mealy Machine and its conversion. Conversion of Finite automata to Regular Expression and vice versa, Testing whether a language is regular or not - Pumping lemma for regular languages, Properties of Regular Languages, Decidable problems on Regular Languages.	**10**
Module 3	**Context free languages:** context free grammar (CFG), Types of CFG - CNF and GNF, Pre-processing of CFGs, Parsing algorithm for context-free grammars - CYK, Pushdown automata (PDA), Non deterministic PDA - Non-context free languages, Equivalences, Closure properties of CFLs, Testing CFG or not - Pumping Lemma for CFLs, Decidable	**10**

	problems on CFLs.	
Module 4	**Turing Machines and Computability theory:** Turing machines, Variants of Turing machines, Non-Halting TM, Turing or church thesis, Linear Bounded Automata (LBA) - context sensitive grammars, Recursively enumerable and recursive languages, Theorems on recursive and recursively enumerable languages, Definition of Algorithm, Countability, Computability, Decidability, Reducibility. **Complexity theory** - Undecidability, Turing Machine halting problem, Undecidable problems - Post Correspondence problem, P and NP problems.	**10**

Books and References:

1. J.E. Hopcroft and J.D. Ullman (2011). “Introduction to Automata Theory, Languages and Computation”, Pearson Education India
2. Alfred V. Aho, Monica S. Lam, Ravi Sethi, and Jeffrey D. Ullman. (2006) "Compilers: Principles, Techniques, and Tools". Pearson Education.
3. Peter Linz (2016), “An Introduction to Formal Languages and Automata”, Jones & Bartlett
4. K.L.P. Mishra, “Theory of Computer Science”, Prentice Hall of India

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Year (Semester)	**Course Title**	**Course Code**	**L-T-P-Credits**
2nd Year (4th Semester)	Digital Electronics and Logic Design	ECT251	2-1-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Objectives: The course will focus on introducing the concepts of logic design and how those concepts can be applied to come up with methodologies that allow the design of digital circuits. The course takes a concrete bottom-up approach starting from the basic number theory and Boolean laws and then building incrementally the design process through logic gates, flip-flops, registers etc. This should allow the student to develop a solid understanding of the basic design process in the digital paradigm. By the end of this course a student will have a more relevant view of the modern digital design field, and a better understanding of how the modern computers and other digital devices function.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	**Course Outcomes**	**Bloom's Taxonomy Level**
CO1	Understand the concepts of logic design and apply those concepts to formulate design problems as Boolean functions.	1, 2, 3
CO2	Analyze the functionality of the formulated design problems at the gate level to avoid any hazards, thereby ensuring a complete timing closure of the intended circuit.	4
CO3	Choose a proper circuit realization for a given problem and analyzing and evaluating the resultant performance in terms of some basic parameters.	4, 5, 6
CO4	Create alternate circuit realizations for a given problem by exploiting the inherent redundancies and analyzing different target elements and platforms.	4, 5

Details of the Syllabus:

Module No.	**Particulars**	**Hours**
Module 1	**Number System & Boolean Algebra:** Binary Number system, Conversion of bases, Complements, Weighted and Non-weighted codes, Binary Arithmetic, Boolean Laws and Logic Gates, Boolean functions- Canonical and Standard forms, Simplification of Boolean Functions, Gate Implementations, Hazards and Glitches, Hazard detection and Hazard free implementations.	12
Module 2	**Combinational Logic Design:** Design procedure, Adders and Subtractors, Encoders and Decoders, Multiplexers/De-multiplexers and their use in combinational logic design, Digital Comparators, Timing response in Combinational networks.	10
Module 3	**Sequential Logic Design:** Latches and Flip-flops, Finite State Machines and Controllers, FSM based design- Counters, Sequence detectors, Signal generators, Moore and Mealy machines, Timing in state machines,	10

	Registers.	
Module 4	**Digital Logic families:** RTL, DCTL, DTL, TTL, ECL, CMOS logic families.	6
Module 5	**Programmable Logic devices:** PLAs, PALs, CPLDs, FPGAs.	4

Recommended Books:

1. Digital Principles and Applications by Donald P. Leach, Albert Paul Malvino and Goutam Saha
2. Digital Logic and Computer Design by M. Morris Mano
3. Modern Digital Electronics by R.P. Jain
4. Digital Design by Frank Vahid
5. Contemporary Logic Design by Randy H. Katz and Gaetano Borriello

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Year (Semester)	**Course Title**	**Course Code**	**L-T-P-Credits**
2nd Year (4th Semester)	Digital Electronics & Logic Design Lab	ECL255	0-0-2-1
Evaluation Policy	**Internal Assessment**	**Final Assessment**	**Total**
	60 Marks	40 Marks	100 Marks

Prerequisite: Digital Electronics & Logic Design.

Objectives: To acquire knowledge and become familiar with the different characterization techniques to analyze, and synthesize the digital logic, combinational and sequential circuits.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	**Course Outcomes**	**Bloom's TaxonomyLevel**
CO1	Identify relevant information to supplement the Digital Electronics & logic Design course.	I, II
CO2	Develop competence in Combinational Logic Problemidentification and solution.	III
CO3	Develop design capability in the field of combinatorial logic using gates and blocks.	III
CO4	Analysis and design of synchronous and asynchronoussequential circuits.	IV, VI

Details of the Syllabus:

Exp. No.	**Particulars**
1	To verify the truth table of following logic gates: AND, OR, NOT, NAND, NOR, XOR and XNOR.
2	To implement XOR and XNOR using universal logic gates.
3	a. To verify DeMorgans law using logic gates. b. To implement typical Boolean expressions and check their equality.
4	To design and realize: - a. Half adder and verify its truth table. b. Full adder and verify its truth table.
5	To design and realize: - a. Half subtractor and verify its truth table. b. Full subtractor and verify its truth table.
6	To design a multiplexer/demultiplexer using two input NAND gates.
7	To design a 4-bit binary to decimal converter.
8	To design a 4-bit binary to gray code converter.
9	To design a modulo-10 counter.

10	Given a frequency *f* obtain the waveforms with frequencies *f*/2, *f*/5 & *f*/10.
11	Design and realize the following flip-flops using logic gates. a. RS flip-flop. b. JK flip-flop. c. D flip-flop. d. T flip-flop.
12	Use PLL as: a. Frequency multiplier. b. Frequency demodulator.

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Year (Semester)	**Course Title**	**Course Code**	**L-T-P-Credits**
2nd Year (4th Semester)	Probability and Statistics	MAT-217	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: A student should have basic knowledge of Set Theory.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	**Course Outcome**	**Blooms Taxonomy Level**
CO1	Analyse various concepts of statistics and apply to various engineering problems	4
CO2	Evaluate various engineering problems using concepts of probability	3
CO3	Solve various engineering problems related to discrete and continuous distributions	3
CO4	Analyse sampling theory and apply it to various engineering problems	4

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	Introduction to basic Statistics, moments, correlation, regression, methods of least square, curve fitting (polynomials, exponentials).	10
Module 2	Basic definitions of probability, conditional probability with standard results, Bays theorem with examples. Discrete and Continuous Random variables, Distribution functions, Expectation and Variance of Probability distribution, and Moment Generating function, Moments and properties.	12
Module 3	Discrete distributions: Binomial, Poisson and Geometric distributions and their applications. Continuous distribution: Uniform, Exponential and Normal distributions, Normal approximation to Binomial distribution and their applications.	10
Module 4	Introduction to sampling theory, types of sampling, purposive sampling, random sampling, simple sampling, stratified sampling, test of significance, null and alternate hypothesis, errors in sampling.	10

Recommended Books:

1. Spiegel, M. R., Schiller, J. and Srinivasan, R. A., *Probability and Statistics*, 3rd Edition, Tata Mc-Graw Hill, (2010).

2. S. C. Gupta and V. K. Kapoor, *Fundamentals of Mathematical Statistics*, 12th Edition, Sultan Chand & Sons Publications, (2020).

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
2nd Year (4th Semester)	Project Management	HST058	0-0-2-1
Evaluation Policy	Mid-Term	Internal Assessment	End-Term
	26 Marks	24 Marks	50 Marks

COURSE OUTCOMES:

After completing this course, the student must demonstrate the knowledge and ability to:

CO1	Apply the project management skills.	BTL 3
CO2	Analyze the project planning and costs.	BTL4
CO3	Appraise various project monitoring strategies	BTL5
CO4	Evaluate the various aspects of projects	BTL6

Detailed Syllabus:

Module-1	Introduction to project management and project selection: Objectives of Project Management- Importance of Project Management- Types of Projects Project Management Life Cycle- Project Selection – Feasibility study: Types of feasibility Steps in feasibility study.	10 Hrs
Module-2	Project planning and implementation: Project Scope- Estimation of Project cost – Cost of Capital – Project Representation and Preliminary Manipulations - Basic Scheduling Concepts - Resource Levelling – Resource Allocation.	10 Hrs
Module-3	Project monitoring and control: Setting a base line- Project management Information System – Indices to monitor progress. Importance of Contracts in projects- Teamwork in Project Management - Attributes of a good project team – Formation of effective teams – stages of team formation.	10 Hrs
Module-4	Project evaluation- Project Auditing – Phases of project Audit- Project closure reports Guidelines for closeout reports. Computers, e-markets and their role in Project management- Risk management- Environmental Impact Assessment. Case studies in Project management.	12 Hrs

Books Recommended:

Text books	1.	Nokes, S. (2015). The definitive guide to project management. Pearson Education India.
	2.	Newell, M., & Grashina, M. (2003). The project management question and answer book. Amacom.
	3.	Berkun, Scott (2005), The Art of Project Management, O'Reilly Media: Cambridge, MA.
	4.	Cook, Curtis R. (2004), Just Enough Project Management, McGraw-Hill: Boston, MA.
Reference books	5.	Crowe, Andy (2006), Alpha Project Managers: What the Top 2% Know that Everyone Else Does Not, Velociteach: Kennesaw, GA.
	6.	Berkun, Scott (2008), Making Things Happen: Mastering Project Management, O'Reilly Media: Cambridge, MA.

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SEMESTER 5TH

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
3rd Year (5th Semester)	Design & Analysis of Algorithms	CST306	2-1-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: Data Structures (CST250)

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	To understand asymptotic notations to analyze the performance of algorithms.	4
CO2	To understand and apply various problem solving techniques such as divide and conquer, greedy algorithm, dynamic programming, etc.	5
CO3	To solve given problem by selecting the appropriate algorithm design technique and justify the selection	6
CO4	To know the concepts of P, NP, NP-hard and NP-complete problems and some important contemporary algortithms.	4

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Analysis of Algorithms:** Algorithm Design paradigms, motivation. Review of algorithmic strategies, asymptotic analysis: upper and lower complexity bounds. Identifying differences among best, average and worst Case Behaviours. Big O, little O, omega and theta notations, Standard complexity classes. Empirical measurements of performance. Time and space trade-offs in algorithms. Analysing recursive algorithms using recurrence relations. **Divide & Conquer:** Structure of divide and conquer algorithms: examples, Binary search, Quick sort, analysis of divide and conquer runtime recurrence relations.	**12**
Module 2	**Greedy Algorithms:** Overview of the greedy paradigm, examples of exact optimization solutions (minimum cost spanning tree), approximate solution (Knapsack problem), single source shortest paths. **Dynamic Programming**: Overview, difference between dynamic programming and divide and conquer, Memoization vs. Tabulation, applications: longest increasing subsequence, shortest path in graph,	**10**

	matrix multiplication, travelling salesperson problem, longest common sequence.	
Module 3	**Graph Algorithms:** Graphs and their Representations, Graph Traversal Techniques: Breadth First Search (BFS) and Depth First Search (DFS), Applications of BFS and DFS, Minimum Spanning Trees (MST), Prim's and Kruskal's algorithms for MST, Connected Components, Dijkstra's Algorithm for Single Source Shortest Paths, Floyd's Algorithm for All-Pairs Shortest Paths Problem. **Back Tracking:** Overview, 8-Queens problem and Knapsack problem.	**9**
Module 4	**Branch & Bound:** LC searching, bounding, FIFO branch and bound, Applications: 0/1 Knapsack problem, Travelling salesperson problem. **Computational complexity:** Complexity measures, Polynomial vs non-polynomial time complexity; NP hard and NP complete classes, Examples. **Other Important Algorithms:** Rabin Karp Algorithm, Knuth-Morris-Pratt Algorithm (KMP), Union Find Algorithm, Z Algorithm, Boruvka's Algorithm, Johnson's Algorithm, Kosaraju's Algorithm, Tarjan's Algorithm	**11**

Books and References:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein (2009), "Introduction to Algorithms", MIT Press, Cambridge
2. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran (2011), "Fundamentals of Computer Algorithms", Second Edition, Universities Press
3. The Design and Analysis of Computer Algorithms by A.V. Aho, J.E. Hopcroft and J.D. Ullman, Addison Wesley.
4. Mark Allen Weiss (2006), "Data Structures and Algorithm Analysis in C++", Third Edition, Pearson Education

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
3rd Year (5th Semester)	Microprocessor	CST307	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Understand the basic structure and operations of a microcomputer.	3
CO2	Familiarize basic architecture of 8085 microprocessors and program 8085 Microprocessor using Assembly Level Language.	4
CO3	Understand the System bus structure and its different operations.	4
CO4	Understand interfacing of 16 bit microprocessor with memory and peripheral chips involving system design and to familiarize basic architecture of 8051 microcontroller	5

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Microcomputer Structure and Operations:** Basic Microcomputer Elements, Typical Microcomputer Structure, CPU, Memory System, Input Output.	**10**
Module 2	**Microprocessors and Memory:** Typical 8, 16 and 32 bit Microprocessors, 8085, Microprocessor Specification, Memory Technologies. **Assembly Language Programming:** Programming Model of 8085, Registers, Fetch, Execute Operation of CPU, Instruction Set, Addressing Modes, Basic Operations, Microprocessor Arithmetic, Program Flow, Control Using Looping and Branching, Stack, Subroutines, Interrupts, Resets	**12**
Module 3	**Bus System:** System Bus Structure, Bus Operations, Cycle by Cycle Operations, Timing and Control, Priority Management, Address	**10**

	Decoding	
Module 4	**Microprocessors Interfacing:** Interfacing concepts, Parallel Input Output, Memory Interfacing, Direct Memory Access. The Serial Subsystems. Programmable Peripheral Interface, Analog Converter Subsystem. **Introduction to 8051 Microcontroller:** Main features, architecture, and addressing modes, comparison with Microprocessors.	**10**

Books Recommended:

1. Gaonkar, R. S. (2000). *The Z-80 Microprocessor: Architecture, Interfacing, Programming, and Design*. Prentice Hall PTR.
2. Hall, D. V. (1992). *MICROPROCESSORS AND INTERFACING*.
3. Fundamentals of microprocessor and microcontroller by B. RAM, Dhanpat Rai Publications.

References:

1. Uffenbeck, J. E. (1987). *The 8086/8088 family: design, programming, and interfacing*. Prentice-Hall, Inc...

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Year (Semester)	**Course Title**	**Course Code**	**L-T-P-Credits**
3rd Year (5th Semester)	Microprocessor Lab	CSL308	0-0-2-1
Evaluation Policy	**Continuous Assessment**		**End Term**
	60 Marks		40 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	**Course Outcomes**	**Bloom's Taxonomy Level**
CO1	Become familiar with the architecture and Instruction set of Intel 8085 microprocessor.	4
CO2	Expose students to the operation of typical 8085 microprocessor trainer kit.	3
CO3	Provide practical hands-on experience with Assembly Language Programming.	5
CO4	Develop and test assembly language programs to use instructions of 8085 and get familiarized with interfacing of various peripheral devices with 8085 using 8279 chip.	6

Lab Details:

S. No.	**Particulars**
1	Develop a program to add two double byte numbers. Develop a subroutine to add two floating point quantities.
2	Develop program to multiply two single byte unsigned numbers, giving a 16 bit product.
3	Develop a subroutine which will multiply two positive floating point numbers.
4	Write a program to divide a 4 byte number by another 4 byte number.
5	Write a program to divide an 8 bit number by another 8 bit number up to a fractional quotient of 16 bit.
6	Write a program for adding first N natural numbers and store the results in memory location X.
7	Write a program which decrements a hex number stored in register C. The Program should half when the program register reads zero.
8	To find the factorial of a given number and searching the smallest number in a given array in 8085 microprocessors.
9	Write a program to introduce a time delay of 100 ms using this program as a

	subroutine display numbers from 01H to OAH with the above calculated time delay between every two numbers.
10	N hex numbers are stored at consecutive memory locations starting from X. Find the largest number and store it at location Y.
11	Interface a display circuit with the microprocessor either directly with the bus or by using I/O ports. Write a program by which the data stored in a RAM table is displayed.
12	Design and interface a circuit to read data from an A/D converter, using the 8255 A in the memory mapped I/O.
13	Design and interface a circuit to convert digital data into Analog signal using the 8255 A in the memory mapped I/O. Interface a keyboard with the microprocessor using 8279 chip and transfer the output to the printer.
14	Design a circuit to interface a memory chip with a microprocessor with a given memory map.
15	Interfacing 8051 with seven segment display.

Books Recommended:

3. Gaonkar, R. S. (2000). *The Z-80 Microprocessor: Architecture, Interfacing, Programming, and Design*. Prentice Hall PTR.
4. Hall, D. V. (1992). *MICROPROCESSORS AND INTERFACING*.

References:

1. Uffenbeck, J. E. (1987). *The 8086/8088 family: design, programming, and interfacing*. Prentice-Hall, Inc...

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
3rd Year (5th Semester)	Operating System	CST309	2-1-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Understand the structure and organization of the file system, services provided by and the design of an operating system.	3
CO2	Understand what a process is and how processes are synchronized and scheduled.	5
CO3	Analyse different approaches to memory management.	4
CO4	Understand the system calls for managing processes, memory, file system and the data structures and algorithms used to implement an OS.	4

Detailed Syllabus:

Module No	Contents	Hours
Module 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.	**10**
Module 2	**Concurrent Processes:** Process concept, Principle of Concurrency, Producer Consumer Problem, Critical Section problem, Semaphores, Classical problems in Concurrency, Inter Process Communication, Process Generation, Process Scheduling. **CPU Scheduling:** Scheduling Concept, Performance Criteria Scheduling Algorithm, Evolution, Multiprocessor Scheduling. **Deadlock:** System Model, Deadlock Characterization, Prevention, Avoidance and Detection, Recovery from deadlock combined approach.	**12**

Module 3	**Memory Management:** Base machine, Resident monitor, Multiprogramming with fixed partition, Multiprogramming with variable partition, Multiple base register, Paging, Segmentation, Virtual memory concept, Demand paging, Performance, Paged replaced algorithm, Allocation of frames, Thrashing, Cache memory, Organization, Impact on performance.	**10**
Module 4	**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.	**10**

Books Recommended:

1. Silberschatz, A., Peterson, J. L., & Galvin, P. B. (1991). *Operating system concepts*. Addison-Wesley Longman Publishing Co., Inc...
2. Andrew, S. T., & Herbert, B. (2015). *Modern operating systems*. Pearson Education.
3. Stallings, W. (1998). *Operating systems internals and design principles*. Prentice-Hall, Inc...

References:

1. Romero, F. (2009). Operating Systems. A concept-based approach. *Journal of Computer Science and Technology*, *9*(2), 112.
2. Bhatt, P. C. P. (2019). *An Introduction to Operating Systems: Concepts and Practice (GNU/Linux and Windows)*. PHI Learning Pvt. Ltd...
3. Deitel, H. M., Deitel, P. J., & Choffnes, D. R. (2004). *Operating systems*. Pearson/Prentice Hall.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
3rd Year (5th Semester)	Python Programming	CST310	2-1-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: Object Oriented Programming (CST201)

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	To learn Syntax, Semantics and create Functions and to handle strings and files in Python.	4
CO2	To implement OOP concepts & to understand Lists, Dictionaries, and Regular Expressions in Python.	3
CO3	To develop skills in networked programming, utilize web services, and interact with databases using SQL in Python.	4
CO4	To learn data manipulation, analysis, and visualization using NumPy, Pandas, and Matplotlib in Python.	6

Detailed Syllabus:

Module No	Contents	Hours
Module 1	Why should you learn to write programs, Variables, expressions and statements, Conditional execution, Functions, Iteration, Strings, Files Lists, Dictionaries, Tuples, Regular Expressions	**12**
Module 2	Classes and objects, Classes and functions, Classes and methods , operator overloading	**10**
Module 3	Networked programs, Using Web Services, Using databases and SQL.	**08**
Module 4	**NumPy**: Arrays, Creation, Manipulation, Indexing, Operations, Aggregation, Statistics. **Pandas**: Series, DataFrames, Ingestion, Exploration, Manipulation, Indexing, Cleaning, Missing Data, Grouping, Aggregation. **Matplotlib**: Pyplot Interface, Basic Plots, Customization, Subplots, Categorical Data, Annotations, Saving Plots.	**12**

Books and References:

1. Charles R. Severance (2016), “Python for Everybody: Exploring Data Using Python 3”, 1st Edition, CreateSpace Independent Publishing Platform.
2. Allen B. Downey (2015), "Think Python: How to Think Like a Computer Scientist”, 2ndEdition, Green Tea Press.
3. Mark Lutz (2011), “Programming Python”, 4th Edition, O’Reilly Media

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
3rd Year (5th Semester)	Python Programming Lab	CSL311	0-0-2-1
Evaluation Policy	**Continuous Assessment**		**End Term**
	60 Marks		40 Marks

Pre-requisites: Object Oriented Programming (CST201)

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Gain practical experience in Python programming language.	4
CO2	Explore Python syntax, data types, control structures, and functions.	5
CO3	Develop skills in implementing algorithms and solving problems using Python.	6
CO4	Apply Python programming concepts to develop scripts, applications, and projects in various domains.	3

Lab details:

S. No	Particulars
1	Create a calculator program
2	Explore string functions
3	Implement Selection Sort, Bubble sort, Insertion sort, Merge sort, Quick sort and Heap sort
4	Implement Stack
5	Read and write into a file
6	Demonstrate usage of basic regular expression
7	Demonstrate use of advanced regular expressions for data validation.
8	Demonstrate use of Tuple, List and Dictionaries .
9	Create Comma Separate Files (CSV), Load CSV files into internal Data Structure
10	Write script to work like a SQL SELECT statement for internal Data Structure made in earlier exercise
11	Write script to work like a SQL Inner Join for an internal Data Structure made in earlier exercise
12	Write a script to implement server and client and exchange messages.
13	Write a program to make 1D and 2D arrays using numpy and perform Array Shape, Array Reshape, Array Iterating, Join, Split, Array filter.
14	Write a program to make Series and DataFrames using pandas and perform basic operations.
15	Draw Labels, Grid, Subplot, Scatter, Bars, Pie charts using matplotlib

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Year (Semester)	**Course Title**	**Course Code**	**L-T-P-Credits**
3rd Year (5th Semester)	Compiler Design	CST312	2-1-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	**Course Outcomes**	**Bloom's Taxonomy Level**
CO1	Analyse and implement various parsing techniques.	4
CO2	Understand and analyse semantic analysis.	4
CO3	Understand and analyse intermediate code.	4
CO4	Realize the importance of code optimization and code generation.	5

Detailed Syllabus:

Module No	**Contents**	**Hours**
Module 1	**Compiler structure:** analysis-synthesis model of compilation, various phases of a compiler, tool based approach to compiler construction. **Lexical analysis:** Interface with input, parser and symbol table, token, lexeme and patterns. Difficulties in lexical analysis, Error reporting and Implementation. Regular definition, Transition diagrams, LEX. **Syntax analysis:** CFGs, ambiguity, associativity, precedence, top down parsing, recursive descent parsing, transformation on the grammars, predictive parsing, bottom up parsing, operator precedence grammars, LR parsers (SLR, LALR, LR), YACC.	**10**
Module 2	**Syntax directed definitions:** inherited and synthesized attributes, dependency graph, evaluation order, bottom up and top down evaluation of attributes, L- and S-attributed definitions. **Type checking:** type system, type expressions, structural and name	**12**

	equivalence of types, type conversion, overloaded functions and operators, polymorphic functions. **Run time system:** storage organization, activation tree, activation record, parameter passing, symbol table, dynamic storage allocation.	
Module 3	**Intermediate code generation:** intermediate representations, translation of declarations, assignments, control flow, Boolean expressions and procedure calls and Implementation issues.	**10**
Module 4	**Code generation and instruction selection:** issues, basic blocks and flow graphs, register allocation, code generation, dag representation of programs, code generation from DAGs, peep hole optimization, code generator generators, specifications of machine.	**10**

Books Recommended:

1. Hoe, A. V., Sethi, R., & Ullman, J. D. (1986). Compilers—principles, techniques, and tools.
2. Fischer, C. N., & LeBlanc Jr, R. J. (1991). *Crafting a Compiler with C*. Benjamin-Cummings Publishing Co., Inc...

