GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER I

Name of Department: - **Computer Science and Engineering**

1. Subject Code: **TCS 101**

   Course Title: **Fundamental of computer and Introduction to Programming**

2. Contact Hours: **L:** 3 **T**: 0 **P**: 0
3. Examination Duration (Hrs): **Theory** 3 **Practical** 0
4. Relative Weight: **CIE** 25 **MSE** 25 **SEE** 50
5. Credits: 3
6. Semester: I
7. Category of Course: DC
8. Pre- requisite: Basic Knowledge of Mathematics

9. **Course Outcome**:**	CO1: Learn the concepts of IT and understand the fundamentals of basic building blocks of computer science. CO2: Understand basic data types and syntax of C programming. CO3: Propose solution to problem by using tools like algorithm and flowcharts. CO4: Analyze and select the best possible solution for decision-based problems using decision making skills and develop the aptitude to solve iterative problems using different types of looping statements. CO5: Implement complex problems as a collection of sub problems by applying modularization in applications using functions. CO6: Apply and implement the concept arrays for providing solution to homogenous collection of data types.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**UNIT- I** Generation of computers, Computer system memory hierarchy, Input/Output, RAM/ROM, Software & Hardware, Understand bit, byte, KB, MB, GB and their relations to each other, Operating System overview, Computer Networks Overview	**8**

	Algorithms and Flow Charts – Examples of Flow charts for loops and conditional statements	
2	**UNIT- 2** First C program - Hello world, How to open a command prompt on Windows or Linux. How to read and print on screen - printf(),scanf(),getchar(), putchar() Variables and Data types - Variables, Identifiers, data types and sizes, type conversions, difference between declaration and definition of a variable, Constants Life of a C program (Preprocessing, Compilation, Assembly, Linking, Loading, Execution), Compiling from the command line, Macros, Operators – equality and assignment, Compound assignment operators, Increment and decrement operators, Performance comparison between pre and post increment/decrement operators, bitwise operators, Logical Operators, comma operator, precedence and associativity.	**10**
3	**UNIT- III** Conditional statements: if statement, if-else statement, ternary statement or ternary operator, nested if-else statement, switch statement, Difference between performance of if else and switch, Advantages of if else and switch over each other Loops: ‘for’ loops, ‘while’ loops, ‘do while’ loops, entry control and exit control, break and continue, nested loops	**8**
4	**UNIT- IV** Functions: Function prototype, function return type, signature of a function, function arguments, call by value, Function call stack, Recursion v/s Iteration, passing arrays to functions, Storage classes: Automatic, Static, Register, External, Static and Dynamic linking implementation, C program memory (show different areas of C program memory and where different type of variables are stored), scope rules.	**7**
5	**UNIT- V** **Arrays:** Single-dimensional arrays, initializing arrays, computing address of an element in array, character arrays, segmentation fault, bound checking, Searching and Sorting.	**10**
	Total	**43**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication/Reprint
	Text Books		
1.	• Peter Prinz, Tony Crawford,"C in a Nutshell", Oreilly Publishers,	1st	2011
2.	• Peter Norton, "Introduction to computers", TMH,	6th	2009
	• E.Balagurusamy,"Programming in ANSI C",McGraw Hill	6th	2015
	Reference Books		
1.	Steve Oualline, "Practical C programming", Orielly Publishers, 2011.	3rd	2011
2.	Brian W Kernighan, Dennis M Ritcie, "The C Programming Language", Prentice Hall, 1988. R3. Herbert Schildt," C: The Complete Reference", 4thEdition.TMH, 2000.	2nd	2000
3.	Yashwant Kanetkar,"Let Us C",BPB Publication	8th	2007

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam / Lab Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER II

Name of Department: - **Computer Science and Engineering**

1. Subject Code: **TCS 201**

   Course Title: **Programming for Problem Solving**

2. Contact Hours: **L:** **3** **T**: **0** **P** **0**

3. Examination Duration (Hrs): **Theory** **3** **Practical** **0**

4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**

5. Credits: **3**

6. Semester: **II**

7. Category of Course : **DC**

8. Pre- requisite: Basic Knowledge of Mathematics and Computer Fundamentals, TCS 101

9. **Course Outcome****:	CO1: Learn and apply concepts of strings and multi-dimensional array for providing solutions to homogenous collection of data types CO2: Propose solution to problem by using tools like algorithm and flowcharts. CO3: Apply the concept of pointers to optimize memory management by overcoming the limitations of arrays. CO4: Process and analyze problems based on heterogeneous collection of data using structures. CO5: Apply concepts of file handling to implement data storage and retrieval tasks. CO6: Implement the basic real life problems using python.