References:

1. Appel, A. W. (2004). *Modern compiler implementation in C*. Cambridge university press.
2. Holub, A. I. (1990). *Compiler design in C* (pp. I-XVIII). Englewood Cliffs, NJ: Prentice Hall.
3. Fraser, C. W., & Hanson, D. R. (1995). *A retargetable C compiler: design and implementation*. Addison-Wesley Longman Publishing Co., Inc...

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
3rd Year (5th Semester)	Communication Systems	ECT307	2-1-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: Signals and systems.

Objectives: To analyze various analog and digital modulation & demodulation schemes, and their receivers

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Understand the basic principles of communication system and Fourier analysis of standard signals.	2
CO2	Analyze various Analog modulation and demodulation schemes.	4
CO3	Understand the conversion of analog signal to digital signal via sampling theorem, quantization and pulse code modulation	4
CO4	To analyze the modulator and demodulator for various digital modulation schemes	5

Details of the Syllabus:

Module No.	Particulars	Hours
Module 1	**Introduction to Amplitude Modulation**: Principles of Amplitude Modulation Systems- DSB, SSB and VSB modulations, Frequency discriminator, Demodulation of AM, Diode detector, Super heterodyne receiver.	10
Module 2	**Angle Modulation:** Basic definitions, Frequency Modulation: Narrow Band FM, Wide Band FM, Spectral characteristics of angle modulated signals, Transmission bandwidth of FM Signals, Generation of FM Signals, Demodulation of FM Signals.	12
Module 3	**Analog to Digital Conversion**: Digital Communication; Benefits of digital communication, Sampling, quantization, PCM, Delta Modulation	10
Module 4	**Digital Modulation Schemes:** Introduction to digital modulation techniques, BPSK, M-PSK, QPSK, M-QAM and FSK. Modulator and demodulator for these modulations in absence of noise.	10

Books Recommended:

1. Communication systems by Simons Haykin
2. Modern Analog and Digital Communication Systems by B P Lathi

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Year (Semester)	**Course Title**	**Course Code**	**L-T-P-Credits**
3rd Year (5th Semester)	Communication Systems- Lab	ECL308	0-0-2-1
Evaluation Policy	**Internal Assessment**		**Final Assessment**
	60 Marks		40 Marks

Objectives: Familiarize the students with analog communication systems. Integration of communication systems theory with experimental and simulation techniques.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	**Course Outcomes**	**Bloom's Taxonomy Level**
CO1	Test and understand working of different electronic equipment used in communication systems	6
CO2	Choose testing and experimental procedures on different types of communication circuits and systems; and analyze their operation under different operating conditions	6
CO3	Analyze and simulate error performance of various digital modulation schemes in the presence of noise.	4
CO4	Analyze and design of communication receivers under different noise conditions.	4

Details of the Syllabus:

Exp. No.	**Particulars**
1	To study the generation of standard signals.
2	To study the spectrum Analysis of standard signals
3	To study the generation and detection of AM signals.
4	To study the generation of DSBSC amplitude modulated signals.
5	To study the detection of DSBSC amplitude modulated signals.
6	To study the generation of frequency modulated signals.
7	To study the detection of frequency modulated signals.
8	To measure sensitivity, selectivity, and fidelity of a radio receiver.
9	To measure the noise figure of AM and FM System.
10	To study zero crossing and PLL receivers of FM signals.
11	To simulate various analog modulation schemes in MATLAB.

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SEMESTER 6TH

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
3rd Year (6th Semester)	Artificial Intelligence	CST354	2-1-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	To understand the fundamentals of computational intelligence	2
CO2	To know about the various knowledge representation methods	3
CO3	To understand the features of neural network and its implementation	4
CO4	To gain knowledge of various data clustering methods, evolutionary computation and neuro – fuzzy systems	4

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Introduction to Al And Production Systems** : Introduction to AI-Problem formulation, Problem Definition - Production systems, Control strategies, Search strategies. Problem characteristics, Production system characteristics - Specialized production system- Problem solving methods - Problem graphs, Matching, Indexing and Heuristic functions - Hill Climbing-Depth first and Breadth first, Constraints satisfaction - Related algorithms, Measure of performance and analysis of search algorithms.	**10**
Module 2	**Representation of Knowledge**: Game playing - Knowledge representation, Knowledge representation using Predicate logic, Introduction to predicate calculus, Resolution, use of predicate calculus, Knowledge representation using other logic-Structured representation of knowledge.	**10**
Module 3	**Knowledge Inference**: Knowledge representation -Production based system, Frame based system. Inference - Backward chaining, Forward chaining, Rule value approach, Fuzzy reasoning - Certainty factors, Bayesian Theory-Bayesian Network-Dempster - Shafer theory.	**10**
Module 4	**Planning and Machine Learning**: Basic plan generation systems - Strips -Advanced plan generation systems – K strips - Strategic explanations - Why, Why not and how explanations. Learning- Machine learning,	**12**

	adaptive Learning. **Expert Systems**: Expert systems - Architecture of expert systems, Roles of expert systems - Knowledge Acquisition – Meta knowledge, Heuristics. Typical expert systems - MYCIN, DART, XOON, Expert systems shells.	

Books and References:

1. Deepak Khemani (2013). A First Course in Artificial Intelligence", McGraw Hill Education (India)
2. Stuart Russell and Peter Norvig (2010), "ArtificialIntelligence: A Modern Approach", 3rd Edition, Prentice Hall.

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Year (Semester)	**Course Title**	**Course Code**	**L-T-P-Credits**
3rd Year (6th Semester)	Artificial Intelligence Lab	CSL355	0-0-2-1
Evaluation Policy	**Continuous Assessment**		**End Term**
	60 Marks		40 Marks

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO No.	**Course Outcomes**	**Bloom's Taxonomy Level**
CO1	Gain practical experience in implementing artificial intelligence (AI) algorithms and techniques.	4
CO2	Explore AI concepts such as search algorithms, machine learning, natural language processing, and computer vision.	5
CO3	Develop skills in using AI libraries and frameworks such as TensorFlow, scikit-learn, and NLTK.	6
CO4	Apply AI techniques to solve real-world problems, analyse data, and create intelligent systems and applications.	3

Lab details:

S. No	**Particulars**
1	Study of PROLOG.
2	Write a program to solve 8 queens‟ problem
3	Solve any problem using depth first search.
4	Solve any problem using the best first search.
5	Solve 8-puzzle problem using best first search
6	Solve Robot (traversal) problem using means End Analysis
7	Solve traveling salesman problems.
8	Implementation of Linear and Logistic regression.
9	Implementing classifiers on MNIST Data set.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
3rd Year (6th Semester)	Computer Networks	CST356	2-1-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Understand network models and architectures.	4
CO2	Specify and identify deficiencies in existing protocols, and then formulate new and better protocols.	6
CO3	Analyse, specify and design the topological and routing strategies for an IP based networking infrastructure.	6
CO4	Explain concepts and theories of networking and apply them to various situations, classifying networks.	3

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Basic concept of network:** Advantages and applications, Types of networks (LAN, MAN and WAN), Different network topologies like star, ring, hybrid, tree. **Network Protocol Architecture:** OSI Reference model, Layers of the OSI model. Physical, Data-link, Network, Transport, Session, Presentation and Application layer.	**10**
Module 2	**Network Switching Techniques:** Circuit switched, message switching and packet switched networks, Datagram and virtual circuit services, Frame relay, ATM**.** **Flow and Error Control:** Stop and wait flow control, Sliding window flow control, error control protocols, ARQ techniques, Stop-&-wait ARQ, Go back by N ARQ, Selective repeat ARQ.	**10**
Module 3	**Routing algorithms:** Routing tables, features of a routing algorithm, classification, optimality principle, sink tree, shortest path algorithm,	**12**

	Dijkstra algorithm, flooding, fixed routing, random routing, adaptive routing, distance vector and link state algorithm. **Medium Access Control Protocols:** TDMA, FDMA, CDMA, ALOHA, Slotted ALOHA, CSMA, CSMA/CD, Ethernet, Token Ring network. **Congestion Control:** Congestion in networks and quality of service.	
Module 4	**Network security:** Need for network data security, plaintext, cipher text, encryption techniques, substitution, transposition, DES encryption standard, Private key, public key, Authentication. **Internetworking and Internet fundamentals:** Network Interconnections, Bridges, Routers, Internet Concepts, Brief concepts about common Channel signalling and Integrated Digital Networking.	**10**

Books Recommended:

1. Stallings, W. (2007). *Data and computer communications*. Pearson Education India.
2. Tanenbaum, A. S. Computer Networks, 'Networks. *Networks," PHI.*
3. Peterson, L. L., & Davie, B. S. (2007). *Computer networks: a systems approach*. Elsevier.

References:

1. Sklar, B. (2021). *Digital communications: fundamentals and applications*. Pearson.
2. Keizer, *"Local Area Networks"* McGraw Hill.
3. Lin, Y. D., Baker, F., & Hwang, R. H. (2011). *Computer Networks: An Open Source Approach*. McGraw Hill.

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Year (Semester)	**Course Title**	**Course Code**	**L-T-P-Credits**
3rd Year (6th Semester)	Computer Networks Lab	CSL357	0-0-2-1
Evaluation Policy	**Continuous Assessment**		**End Term**
	60 Marks		40 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	**Course Outcomes**	**Bloom's Taxonomy Level**
CO1	Gain a firm understanding of networking concepts learned in the course work by practical demonstration.	4
CO2	Have working knowledge of the protocols to be used at various levels of the architecture	3
CO3	Learn principles and methodologies for designing efficient and scalable computer networks.	6
CO4	Explore VPN technologies for secure remote access and site-to-site connectivity.	6

Lab Details:

S. No.	**Particulars**
1	Introduction & Network Wire Crimping.
2	Ethernet.
3	Token Ring.
4	Switched LANs.
5	Network Design.
6	ATM.
7	RIP: Routing Information Protocol.
8	OSPF: Open Shortest Path First.
9	TCP: Transmission Control Protocol.
10	Queuing Disciplines.
11	RSVP: Resource Reservation Protocol.
12	Firewalls and VPN.
13	Applications.

Books Recommended:

1. Stallings, W. (2007). *Data and computer communications*. Pearson Education India.
2. Tanenbaum, A. S. Computer Networks, 'Networks. *Networks," PHI.*

3. Peterson, L. L., & Davie, B. S. (2007). *Computer networks: a systems approach*. Elsevier.

References:

1. Sklar, B. (2021). *Digital communications: fundamentals and applications*. Pearson.
2. Keizer, *"Local Area Networks"* McGraw Hill.
3. Lin, Y. D., Baker, F., & Hwang, R. H. (2011). *Computer Networks: An Open Source Approach*. McGraw Hill.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
3rd Year (6th Semester)	Computer Organization & Architecture	CST358	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Understand the basics of computer organization: structure and operation of computers and their peripherals.	4
CO2	Describe arithmetic and logical operations with integer and floating-point operands and their representation in computers and implement the Hardware for Arithmetic Operations.	3
CO3	Study basic processing unit and organization of simple processor, concept of pipelining and other large computing systems.	4
CO4	Study hierarchical memory systems including cache memories, virtual memory and different ways of communicating with I/O devices and standard I/O interfaces.	4

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Introduction:** Overview of basic digital building blocks; basic structure of a digital computer. Basic Performance Equation, Clock Rate, Performance Measurement. Logical operation, hardware implementation, Real numbers - fixed and floating point, IEEE754 representation.	**10**
Module 2	**CPU Sub block:** Data path - ALU, Registers, CPU buses; Control path – microprogramming (only the idea), hardwired logic; External interface. Various addressing modes. Concept of subroutine and subroutine call. Use of stack for handling subroutine call and return, instruction interpretation and execution.	**12**
Module 3	**Memory Sub block:** Memory organization; concepts of semiconductor memory, CPU memory interaction, organization of memory modules, cache memory and related mapping and replacement policies, virtual memory.	**10**
Module 4	**Pipelining:** Introduction to pipelining, Instruction pipeline, Arithmetic pipeline, Data hazards, instruction hazards, performance considerations.	**10**

	I/O Sub block: I/O techniques - interrupts, polling, DMA; Synchronous vs. Asynchronous I/O; Controllers.	

Books Recommended:

1. Hamacher, V. C., Vranesic, Z. G., Zaky, S. G., Vransic, Z., & Zakay, S. (1996). *Computer organization* (pp. 224-238). McGraw-Hill.
2. Pedroni, V. A. (2020). *Circuit design with VHDL*. MIT press.

References:

1. Heuring, V. P., Jordan, H. F., & Murdocca, M. (1997). *Computer systems design and architecture* (pp. 519-520). Addison-Wesley.
2. Chapman, B., Jost, G., & Van Der Pas, R. (2007). *Using OpenMP: portable shared memory parallel programming*. MIT press.
3. Siegel, H. J. (1985). *Interconnection networks for large-scale parallel processing: theory and case studies*. Lexington books.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
3rd Year (6th Semester)	Java Programming	CST359	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: Object Oriented Programming (CST201)

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	To learn Syntax, Semantics and create functions, classes and their objects	4
CO2	Learn and implement principles and concepts of Object Orientation such as Abstraction, Data Hiding, and Polymorphism.	4
CO3	Develop programs by using inbuilt libraries and importing Packages.	5
CO4	The students will learn to create and handle threads, interfaces and applets.	3

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Overview of Basic OOP Concepts:** Need for object-oriented paradigm: Agents, responsibility, messages, methods, classes and instances, class hierarchies (Inheritance), method binding, datatype, variables, scope and lifetime of variables, arrays, operators, expressions, control statements, type conversion and casting, classes and objects, constructors, methods, access control, this keyword, garbage collection, overloading methods and constructors, parameter passing, recursion, string handling, inheritance, super keyword, polymorphism- method overriding, abstract classes.	**12**
Module 2	**Packages and Interfaces:** Defining, Creating and Accessing a Package, Understanding CLASSPATH, importing packages, differences between classes and interfaces, defining an interface, implementing interface, applying interfaces, variables in interface and extending interfaces. Exploring packages – Java.io, Java.util. **Exception handling and multithreading:** Concepts of exception handling, benefits of exception handling, Termination or resumptive models, exception hierarchy, usage of try, catch, throw, throws and	**12**

	finally, built in exceptions, creating own exception sub classes. Differences between multithreading and multitasking, thread life cycle, creating threads, synchronizing threads, daemon threads, thread groups.	
Module 3	**Event Handling:** Events, Event sources, Event classes, Event Listeners, Delegation event model, handling mouse and keyboard events, Adapter classes, inner classes. The AWT class hierarchy, user interface components- labels, button, canvas, scrollbars, text components, check box, checkbox groups, choices, lists panels – scrollpane, dialogs, menubar, graphics, layout manager – layout manager types – boarder, grid, flow, card and grib bag. **Applets:** Concepts of Applets, differences between applets and applications, life cycle of an applet, types of applets, creating applets, passing parameters to applets.	**10**
Module 4	**Swing:** Introduction, limitations of AWT, MVC architecture, components, containers, exploring swing-JApplet, JFrame and JComponent, Icons and Labels, text fields, buttons – The JButton class, Check boxes, Radio buttons, Combo boxes, Tabbed Panes, Scroll Panes, Trees, and Tables. **JDBC**: JDBC Drivers, JDBC API,Executing statements, prepared statements and callable statements	**8**

Books and References:

1. R. Nageswara Rao (2016), "Core Java: An Integrated Approach", Dreamtech Press
2. An Introduction to programming and OO design using Java, J.Nino and F.A. Hosch, John wiley & sons.
3. Y. Daniel Liang, "Introduction to Java programming", 6th edition, Pearson education.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
3rd Year (6th Semester)	Java Programming Lab	CSL360	0-0-2-1
Evaluation Policy	**Continuous Assessment**		**End Term**
	60 Marks		40 Marks

Pre-requisites: CSL202

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Gain hands-on experience in the Java programming language.	4
CO2	Explore Java syntax, data types, control structures, and object-oriented concepts.	5
CO3	Develop skills in implementing algorithms, data structures, and applications in Java.	6
CO4	Apply Java programming concepts to develop projects, solve problems, and create reusable software components.	3

Lab details:

S. No	Particulars
1	**Basic OOP Concepts:** Write a Java program demonstrating the concept of class and object. Create a class representing a 'Person' with attributes like name and age, and instantiate objects to display their details.
2	**Inheritance and Polymorphism:** Implement a Java program illustrating inheritance and method overriding. Create a base class 'Shape' with methods to calculate area and perimeter, and derive subclasses like 'Circle' and 'Rectangle' to calculate their specific areas.
3	**Packages and Interfaces:** Create a package named 'utilities' and define an interface 'Sortable' with a method 'sort'. Implement this interface in a class 'BubbleSort' to sort an array of integers. Demonstrate the usage of this package in another class.
4	**Exception Handling and Multithreading:** Develop a Java program that reads an integer from the user and handles exceptions such as InputMismatchException and ArithmeticException. Use multithreading to perform a time-consuming task concurrently while waiting for user input.
5	**Event Handling:** Build a Java GUI application to handle mouse events. Implement functionalities to display coordinates when the mouse is clicked and change the color of

	a component when the mouse hovers over it.
6	**Applets:** Create a Java applet that displays a simple animation (e.g., moving shapes). Implement the applet lifecycle methods such as init(), start(), stop(), and paint() to manage the animation.
7	**Swing Components:** Design a Java Swing application for a basic calculator. Utilize components such as JTextFields, JButtons, and JLabels to perform arithmetic operations (addition, subtraction, multiplication, division).
8	**JDBC:** Write a Java program to connect to a MySQL database using JDBC. Execute SQL statements to create tables, insert data, and perform queries. Demonstrate the usage of PreparedStatement to prevent SQL injection attacks.
9	**Advanced OOP Concepts:** Implement a Java program illustrating method overloading and constructor chaining. Create a class 'MathOperations' with overloaded methods to perform addition with different parameter types (int, double). Chain constructors to initialize objects with default values.
10	**Advanced Swing Components:** Develop a Java Swing application for a simple address book. Use components like JTable to display contact information (name, phone number, email) and provide functionalities to add, edit, and delete contacts

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SEMESTER 7TH

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Year (Semester)	**Course Title**	**Course Code**	**L-T-P-Credits**
4th Year (7th Semester)	Network Security	CST414	2-1-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	**Course Outcomes**	**Bloom's Taxonomy Level**
CO1	Understand important security goals in the networks Confidentiality, Integrity, Authenticity, Non-repudiation and Availability and cryptographic techniques to implement these security goals.	3
CO2	Provide a necessary review of mathematical concepts to implement different cryptographic techniques to achieve the network security goals.	4
CO3	Provide a deeper dive to the field of cryptography- symmetric and asymmetric key cryptography and methods to implement them.	5
CO4	Explore the security implementations in different network layers- application, transport and network.	4

Detailed Syllabus:

Module No	**Contents**	**Hours**
Module 1	**Introduction:** Review of Layered Architecture of the Network - the OSI Reference Model, Computer Security Concepts, The OSI Security Architecture, Security - Attacks, Services and Mechanisms. **Cryptography Introduction-Classical Encryption Techniques:** Techniques for Implementing Security Goals: An Overview of Cryptography and Steganography, A brief recap of cryptographic principles and motivations for secure network, General thoughts on breaking the cryptosystems.	**10**
Module 2	**Review & Self Study - Mathematics for Symmetric Key Cryptography**: Review of important mathematical concepts: Divisibility, Modular Arithmetic, Groups and Rings. Classical Encryption Techniques - Substitution and Transposition	**10**

	Random Number (PRN) Generation and Stream Cipher: Random Numbers, True Random Number Generators, Pseudo Random Numbers - principles and generators, Cryptographically Secure Random Number Generators, One Time Pad, Stream Cipher- RC4. **Block Cipher Operations:** Modes of Operations, Electronic Code Book Mode, Cipher Block Chaining Mode, Output Feedback Mode, Cipher Feedback Mode, Counter Mode, Enhancing the Security of Block Ciphers: Multiple Encryption, 3DES and DESX, Meet-in-the Middle Attack.	
Module 3	**Block Ciphers - Data Encryption Standard (DES) and Advanced Encryption Standard (AES)**: Block Cipher Structure, Introduction to Data Encryption Standard, Triple DES - introduction, structure & implementation, Fields, Finite Fields - GF (p), GF (2n) and polynomial arithmetic. Advanced Encryption Standard (AES) - Introduction, structure & implementation. **Data Integrity:** Introduction & Motivation, Hash Functions from Block Cipher, Message Digest (MD) Hash Family, Secure Hash Algorithm (SHA-1 and SHA-3), Message Authentication Codes (MAC). **Review & Self Study - Mathematics for Asymmetric Key Cryptography:** Review of important mathematical concepts used in asymmetric key cryptography – Euclidean and Extended Euclidean Algorithm, Euler's Phi Function, Prime Numbers and Primality Testing, Euler's and Fermat's Theorem. **Asymmetric Key Cryptography:** Introduction & Principles of Asymmetric Key Cryptography, Different Public Key Algorithms, Introduction to RSA, RSA in Practice and Attacks, Diffie-Hellman Key Exchange. **Digital Signatures:** Introduction & Motivation, Principles and Applications, RSA based Digital Signature, RSA Probabilistic Signature Scheme.	**12**
Module 4	**Mutual Trust - Key Management and User Authentication:** Introduction and challenges in key distribution, Symmetric Key Distribution and Agreement, Public Key Distribution, Principles of user authentication, User Authentication Protocol – Kerberos, Public-Key Infrastructure. **Security at the Application Layer**: Application Layer Security - Objectives, Issues and Need, Email Security, Pretty Good Privacy, Secure/Multipurpose Internet Mail Extension, Domain Keys Identified Mail. **Security at the Transport Layer:** Web Security-Threats and Challenges, Securing Web-based transactions at the transport layer, Secure Socket Layer, Transport Layer Security, HTTPS, Combining HTTP and SSL/TLS - the secure HTTPS, Remote login, Challenges, One Possible	**10**

	Solution Approach – SSH, Wireless Security – TLS and WAP End-to-End Security. **Security at the Network Layer**: IP Security- Overview and Policy, Encapsulating Security Payload, Combining Security Associations, Internet Key Exchange, Cryptographic Suites. **System Security:** Malwares – Virus, Worms, etc, Malicious Software and Anti-malwares, Distributed Denial of Service Attacks, Intruders and Intrusion Detection, Firewall Need and Characteristics, Types of Firewalls and Biasing, Firewall Location and Configurations.	

Books Recommended:

1. Stallings, W., & Tahiliani, M. P. (2014). Cryptography and network security: principles and practice, vol. 6. *Editor: Pearson London*.

References:

1. Paar, C., & Pelzl, J. (2009). *Understanding cryptography: a textbook for students and practitioners*. Springer Science & Business Media.
2. Schneier, B. (2007). *Applied cryptography: protocols, algorithms, and source code in C*. john wiley & sons.
3. Kurose, J. F. (2005). *Computer networking: A top-down approach featuring the internet, 3/E*. Pearson Education India.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
4th Year (7th Semester)	Network Security Lab	CSL415	0-0-2-1
Evaluation Policy	**Continuous Assessment**		**End Term**
	60 Marks		40 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Understand principles of web security.	4
CO2	Guarantee a secure network by monitoring and analysing the nature of attacks through cyber/computer forensics software/tools.	6
CO3	Exhibit knowledge to secure corrupted systems, protect personal data, and secure computer networks in an Organization.	3
CO4	Ability to compare merits and demerits of different Cryptographic techniques and take decisions while securing a network.	4

Lab Details:

S. No.	Particulars
1	Setting Up the System for testing purpose: Learning Basic Commands.
2	Software Requirements. Security Attacks: ARP Attacks (ARP Cache Poisoning, ARP Man in the Middle Attack).
3	IP Attacks (IP Fragmentation Attack, IP Teardrop Attack).
4	ICMP Attacks (Ping of Death, Smurf Attack, ICMP Destination Unreachable, ICMP Redirect, ICMP Source Quench).
5	TCP Attacks (SYN Flooding Attack, TCP RST Attack), UDP Attack.
6	Understand the Tools and Techniques: IEXPRESS 2.0, CAY KARAT, Damm Web Application Vulnerabilities (DWAV), WebGoat, ProRat Trojan, Key Logger, Steganographer etc.
7	Nmap Port Scanning: TCP Port Scanning (TCP Connect () Scanning, TCP SYN Scan, TCP FIN Scan, XMAS Scan, TCP NULL Scan).
8	UDP Port Scanning, Performing Stealth Scan of a Selected Computer.

Books Recommended:

6. Stallings, W., & Tahiliani, M. P. (2014). Cryptography and network security: principles and practice, vol. 6. *Editor: Pearson London*.

References:

1. Paar, C., & Pelzl, J. (2009). *Understanding cryptography: a textbook for students and practitioners*. Springer Science & Business Media.
2. Schneier, B. (2007). *Applied cryptography: protocols, algorithms, and source code in C*. john wiley & sons.
3. Kurose, J. F. (2005). *Computer networking: A top-down approach featuring the internet, 3/E*. Pearson Education India.

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Electives

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Simulation and Modelling	CST001	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Introduce students to the simulation and modelling techniques.	3
CO2	Understand the fundamental concepts of optimization, gain proficiency in basic probability concepts and explore local stability theory in the context of dynamical systems.	4
CO3	Provide students with opportunities to develop basic simulation and modelling skills with respect to carrying out research projects using any simulation method on the computer.	6
CO4	Gain insight into real-world problems encountered in engineering and biological sciences domains.	6

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Mathematical Model:** Types of Mathematical models and properties **Procedure of modelling:** Graphical method: Barterning model	**10**
Module 2	**Basic optimization, Basic probability:** Monte-Carlo simulation , Approaches to differential equation: Heun method , Local stability theory: Bernoulli Trials, Classical and continuous models	**10**
Module 3	**Simulation:** General techniques for simulating continuous random variables , simulation from Normal and Gamma distributions , Simulation from discrete probability distributions, Simulating a non – homogeneous Poisson Process and queuing system	**12**
Module 4	**Case Studies:** Case studies in problems of engineering and biological sciences	**10**

Books Recommended:

1. Giordano, F. R., Weir, M. D., & Fox, W. P. (2003). Mathematical modelling. *Thomson-Brookes/Cole*.
2. Law, A. M., Kelton, W. D., & Kelton, W. D. (2007). *Simulation modelling and analysis* (Vol. 3). New York: McGraw-Hill.

References:

1. Fowler, A. C. (1997). *Mathematical models in the applied sciences* (Vol. 17). Cambridge University Press.
2. S.M. Ross, Simulation, India Elsevier Publication.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Graph Theory	CST002	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Learn the basic terminology and results concerning graphs.	4
CO2	Learn proof techniques and algorithms involving graphs.	4
CO3	Learn how to apply computer programs to study graphs and open problems in graph theory	5
CO4	Provide an acquaintance with mathematical notation used to express physical and natural laws.	5

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Introduction:** Graph Terminology, Incidence and Degree, Isolated vertex, pendant vertex and Null Graph, Isomorphism, Walks, Paths and Circuits, Connected Graphs, Disconnected graphs and Components, Euler Graphs, Operations on graphs, Hamiltonian paths and circuits, The Travelling salesman problem, Konigsberg bridge problem, Three utility problem.	**10**
Module 2	**Trees:** Properties of Trees, Distance and Centres in a tree, Rooted and Binary Trees, Spanning Trees. Algorithms for finding minimal spanning tree: Kruskal algorithm, Prim's algorithm. **Cut-sets and Cut-Vertices:** Cut-sets, All cut-sets in a graph, Fundamental Circuits and cut-sets, connectivity and separability, Network Flows, 1-isomorphism, 2-isomorphism.	**12**
Module 3	**Planar and Dual Graphs:** Planar Graphs, Kuratowski's two graphs, Kuratowski's Theorem, Detection of planarity, Geometric dual, Combinatorial dual.	**10**

	Matrix Representation of Graphs: Incidence matrix, Circuit matrix, Cut-set matrix, path matrix and Adjacency matrix.	
Module 4	**Coloring, Covering, and Partitioning:** Chromatic number, Chromatic partitioning, Chromatic polynomial, Matching, Coverings, The Four Color problem. **Directed Graphs:** Types of digraphs, Euler Digraphs, Trees with directed edges, Matrix representation of digraphs, Tournaments, Acyclic digraphs and decyclization. **Graph theoretic Algorithms:** Shortest path algorithms, Dijkstra algorithm, Warshall - Floyd algorithm, Depth-First search in a graph, Breadth – first search in a graph.	**10**

Books Recommended:

1. Narsingh, D. (1974). *Graph theory with applications to engineering and computer science*. Prentice-Hall.
2. R.J. Wilson, Introduction to Graph Theory, Fourth Edition, Pearson Education, 2003.

References:

1. West, D. B. (2001). *Introduction to graph theory* (Vol. 2). Upper Saddle River: Prentice hall.
2. Even, S. (2011). *Graph algorithms*. Cambridge University Press.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Digital Signal Processing	CST003	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Develop methods for processing discrete-time signals.	6
CO2	Understand the processes of A-D and D-A conversion.	4
CO3	Acquire some familiarity with digital filters in terms of design and implementation and to become familiar with how various types of filters affect signal characteristics.	4
CO4	Understand the Discrete Fourier Transform and Discrete Spectral Analysis and become familiar with some applications of digital processing	5

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Discrete Time Signals And Systems :**Representation of discrete time signal – classifications – Discrete time – system – Basic operations on sequence – linear – Time invariant – causal – stable – solution to difference equation – convolution sum – correlation – Discrete time Fourier series – Discrete time Fourier transform.	**10**
Module 2	**Fourier And Structure Realization:** Discrete Fourier transform properties – Fast Fourier transform – Z-transform – structure realization – Direct form – lattice structure for FIR filter – Lattice structure for IIR Filter.	**10**
Module 3	**Filters:** FIR Filter – windowing technique – optimum equiripple linear phase FIR filter – IIR filter – Bilinear transformation technique – impulse invariance method – Butterworth filter – Tchebycheff filter.	**10**
Module 4	**Multistage Representation:** Sampling of band pass signal – anti aliasing filter – Decimation by an integer factor – interpolation by an integer factor – sampling rate conversion – implementation of digital filter banks – sub-band coding – Quadrature mirror filter – A/D conversion –	**12**

	Quantization – coding – D/A conversion – Introduction to wavelets. **Digital Signal Processors:** Fundamentals of fixed point DSP architecture – Fixed point number representation and computation – Fundamentals of floating point DSP architecture – floating point number representation and computation – study of TMS 320 C 54XX processor – Basic programming – addition – subtraction – multiplication – convolution – correlation – study of TMS 320 F2XXX processor – Basic programming – convolution – correlation.	

Books Recommended:

1. Proakis, J. G. (2007). *Digital signal processing: principles, algorithms, and applications, 4/E*. Pearson Education India.
2. Salivahanan, S., Vallavaraj, A., & Gnanapriya, C. (2001). Digital Signal Processing, McGraw-Hill.
3. Hu, Y. H. (Ed.). (2001). *Programmable Digital Signal Processors: Architecture: Programming, and Applications*. CRC Press.

References:

1. Rabiner, L. R., & Gold, B. (1975). Theory and application of digital signal processing. *Englewood Cliffs: Prentice-Hall*.
2. Ludeman, L. C. (1986). *Digital Signal Processing*. Addison-Wesley Longman Publishing Co., Inc...

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Multimedia Technology	CST004	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Understand the architecture and components of multimedia systems and gain knowledge of audio and speech processing techniques.	4
CO2	Learn about image acquisition, representation, compression techniques and understand the fundamentals of data communication and networking related to multimedia application.	5
CO3	Learn about hypermedia authoring and publishing techniques.	4
CO4	Provide programming training in multimedia computing, multimedia system design and implementations	6

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Introduction to Multimedia Systems:** Architecture and components, multimedia distributed processing model, synchronization, orchestration and quality of service architecture. **Audio and Speech:** Data acquisition, sampling and quantization, human speech production mechanism, digital model of speech Production, analysis and synthesis, psycho-acoustics, low bit rate speech compression, MPEG audio compression.	**10**
Module 2	**Images and Video:** Image acquisition and representation, composite video signal, NTSC, PAL and SECAM video standards; Bi-level image compression standards, JPEG and MPEG. **Multimedia Communication:** Fundamentals of data communication and networking, bandwidth requirements of different media; Real time constraints: Audio latency, video data rate; Multimedia over LAN and	**12**

	WAN, multimedia conferencing.	
Module 3	**Hypermedia Presentation:** Authoring and publishing, linear and nonlinear presentation, structuring information, different approaches of authoring hypermedia documents, hypermedia data models and standards.	**10**
Module 4	**Multimedia Information Systems:** Operating system support for continuous media applications, limitations of OS, new OS support, media stream protocol, file system support for continuous media, data models for multimedia and hypermedia information, content based retrieval of unstructured data.	**10**

Books Recommended:

1. Li, Z. N., Drew, M. S., & Liu, J. (2004). *Fundamentals of multimedia* (pp. 253-265). Upper Saddle River (NJ): Pearson Prentice Hall.
2. Hillman, D. (1998). Multimedia technology and applications. *(No Title)*.

References:

1. Steinmetz, R., & Nahrstedt, K. (2012). *Multimedia: computing, communications and applications*. Pearson Education India.
2. Koegel Buford, J. F. (Ed.). (1994). Multimedia systems.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Logic Programming	CST005	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Develop an understanding of basic knowledge and practical experience in logic programming.	4
CO2	Learn about the formal concepts used as a theoretical basis for logic programming.	4
CO3	Interpret problems in a style that suits logic programming.	3
CO4	Understand principles of declarative specification, and its relation to procedural realisations.	4

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Proposition Logic:** Introduction of logic and functional paradigm, propositional concepts, semantic table, problem solving with semantic table. **Natural Deduction and Axiomatic Propositional Logic:** Rules of natural deduction, sequent calculus, axiomatic systems, Meta theorems. Important properties of AL (Axiomatic Logic), resolution, resolving arguments.	**10**
Module 2	**Introduction to Predicate Logic:** Objects, predicates and quantifiers, functions, first order language, quantifiers, scope and binding, substitution. An axiomatic system for first order predicate logic, soundness and completeness, Axiomatic semantics and programming. **Semantic Tableaux & Resolution in Predicate Logic:** Semantic tableaux, instantiation rules, problem-solving in predicate logic, normal	**12**

	forms. Herbrand universes and H-interpretation, resolution, unification, resolution as a computing tool.	
Module 3	**Prolog Concepts:** Programming in Prolog (overview), Meta level programming and Meta interpreters. Nondeterministic programming, incomplete data structure, second order programming in Prolog. Logic grammars: definite clause grammar, A grammar interpreter.	**10**
Module 4	**Lazy and Eager Evaluation Strategies:** Evaluation strategies, Lazy evaluation: evaluation order and strictness of function, programming with lazy evaluation, interactive functional program, delay of unnecessary computation, infinite data structure, eager evaluation and reasoning.	**10**

Books Recommended:

1. Kelly, J. J. (1997). *The essence of logic*. Pearson Education India.
2. Kaushik, S. (2007). *Logic and prolog programming*. New Age International.
3. Hagiya, M., & Wadler, P. (Eds.). (2006). *Functional and Logic Programming: 8th International Symposium, FLOPS 2006, Fuji-Susono, Japan, April 24-26, 2006, Proceedings* (Vol. 3945). Springer.

References:

1. Chang, C. L., & Lee, R. C. T. (2014). *Symbolic logic and mechanical theorem proving*. Academic press.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Embedded Systems	CST006	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Develop a comprehensive understanding of microcontrollers, embedded processors, and their applications in various industries, including their role in controlling and monitoring embedded systems.	3
CO2	Gain insight into the internal architecture of microcontrollers and learn how to interface them with different peripheral devices such as sensors, actuators, displays, and communication modules.	4
CO3	Develop proficiency in writing programs for microcontrollers using programming languages such as C, assembly language, or embedded-specific languages, and understand the principles of embedded software development.	5
CO4	Gain familiarity with the design concepts and methodologies used in embedded system development.	4

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Introduction:** Concept of Real time Systems, Challenges in Embedded System Design. Introduction to Microcontrollers and Embedded Processors, Microcontrollers survey, four bit, eight bit, sixteen bit, thirty two bit Microcontrollers, Comparing Microprocessors and Microcontrollers, Overview of the 8051 family.	**10**
Module 2	**The 8051 Architecture:** Hardware, Oscillator and clock, program counter, data pointer, registers, stack and stack pointer, special function registers. **Memory organization:** Program memory, data memory, Input / Output Ports, External memory counter and timer, serial data Input / output, Interrupts.	**10**

Module 3	**8051 Assembly Language Programming:** Structure of Assembly language Assembling and running an 8051 program, Addressing modes, Accessing memory using various addressing modes. **Instruction set:** Arithmetic operations and Programs, Logical operations and Programs, Jump and Call instructions and Programs, I /O Port Programs, Single bit instructions and Programs, Timer and counter and Programs.	**12**
Module 4	**8051 Serial Communication:** Connection to RS-232, Serial Communication Programming, Interrupts Programming. **Microcontroller Interfacing:** Key Board, Displays, Pulse Measurement, D / A and A/D conversion, Stepper Motor **Basic concept of PIC microcontroller:** Microcontroller Architecture, PIC16F.	**10**

Books Recommended:

1. Mazidi, M. A., & Mazidi, J. G. (1999). *The 8051 Microcontroller and Embedded Systems with Disk*. Prentice Hall PTR.
2. Ayala, K. J. (1995). The 8051 microcontroller. *Penram, India*.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Advanced Java & Android Programming	CST007	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Develop an understanding of the Java Collections Framework.	4
CO2	Learn the basics of networking and socket programming in Java, including creating client-server applications, handling TCP/IP communication, and implementing protocols.	4
CO3	Gain proficiency in database connectivity using JDBC (Java Database Connectivity).	3
CO4	Gain familiarity with Android development using Java, including setting up the Android development environment, creating user interfaces, handling events, and deploying apps to Android devices.	6

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Collections:** Collection Interfaces, Concrete Collections, Collections Framework Multithreading: Creating thread and running it, Multiple Thread acting on single object, Synchronization, Thread communication, Thread group, Thread priorities, Daemon Thread, Life Cycle of Thread.	**10**
Module 2	**Networking:** Internet Addressing, Inet, Factory Methods, Instance Methods, TCP/IP Client Sockets, URL, URL Connection, TCP/IP Server Sockets, Datagram. Enterprise Java Bean: Preparing a Class to be a JavaBean, Creating a JavaBean, JavaBean Properties, Types of beans, Stateful Session bean, Stateless Session bean, Entity bean.	**10**
Module 3	**Java Database Connectivity (JDBC):** Merging Data from Multiple Tables: Joining, Manipulating Databases with JDBC, Prepared Statements, Transaction Processing, Stored Procedures C. Servlets:	**10**

	Servlet Overview and Architecture, Interface Servlet and the Servlet Life Cycle, Handling HTTP get Requests, Handling HTTP post Requests, Redirecting Requests to Other Resources, Session Tracking, Cookies, Session Tracking with Http Session.	
Module 4	**Introduction Smart Phone Application Development:** Android Architecture, User Interface Architecture, Activities and Intents, Threads, Services, Receivers and Alerts, User Interface layouts, user interface events, UI Widgets, Notification and Toast, Menus, Dialogs, Lists, Locations and Maps. Hardware interface-Camera, Sensors, Telephony, Bluetooth, Near Field communication, Working with Data Storage, Using Google maps, Animation and Content Providers. Network Communication, Services, Publishing your App.	**12**

Books Recommended:

1. Deitel, P. J., & Deitel, H. M. (2014). *Java SE 8 for programmers* (Vol. 8). Pearson Education.
2. Griffiths, D., & Griffiths, D. (2021). *Head First Android Development*. "O'Reilly Media, Inc.".

References:

1. Deitel, H. M. (2001). *Advanced Java 2 platform How to program*.
2. Goncalves, A. (2009). *Beginning Java EE 6 Platform with GlassFish 3: from novice to professional*. Apress.
3. Horton, J. (2015). *Android programming for beginners*. Packt Publishing Ltd.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	System on Chip	CST008	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Understand the fundamentals of SoC design, including its architecture, components, and integration of various hardware and software elements.	4
CO2	Gain an understanding of embedded systems and their role in SoC design, including microcontrollers, microprocessors, sensors, actuators, and communication interfaces.	4
CO3	Learn about hardware/software co-design methodologies for developing SoCs, including hardware/software partitioning, interface design, and co-simulation.	5
CO4	Apply the knowledge and skills acquired throughout the course to design, implement, and evaluate an application-specific SoC project, incorporating design constraints, performance requirements, and design trade-offs.	6

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Introduction:** Architecture of the present-day SoC - Design issues of SoC- Hardware-Software Code sign – Core Libraries – EDA Tools. **Design Methodology for Logic Cores:** SoC Design Flow – guidelines for design reuse – Design process for soft and firm cores – Design process for hard cores – System Integration. **Design Methodology for Memory and Analog Cores:** Embedded memories – design methodology for embedded memories – Specification of Analog circuits – High speed circuits.	**10**

Module 2	**Design Validation:** Core-Level validation – Core Interface verification - SoC design validation. **Core and SoC Design Examples:** Microprocessor Cores – Core Integration and On-chip bus – Examples of SoC.	**10**
Module 3	**Configurable Processors: A Software View:** Processor Hardware/Software Cogeneration, The Process of Instruction Definition and Application Tuning. The Basics of Instruction Extension d. The Programmer's Model .Processor Performance Factors. Example: Tuning a Large Task, Memory-System Tuning h. Long Instruction Words. **Configurable Processors: A Hardware View:** Application Acceleration: A Common Problem. Introduction to Pipelines and Processors. Hardware Blocks to Processors d. Moving from Hardwired Engines to Processors. Designing the Processor Interface. Novel Roles for Processors in Hardware Replacement, Processors, Hardware Implementation, and Verification Flow	**12**
Module 4	**Advanced Topics in SOC Design:** Pipelining for Processor Performance, Inside Processor Pipeline Stalls, Optimizing Processors to Match Hardware d. Multiple Processor Debug and Trace and Issues in Memory Systems.	**10**

Books Recommended:

1. Rajsuman, R. (2000). *System-on-a-chip: Design and Test*. Artech.
2. Furber, S. B. (2000). *ARM system-on-chip architecture*. Pearson Education.
3. Black, D. C., & Donovan, J. (Eds.). (2004). *SystemC: From the ground up*. Boston, MA: Springer US.

References:

1. Reis, R., & Jess, J. (2004). Design Of system on a chip devices and components.
2. Wang, L. T., Stroud, C. E., & Touba, N. A. (2007). System-on-chip test architectures: nanometer design for testability (systems on silicon).
3. Harris, D., & Harris, S. (2010). *Digital design and computer architecture*. Morgan Kaufmann.
4. Chu, P. P. (2006). *RTL hardware design using VHDL: coding for efficiency, portability, and scalability*. John Wiley & Sons.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Advanced Internet Technologies	CST009	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Gain a brief overview of the Internet, understand the basics of web server administration and markup languages.	4
CO2	Learn about the Document Object Model (DOM) for manipulating HTML and XML documents dynamically, including accessing and modifying document elements using JavaScript.	5
CO3	Understand the concept of Web Forms in ASP.NET and to learn the process of creating and hosting websites using ASP.NET.	6
CO4	Understand the architecture and components of the .NET Framework and to gain familiarity with creating Windows applications using .NET.	6

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Introduction to the Internet:** Brief overview of Internet, Internet and routing protocols, Web Server administration, Client Sever implementation, Cyber law, Search Engine Optimization Techniques, Web Based Systems. **Web 2.0:** Search, content networks, user-generated content, blogging, social networking, social media, tagging, social bookmarking, rich Internet applications, web services, location based services, Web 2.0 monetization and business models, future of the Web. **Mark up Languages (HTML, XHTML):** HTML, dynamic HTML, XHTML syntax, headings, linking, images, special characters and horizontal rules, lists, tables, forms, internal linking, Meta elements. **Cascading Style Sheets (CSS):** Separation of content and presentation,	**10**

	inline styles, embedded style sheets, conflicting styles, linking external style sheets, positioning elements, backgrounds, element dimensions, box model and text flow, media types, building a CSS drop-down menu, user style sheets.	
Module 2	**JavaScript:** Client side scripting, control statements, functions, arrays, objects, events. **Document object model:** Objects and collections, Extensible Mark-up Language (XML) and RSS: Advantages and applications, structuring data, XML namespaces, Document Type Definitions (DTDs), XML vocabularies, RSS. Other advanced internet technologies: including HTML5, JSON and JQuery.	**10**
Module 3	**Introduction to .NET:** Overview of the .NET Framework - Common Language Runtime – Framework Class Library - Understanding the C# Compiler. **Basics of C#:** Working with Variables - Making Decisions. Classes and Objects: Methods – Properties - Interface- Partial class- Null and Casting Handling Exceptions. **Windows and Dialogs:** MDI – Dialogs, Lists: List Box - Tree view control - Menus and Toolbars – Delegates and Events Generics. Data Access With .Net: ADO.NET overview - Commands - Data Reader - XML Schemas - Populating a dataset. .Net Programming with SQL Server: Reading and writing streamed Xml - converting ADO.Net to Xml data.	**12**
Module 4	**ASP.NET Web Forms and Controls:** Web Forms Controls -Data Binding and Data Source Controls – Validation, Controls-Master and Content pages. The Asp.Net Application Environment: Configuration Files - ASP.NET, Application Security -Caching. **Website Creation:** Creation and hosting of websites including data connectivity.	**10**

Books Recommended:

1. HM Deitel-Deitel & Associates, Inc. (2007). *Internet & World Wide Web: how to program*. Pearson Education India.
2. Stepp, M., Miller, J., & Kirst, V. (2012). *Web Programming Step by Step*. Step by Step Publishing.
3. Perry, S. C. (2006). Core C# and. NET.
4. Wright, H. (2006). *Beginning Visual C# 2005 Express Edition: From Novice to Professional*. Apress.

References:

1. Rodriguez, A., Gatrell, J., Karas, J., & Peschke, R. (2002). *TCP/IP Tutorial and Technical overview*. Saddle River, New Jersey: Prentice Hall.
2. Liebeherr, J., & Zarki, M. E. (2003). *Mastering Networks: An Internet Lab Manual*. Addison-Wesley Longman Publishing Co., Inc...
3. http://www2.sta.uwi.edu/~anikov/comp6350/links.htm
4. http://www.cs.utsa.edu/~cs4413
5. http://www2.sta.uwi.edu/~anikov/comp3500/lectures.htm

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Wireless Communication	CST010	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Understand the fundamentals of cellular communication systems, including the evolution from 2G to 5G, and the key technologies and standards driving each generation.	4
CO2	Learn essential cellular concepts such as frequency reuse, co-channel and adjacent channel interference, carrier-to-interference ratio (C/I), handoff mechanisms, blocking probability, and Erlang capacity.	4
CO3	Explore the effects of wireless propagation, including multipath fading, shadowing, and the various channel models used to characterize wireless communication environments.	5
CO4	Understand advanced wireless technologies and their applications in improving spectral efficiency and data rates in cellular systems.	6

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Cellular Systems:** Overview of Cellular Systems and evolution 2g/3G/4G/5G.	**10**
Module 2	**Cellular Concepts:** Frequency reuse, Co-channel and Adjacent channel Interference, C/I, Handoff, Blocking, Erlang Capacity.	**10**
Module 3	**Channel Models:** Multipath fading, Shadowing, Fading margin, Shadowing margin. **Wireless propagation**: Link budget, Free-space path loss, Noise figure of receiver, Antenna Diversity.	**12**
Module 4	**Wireless Channel Capacity:** Signal-to-noise ratio (SNR), modulation	**10**

	schemes. **Wireless technologies:** Code Division Multiple Access (CDMA), Multiple Input Multiple Output (MIMO), and Orthogonal Frequency Division Multiplexing (OFDM).	

Books Recommended:

1. Rong, Z., & Rappaport, T. S. (1996). *Wireless communications: Principles and practice, solutions manual*. Prentice Hall.
2. Goldsmith, A. (2005). *Wireless communications*. Cambridge university press.

References:

1. John, G. (1995). Proakis, Digital Communications, McGraw-Hill. *3rd edition*.
2. Haykin, S. S., & Moher, M. (2011). *Modern wireless communications*. Pearson Education India.
3. Molisch, A. F. (2012). *Wireless communications* (Vol. 34). John Wiley & Sons.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Fault Tolerant Computing	CST011	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Examine the concepts and techniques for redundant designs, which can make a system fault tolerant.	4
CO2	Discuss the importance of fault tolerance in the design of safety critical systems.	3
CO3	Examine testing techniques and algorithms in hardware, software and communications	4
CO4	Explore recent advancements and emerging topics in fault-tolerant systems, and understand their implications for designing resilient systems.	6

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Fundamental Concepts:** Definitions of fault tolerance, fault classification, fault tolerant attributes and system structure.	**10**
Module 2	**Fault-Tolerant Design Techniques:** Information redundancy, hardware redundancy, and time redundancy. **Dependability Evaluation Techniques:** Reliability and availability models: (Combinatorial techniques, Fault-Tree models, Markov models), Performability Models.	**10**
Module 3	**Architecture of Fault-Tolerant Computers (Case Study):** General-purpose systems, high-availability systems, long-life systems, critical systems. **Software Fault Tolerance:** Software faults and their manifestation, design techniques, reliability models.	**12**

	Fault Tolerant Parallel/Distributed Architectures: Shared bus and shared memory architectures, fault tolerant networks.	
Module 4	**Recent topics in fault tolerant systems:** Security, fault tolerance in wireless/mobile networks and Internet.	**10**

Books Recommended:

1. Koren, I., & Krishna, C. M. (2020). *Fault-tolerant systems*. Morgan Kaufmann.

References:

1. Johnson, B. W. (Ed.). (1988). *Design & analysis of fault tolerant digital systems*. Addison-Wesley Longman Publishing Co., Inc...

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Image Processing	CST012	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Gain an overview of digital image processing, including its definition, scope, and applications in various fields.	4
CO2	Learn about different image enhancement techniques, and understand the process of image restoration and reconstruction.	4
CO3	Explore color image processing techniques, image compression and segmentation and understand their applications in analyzing and interpreting color images.	5
CO4	Gain an introduction to pattern recognition.	4

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Introduction:** Digital Image Processing, Steps in Digital Image Processing, Components of image processing System, Image sensing and acquisition, sampling and quantization, relationships between pixels.	**10**
Module 2	**Image enhancement techniques:** Spatial domain, Frequency domain and using Fuzzy techniques. Intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters. Filtering in the Frequency Domain. **Image Restoration and Reconstruction:** A Model of the Image Degradation/Restoration Process, Noise Models, Restoration in the Presence of Noise Only-Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering Linear, Position Invariant Degradations, Inverse Filtering, Wiener Filtering, Constrained Least Squares Filtering, Geometric Mean Filter.	**12**
Module 3	**Color Image Processing:** Color Models, Color Transformations, Image Segmentation Based on Color. Wavelets and Multi-resolution Processing:	**10**

	Background, Multi-resolution Expansions, Wavelet Transforms in One Dimension **Image Compression and Segmentation:** Fundamentals, Image Compression Models, Compression Methods, Point, Line, and Edge Detection, Thresholding, Region-Based Segmentation.	
Module 4	**Pattern Recognition:** Introduction, importance, Features, Feature vectors, and classifiers, Supervised, unsupervised and semi-supervised Learning, Bayes Decision Theory, Bayesian classification for Normal Distributions, The Naive - Bayes Classifier, The Nearest Neighbor Rule.	**10**

Books Recommended:

1. Gonzalez, R. C. (2009). *Digital image processing*. Pearson education India.
2. Koutroumbas, K., & Theodoridis, S. (2008). *Pattern recognition*. Academic Press.

References:

1. Pratt, W. K. (2007). *Digital image processing: PIKS Scientific inside* (Vol. 4). Hoboken, New Jersey: Wiley-interscience.
2. Anil K. Jain, "Fundamentals of Digital Image Processing", Prentice-Hall India, 2007.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	System Design using HDL	CST013	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Gain proficiency in VHDL for describing combinational networks, modeling flip-flops, multiplexers, and counters, and understand compilation and simulation processes for VHDL code.	4
CO2	Understand state machine charts for digital design, including their derivation, realization, and implementation in VHDL, and apply them to design and implement digital systems like the dice game.	4
CO3	Explore different types of PLDs such as read-only memories (ROMs), programmable logic arrays (PLAs), and design methodologies for sequential PLDs, and apply them in designing a keypad scanner.	5
CO4	Explore advanced topics in VHDL and develop VHDL models for memories to understand their applications in digital system design.	5

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Introduction:** VHDL description of combinational networks, Modeling flip-flops using VHDL, VHDL models for a multiplexer, Compilation and simulation of VHDL code, Modeling a sequential machine, Variables, Signals and constants, Arrays, VHDL operators, VHDL functions, VHDL procedures, Packages and libraries, VHDL model for a counter.	**10**
Module 2	**Digital Design with SM Charts:** State machine charts, Derivation of SM charts, Realization of SM charts. Implementation of the dice game, Alternative realization for SM charts using microprogramming, Linked state machines. **Designing With Programmable Gate Arrays And Complex Programmable Logic Devices:** Xlinx 3000 series FPGAs, Designing with FPGAs, Xlinx 4000 series FPGAs, using a one- 2 106 hot state	**10**

	assignment, Altera complex programmable logic devices (CPLDs), Altera FELX 10K series COLDs.	
Module 3	**Designing With Programmable Logic Devices:** Read-only memories, Programmable logic arrays (PLAs), Programmable array logic (PLAs), Other sequential programmable logic devices (PLDs), Design of a keypad scanner. **Design Of Networks For Arithmetic Operations:** Design of a serial adder with accumulator, State graphs for control networks, Design of a binary multiplier, Multiplication of signed binary numbers, Design of a binary divider. **Floating - Point Arithmetic:** Representation of floating-point numbers, Floating-point multiplication, and Other floating-point operations.	**12**
Module 4	**Additional Topics In VHDL:** Attributes, Transport and Inertial delays, Operator overloading, Multi-valued logic and signal resolution, IEEE-1164 standard logic, Generics, Generate statements, Synthesis of VHDL code, Synthesis examples, Files and Text IO. **VHDL Models For Memories And Buses:** Static RAM, A simplified 486 bus	**10**

Books Recommended:

1. Roth, C. H. (1998). *Digital systems design using VHDL*. Wadsworth Publ. Co...
2. Ashenden, P. J. (2008). *The student's guide to VHDL*. Elsevier.

References:

1. Brown, S. (2005). *Fundamentals of digital logic with VHDL design*.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Real Time Systems	CST014	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Explain the fundamental principles underlying the programming of real-time systems, including the concepts of time and resource constraints, and the importance of meeting deadlines in real-time applications.	4
CO2	Understand the design principles and functionalities of real-time operating systems (RTOS), including task scheduling algorithms, interrupt handling mechanisms, resource management, and synchronization mechanisms to ensure timely and deterministic execution of tasks.	4
CO3	Demonstrate proficiency in using real-time system programming languages and real-time operating systems for developing real-time applications.	5
CO4	Analyze real-time systems with regard to meeting time and resource restrictions, including performance analysis, profiling, and debugging techniques to identify bottlenecks, latency issues, and resource contention in real-time applications.	4

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Real Time Systems:** Concept of Real Time System, Performance measures of Real Time System, Real Time Application. Real time computing - Concepts; Structure of a real time system – Characterization of real time systems and tasks - Hard and Soft timing constraints - Issues in real time computing, Design Challenges - Performance metrics - Prediction of Execution Time : Source code analysis, Micro-architecture level analysis, Cache and pipeline issues- Programming Languages for Real-Time Systems.	**10**

Module 2	**Task Assignment and Scheduling:** Different task model, Scheduling hierarchy, Offline versus Online Scheduling, Clock Drives. Model of Real Time System, **Scheduling:** Hierarchy scheduling of Periodic Task - Assumptions, fixed versus dynamic priority algorithms, schedulability test for fixed priority task with arbitrary deadlines. Scheduling of A-periodic and Sporadic Tasks. Scheduling for applications having flexible constrains, Scheduling Real Time Tasks in Multiprocessor and Distributed Systems.	**12**
Module 3	**Resources and Resource Access Control:** Handling Resource sharing and dependency among real time tasks - Assumptions on resources and their usage, resource contention, resource access control (Priority Ceiling Protocol, Priority Inheritance protocol, Slack Based Priority Ceiling Protocol, Pre-emption Ceiling Protocol).	**10**
Module 4	**Communication and Databases:** Real Time Communication (hard and soft real time communication, traffic scheduling disciplines, QoS guarantees), Real Time Databases (Optimistic vs Pessimistic concurrency control protocols).	**10**

Books Recommended:

1. C.M. Krishna, Kang G. Shin, Real Time Systems, International Edition, McGraw Hill Companies.
2. Liu, J. W. (2006). *Real-time systems*. Pearson Education India.

References:

1. Laplante, P. A. (2004). *Real-time systems design and analysis* (p. xxi). New York: Wiley.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Unix & Shell Programming	CST015	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Understand the basics of file and directory structure in Unix, including file permissions, directory hierarchy, and devices, and learn common commands for file and directory manipulation.	4
CO2	Learn about command line structure, meta characters, creating new commands, shell variables, input/output redirection, loops, conditional expressions, and shell attributes for customizing command line behaviour.	4
CO3	Develop proficiency in customizing commands, program arguments and writing shell scripts for automating tasks, including functions, loops, traps for handling interrupts, file manipulation, and program development using Unix system calls.	6
CO4	Learn the basics of program development in Unix, including writing simple programs using built-in functions, and performance evaluation techniques and explore document preparation techniques.	5

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**File and common commands** - Shell - More about files Directories- Unix system - Basics of file Directories and filenames - Permissions - modes - Directory hierarchy - Devices – the grep family - Other filters - the stream editor sed - the awk pattern scanning and processing language - files and good filters.	**10**
Module 2	**Command line structure**: Meta characters - Creating new commands - Command arguments and parameters - program output as arguments – Shell variables - More on I/O redirection - loop in shell programs - Bundle - Setting shell attributes, Shift command line parameters - Exiting a command or the shell, evaluating arguments - Executing command	**10**

	without invoking a new process - Trapping exit codes – Conditional expressions.	
Module 3	**Customizing the cal command**: Functions of command, While and Until loops - Traps - Catching interrupts - Replacing a file Overwrite - Zap - Pick command – News command - Get and Put tracking file changes. **Standard input and output:** Program arguments - file access - A screen at a time printer - On bugs and debugging - Examples Zap pick - Interactive file comparison program - Accessing the environment - Unix system calls – Low level I/O, File system Directories and modes, Processors, Signal and Interrupts.	**12**
Module 4	**Program development**: Four function calculator - Variables and error recovery – Arbitrary variable names, Built in functions, Compilation into a machine, Control flow and relational operators, Functions and procedures - Performance evaluation Ms macro package – Troff level – Tbl and eqnpreprocessors Manual page - Other document preparation.	**10**

Books Recommended:

1. Maurice, J. (1986). *The Design of the Unix Operating System*. Prentice Hall.
2. Forouzan, B. A., & Gilberg, R. F. (2003). UNIX and Shell programming: a textbook.
3. Das, S. (2005). *Your UNIX: The ultimate guide*. McGraw-Hill, Inc...

References:

1. Glass, G., & Ables, K. (1999). *UNIX for Programmers and Users*. Prentice Hall.
2. Kernighan, B. W., & Pike, R. (1984). *The UNIX programming environment* (Vol. 270). Englewood Cliffs, NJ: Prentice-Hall.
3. Rosen, K. H., Host, D. A., Klee, R., & Rosinski, R. R. (2006). *UNIX: the complete reference*. McGraw-Hill, Inc...

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	High Speed Networks	CST016	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Develop an understanding of the basics of high speed networking technologies.	4
CO2	Gain an overview of LAN technologies.	4
CO3	Learn about queuing models and their characteristics, explore congestion control mechanisms and traffic management techniques in high-speed networks.	3
CO4	Understand the principles of TCP and ATM congestion control mechanisms.	4

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**High speed networks**: Frame Relay Networks, Asynchronous transfer mode, ATM Protocol Architecture, ATM logical connection, ATM Cell, ATM Service Categories, AAL.	**10**
Module 2	**High Speed LANs:** Overview of LAN technologies, Evolution of high-speed LANs, Importance and applications of high-speed LANs.	**10**
Module 3	**Queuing Models:** Single Server Queues, Effects of Congestion, Congestion Control, Traffic Management, Congestion Control in Packet Switching Networks, Frame Relay Congestion Control.	**12**
Module 4	**TCP and ATM congestion control**: Integrated and Differentiated services, Integrated services architecture approach, components, services, queuing, protocols for QoS support.	**10**

Books Recommended:

1. Forouzan, B. A. (2007). *Data communications and networking*. Huga Media.

2. Stallings, W. (1999). *ISDN and Broadband ISDN with Frame Relay and ATM*. Pearson Education India.

References:

1. Tanenbaum, A. S. (2003). Computer Networks Forth Edition. *Vrije Universiteit*.
2. Sheldon, T. (2001). *McGraw-Hill's Encyclopedia of Networking and Telecommunications*. McGraw-Hill Professional.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Advanced Algorithms	CST017	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Gain a foundational understanding of algorithms as problem-solving techniques and learn the importance of algorithmic efficiency and correctness in solving computational problems.	4
CO2	Explore various algorithm design paradigms and how to apply different algorithmic strategies to solve different types of problems.	3
CO3	Understand the concept of approximation algorithms and their applications.	4
CO4	Learn the basics of linear programming, including initial basic feasible solutions, feasibility of systems and explore the concepts of NP-hard and NP-complete classes in computational complexity theory.	4

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Analysis of Algorithms:** Review of algorithmic strategies, asymptotic analysis: upper and lower complexity bounds. Identifying differences among best, average and worst case behaviours. Big O, little O, omega and theta notations, Standard complexity classes. Empirical measurements of performance. Time and space trade-offs in algorithms. Analysing recursive algorithms using recurrence relations.	**10**
Module 2	**Fundamental Computing Algorithms:** Numerical algorithms, Sequential and binary search algorithms. Quadratic sorting algorithms and O (n log n) sorting algorithms. Algorithms on graphs and their complexities using Greedy Approach for – Prim's and Kruskal Algorithm for minimum spanning tree, Single source shortest path Algorithm, all pair shortest paths in Graph – Bellman Ford Algorithm, Floyd Warshall	**12**

	Algorithm.	
Module 3	**Approximation Algorithms:** Introduction, Approximation Algorithms for – Vertex Cover, Sum of Subsets, TSP, Job scheduling, Knapsack Problems. Probabilistically good algorithms, Polynomial Time Approximation.	**10**
Module 4	**Linear Programming:** Introduction, initial basic feasible solution. Feasibility of a system, Simplex Algorithm. Standard and Slack forms, Formulation of problems as linear programs, Checking Feasibility of System using B – Rule Algorithm. Optimization. KKT Algorithm. Expectations: Introduction, Moments, Expectations of functions of more than one random variable. **Computational complexity:** Complexity measures, Polynomial versus non-polynomial time complexity; NP hard and NP complete classes.	**10**

Books Recommended:

1. Trivedi, K. S. (2008). *Probability & statistics with reliability, queuing and computer science applications*. John Wiley & Sons.
2. Leiserson, C. E., Rivest, R. L., Cormen, T. H., & Stein, C. (1994). *Introduction to algorithms* (Vol. 3). Cambridge, MA, USA: MIT press.

References:

1. Skiena, S. S. (1998). *The algorithm design manual* (Vol. 2). New York: springer.
2. Knuth, D. E. (2007). Computer programming as an art. In *ACM Turing award lectures* (p. 1974).
3. Goodrich, M. T., & Tamassia, R. (2001). *Algorithm design: foundations, analysis, and internet examples*. John Wiley & Sons.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Reconfigurable Computing	CST018	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Gain knowledge of device architecture in reconfigurable computing.	4
CO2	Learn how to program FPGA applications using Hardware Description Languages (HDLs) and techniques for technology mapping in reconfigurable computing.	3
CO3	Explore instance-specific design techniques for reconfigurable computing.	4
CO4	Study real-world case studies of FPGA applications.	5

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Reconfigurable Computing Hardware:** Device Architecture, Reconfigurable Computing Architectures, Reconfigurable Computing Systems, Reconfiguration Management.	**10**
Module 2	**Programming Reconfigurable Systems:** Compute Models and System Architectures, Programming FPGA Applications in VHDL, Compiling C for Spatial Computing, Stream Computations Organized for Reconfigurable Execution, Programming Data Parallel FPGA Applications Using the SIMD/Vector Model, Operating System Support for Reconfigurable Computing. **Mapping Designs to Reconfigurable Platforms:** Technology Mapping, FPGA Placement for General-purpose FPGAs, Data-path Composition, Specifying Circuit Layout on FPGAs, Retiming, Re-pipelining, and C-slow Retiming, Configuration Bit-stream Generation, Fast Compilation Techniques.	**12**

Module 3	**Application Development:** Implementing Applications with FPGAs, Instance-specific Design, Precision Analysis for Fixed-point Computation, Distributed Arithmetic, CORDIC Architectures for FPGA Computing, Hardware/Software Partitioning.	**10**
Module 4	**Case Studies of FPGA Applications:** SPIHT Image Compression, Automatic Target Recognition Systems on Reconfigurable Devices, Boolean Satisfiability: Creating Solvers Optimized for Specific Problem Instances, Multi-FPGA Systems: Logic Emulation, Finite Difference Time Domain: A Case Study Using FPGAs, Network Packet Processing in Reconfigurable Hardware.	**10**

Books Recommended:

1. Hauck, S., & DeHon, A. (2010). *Reconfigurable computing: the theory and practice of FPGA-based computation*. Elsevier.

References:

1. Bobda, C., & Hartenstein, R. (2007). *Introduction to reconfigurable computing: architectures, algorithms, and applications* (Vol. 1, No. 1.5). Netherlands: Springer.
2. Nurmi, J. (Ed.). (2007). *Processor design: system-on-chip computing for ASICs and FPGAs*. Springer Science & Business Media.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Computer Vision	CST019	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Introduce students the fundamentals of image formation.	4
CO2	Introduce students the major ideas, methods, and techniques of computer vision and pattern recognition.	3
CO3	Develop an appreciation for various issues in the design of computer vision and object recognition system.	5
CO4	Provide the student with programming experience from implementing computer vision and object recognition applications.	6

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Introduction:** History about computer vision, introduction to vision, computer graphics, image processing, human and computer vision. **Image Formation Models:** Monocular imaging system, Orthographic & Perspective Projection, Camera model and Camera calibration, Binocular imaging systems. **Recognition Methodology:** Conditioning, Labeling, Grouping, Extracting and Matching.	**10**
Module 2	**Morphological Image Processing:** Introduction, Dilation, Erosion, Opening, Closing, Hit-or-Miss transformation, Morphological algorithm operations on binary images, Morphological algorithm Operations on gray-scale images, Thinning, Thickening, Region growing, region shrinking. **Image Representation and Description:** Representation schemes, Boundary descriptors, Region descriptors.	**10**

	Binary Machine Vision: Thresholding, Segmentation, Connected component labeling, Hierarchal segmentation, spatial clustering, Split & merge, Rule-based Segmentation, Motion based segmentation.	
Module 3	**Area Extraction:** Concepts, Data-structures, Edge, Line Linking, Hough transform, Line fitting, Curve fitting (Least square fitting). **Region Analysis:** Region properties, External points, spatial moments, mixed spatial gray-level moments, Boundary analysis: Signature properties, Shape numbers. **Facet Model Recognition:** Labeling lines, Understanding line drawings, Classification of shapes by labeling of edges, Recognition of shapes, Consisting labeling problem, Backtracking Algorithm Perspective Projective geometry, Inverse perspective Projection, Photogrammetry - from 2D to 3D.	**10**
Module 4	**Image matching:** Intensity matching of ID signals, Matching of 2D image, Hierarchical image matching, 2D representation, Global vs. Local features. **General Frame Works for Matching:** Distance relational approach, ordered structural matching, View class matching, Models database organization. **Knowledge Based Vision:** Knowledge representation, Control strategies, Information Integration. **Object recognition:** Hough transforms and other simple object recognition methods, Shape correspondence and shape matching Principal component analysis, Shape priors for recognition.	**12**

Books Recommended:

1. Haralick, R. M., & Shapiro, L. G. (1992). *Computer and robot vision* (Vol. 1). Reading, MA: Addison-wesley.
2. Forsyth, D. A., & Ponce, J. (2002). *Computer vision: a modern approach*. Prentice hall professional technical reference.
3. Trucco, E., & Verri, A. (1998). *Introductory techniques for 3-D computer vision* (Vol. 201, pp. 10-5555). Englewood Cliffs: Prentice Hall.

References:

1. Sonka, M., Hlavac, V., & Boyle, R. (2013). *Image processing, analysis and machine vision*. Springer.
2. Horn, B. (1986). *Robot vision*. MIT press.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Advanced Computer Network	CST020	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Review fundamental concepts of computer networks and the principles of layered communication and how different layers interact in network communication.	4
CO2	Explore Transport and Application layer protocols.	4
CO3	Learn about wireless links and wireless network architectures.	3
CO4	Understand protocols for real-time interactive applications and gain an understanding of basic cryptographic concepts including symmetric and public-key algorithms.	5

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Introduction to Computer Networks:** Review – Computer networks and layered architecture. Asynchronous Transfer Mode: ATM layered model, switching and switching fabrics, network layer in ATM, QOS, and LAN emulation.	**10**
Module 2	**Transport Layer:** Elements of transport protocols; Internet transport protocols: TCP and UDP, TCP connection management, congestion control. **Application Layer:** Network application architectures: Client-server, P2P and hybrid; Application layer protocols: DNS, FTP, TFTP, TELNET, HTTP and WWW, SMTP and electronic mail; Network management and SNMP.	**10**
Module 3	**Wireless and Mobile:** Wireless and Mobile Networks: Wireless links and network characteristics, 802.11 wireless LANs, mobility management, addressing and routing, mobile IP, WAP, mobility in cellular networks.	**10**
Module 4	**Multimedia Networking:** Streaming audio and video, RTSP, jitter removal and recovery from lost packets; Protocols for real-time interactive applications: RTP, RTCP, SIP, H.323; Content distribution	**12**

	networks; Integrated and differentiated services, RSVP. **Introduction to Network Security:** Cryptography, symmetric and public-key algorithms, digital signatures, communication security, authentication protocols, Email security, PGP and PEM.	

Books Recommended:

1. Kurose, J. F., & Ross, K. W. Computer Networking.

References:

1. Comer, D. (2004). *Computer networks and internets: with internet applications* (Vol. 1). Pearson Education India.
2. Walrand, J., & Varaiya, P. P. (2000). *High-performance communication networks*. Morgan Kaufmann.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Advanced Computer Graphics	CST021	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Understand the basics of geometry processing.	4
CO2	Understand and work with advanced rendering methods.	4
CO3	Design programs for advanced animation methods.	6
CO4	Understand issues of modern graphics research.	4

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Advanced Rendering Techniques:** Photorealistic rendering, Global Illumination, Participating media rendering, Ray tracing, Monte Carlo algorithm, Photon mapping.	**10**
Module 2	**Texture Synthesis and Image Processing:** Environmental mapping, Texture synthesis, anisotropic image smoothing.	**10**
Module 3	**Volume Rendering:** Volume graphics overview, Marching cubes, Direct volume rendering.	**10**
Module 4	**Surfaces and Meshes:** Subdivision, Distance fields and level sets. **Physically-based Modeling:** Stable fluid solver, Lattice Boltzmann method.	**12**

Books Recommended:

1. Foley, J. D., & Van Dam, A. (1996). Steven K. Feiner, and John F. Hughes. *Computer Graphics: Principles and Practice, Addison-Wesley Publishing Company, Reading, Massachesetts.*
2. Alan, W., & Mark, W. (1992). Advanced animation and rendering techniques. *Theory and Practice Wokingham*, 339-368.

References:

1. Humphreys, G., & Pharr, M. (2004). *Physically Based Rendering*. Morgan Kaufmann.
2. Moller, T., Haines, E., Hoffman, N., Pesce, A., Iwanicki, M., & Hillaire, S. (2002). Real-Time Rendering, AK Peters.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Advanced Database Management Systems	CST022	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Gain a solid understanding of the fundamental concepts underlying physical database systems.	4
CO2	Learn about concepts of transaction processing in database systems.	4
CO3	Gain an understanding of semi-structured data and explore XML-related technologies.	4
CO4	Understand the motivation behind exploring emerging trends in database technologies and learn techniques for optimizing the performance of database applications.	3

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Physical Database Design & Tuning:** Database workloads, physical design and tuning decisions, Need for Tuning Index selection: Guideline for index selection, Clustering & Indexing Tools for index selection Database Tuning: Tuning indexes, Tuning Conceptual schema Tuning Queries &views, Impact of Concurrency, Benchmarking.	**10**
Module 2	**Advanced Transaction Processing:** Transaction Processing Monitors, Transactional Workflow, Real time transaction System, Long duration Transactions, Transaction Management in Multi-databases, Distributed Transaction Management, Main Memory Databases, and Advanced Transaction Models.	**10**
Module 3	**Semi-Structured Data and XML:** Semi-Structured Data, Introduction to XML, XML hierarchical Model, DTD & XML schema, XML Namespace, XML query & Transformation: Xpath, XSLT, XQuery, Storage of XML data, XML Technologies: DOM &SAX Interfaces X pointer, Xlink, XHTML, SOAP, WSDL, UDDI, XML database Application.	**10**

Module 4	**Emerging Trends in Databases:** Introduction, Motivation, Temporal databases, Spatial & geographic databases, Multimedia Databases, Mobility & personal Databases. **Advanced Application Development**: Performance Tuning, Performance Benchmarks, Standardization, E-Commerce, Legacy Systems, Large-scale Data Management with HADOOP, Semi structured database COUCHDB: Introduction, Architecture and principles, features.	**12**

Books Recommended:

1. Silberschatz, A. (1999). Henry F. Korth. *Sudarsham, 《Database System Concept》, McGraw--Hill*.
2. Ceri, S., & Pelagatti, G. (1984). *Distributed databases principles and systems*. McGraw-Hill, Inc...
3. Connolly, T. M., & Begg, C. E. (2005). *Database systems: a practical approach to design, implementation, and management*. Pearson Education.

References:

1. Abiteboul, S., Manolescu, I., Rigaux, P., Rousset, M. C., & Senellart, P. (2011). *Web data management*. Cambridge University Press.
2. Ramakrishnan, R., Derstadt, J. G. J., Selikoff, S., & Zhu, L. (2006). Database Management Systems Solutions Manual. *University of Winconsin, USA*.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Advanced Computer Architecture	CST023	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Learn basic understanding of Modern Computer Architecture.	4
CO2	Gain a solid understanding of the Multi-Threading and Multi-Core programming concepts.	4
CO3	Identify cache and memory related issues in multi-processors.	4
CO4	Learn about the various techniques used to obtain performance improvement and power savings in current processors	3

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Modern Computer Architectures**: Introduction, Fundamentals of RISC, CISC, Instruction Level Parallelism (ILP) – Concepts and Challenges, Branching with Prediction, Dynamic Scheduling: Hazards and Solutions, Measuring Performance of ILP, Limitations of ILP.	**10**
Module 2	**Thread Level Parallelism & Multi-Core Architecture:** Thread Level Parallelism, Simultaneous Multi-Threading, Multi-Processor Architecture: Types, Limitations; Evolution of Multi-Core, Architecting with Multi-Core: Homogenous and heterogeneous cores, Shared recourses, shared busses, and optimal resource sharing strategies, Performance Evaluation of Multi-Core Processors.	**10**
Module 3	**Memory Module Design:** Conceptual view of memory cell, Memory address map, Memory connections to CPU, Cache memory-Cache memory management techniques. Types of cache's: Look through, look aside, write through, write around, unified Vs. Split, multilevel, cache levels. Shared memory multiprocessors, Synchronization, small-scale symmetric multiprocessors on a snoopy bus, cache coherence on snoopy buses, Scalable multiprocessors, Directory based cache coherence, Interconnection network, Memory consistency models, Software	**10**

	distributed shared memory.	
Module 4	**Multi-Threading Concepts:** Fundamentals of Multi-threaded programming, Concurrency vs. Parallelism, Threading design concepts for developing an application, Correctness Concepts: Critical Region, Mutual exclusion, Synchronization, Race Conditions. Performance Concepts: Simple Speedup, Computing Speedup, Efficiency, Granularity, Load Balance. Multithreading in hardware, Chip multiprocessing, current research and future trends. **Multi-Core Programming:** Introduction to OpenMP, OpenMP directives, Parallel constructs, Work-sharing constructs, Data environment constructs, Synchronization constructs, Extensive API library for finer control, benchmarking multi-core architecture: Bench marking of processors. Comparison of processor performance for specific application domains.	**12**

Books Recommended:

1. Hennessy, J. L., & Patterson, D. A. (1990). Computer architecture.
2. Akhter, S., & Roberts, J. (2006). *Multi-core programming* (Vol. 33). Hillsboro, Oregon: Intel press.

References:

1. Heuring, V. P., Jordan, H. F., & Murdocca, M. (1997). *Computer systems design and architecture* (pp. 519-520). Addison-Wesley.
2. Chapman, B., Jost, G., & Van Der Pas, R. (2007). *Using OpenMP: portable shared memory parallel programming*. MIT press.
3. H. J. Siegel. Interconnection Network for Large Scale Parallel Processing, McGraw Hill, 1990.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Advanced Compilation Techniques	CST024	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Understand the structure and architecture of compilers, including their components and phases.	4
CO2	Learn about basic blocks and loops in control and data flow analysis techniques and explore scalar optimization techniques.	4
CO3	Analyse instruction scheduling techniques for pipelined architecture, delayed-load architectures and understand performance evaluation techniques for compilers.	4
CO4	Explore loop transformations and learn about automatic memory management techniques such as garbage collection and their impact on data locality.	5

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Introduction:** Compiler structure, architecture and compilation, sources of improvement.	**10**
Module 2	**Control flow analysis:** Basic blocks & loops. Data flow analysis and optimizations: bit vectors, iterative frameworks, interval analysis, reaching definitions, liveness, common sub expression elimination, constant propagation. Control flow analysis: dominators, control dependence. **Static-single assignment:** Static-single assignment, constant propagation. **Scalar optimization:** loop invariant code motion, common sub expression elimination, strength reduction, dead code elimination, loop optimizations, etc.	**10**

Module 3	**Instruction scheduling:** Pipelined architectures, delayed-load architectures, list scheduling. **Register allocation:** coloring, allocation, live range splitting. **Performance evaluation:** Interprocedural analysis: side effects, flow-insensitive, flow-sensitive, constants, inlining. **Alias analysis:** alias analysis, method resolution. Searching, indexing, and their implications to memory management. Information extraction and feature selection. Points-to Analysis Supervised, unsupervised-learning, and stream mining.	**12**
Module 4	**Data dependence analysis:** Dependence testing, dependence graphs. **Loop transformations:** Interchange, tiling, fusion, distribution, splitting Just-in-time compilation: fast global optimization. **Garbage collection:** Automatic memory management and data locality. Optimal Integrated Code Generation with OPTIMIST.	**10**

Books Recommended:

1. Alfred, V., Monica, S., Ravi, S., & Jeffrey D, U. (2007). Compilers Principles, Techniques.
2. Masthan, G. B. (1993). Mapping and Compilation-Methods and Techniques. *Geological Society of India*, *42*(4), 423-423.

References:

1. http://www.ece.cmu.edu/~ece447/s13/lib/exe/fetch.php?...advancedcaching...ppt
2. Bacon, D. F., Graham, S. L., & Sharp, O. J. (1994). Compiler transformations for high-performance computing. *ACM Computing Surveys (CSUR)*, *26*(4), 345-420.
3. Padua, D. A., & Wolfe, M. J. (1986). Advanced compiler optimizations for supercomputers. *Communications of the ACM*, *29*(12), 1184-1201.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Principles of Cryptography	CST025	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Provide a basic introduction to central aspects of symmetric and asymmetric cryptography.	4
CO2	Gain proficiency in fundamental mathematical concepts relevant to cryptography.	3
CO3	Explore classical cryptosystems and their vulnerabilities and learn about stream ciphers, block ciphers, cryptographic hash functions and message authentication codes (MACs) for data integrity and authentication.	5
CO4	Analyse the public key cryptography and its relevance in modern cryptographic algorithms.	4

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Introduction to Cryptography:** Basics of Symmetric Key Cryptography, Basics of Asymmetric Key Cryptography, Hardness of Functions.	**10**
Module 2	**Mathematical Background for Cryptography:** Number Theory, GCD, Groups, Rings, Fields, Properties, Chinese Remainder Theorem.	**10**
Module 3	**Classical Cryptography:** Introduction to Some simple cryptosystems and their Cryptanalysis. Shannon's Theory, Secret vs. Public Key Cryptography. **Stream ciphers and Block Ciphers:** DES and Alternatives, AES, Cryptographic Hash Functions and MAC.	**10**
Module 4	**Public Key Cryptography:** RSA Cryptosystem and Factoring Integers. **Discrete Logarithm Problems:** Discrete Logarithm Problem in Prime	**12**

	Fields, Generalized Discrete Logarithm Problem. Attacks against Discrete Logarithm Problem. Public Key Cryptosystems based on the Discrete Logarithm Problem. **Elliptic Curve Cryptography:** Elliptic Curve Cryptosystems. Digital Signatures.	

Books Recommended:

1. Delfs, H., Knebl, H., & Knebl, H. (2002). *Introduction to cryptography* (Vol. 2). Heidelberg: Springer.
2. Mao, W. (2003). *Modern cryptography: theory and practice*. Pearson Education India.

References:

1. Boneh, D., & Shoup, V. (2020). A graduate course in applied cryptography. *Draft 0.5*.
2. Katz, J., & Lindell, Y. (2007). *Introduction to modern cryptography: principles and protocols*. Chapman and hall/CRC.
3. Katz, J., & Lindell, Y. (2007). *Introduction to modern cryptography: principles and protocols*. Chapman and hall/CRC.
4. Goldrech, O. (2001). Foundations of Cryptography Teaching Notes.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Neural Networks	CST026	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Introduce major deep learning algorithms, the problem settings, and their applications to solve real world problems.	4
CO2	Understand the role of neural networks in engineering, artificial intelligence, and cognitive modelling.	4
CO3	Provide knowledge in developing the different algorithms for neural networks	3
CO4	Design and implement Neuro evolution algorithms to evolve neural networks for solving complex tasks and optimizing performance in various domains.	6

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Introduction to neural networks:** Biological and Artificial neurons, McCulloch Pitts Neuron, Thresholding Logic, Perceptron's, Perceptron Learning Algorithm and Convergence, Multilayer Perceptron's (MLPs), Representation Power of MLPs, Network Architectures.	**10**
Module 2	**Multilayer networks:** Sigmoid Neurons, Gradient Descent(GD) , Feed forward Neural Networks, Representation Power of Feed forward Neural Networks, Back propagation (BP) , Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, Recurrent networks and unsupervised learning, Hopfield network - energy; stability; capacity, Boltzmann machine, Kohonen‟sself organizing feature maps.	**10**
Module 3	**Associative memory:** Auto associative memories, Hetero associative memories, performance measures, associative memory models, Applications of associative memories. **Convolutional Neural Networks:** Visualizing Convolutional Neural	**12**

	Networks, Guided Back propagation, Fooling Convolutional Neural Networks.	
Module 4	**Neuro Evolution:** Introduction to Neuro evolution, Weight evolution, Topology evolution, Learning rule evolution, Deep Neuro Evolution. Neuro evolution uses and introduction to evolutionary algorithms to build Neural networks	**10**

Books Recommended:

1. Fu, L. (1994). *Neural networks in computer intelligence*. McGraw-Hill, Inc.

References:

1. Freeman, J. A., & Skapura, D. M. (1991). *Neural networks: algorithms, applications, and programming techniques*. Addison Wesley Longman Publishing Co., Inc.
2. Du, K. L., & Swamy, M. N. (2013). *Neural networks and statistical learning*. Springer Science & Business Media.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Pervasive Computing	CST027	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Understand pervasive computing concepts, including ubiquitous computing and context-awareness.	2
CO2	Explore pervasive technologies and architectures, such as sensor networks and IoT devices.	4
CO3	Develop practical skills in designing and implementing context-aware applications for pervasive environments.	5
CO4	Evaluate the performance, usability, and security of pervasive systems, considering societal impact and ethical considerations.	5

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Introduction to Pervasive Computing:** Past, present, future; the pervasive computing market, m- Business, Challenges and future of Pervasive Computing, **Application Examples of Pervasive Computing:** Retail, Airline Check-in and booking, Sales force automation, Healthcare, Tracking, Car Information Systems, Email Access via WAP and voice	**10**
Module 2	**DeviceTechnology for PervasiveComputing :** Hardware, Human-machine interfaces, Biometrics, Operating Systems, Java for pervasivedevices, Outlook **Device Connectivity:** Protocols, Security, Device Management **Developing WML Applications:** Developing WML Applications: WML documents, developing a WML application, WML tags, registration WML listing and WML script.	**12**
Module 3	**MIDP Programming:** MIDP Programming: J2ME MIDP user interface, MIDP application, developing a MIDP application, MIDP Classes: MIDlet class, MIDP GUI classes, MIDlet high-level events, low- level APIs and event handling.	**12**

	Advanced MIDP Programming : Network programming, MIDP database programming, MIDlet provisioning, Bluetooth application.	
Module 4	**Developing VoiceXML Applications** Developing VoiceXML Applications: VoiceXML applications, VoiceXML TAGS, ECMAScript – Java Card Application: Java card VM, APDUs, java card API, host applications.	**8**

Books and References:

1. Guruduth S. Banavar, Norman H. Cohen, ChandraNarayanaswami (2012), "Pervasive Computing: An Application-Based Approach", Wiley Interscience.
2. Jochen Burkhardt, Dr. Horst Henn, Stefan Hepper (2005), "Pervasive Computing Technology and Architecture of Mobile Internet Applications", Pearson Education.
3. Stefen Poslad (2010), "Ubiquitous Computing: Smart Devices, Environments and Interactions", Wiley Student Edition.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Distributed and Parallel Computing	CST028	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Understand fundamental concepts of distributed and parallel computing.	2
CO2	Explore distributed computing architectures, algorithms, and protocols.	3
CO3	Develop practical skills in designing and implementing parallel algorithms and systems.	4
CO4	Evaluate the performance, scalability, and fault tolerance of distributed and parallel computing systems.	5

Detailed Syllabus:

Module No	Contents	Hours
Module 1	An overview of parallel computing, Languages and programming environments, Message passing computing, Partitioning and divide-and-conquer strategies, Pipelined computations, Synchronous computations, Load balancing and termination detection, Programming with shared memory. Algorithms and applications Components of distributed systems, Communication technologies, communication services.	**12**
Module 2	Distributed algorithms and protocols: examples of distributed algorithms, clock synchronization, logical and vector clocks, election algorithms, consensus algorithms, proof of correctness, complexity analysis. Distributed operating systems: system models, file services, name services, process synchronization and coordination, case studies.	**12**
Module 3	Distributed shared memory: algorithms for implementing DSM, Coherence protocols. Distributed resource management: load sharing, load balancing, resource monitoring	**10**

Module 4	Failure recovery and fault tolerance: check-pointing, recovery, Fault-tolerant models and protocols. Research issues in distributed systems, real-time protocols, Standardization issues, cluster and grid computing.	**8**

Books and References:

1. George Coulouris, Jean Dellimore and Tim KIndberg (2017), “Distributed Systems: Concepts and Design”, Pearson Education.
2. Tanenbaum, Maarten van Steen (2017), "Distributed Systems: Principles and Paradigms", Pearson
3. Vijay K. Garg (2016), “Elements of Distributed Computing”,Wiley

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Cloud Computing	CST029	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Understand the fundamentals of Cloud computing, services and deployment models.	2
CO2	Learn the concept of Cloud infrastructure model and techniques to access the Cloud.	3
CO3	Understand the concept of Cloud Security and Cloud storage standards	3
CO4	Understand the key technical and organizational challenges for developing Cloud applications	4

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Cloud Computing Basics:** Cloud Computing Overview; Characteristics; Applications; Internet and Cloud; Benefits; Limitations; Challenges. **Cloud Computing Services and Deployment Models:** Infrastructure as a Service; Platform as a Service; Software as a Service; Private Cloud; Public Cloud; Community Cloud; Hybrid Cloud	**12**
Module 2	**Cloud Computing vs Other Computing Technologies:** Overview of Grid, Peer-to-Peer, Pervasive and Utility Computing technologies; their characteristics and comparison between them **Accessing the Cloud:** Hardware and Infrastructure requirements; Access Mechanisms: Web Applications, Web APIs, Web Browsers. Virtualisation, Difference between Virtual Machines and Cloud PCs	**10**

Module 3	**Cloud Storage and Cloud Standards:** Overview; Storage as a Service; Cloud Storage Issues; Challenges; Standards **Security Issues**: Securing the Cloud, Securing Data, Establishing identity and presence. Identity Access Management (IAM Roles and IAM Policies), Security Groups, NACLs (with respect to AWS), IGW vs VPN gateway	**10**
Module 4	**Developing Applications:** Major Players in Cloud Business; Overview of Service Oriented Architecture; Tools for developing cloud services and applications. Deploying Applications: What is Infrastructure as a Code, AWS Cloudformation, Analysis of a simple Cloudformation Template, Serverless Application Model (SAM) **Practice Cloud IT Model:** Analysis of Case Studies when deciding to adopt cloud computing architecture. How to decide if the cloud is right for your requirements. Cloud based service, applications and development platform deployment so as to improve the total cost of ownership (TCO).	**10**

Books and References:

1. Erl, Thomas; Puttini, Ricardo; Mahmood, Zaigham (2013), "Cloud Computing: Concepts, Technology & Architecture", Prentice Hall
2. Buyya, Rajkumar; Broberg, James; Goscinski, Andrzej M. (2011), "Cloud Computing: Principles and Paradigms", Wiley
3. Miller, Michael (2018), "Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online", Que Publishing
4. Reese, George (2013), "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud", O'Reilly Media
5. Bahga, Arshdeep; Madisetti, Vijay (2014), "Cloud Computing: A Hands-On Approach", Morgan Kaufmann

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Software Project Management	CST030	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Understand principles and practices of software project management.	2
CO2	Explore methodologies, frameworks, and tools used in software project management.	4
CO3	Develop skills in project planning, scheduling, and resource allocation.	4
CO4	Apply project management techniques to successfully initiate, plan, execute, monitor, and close software projects.	3

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Project Management:** The management spectrum, the people, the product, the process, the project, the W5HH principle, critical practices. **Metrics for Process and Project:** Metrics in the process and project Domains, software measurements, metrics for software quality, integrating metrics within software process, metrics for small organizations, establishing a software metrics program.	**12**
Module 2	**Estimation:** Observations, Project planning Process, software scope and feasibility, resources, software project estimation, decomposition techniques, empirical estimation models, estimation for object oriented projects, estimation for Agile development and web engineering projects, the make/buy decision. **Project Scheduling:** Basic concepts, project scheduling, defining a task set and task network, scheduling, earned value analysis. **Risk Management:** Reactive V/S proactive Risk Strategies, software risks, Risk identification, Risk projection, risk refinement, risk mitigation, monitoring and management, the RMMM plan.	**10**

Module 3	**Quality Planning:** Quality Concepts, Procedural Approach to Quality Management, Quantitative Approaches to Quality Management, Quantitative Quality Management Planning, Setting the Quality Goal, Estimating Defects for Other Stages, Quality Process Planning, Defect Prevention Planning. **Quality Management:** Quality Concepts, Software Quality assurances, software reviews, formal technical reviews, Formal approaches to SQA, Statistical Software Quality assurances.	**10**
Module 4	**Change Management:** Software Configuration Management, The SCM repository, SCM Process, Configuration Management for Web Engineering. **Project Execution And Closure:** Reviews. The Review Process, Planning, Overview and Preparation, Group Review Meeting, Rework and Follow-up, One-Person Review, Guidelines for Reviews in Projects, Data Collection, Analysis and Control Guidelines, Introduction of Reviews and the NAH Syndrome. **Project Monitoring and Control:** Project Tracking, Activities Tracking, Defect Tracking, Issues Tracking, Status Reports, Milestone Analysis, Actual Versus Estimated Analysis of Effort and Schedule, Monitoring Quality, Risk-Related Monitoring. Project Closure: Project Closure Analysis.	**10**

Books and References:

1. Schwalbe, Kathy (2021), "Information Technology Project Management", Cengage Learning
2. Hughes, Bob; Cotterell, Mike (2012), "Software Project Management", McGraw-Hill Education
3. Kugler, Hans-Jürgen (2014), "Software Project Management: A Process-Driven Approach", Springer
4. Henry, Joel (2018), "Software Project Management For Dummies", For Dummies
5. Stellman, Andrew; Greene, Jennifer (2014), "Head First PMP: A Learner's Companion to Passing the Project Management Professional Exam", O'Reilly Media

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Big Data	CST031	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Examine data for applying a suitable data analytic approach using Hadoop	4
CO2	Demystify large-scale unstructured data and processing using Hadoop MapReduce.	4
CO3	Assess and utilize the big data storage and analytic patterns and use NoSQL databases.	4
CO4	Realize the emerging technologies aligned with big data analytics and work with Pig, Hive	5

Detailed Syllabus:

Module No	Contents	Hours
Module 1	Data Analytics types – Example applications, Big Data - Characteristics, Limitations. Introduction to Hadoop – Key characteristics, RDBMS vs. Hadoop, Hadoop Components, Hadoop Ecosystem, Cluster modes, Data loading techniques and tools, Cluster architecture, Resource Management, Use cases.	**10**
Module 2	Hadoop Distributed File System (HDFS) – Architecture, YARN, Daemons, Anatomy of File Read and Write, Replica placement strategy, Working with HDFS commands, Processing data with Hadoop. Map Reduce Programming – Mapper, Reducer, Combiner, Partitioner. YARN MR Application Execution Flow	**12**
Module 3	Ingestion and Streaming Pattern, Storage Patterns, Access Patterns, Discovery and Analysis Patterns, Visualization Patterns, Deployment Patterns. NoSQL – Types of NoSQL databases, Use cases, SQL vs. NoSQL, Hadoop vs. SQL. Case study: Providing Structure to Unstructured Data, Identification, De- identification and Re-identification, Immutability and Immortality Application Architecture.	**10**

Module 4	Big Data Non-Functional Requirements (NFRs), Data Privacy and Ethics, The privacy landscape, Preferences, Personalization and Relationships, Rights and Responsibility. Need of distributed computing for Big Data, Virtualization, Cloud and Big Data, Traditional Business Intelligence (BI) vs. Big Data, Introduction to tools used for big data – Pig and Hive.	**10**

Reference Books:

1. White, Tom (2015), "Hadoop: The Definitive Guide", O'Reilly Media
2. Seema Acharya, Subhashini Chellappan (2019). Big Data and Analytics, 2nd Edition, Wiley India.
3. Marz, Nathan; Warren, James (2015), "Big Data: Principles and best practices of scalable real-time data systems", Manning Publications.
4. Nitin Sawant and Himanshu Shah (2014). Big Data Application Architecture Q&A - A Problem Solution Approach, Apress.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Cyber Laws & Forensics	CST032	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Understand the legal frameworks and regulations governing cybersecurity and digital forensics.	2
CO2	Explore cybercrime types, threats, and attack vectors.	4
CO3	Develop skills in digital evidence collection, preservation, and analysis.	4
CO4	Apply forensic techniques and tools to investigate cyber incidents and support legal proceedings.	3

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Introduction to Forensics and Cyber Crime:** Fundamentals of computer, Internet Technology, E-Governance & E-Business, crime, criminology, origin, source, recent trends. Emergence of information based society, economic, administration, social, dependence of use of information, accession, threats, civil society and global society, Overview of computer forensics and Investigative Techniques, Computer forensic tools, activities of forensic investigations and testing methodology. **Types and Categories of Cyber Crime:** Personal, Business, Financial, Office Security, Cyber Crime – Complete transparency, hacking/cracking, denial of service, IP piracy, phrasing, hetaerism etc. Cyber Attack – cyber attackers.	**12**
Module 2	**Role of Computers and Internet in Cyber crime, penetration testing and auditing :** Computer as witness, evidence, act, defining evidence, computer forensics, computer storage, media of electric record for use of course of law. Customers and legal agreements, Router penetration testing, Firewalls penetration testing, Intrusion detection system penetration testing, Wireless networks penetration testing, Password cracking penetration testing, Social engineering penetration testing,	**12**

	Application penetration testing, Policies and controls testing. Penetration testing report and documentation writing, Policies and procedures Security Policies-checklist.	
Module 3	**Cyber Security:** The concept of cyber security , meaning, scope and the frame work, basic structure development and management, Rules, Regulations, Act, Legislation - Meaning, Scope, Difference between Rules.	**8**
Module 4	**Need for a Cyber Act:** The Indian Context, Need for a Cyber Act, Information Technology Act, Scope and further Development, Information Technology Act (Amendment), coverage of Cyber Security and Cyber Crime Indian cyber Laws vs. cyber laws of U.S.A, similarities, scope and coverage, Effectiveness. **Laboratory work:** Consists of gathering information, evidence with tools like WinHex, Metasploit and Social Engineering toolkit.	**10**

Books and References:

1. Shavers, Brett (2016), "Cyber Forensics: A Field Manual for Collecting, Examining, and Preserving Evidence of Computer Crimes", Syngress
2. Walden, Ian (2019), "Computer Crimes and Digital Investigations", Oxford University Press
3. Rajewski, Jonathan; Ramsay, J. (2019), "Cybercrime and Digital Forensics: An Introduction", Routledge
4. Sammons, John (2019), "Digital Forensics: Threatscape and Best Practices", Syngress
5. Krause, Jonathan (2019), "Cybersecurity and Cyberwar: What Everyone Needs to Know®", Oxford University Press

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Expert Systems	CST033	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Understand the principles and components of expert systems.	2
CO2	Explore knowledge representation techniques, such as rules, frames, and semantic networks.	4
CO3	Develop skills in building and maintaining expert systems using tools like CLIPS or Prolog.	4
CO4	Apply expert systems in various domains, including healthcare, finance, and engineering, to provide intelligent decision support.	3

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Overview**: Background, general introduction. Forward and backward chaining, conflict resolution. Uses: structured selection, configuration, diagnosis and business rules. **Rule-based expert systems**: Logic and Inferences: Propositional Logic, First Order Logic, Soundness and Completeness, Forward and backward chaining. Uncertainty, fuzzy logic and belief nets. Expert System Shells.	**12**
Module 2	**Other expert system paradigms**: PIES example system (Pan and Tenenbaum) OOPs, frames, Case-based reasoning and help desks, Recommender systems (CDNow Case Study). Scheduling (Steelmaking example: Dorn and Slany).	**10**
Module 3	**Building expert systems**: CLUES example system (Talebzadeh, Mandutianu and Winner), Building expert systems Discussion of shells. Knowledge Management (Wiki web case study)	**10**
Module 4	**Machine learning and data-base mining**: AI-Agents. State Space Search: Depth First Search, Breadth First Search, DFID. Heuristic Search:	**10**

	Best First Search, Hill Climbing, Beam Search. Randomized Search: Simulated Annealing. Data Mining Decision Trees, Neural Networks, Text Mining, Web mining, Current trends in AI.	

Books and References:

1. Jackson, Peter; Jackson, Tom (2004), "Introduction to Expert Systems", Pearson Education
2. Giarratano, John; Riley, Gary (2003), "Expert Systems: Principles and Programming", PWS Publishing Company
3. Schwartz, Daniel G. (1990), "Expert Systems: Applications for Structural, Transportation, and Environmental Engineering", McGraw-Hill Education
4. Quinlan, J. R. (1993), "C4.5: Programs for Machine Learning", Morgan Kaufmann

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Mobile Computing	CST034	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Understand the principles and technologies underlying mobile computing.	2
CO2	Explore mobile device architectures, operating systems, and networking protocols.	4
CO3	Develop skills in mobile application development for various platforms (iOS, Android, etc.).	4
CO4	Apply mobile computing concepts to design and implement responsive, secure, and efficient mobile applications.	3

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Mobile Computing (MC):** Introduction to MC, novel applications, limitations, and architecture. **GSM:** Mobile services, System architecture, Radio interface, Protocols, Localization and calling, Handover, Security, and New data services.	**12**
Module 2	**Wireless Medium Access Control:** Motivation for a specialized MAC (Hidden and exposed terminals, Near and far terminals), SDMA, FDMA, TDMA, CDMA. **Mobile Network Layer:** Mobile IP (Goals, assumptions, entities and terminology, IP packet delivery, agent advertisement and discovery, registration, tunnelling and encapsulation, optimizations), Dynamic Host Configuration Protocol (DHCP).	**10**
Module 3	**Mobile Transport Layer:** Traditional TCP, Indirect TCP, Snooping TCP, Mobile TCP, Fast retransmit/fast recovery, Transmission /time-out freezing, Selective retransmission, Transaction oriented TCP. **Database Issues:** Hoarding techniques, caching invalidation mechanisms,	**10**

	client server computing with adaptation, power aware and context-aware computing, transactional models, query processing, recovery, and quality of service issues.	
Module 4	**Data Dissemination:** Communications asymmetry, classification of new data delivery mechanisms, pushes based mechanisms, pull-based mechanisms, hybrid mechanisms, selective tuning (indexing) techniques. **Mobile Ad hoc Networks (MANETs):** Wireless Application Protocol-WAP.	**10**

Books and References:

1. Saha, Amit Kumar (2013), "Mobile Computing: Technology, Applications, and Service Creation", McGraw-Hill Education
2. Salkintzis, Apostolis K. (2009), "Mobile Computing: Technology, Applications, and Service Creation", Wiley
3. Talukdar, Anupam (2015), "Mobile Computing: Theory and Practice", Oxford University Press
4. Kumar, Asoke; Talukdar, Anupam (2011), "Mobile Computing: Theory and Practice", Oxford University Press
5. Padhy, Niranjan (2013), "Mobile Computing: Principles, Designing, and Programming", Oxford University Press

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Green Computing	CST035	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Understand the principles and objectives of green computing.	2
CO2	Explore energy-efficient computing technologies and practices.	4
CO3	Develop skills in optimizing hardware, software, and infrastructure for energy conservation.	4
CO4	Apply green computing principles to reduce carbon footprint, minimize environmental impact, and promote sustainability in IT operations.	3

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Origins**, Regulations and industry initiatives-Government, Industry. Approaches. **Virtualization**: Green maturity model for virtualization, Virtualization level: Level 0, Level 1, Level 2, Level 3.	**10**
Module 2	**Terminal servers**, Power management, Operating system support, Power supply, Storage, video card, Display. Web, temporal and spatial data mining materials recycling, Tele- computing. Thin clients: Introduction of thin clients, Characteristics of thin clients, Thin client variants.	**10**
Module 3	**Middleware support** for green computing, Tools for monitoring, HPC computing, Green Mobile, Embedded computing and networking, Management frameworks, Standards and metrics for computing green. **Environmentally Sustainable Infrastructure Design:** Sustainable technology, Sustainable intelligence, decomposing infrastructure environment. **Profiling Energy Usages for Efficient Consumption:** Profiling energy usages for the application. Profiling energy usages for the operating	**10**

	system and Extra energy usages profile.	
Module 4	**Green Networking:** Where to save energy in wired networking, Taxonomy of green networking research: Adaptive link rate, Interface proxying, Energy ware infrastructure, Energy ware application. **Efficient-Efficient Data Canters:** Reason for over power consumption in data centers, Data center management architecture in greener perspective. **Green Cellular Networking:** Survey, Measuring greenness metrics, Energy saving in base stations, Research issues, Challenges, Future generation wireless systems, Wireless sensor network for green networking.	**12**

Books and References:

1. Murugesan, San (2017), "Harnessing Green IT: Principles and Practices", Wiley
2. Qi, Jiayin (2017), "Green Communications: Principles, Concepts and Practice", CRC Press
3. Urgaonkar, Bhuvan; Sivasubramaniam, Anand; Wood, Timothy; Kant, Krishna (2016), "Green Cloud Computing: Balancing Energy in Computation, Storage, and Transport", Morgan Kaufmann
4. Stojmenovic, Ivan; Milutinovic, Veljko (2015), "Green Mobile Devices and Networks: Energy Optimization and Scavenging Techniques", Cambridge University Press
5. Lago, Patricia; Gómez, Jorge; Naranjo, David (2019), "Sustainable Software Engineering for Green Information Systems", Springer

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Introduction to Robotics	CST036	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Understand the fundamentals of robotics, including robot components and applications.	2
CO2	Explore robot design principles, kinematics, and dynamics.	4
CO3	Develop skills in programming robots for various tasks and environments.	4
CO4	Apply robotics concepts to design, build, and control robotic systems for real-world applications.	3

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Basic Concepts :** Brief history-Types of Robot–Technology-Robot classifications and specifications-Design and control issues- Various manipulators – Sensors - work cell - Programming languages.	**10**
Module 2	**Direct And Inverse Kinematics:** Mathematical representation of Robots - Position and orientation – Homogeneous transformation-Various joints- Representation using the DenavitHattenberg parameters -Degrees of freedom- Direct kinematics-Inverse kinematics- SCARA robots- Solvability – Solution methods-Closed form solution.	**12**
Module 3	**Manipulator Differential Motion And Statics :** Linear and angular velocities-Manipulator Jacobian-Prismatic and rotary joints–Inverse -Wrist and arm singularity - Static analysis - Force and moment Balance.	**10**
Module 4	**Path Planning :** Definition-Joint space technique-Use of p-degree polynomial- Cubic polynomial-Cartesian space technique - Parametric descriptions - Straight	**12**

	line and circular paths - Position and orientation planning. **Dynamics And Control:** Lagrangian mechanics-2DOF Manipulator-Lagrange Euler formulation-Dynamic model – Manipulator control problem- Linear control schemes-PID control scheme-Force control of robotic manipulator.	

Books and References:

1. Craig, John J. (2004), "Introduction to Robotics: Mechanics and Control", Pearson
2. Niku, Saeed B. (2010), "Introduction to Robotics: Analysis, Systems, Applications", Wiley
3. Murphy, Robin R. (2010), "Introduction to AI Robotics", MIT Press
4. Poole, Harry H. (2017), "Introduction to Robotics: Mechanics and Control", Pearson
5. Addison Wesley (2008), "Introduction to Robotics", Pearson

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Data Analytics	CST037	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Perform intense exploratory data analytics using statistical and data visualization tools.	3
CO2	Apply principles of sample spaces, probability axioms, conditional probabilities, and key probability distributions	4
CO3	Apply Central Limit Theorem to estimate population parameters, analyze sample statistics, and use Chi-square distribution to evaluate sample proportion and time-series analytics.	4
CO4	Perform hypothesis testing, comparing z-tests and t-tests, addressing errors, plotting distributions, and exploring chi-square tests	5

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Applied Statistics and Data visualization:** Statistical Analytics vs. Algorithmic Analytics, Engineering data science and analytics system, descriptive statistics, Different types of data – Qualitative and Quantitative data, Describing relationship between variables, Characteristics of Measures of Centrality, Effect of Transformations, Measures of Spread, data standardization, Distribution of a categorical variable, Joint distribution of two variables.	**10**
Module 2	**Sample spaces, Probability and Random Variables:** Experiments and sample spaces, Events of an Experiment, Axioms and properties of Probability, Designing probability functions, conditional probabilities – Total probability theorem, Bayes' theorem, Independent events. Random Variables – Probability Mass functions, Discrete distribution, Bernoulli Distribution, Binomial Distribution, Geometric distribution, Uniform Distribution, Properties of Expectation, variance, Normal distributions.	**12**

Module 3	**Inferential Statistics:** Distribution of Sample statistics, Estimate Population parameters, Random Sample, Probability space. Central Limit Theorem – Implications of CLT, Likelihood of Sample mean, Approximating Distributions. Chi-square distribution – Expectation of Proportion, Variance of Proportion. Example Estimation with Time series Analytics.	**10**
Module 4	**Hypothesis Testing**: Effect of η, σ, α, z-test vs. t-test, hypothesis testing proportion, type 1 and type 2 errors, Two-tailed and one-tailed z-test, Two-tailed and one-tailed t-test, Plotting Distribution, chi-square test of independence, Case studies.	**12**

Books and References:

1. Paul Newbold, William L. Carlson, Betty M. Thorne. Statistics for Business and Economics, 7th Edition, 2009, Prentice Hall.
2. Prem S. Mann, Introductory Statistics, 7th Edition, 2010, Wiley.
3. Murray R. Spiegel, Larry J. Stephens. Schaum's Outline of Statistics, 2018, 6th Edition, Schaum Outline Series, Tata McGraw Hill.
4. Lander, Jared P. (2013), "R for Everyone: Advanced Analytics and Graphics", 1st Edition, Addison-Wesley Professional.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Computational Biology	CST038	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Understand the integration of computational techniques in biological research.	2
CO2	Explore algorithms for sequence analysis, structural prediction, and systems biology.	4
CO3	Develop skills in bioinformatics tools and databases for biological data analysis.	4
CO4	Apply computational methods to address biological questions, model biological processes, and analyse genomic data.	3

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Systems biology:** Self-organization, emergence, modularity and abstraction, feedback, control analysis, Enzyme Kinetics and **Thermodynamics:** The Law of Mass Action; Reaction Kinetics, Rate Equation, Michaelis-Menten Equation, Hill Equation, Interaction networks overview- Gene Regulatory Network, Protein – Protein Interaction Network, Signaling Pathways, Metabolic path-ways; network motifs, **Systems Biology tools and standards:** Matlab Systems Biology toolbox; SBML; SBGL (Systems Biology Graphical Language); KEGG; Tools for systems Biology- Cell designer; Cytoscape.	**10**
Module 2	**Synthetic Biology:** Engineering Biology; design and construction of novel biological systems; Abstraction hierarchy-Part, Device, Systems; Bio-Bricks - a standard for (physical) DNA composition, Designing a biological system from Bio-bricks; iGEM; SBOL, Computational Synthetic biology: Codon optimization; AND gate and OR gate in biology; Operons; Switches and clocks; Re-pressilator; Applications- Environment, Energy, Pharmaceutical needs, Ethical issues of Synthetic Biology.	**10**

Module 3	**Niche areas in Genomics:** Toxic-genomics, Pharmacogenomics, Pharmaco-genetics, SNP, Personalized medicine, Meta-genomics, Comparative genomics, Functional genomics, structural genomics, QTL, HGP. Next Generation Sequencing methods, Overview of data compression, Need for compression, Scope of NGS data compression.	**10**
Module 4	**Advanced topics in CADD:** Molecular dynamics simulations, Force fields, Energy minimization, pharmacodynamics & pharmacokinetics, 2D and 3D screening, Identification of targets in silico, GPCRs, Peptides as drugs, introduction to Ayur- informatics. **Metabolomics:** Metabolism, metabolomite, metabolome, metabolomic separation and analysis techniques, metabolic profiling, metabolic fingerprinting, Metabolome informatics. Resources/databases of metabolomics, Applications; Epigenetics	**12**

Books and References:

1. Pevzner, Pavel A.; Shamir, Ron (2011), "Bioinformatics for Biologists", Cambridge University Press
2. Waterman, Michael S. (1995), "Introduction to Computational Biology: Maps, Sequences and Genomes", Chapman and Hall/CRC
3. Westhoff, Jakob (2020), "Introduction to Computational Biology: An Evolutionary Approach", Springer
4. Istrail, Sorin; Pevzner, Pavel; Waterman, Michael (2009), "Computational Biology: A Practical Introduction to BioData Processing and Analysis with Linux, MySQL, and R", O'Reilly Media
5. Wünschiers, Röbbe (2017), "Systems Biology: A Textbook", Wiley-VCH

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Special Topics in Computer Science	CST039	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Gain in-depth knowledge of advanced topics in artificial intelligence (AI), machine learning (ML), data mining, and data visualization.	2
CO2	Explore cutting-edge techniques and algorithms used in recommendation systems and predictive analytics.	4
CO3	Develop practical skills in implementing AI and ML models for solving real-world problems.	6
CO4	Apply data visualization techniques to communicate insights and patterns extracted from large datasets effectively.	3

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Introduction:** Introduction to Data Science, Steps in doing data Science, Skills needed to do data Science, Datafication **Statistical Inference** Populations and samples, Statistical modelling, probability distributions, fitting a model, Intro to R **Exploratory Data Analysis and the Data Science Process** - Basic tools (plots, graphs and summary statistics) of EDA, Philosophy of EDA, The Data Science Process, Case Study: RealDirect (online real estate firm)	**12**
Module 2	**Introduction to Machine Learning**: Linear Regression ,K- Nearest Neighbors (K-NN), k-means, Motivating application: Filtering Spam , Why Linear Regression and k-NN are poor choices for Filtering Spam , Naive Bayes and why it works for Filtering Spam , Data Wrangling: APIs and other tools for scrapping the Web **Feature Generation and Feature Selection (Extracting Meaning From Data)** - Motivating application: user (customer) retention Feature Generation (brainstorming, role of domain expertise, and place for imagination), Feature Selection algorithms – Filters; Wrappers; Decision	**10**

	Trees; Random Forests.	
Module 3	**Recommendation Systems**: Building a User-Facing Data Product, Algorithmic ingredients of a Recommendation Engine, Dimensionality Reduction, Singular Value Decomposition, Principal Component Analysis, Exercise: build your own recommendation system **Mining Social-Network Graphs:** Social networks as graphs, Clustering of graphs, Direct discovery of communities in graphs, Partitioning of graphs, Neighbourhood properties in graphs.	**10**
Module 4	**Data Visualization** Basic principles, ideas and tools for data visualization, Examples of inspiring (industry) projects, Exercise: create your own visualization of a complex dataset. **Data Science and Ethical Issues**: Discussions on privacy, security, ethics, A look back at Data Science , Next-generation data scientists	**10**

Books and References:

1. Russell, Stuart J.; Norvig, Peter (2009), "Artificial Intelligence: A Modern Approach", Pearson
2. Hastie, Trevor; Tibshirani, Robert; Friedman, Jerome (2009), "The Elements of Statistical Learning: Data Mining, Inference, and Prediction", Springer
3. Witten, Ian H.; Frank, Eibe; Hall, Mark A.; Pal, Christopher J. (2016), "Data Mining: Practical Machine Learning Tools and Techniques", Morgan Kaufmann
4. Fry, Ben (2008), "Visualizing Data", O'Reilly Media
5. Aggarwal, Charu C. (2015), "Recommender Systems: The Textbook", Springer

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	System & Network Administration	CST040	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: CST308, CST355

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Analyse the operating system design concerning scalability and security.	4
CO2	Develop a design for a local area network with the necessary application level services.	5
CO3	Develop and Configure an IP addressing scheme with the necessary network level services.	5
CO4	Analyse the storage and security implications in the system administration.	4

Detailed Syllabus:

Module No	Contents	Hours
Module 1	Unix Operating System – Unix features, the shell, A portable, multitasking, multiuser system. File Systems and Storage models – Network Attached Storage, Storage Area Networks, Cloud Storage. Disk Devices and Interfaces – RAID, File system types. Windows Server and Unix File System.	**12**
Module 2	System Components, Networked Communities, Host Management, User Management, Models of Network and System Administration, Configuration and Maintenance, Application Level Services.	**10**
Module 3	Introduction to Networks, OSI reference model, topologies, Network protocols, Routing and switching, LAN/WAN, Configuring and managing firewalls, Managing VPNs. Configuring and managing routers, Monitoring network performance, Analyzing network traffic. Datacenters Overview - Running a Datacenter. Network Level Services.	**12**
Module 4	Principles of Security, Security Implications, Analytical System Administration. Planning and implementing disaster recovery procedures – Data storage, Backup and Restore, Web and cloud Services	**10**

Books and References:

1. Maurice J. Bach, The Design of the UNIX Operating System, Prentice Hall Software series, Pearson. 1986.
2. Burgess, Mark (2009), "Principles of Network and System Administration", Wiley.
3. Limoncelli, Thomas A.; Hogan, Christina J.; Chalup, Strata R. (2016), "The Practice of System and Network Administration", Addison-Wesley Professional
4. Dittner, Paul M. (2018), "Networking for Systems Administrators", O'Reilly Media
5. Joseph Davies, Understanding IPv6: Your Essential Guide to IPv6 on Windows Networks, 3rd Edition, 2012, Microsoft Press.
6. Jean Andrews, A+ Guide to Managing and Maintaining Your PC, 8th Edition, 2013, Cengage Learning.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Pattern Recognition	CST041	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Understand the principles and techniques of pattern recognition.	2
CO2	Explore algorithms and methods for feature extraction, classification, and clustering.	4
CO3	Develop skills in designing and implementing pattern recognition systems for various applications.	4
CO4	Apply pattern recognition techniques to analyse and interpret complex data patterns in fields such as image processing, speech recognition, and bioinformatics.	3

Detailed Syllabus:

Module No	Contents	Hours
Module 1	Introduction to patterns and pattern recognition application development: Supervised pattern detection I (Bayes classifiers) Feature extraction - multivariate data Feature extraction - image data Supervised pattern detection II (linear classifiers) Unsupervised pattern detection I (clustering) Supervised pattern detection III (non-linear classifiers, neural networks, support vector machines) Supervised pattern detection IV (rule-based classifiers) Unsupervised pattern detection II (self-organization, competitive learning) **Basics of Probability, Random Processes and Linear Algebra (recap)**: Probability: independence of events, conditional and joint probability, Bayes theorem Random Processes: Stationary and non-stationary processes, Expectation, Autocorrelation, Cross-Correlation, spectra.	**12**
Module 2	**Bayes Decision Theory**: Minimum-error-rate classification. Classifiers, Discriminant functions, Decision surfaces. Normal density and discriminant functions. Discrete features. **Parameter Estimation Methods**: Maximum-Likelihood estimation:	**10**

	Gaussian case. Maximum a Posteriori estimation. Bayesian estimation: Gaussian case. Unsupervised learning and clustering - Criterion functions for clustering. Algorithms for clustering: K-Means, Hierarchical and other methods. Cluster validation. Gaussian mixture models, Expectation-Maximization method for parameter estimation. Maximum entropy estimation. Sequential Pattern Recognition. Hidden Markov Models (HMMs). Discrete HMMs. Continuous HMMs. Nonparametric techniques for density estimation. Parzen-window method. K- Nearest Neighbor method	
Module 3	**Dimensionality reduction**: Principal component analysis - it relationship to eigen analysis. Fisher discriminant analysis - Generalized eigen analysis. Eigen vectors/Singular vectors as dictionaries. Factor Analysis, Total variability space - a dictionary learning methods. Non-negative matrix factorization - a dictionary learning method. **Linear discriminant functions**: Gradient descent procedures, Perceptron, Support vector machines - a brief introduction.	**10**
Module 4	**Artificial neural networks**: Multilayer perceptron - feedforward neural network. A brief introduction to deep neural networks, convolutional neural networks, recurrent neural networks. **Non-metric methods for pattern classification**: Non-numeric data or nominal data. Decision trees: Classification and Regression Trees (CART).	**10**

Books and References:

1. Bishop, Christopher M. (2006), "Pattern Recognition and Machine Learning", Springer
2. Duda, Richard O.; Hart, Peter E.; Stork, David G. (2012), "Pattern Classification", Wiley
3. Theodoridis, Sergios; Koutroumbas, Konstantinos (2009), "Pattern Recognition", Academic Press
4. Gose, Earl; Johnsonbaugh, Richard; Jost, Steve (2010), "Pattern Recognition and Image Analysis", Prentice Hall
5. Jähne, Bernd (2005), "Digital Image Processing: Concepts, Algorithms, and Scientific Applications", Springer

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Natural Language Processing	CST042	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Utilize tokenization, stemming, and lemmatization, apply word2vec, evaluate N-gram models.	3
CO2	Build and evaluate text classification and sentiment analysis system	4
CO3	Design named entity recognition systems for classifying text and improving search algorithms.	5
CO4	Apply NLP techniques to analyse and understand unstructured textual data.	4

Detailed Syllabus:

Module No	Contents	Hours
Module 1	Introduction to NLP - NLP tasks, challenges, Tokenization, Lemmatization, Stemming, Sentence segmentation, Phrase identification, Regular Expressions, Text Normalization, Edit distance. Word Sense Disambiguation (WSD), Word Vector Representations - word2vec, Parsing. N-grams – Estimating N-gram probabilities, Learning N-grams models – Evaluation of N-gram Models and Perplexity.	**12**
Module 2	Text Classification – Naïve Bayes - Formalizing the classifier, learning, relationship to Language Modeling, Multinomial Naïve Bayes, Evaluation metrics – Precision, Recall and F-measure. Sentiment Analysis – Sentiment Lexicons, Learning sentiment lexicons – Turney's algorithm, WordNet approach, Domain specific.	**10**
Module 3	Named Entity Recognition – Applications of NER, Challenges, Annotation, Evaluation. Approaches for NER – List lookup, Shallow parsing, Shallow parsing with context, Learning based Approaches for NER. Sequence Models for Named Entity Recognition, Maximum Entropy Sequence Models.	**10**

Module 4	Applications of NLP- Next Word Prediction, Spell-correction, Text summarization – extractive and abstractive, Information Retrieval using language models - Vector space model, term weighting, improving user queries, Information Extraction, Machine Translation using sequence modeling.	**12**

References Books:

1. Pushpak Bhattacharyya, Aditya Joshi. Natural Language Processing, Wiley, Dec 2023, ISBN: 978-9357462389.
2. Jurafsky, Dan; Martin, James H. (2013), " Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", 2nd Edition, Pearson Education India.
3. Eisenstein, Jacob (2019), "Introduction to Natural Language Processing", MIT Press.
4. Manning, Christopher D.; Schütze, Hinrich (1999), "Foundations of Statistical Natural Language Processing", MIT Press.
5. Jurafsky, Daniel; Martin, James H. (2008), " Speech and Language Processing: International Edition", 2nd edition, Pearson
6. Aaron Courville, Ian Goodfellow, Yoshua Bengio (2016), "Deep Learning (Adaptive Computation and Machine Learning series)", MIT Press.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Quantum Computing	CST043	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Understand the principles and fundamentals of quantum computing.	2
CO2	Explore quantum algorithms, quantum gates, and quantum circuit design.	4
CO3	Develop skills in programming and simulating quantum algorithms using quantum computing frameworks.	4
CO4	Apply quantum computing concepts to solve problems in cryptography, optimization, and machine learning.	3

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Introduction and Background:** Overview, Computers and the Strong Church–Turing Thesis, The Circuit Model of Computation, A Linear Algebra Formulation of the Circuit Model, Reversible Computation, A Preview of Quantum Physics, Quantum Physics and Computation. **Linear Algebra and The Dirac Notation**: The Dirac Notation and Hilbert Spaces, Dual Vectors, Operators, The Spectral Theorem, Functions of Operators, Tensor Products, The Schmidt Decomposition Theorem, Some Comments on the Dirac Notation. **Qubits and The Framework of Quantum Mechanics:** The State of a Quantum System, Time-Evolution of a Closed System, Composite Systems, Measurement, Mixed States and General Quantum Operations.	**12**
Module 2	**A Quantum Model of Computation:** The Quantum Circuit Model, Quantum Gates, Universal Sets of Quantum Gates, Efficiency of Approximating Unitary Transformations, Implementing Measurements with Quantum Circuits. **Superdense Coding and Quantum Teleportation:** Superdense Coding, Quantum Teleportation, An Application of Quantum Teleportation.	**12**

	Introductory Quantum Algorithms: Probabilistic Versus Quantum Algorithms, Phase Kick-Back, The Deutsch Algorithm, The Deutsch–Jozsa Algorithm, Simon's Algorithm.	
Module 3	**Algorithms With Superpolynomial Speed-Up:** Quantum Phase Estimation and the Quantum Fourier Transform, Eigenvalue Estimation, Finding-Orders, Finding Discrete Logarithms, Hidden Subgroups, Related Algorithms and Techniques. **Algorithms Based on Amplitude Amplification:** Grover's Quantum Search Algorithm, Amplitude Amplification, Quantum Amplitude Estimation and Quantum Counting, Searching Without Knowing the Success Probability, Related Algorithms and Techniques	**9**
Module 4	**Quantum Computational Complexity Theory and Lower Bounds:** Computational Complexity, The Black-Box Model, Lower Bounds for Searching in the Black-Box Model: Hybrid Method, General Black-Box Lower Bounds, Polynomial Method, Block Sensitivity, Adversary Methods. **Quantum Error Correction:** Classical Error Correction, The Classical Three-Bit Code, Fault Tolerance, Quantum Error Correction, Three- and Nine-Qubit Quantum Codes, Fault- Tolerant Quantum Computation.	**9**

Books and References:

1. Nielsen, Michael A.; Chuang, Isaac L. (2010), "Quantum Computation and Quantum Information", Cambridge University Press
2. Rieffel, Eleanor G.; Polak, Wolfgang H. (2011), "Quantum Computing: A Gentle Introduction", MIT Press
3. Mermin, N. David (2007), "Quantum Computer Science: An Introduction", Cambridge University Press
4. Van Meter, Rod; Brun, Todd A. (2016), "Quantum Networking", Wiley
5. Johnston, Eric R.; McMahon, Paul J. L.; Lapata, Mirella (2019), "Quantum Computing for Computer Scientists", Cambridge University Press

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Deep Learning	CST044	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Exposed to basics of neural network models & algorithms for deep neural networks.	3
CO2	Characterize of optimization algorithms and non-linear activation functions.	3
CO3	Learn various initialization methods and regularization techniques.	5
CO4	Build convolutional networks and use them to classify images.	5

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Introduction to Neural Networks:** 6 elements of machine learning/deep learning – Data, task, model, loss function, learning algorithm, evaluation. MP Neuron, Perceptron, Sigmoid Neuron, Gradient Descent, Feedforward Neural networks, Back propagation algorithm. Loss functions: Squared Error loss, Cross Entropy.	**8**
Module 2	**Optimization algorithms and activation functions:** Gradient Descent (GD), Momentum based GD, Nesterov's accelerated GD, stochastic GD, mini-batch GD, Adagrad, RMSProp, Adam. Epochs, Learning rate. Activation functions: sigmoid, ReLU, tanh.	**10**
Module 3	**Initialization techniques and regularization:** Initialization techniques: Xavier and He initialization. Analyzing the behaviour of the simple and complex models, Bias and Variance, Overfitting in deep neural networks, Hyper parameter tuning, L2 regularization, data augmentation and early stopping.	**10**
Module 4	**Convolutional Neural Networks (CNN):** Convolution operation (1D/2D), 2D convolution with 3D filter, Padding and Stride. Convolution operation related to Neural Network, Sparse Connectivity and Weight Sharing, Max Pooling and NonLinearities, Training CNNs. CNN architectures: AlexNet, ZFNet, VGGNet, GoogleNet, ResNet. Batch	**14**

	Normalization, Dropout. **Recurrent Neural Networks (RNN):** Sequence Learning problems, Intuition behind RNN, sequence classification, sequence labelling, Model, Loss function, Learning algorithm, Evaluation. Vanishing and Exploding gradient. LSTMs and 3 GRUs, Encoder Decoder models, Attention mechanism.	

Books and References:

1. Aaron Courville, Ian Goodfellow, Yoshua Bengio (2016), "Deep Learning (Adaptive Computation and Machine Learning series)", MIT Press.
2. Bengio, Yoshua, Ian J. Goodfellow, and Aaron Courville. "Deep learning." An MIT Press book in preparation. (2015)
3. Bengio, Yoshua. "Learning deep architectures for AI." Foundations and trends in Machine Learning 2.1 (2009): 1127.
4. Nithin Buduma, Nikhil Buduma, Joe Papa (2022), "Fundamentals of Deep Learning ", 2nd Edition, O'Reilly Media, Inc.
5. Géron, Aurélien (2019), "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow", O'Reilly Media, Inc.
6. Haykin, Neural Networks and Learning Machines, 3rd Edition, Pearson Education India, 2016.
7. John D. Kelleher, Deep Learning (The MIT Press Essential Knowledge series), Illustrated Edition, The MIT Press, 2019.
8. Hochreiter, Sepp, and Jargen Schmidhuber. "Long short-term memory." Neural computation 9.8 (1997): 17351780.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Introduction to Data Science	CST045	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Pipeline the data collection and data visualization using either R or Python for data science projects.	3
CO2	Analyze data types, explore statistical distributions, compute probabilities, and apply confidence intervals and hypothesis testing for inference.	4
CO3	Discover data patterns with association rules, regression, classification and clustering, outlier detection, and apply data warehousing and OLAP operations.	5
CO4	Apply pattern recognition techniques and explore data science case studies to solve real-world problems using data-driven approaches.	6

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Data Collection:** planning and data collection tools. Web scraping, Graph data repositories, IoT and Sensor Data collection. **Data Visualization**: Exploratory Data Analysis (EDA), guidelines for good plot, Business Intelligence and Visualization tools - Plotting Large Data, Visualizing Graph Data. **R for Data Science**: Introduction to R, Data Transformation, EDA with R, Tidy data, Relational data, Strings, Factors, Functions, Vectors, Iterators, and Visualizing models.	**10**
Module 2	**Descriptive statistics**: Different types of data - Qualitative and Quantitative data, Describing relationship between variables, Characteristics of Measures of Centrality. **Probability and Statistics**: Events, Sample Space, Simple Probability, Joint Probability, Conditional Probability, Bayes theorem. Probability and statistics distribution – binomial distribution, poisson distribution, normal distribution, Central Limit Theorem, Confidence Intervals, Hypothesis	**12**

	Testing.	
Module 3	**Data Mining**: Knowledge Discovery in Databases, Frequent patterns, association rules, support and confidence, Apriori, FP Growth. Regression, Classification, Clustering, Outlier analysis - outlier detection methods – Proximity-based methods, clustering-based methods, classification-based Methods, Outlier Detection for high dimensional data. **Data Warehousing**: OLTP vs. OLAP, Data Warehouse Architecture, data cube measures and computation, OLAP operations.	**10**
Module 4	**Pattern Recognition**: Pattern representation, Feature Extraction – Fisher's Linear Discriminant, Principal Component Analysis (PCA), Feature selection, Hidden Markov Models. **Data Science case studies**: Customer Segmentation for Marketing, Healthcare Analytics, Fraud Detection in Finance, Environmental Data Analysis.	**10**

Books and References:

1. Hadley Wickham, Garrett Grolemund, (2016) R for Data Science - Import, Tidy, Transform, Visualize, and Model Data, O'Reilly Media Inc.
2. Jiawei Han, Micheline Kamber, Jian Pei Professor, (2011) Data Mining: Concepts and Techniques (The Morgan Kaufmann Series in Data Management Systems), 3rd Edition, Morgan Kaufmann.
3. Christopher M. Bishop, (2016) Pattern Recognition and Machine Learning, Springer.
4. Grus, Joel (2019), "Data Science from Scratch: First Principles with Python", 2nd Edition, O'Reilly Media Inc.
5. VanderPlas, Jake (2016), "Python Data Science Handbook", O'Reilly Media Inc.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Internet Of Things	CST046	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Understand the concepts and components of the Internet of Things (IoT).	2
CO2	Explore IoT architectures, communication protocols, and sensor technologies.	4
CO3	Develop skills in designing and implementing IoT applications and systems.	4
CO4	Apply IoT concepts to create connected devices, monitor and control remote assets, and collect and analyze data for smart decision-making.	3

Detailed Syllabus:

Module No	Contents	Hours
Module 1	What is The Internet of Things? Overview and Motivations, Examples of Applications, IPV6 Role, Areas of Development and Standardization, Scope of the Present Investigation. Internet of Things Definitions and frameworks-IOT Definitions, IOT Frameworks, Basic Nodal Capabilities. Internet of Things Application Examples-Overview, Smart Metering/Advanced Metering Infrastructure-Health/Body Area Networks, City Automation, Automotive Applications, Home Automation, Smart Cards, Tracking, Over-The-Air-Passive Surveillance/Ring of Steel, Control Application Examples, Myriad Other Applications.	**10**
Module 2	Fundamental IOT Mechanism and Key Technologies- Identification of IOT Object and Services, Structural Aspects of the IOT, Key IOT Technologies. Evolving IOT Standards- Overview and Approaches, IETF IPV6 Routing Protocol for RPL Roll, Constrained Application Protocol, Representational State Transfer, ETSI M2M,Third Generation Partnership Project Service Requirements for Machine-Type Communications, CENELEC, IETF IPv6 Over Low power WPAN, Zigbee IP(ZIP),IPSO	**10**

Module 3	Layer ½ Connectivity: Wireless Technologies for the IOT- WPAN Technologies for IOT/M2M, Cellular and Mobile Network Technologies for IOT/M2M, Layer 3 Connectivity: IPv6 Technologies for the IOT: Overview and Motivations. Address Capabilities, IPv6 Protocol Overview, IPv6 Tunnelling, IPSec in IPv6, Header Compression Schemes, Quality of Service in IPv6, Migration Strategies to IPv6.	**10**
Module 4	Case Studies illustrating IOT Design-Introduction, Home Automation, Cities, Environment, Agriculture, Productivity Applications. Data Analytics for IOT –Introduction, Apache Hadoop, Using Hadoop Map Reduce for Batch Data Analysis, Apache Oozie, Apache Spark, Apache Storm, Using Apache Storm for Real- time Data Analysis, Structural Health Monitoring Case Study.	**12**

Books and References:

1. Schwartz, Marco; Manickum, Oliver (2018), "Building the Internet of Things: Implement New Business Models, Disrupt Competitors, Transform Your Industry", McGraw-Hill Education
2. Buyya, Rajkumar; Dastjerdi, Amir Vahid (2016), "Internet of Things: Principles and Paradigms", Elsevier
3. Waher, Peter (2017), "Learning Internet of Things", Packt Publishing
4. Doukas, Charalampos (2016), "Building the Internet of Things: Implement New Business Models, Disrupt Competitors, Transform Your Industry", Springer
5. O'Reilly, Tim (2016), "Designing for the Internet of Things", O'Reilly Media

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Advanced Cryptography	CST047	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Gain an in-depth understanding of advanced cryptographic techniques and protocols.	2
CO2	Explore cryptographic algorithms for encryption, digital signatures, and key exchange.	4
CO3	Develop skills in cryptographic analysis, cryptanalysis, and protocol design.	4
CO4	Apply advanced cryptography concepts to secure data transmission, authentication, and privacy protection in various applications and systems.	3

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Introduction** :Attacks on computers and computer security, need for security, approaches , principles, types of attacks ,operational model of network security Cryptography concepts and techniques, substitution, transposition, encryption and decryption, symmetric, Asymmetric key cryptography, key range size, possible type of attacks. Mathematics of cryptography and DES Block ciphers modes, feistel ciphers DES. Working of DES, cracking DES, problems on DES, 2DES, 3DES, DES design ,Side channel attacks, Differential cryptanalysis.	**10**
Module 2	Symmetric-Key Cryptography: Glosis field theory, AES, overview of Rijndael - comparison with others. Symmetric ciphers, Blowfish in practice ,RC4, RC5,RC6,IDEA, RSA Asymmetric-Key Cryptography RSA, Elliptic curve cryptography ECC, Digital certificates and PK	**12**

Module 3	Cryptographic Hash Functions Hashing schemes SHA-family, MAC, Digital Signature RSA El Gomel , DSS DSA, Authentication Protocols , applications Kerberos, X.509,Directory services Network Security Internet security protocols , SSL,TLS TSP WAP security, SET Hashing Authentication & Signature Schemes E-mail security, Email architecture SSL, PGP, MIME, S/MIME Internet Protocol Security (IPSec) IPSec architecture, IPSec verses other layers security Mobile IPSec, VPN, Web security SSL, TLS, SET etc	**12**
Module 4	System Security Intruders, types of attacks, protecting against Intruders honeypots, scanning and analysis tools, Viruses and worms, types of viruses, protection, Firewall architecture implementing firewalls, xml firewalls, trusted systems, trusted system applications, multi-level security, trusted products. Security implementation, wireless security, securities in Adhoc-networks.	**8**

Books and References:

1. William Stallings (2014), “Cryptography And Network Security Principles and Practices”, Prentice Hall
2. Schneier, Bruce (2015), "Applied Cryptography: Protocols, Algorithms, and Source Code in C", Wiley
3. Katz, Jonathan; Lindell, Yehuda (2014), "Introduction to Modern Cryptography: Principles and Protocols", CRC Press
4. Paar, Christof; Pelzl, Jan (2010), "Understanding Cryptography: A Textbook for Students and Practitioners", Springer
5. Stinson, Douglas R. (2005), "Cryptography: Theory and Practice", CRC Press

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Data Mining	CST048	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Understand the principles and methodologies of data mining.	2
CO2	Explore data pre-processing, pattern discovery, and predictive modelling techniques.	4
CO3	Develop skills in using data mining algorithms and tools for knowledge discovery.	4
CO4	Apply data mining concepts to extract valuable insights, identify patterns, and make data-driven decisions across various domains.	3

Detailed Syllabus:

Module No	Contents	Hours
Module 1	Introduction to Data Mining: Introduction: Scope of Data Mining: What is Data Mining; How does Data Mining Works, Predictive Modelling: Data Mining and Data Warehousing: Architecture for Data Mining: Profitable Applications: Data Mining Tools Business Intelligence: Introduction, Business Intelligence, Business Intelligence tools, Business Intelligence Infrastructure, Business Intelligence Applications, BI versus Data Warehouse, BI versus Data Mining, Future of BI.	**12**
Module 2	Data Pre-processing: Introduction, Data Pre-processing Overview, Data Cleaning, Data Integration and Transformation, Data Reduction, Discretization and Concept Hierarchy Generation. Data Mining Techniques- An Overview: Introduction, Data Mining, Data Mining Versus Database Management System, Data Mining Techniques- Association rules, Classification, Regression, Clustering, Neural networks.	**12**

Module 3	Clustering: Introduction, Clustering, Cluster Analysis, Clustering Methods- K means, Hierarchical clustering, Agglomerative clustering, Divisive clustering, clustering and segmentation software, evaluating clusters. Web Mining: Introduction, Terminologies, Categories of Web Mining – Web Content Mining, Web Structure Mining, Web Usage Mining, Applications of Web Mining, and Agent based and Data base approaches, Web mining Software.	**10**
Module 4	Applications of Data mining: Introduction, Business Applications Using Data Mining- Risk management and targeted marketing, Customer profiles and feature construction, Medical applications (diabetic screening), Scientific Applications using Data Mining, Other Applications.	**8**

Books and References:

1. Han, Jiawei; Kamber, Micheline; Pei, Jian (2011), "Data Mining: Concepts and Techniques", Morgan Kaufmann
2. Witten, Ian H.; Frank, Eibe; Hall, Mark A. (2016), "Data Mining: Practical Machine Learning Tools and Techniques", Morgan Kaufmann
3. Aggarwal, Charu C. (2015), "Data Mining: The Textbook", Springer
4. Dunham, Margaret H. (2011), "Data Mining: Introductory and Advanced Topics", Pearson
5. Tan, Pang-Ning; Steinbach, Michael; Kumar, Vipin (2005), "Introduction to Data Mining", Pearson

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Advanced Graph Algorithms	CST049	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Understand advanced graph theory concepts and graph algorithms.	2
CO2	Explore algorithms for graph traversal, shortest paths, and network flow problems.	4
CO3	Develop skills in analyzing and optimizing graph algorithms for efficiency and scalability.	4
CO4	Apply advanced graph algorithms to solve complex problems in network analysis, social networks, and optimization.	3

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Basics:** Introduction, Machine Model, Graph Data Structures, Bipartite Graphs, Eulerian Graphs, Circuits & Trails, Fleury's Algorithm, Hierholzer's Algorithm **Connectivity:** Top. Sort, Detecting Strong Components, 2- Connectivity / 2-Edge-Connectivity, (Open) Ear Decompositions, Strong Orientations, Testing 2-(Edge-)Connectivity in Linear Time, Bipolar Orientations, s-t-Numberings + Algorithm	**12**
Module 2	**Matchings:** Definitions, Hopcroft–Karp algorithm, Edmonds algorithm, Hall's Theorem, Hungarian Method for Bipartite Weighted Matchings, Weighted Matchings in General Graphs, Some approximate approach **Dynamic Algorithms:** Dynamic Connectivity and Spanning Trees in Amortized Poly-log time, Dynamic Connectivity in Worst-case O(n½) time	**10**
Module 3	**Planar Graphs:** Planar Separator Theorem and its Applications, Embeddings (combinatorial + planar), Euler's Formula, Kuratowski's Theorem, Detour to Platonic Solids, Dual Graphs, Interdigitating Trees, Half-Edge Data Structure, Decremental Dynamic Adjacency Queries,	**10**

	Max-Cut in polynomial time, Minimum Spanning Trees in linear time, Shortest Paths with Matrix Multiplication.	
Module 4	**NP-Hard Problems:** Intro (FPT). Vertex Cover: FPT algorithm, Buss' kernel. Feedback Vertex Set: FPT algorithm, Kernels for Vertex Cover by Matching and for Feedback Vertex Set, Hamiltonian Path Problem, k-Path, Chromatic number, FPT Cut Problems: Important separators, Multiway Cut, Treewidth: Tree decompositions, Algorithmic use (dynamic programming), Introduction to Bidimensionality, Planar Graphs: Linear Kernels, Bidimensionality, Subexponential Time Parameterized Algorithms, Problems on Restricted Graph Classes, Combinatorial Algorithms for Linear Fisher Markets	**10**

Books and References:

1. Eppstein, David (2002), "Graph Algorithms", Cambridge University Press
2. Kleinberg, Jon; Tardos, Éva (2006), "Algorithm Design", Pearson
3. Cormen, Thomas H.; Leiserson, Charles E.; Rivest, Ronald L.; Stein, Clifford (2009), "Introduction to Algorithms", MIT Press
4. Abiteboul, Serge; Manolescu, Ioana; Rigaux, Philippe; Rousset, Marie-Christine; Senellart, Pierre (2011), "Web Data Management", Cambridge University Press
5. Havel, Václav (2008), "Computational Graph Theory", Springer

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Advanced Java	CST050	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Gain a deeper understanding of advanced Java concepts and features.	2
CO2	Explore topics such as generics, multithreading, and concurrency in Java.	4
CO3	Develop skills in using advanced Java libraries and frameworks.	4
CO4	Apply advanced Java techniques to design and implement robust, scalable, and efficient applications.	3

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Collections:** Collection Interfaces, Concrete Collections, The Collections Framework **Multithreading:** Creating thread and running it, Multiple Thread acting on single object, Synchronization, Thread communication, Thread group, Thread priorities, Daemon Thread, Life Cycle of Thread. **Networking:** Internet Addressing, InetAddress, Factory Methods, Instance Methods, TCP/IP Client Sockets, URL, URL Connection, TCP/IP Server Sockets, Datagrams	**13**
Module 2	**Enterprise Java Bean:** Preparing a Class to be a JavaBean, Creating a JavaBean, JavaBean Properties, Types of beans, Stateful Session bean, Stateless Session bean, Entity bean. **Java Database Connectivity (JDBC):** Merging Data from Multiple Tables: Joining, Manipulating Databases with JDBC, Prepared Statements, Transaction Processing, Stored Procedures C.	**10**
Module 3	**Servlets:** Servlet Overview and Architecture, Interface Servlet and the Servlet Life Cycle, Handling HTTP get Requests, Handling HTTP post Requests, Redirecting Requests to Other Resources, Session Tracking, Cookies, Session Tracking with HttpSession.	**11**

	JavaServer Pages (JSP): Introduction, JavaServer Pages Overview, A First JavaServer Page Example, Implicit Objects, Scripting, Standard Actions, Directives, Custom Tag Libraries Remote Method Invocation: Defining the Remote Interface, Implementing the Remote Interface, Compiling and Executing the Server and the Client.	
Module 4	**Common Object Request Broker Architecture (CORBA**): Technical/Architectural Overview, CORBA Basics, CORBA services. Introduction Smart Phone Application Development: Introduction to android platform, Creating application template, adding activity, intent, services to application, receivers and alerts.	**8**

Books and References:

1. Bloch, Joshua (2008), "Effective Java", Addison-Wesley Professional
2. Horstmann, Cay S.; Cornell, Gary (2017), "Core Java Volume II - Advanced Features", Pearson
3. Arnold, Ken; Gosling, James (2006), "Java™ Programming Language, The, Fourth Edition", Addison-Wesley Professional
4. Oaks, Scott (2014), "Java Performance: The Definitive Guide", O'Reilly Media

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Machine Learning	CST051	2-1-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: Artificial Intelligence (CST352)

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Understand the foundational concepts, algorithms, and techniques of machine learning.	2
CO2	Apply various machine learning algorithms to solve real-world problems and analyze their performance.	3
CO3	Explore advanced topics in machine learning, including deep learning, reinforcement learning, and ensemble methods.	4
CO4	Learn how to deploy machine learning models effectively and consider ethical implications in AI deployment. .	5

Detailed Syllabus:

Module No	Contents	Hours
Module 1	Introduction to Machine Learning (ML): Supervised, Semi supervised, unsupervised machine learning, Types of datasets, Introduction to classification. Decision trees - Hunt's algorithm, GINI index, ID3, C4.5, Tree pruning. KNN, Naïve Bayes (Multinomial NB, Gaussian NB).	**10**
Module 2	SVMs and Ensemble Learning: SVM – Linear classifier, Margin of SVM, SVM parameter tuning, handling class imbalance in SVM. Ensemble Learning – Majority voting, Bagging, Random forest, Boosting, Stacking. Gradient boosted machines (GBM).	**10**
Module 3	Artificial Neural Networks (ANNs): MP Neuron, Perceptron, Sigmoid neuron, decision boundary for a single neuron, 6 elements of ML – Data, task, model, loss function, learning algorithm, evaluation. Feed forward Neural Networks, Back propagation. Optimization algorithms: GD, Momentum based GD, SGD, Mini-batch GD Linear regression and Logistic Regression: Linear regression: regression task, regression vs. classification. Multiple linear regression. Ridge regularization, Lasso regularization, Elastic net regularization, evaluation	**14**

	metrics and practical considerations for regression. Logistic regression: regression for classification. decision boundary.	
Module 4	Clustering, Dimensionality Reduction and ML case studies: Clustering: K-means, hierarchical agglomerative clustering, applications of clustering, evaluation of cluster quality, ensemble methods for clustering. Dimensionality Reduction: PCA, LDA	**8**

Books and References:

1. Harrington, Peter (2012), "Machine learning in action", Manning Publications Co.
2. Tom Mitchell, Machine Learning, McGraw Hill, 1997
3. Sergios Theodoridis, Konstantinos Koutroumbas, Pattern Recognition, Academic Press, 2009.
4. Hastie, Tibshirani, Friedman, The Elements of Statistical Learning, Springer, 2001.
5. E them ALPAYDIN (2004), "Introduction to Machine Learning", The MIT Press.
6. Bishop, C. M. (2007), "Pattern recognition and machine learning", New York: springer.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Computer Graphics	CST052	2-1-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Demonstrate an understanding of contemporary graphics hardware and of basic terminology, scope and techniques of Computer Graphics.	4
CO2	Demonstrate and implement the 2D primitive drawing algorithms.	3
CO3	Demonstrate area filling algorithms, line/ Polygon clipping along with various 2D transformations 2D viewing and Coordinate representations.	3
CO4	Understand the 3D graphic primitives along with various Transformations and Other algorithms and Projection Techniques for representing 3D graphic objects	5

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Introduction:** Coordinate representation, Pixel, Raster Scan & Random Scan methods, colour CRT Raster scan basics, video basics, interactive devices, graphics input and output devices, mouse, track ball, light pen, digitizer, thumb wheel, raster scan graphics.	**10**
Module 2	**Graphics Primitives:** 2D Primitives - Output primitives – Line, Circle and Ellipse drawing algorithms - Attributes of output primitives – Two dimensional Geometric transformation - Two dimensional viewing –Line, Polygon, Curve and Text clipping algorithms.	**10**
Module 3	**Parallel and Perspective projections:** Three dimensional object representation –Polygons, Curved lines, Splines, Quadric Surfaces- Visualization of data sets - 3D transformations – Viewing -Visible surface identification. Basic Raster Graphics Algorithms. Geometric Modelling in 3- D. Viewing in 3-D. Concept of Synthetic Camera. Dialogue Design.	**12**

	Graphics User Interfaces. Windowing Systems. **Rendering:** Introduction to Shading models – Flat and Smooth shading – Adding texture to faces – Adding shadows of objects – Building a camera in a program – Creating shaded objects – Rendering texture – Drawing Shadows, Graphical Modelling of Discrete events.	
Module 4	**Introduction to Picture Synthesis and Analysis:** Conceptual Framework of an Interactive Graphical Simulation System. Simulation of Discrete Event Displays, Animation Techniques, Basic Rules for Animation. Graphical Simulation of continuous motion. Role of Virtual Reality in Graphical Simulation.	**10**

Books Recommended:

1. Hearn, D. (1997). Computer graphics, C version. Pearson Education India.
2. Preparata, F. P., & Shamos, M. I. (2012). Computational geometry: an introduction. Springer Science & Business Media.

References:

1. Rogers, D. F. (1986). Procedural elements for computer graphics. McGraw-Hill, Inc...
2. Rogers, D. F., & Adams, J. A. (1989). Mathematical elements for computer graphics. McGraw-Hill, Inc.
3. Blandford, A. E. (1987). Computer graphics: Roy A. Plastock and Gordon Kalley. McGraw-Hill,

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Advanced Data Structures	CST053	2-1-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: Data Structures (CST250)

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Apply the concept of Abstract Data Types, Mathematical preliminaries and other performance measures for data structures.	3
CO2	Explore tree data structures and applications of various tree data structures.	4
CO3	Review of Heap and its types and corresponding properties .	4
CO4	Understanding of Disjoint Set Data Structures and Amortized Analysis	5

Detailed Syllabus:

Module No	Contents	Hours
Module 1	**Introduction**: Abstract data types; Data Representation; Elementary data types; Basic concepts of data Structures; Mathematical preliminaries - big-Oh notation; efficiency of algorithms; notion of time and space complexity; performance measures for data structures. Skip Lists.	8
Module 2	**Tree data structures:** Binary Trees, Application of Binary Trees (Huffman Coding).Understanding Binary Search Trees, Balanced Trees, AVL Trees, Red Black Trees, m-way search trees, B-Tree, 2-3 Trees, 2-3-4 Trees. Introduction to Splay Trees, Leftist Trees. Tries and pattern matching, Suffix Trees, k-d trees, Segment trees and their application.	12
Module 3	**Heaps:** Review of Heap and Heap Properties. Introduction to different types of Heaps and their properties: Binomial Heaps, Fibonacci Heaps, Leftist Heaps, Deaps, Treaps. Binomial Queues.	10
Module 4	Disjoint Set Data Structure	4
Module 5	Amortized Analysis	8

Books and References:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein (2009), Introduction to Algorithms, Third Edition, MIT Press.
2. Bhagat Singh, Thomas L. Naps (1985). Introduction to Data Structures. Thomson Learning
3. Sartaj Sahni (1998), "Data structures, Algorithms and Applications in C++ ", McGraw Hill.
4. E. Horowitz, S. Sahni (2008), "Fundamentals of Data Structures", Computer Science Press
5. Narasimha Karumanchi (2016), Data Structures and Algorithms Made Easy: Data Structure and Algorithmic Puzzles, Second Edition, Career Monk publisher.
6. Seymour Lipschutz (2017), "Data Structures with C", (Schaum's Outline Series), McGraw Hill.

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Numerical Methods	MTH707	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Understand the principles and techniques of numerical analysis.	2
CO2	Explore numerical methods for solving equations, interpolation, and numerical integration.	4
CO3	Develop skills in implementing numerical algorithms using computational tools.	4
CO4	Apply numerical methods to solve mathematical problems and simulate real-world phenomena accurately and efficiently.	3

Detailed Syllabus:

Module No	Contents	Hours
Module 1	Linear Algebra: Matrices, Matrics decomposition: LU decomposition, Cholesky decomposition, spectral decomposition, Matrix Eigen-value problem, Gerchgorin's theorem, Eignen value by iteration, generalized inverse of a matrix, solution of linear system by decomposition method, Jacobi method.	**12**
Module 2	Nonlinear system of equations: Newton's method, Powel Hybrid method. Differential equations: Generalised characteristic value problems, phase plane and critical points, stability and phase plane methods in nonlinear equations. Boundary value problems, mixed boundary conditions, boundary conditions at infinity, nonlinear boundary value problems, linear eigen value problems.	**10**
Module 3	Differential Equations: Taylor series method, Euler method, Runge-Kutta method. Numerical solutions to Partial Differential Equations: Second order quasi-linear equations, numerical solutions.	**10**
Module 4	Approximate Analytic methods: Variational methods, weighted residual methods – Galerkin's method, collocation method, Functional, quadratic	**10**

	functionals. Numerical Integration – Gauss Legendre, Quadrature, Error Analysis, Convergence of solution. Finite element and Boundary element method.	

Books and References:

1. Chapra, Steven C.; Canale, Raymond P. (2014), "Numerical Methods for Engineers", McGraw-Hill Education
2. Quarteroni, Alfio; Saleri, Fausto (2014), "Scientific Computing with MATLAB and Octave", Springer
3. Kincaid, David; Cheney, Ward (2002), "Numerical Mathematics and Computing", Cengage Learning
4. Heath, Michael T. (2002), "Scientific Computing: An Introductory Survey", McGraw-Hill Education
5. Trefethen, Lloyd N.; Bau, David (1997), "Numerical Linear Algebra", SIAM

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Year (Semester)	Course Title	Course Code	L-T-P-Credits
	Operations Research	MAT-002	3-0-0-3
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Pre-requisites: A student should have basic knowledge of Matrix Theory.

Course Outcomes: At the end of the course, a student should be able to:

CO No.	Course Outcome	Blooms Taxonomy Level
CO1	Formulate LPP's and apply various optimization methods for solving these.	6
CO2	Solve transportation problems using different optimization methods.	3
CO3	Solve assignment problems using different optimization techniques.	3
CO4	Solve problems related to game theory.	3

Syllabus

Module No.	Contents	Hours
Module 1	Introduction to Operations Research: Basics definitions, Scope, Objectives, Linear Programming Problem (LPP), Formulation of LPP, Graphical solution of LPP, Simplex Method, Artificial variables, Big-M method, Two-phase method, degeneracy and unbounded solutions.	10
Module 2	Transportation Problem. Formulation, balanced solution and unbalanced Transportation problems. Finding basic feasible solutions – Northwest corner rule, Least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method.	10
Module 3	Assignment problem, Formulation, Hungarian method for optimal solution. Solving unbalanced problem. Travelling salesman problem and assignment problem, Sequencing models, Solution of Sequencing Problem – Processing n Jobs through 2 Machines – Processing n Jobs through 3 Machines – Processing 2 Jobs through m machines. Replacement model	12

Module 4	Game Theory: Introduction to Game theory, Two-person zero sum games. Dominance, Graphical method for $(2 \times n)$ and $(m \times 2)$ games, Matrix methods for $m \times n$ games.	10

Recommended Books:

1. S. D. Sharma, *Operations Research*, 17th Edition, KNRN publishers, (2014).

2. H. A. Taha, *Operations Research-An Introduction*, 10th Edition, Pearson Education India, (2017).