*** Describe the specific knowledge, skills, or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	**Contents**	**Contact Hours**
1	**UNIT- I** Multi-Dimensional Arrays- Initializing arrays , row major and column major form of an array, character strings and arrays, Strings – Declaration of strings, Initialization of strings using arrays and pointers, Standard library functions of string.	**6**
2	**UNIT- 2**	**10**

	Pointers –Basic of pointers and addresses, Pointers and arrays, Pointer arithmetic, passing pointers to functions, call by reference. Accessing string through pointers. Dynamic memory management in C - malloc(), calloc(), realloc(), free(), memory leak,Dangling, Void, Null and Wild pointers Structures - Structures, array of structures, structure within structure, union, typedef, self-referential structure, pointer to structure	
3	**UNIT- III** **File Handling** - Opening or creating a file, closing a file, File modes, Reading and writing a text file using getc(), putc(), fprintf() ,fscanf(),fgets(), fputs(), Reading and writing in a binary file, counting lines in a text file, Search in a text file, Random file accessing methods- feof(), fseek(), ftell() and rewind() functions.	**8**
4	**UNIT- IV** **Introduction to Python-** History of Python, Need of Python Programming, Python features, First Python Program, Running python Scripts, Variables, Reserved words, Lines and indentation, Quotations, Comments, Input output. Data Types, Operators and Expressions: Standard Data Types – Numbers, strings, Boolean, Operators – Arithmetic Operators, comparison Operators, assignment Operators, logical Operators, Bitwise Operators.	**10**
5	**UNIT- V** Control flow – if, if-elif-else, for, while, break, continue, pass, range(), nested loops. Functions – Handling functions in Python File Handling – Reading text file, writing text file, copying one file to another	**10**
	Total	**44**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication /Reprint**
	Text Books		
1.	• Peter Prinz, Tony Crawford,"C in a Nutshell", Oreilly Publishers,	1st	2011

2.	• Yashwant Kanetkar,"Let Us C",BPB Publication	8th	2007
	Reference Books		
1.	• Steve Oualline, "Practical C programming", Orielly Publishers, 2011.	3rd	2011
2.	• Brian W Kernighan, Dennis M Ritcie,"The C Programming Language",Prentice Hall, 1988. R3. Herbert Schildt," C: The Complete Reference", 4thEdition.TMH, 2000.	2nd	2000
3.	• E.Balagurusamy,"Programming in ANSI C", McGraw Hill	6th	2015

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam / Lab Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER III

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS-308** Course Title: **Logic Design & Computer Organization**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **3**
7. Category of Course: **DC**
8. Pre-requisite: Basic Electronics Engineering (TEC 101/201)

9. **Course Outcome:**	After completion of the course the students will be able to**:** CO1: Understand the process of minimizing Boolean function and obtaining the combinational logic circuits from Boolean functions. CO2: Analyze the basic storage elements in digital circuits and develop sequential circuits by applying them. CO3: Evaluate the design of different types of register, counter, and programmable logic devices. CO4: Apply the concept of digital logic circuits in computer organization & architecture and evaluate the computer performance. CO5: Create the arithmetic logic used in computer and describe the machine instruction execution. CO6: Understand the memory hierarchy of computer and how different I/O devices interact with the processing unit.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	**Contents**	**Contact Hours**
1	**Unit 1:** Simplification of Boolean Function using K-map method (upto 5 variables) and Quine-Mc Clusky method. Nand and Nor Implementation. Combinational Logic: Introduction, Analysis & Design Procedure, Binary Adder & Subtractor, Decimal Adder, Binary Multiplier, Magnitude Comparator, Decoders, Encoders, Multiplexers, Demultiplexers, code conversion. Introduction to HDL description of combinational logic circuits.	10
2	**Unit 2**: Sequential Logic: Introduction, Types of Sequential circuits, Basic storage elements (Latch and Flip-flops), Characteristic equations & tables, excitation	8

	table, Flip-flop conversion, Analysis and design of synchronous sequential circuits.	
3	**Unit 3:** Registers, Shift register, Universal shift register, Counters (Ripple & Synchronous): Introduction & Design, Introduction to memory, types of memory, PLD: PAL, PLA, ROM Introduction to Computer Organization & Architecture, Von Neumann and Harvard Architecture, RISC and CISC machines, Evolution of Intel x86 and ARM architecture, Basic measures of computer performance, Amdahl's Law, Little's Law.	10
4	**Unit 4:** Computer Arithmetic (Integer and Floating Point): Representation, Addition, Subtraction, Multiplication and Division. Machine Instruction characteristics, Addressing Modes, Processor structure and operation, Instruction Cycle, Instruction Pipelining: Strategy, performance, Hazards. Control unit operation and microprogrammed control.	10
5	**Unit 5:** Memory hierarchy: Locality and performance, Cache memory: Principles and elements of design, Internal memory, External memory, I/O interface: External devices, I/O modules, Programmed I/O, Interrupt driven I/O, Direct Memory Access. Introduction to alternative architectures.	10
	Total	**48**

11**. Suggested Books:**

S.No	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	M. Morris Mano, Digital Logic and Computer Design, Pearson	1st	2016
2.	W. Stalling, Computer Organization and Architecture, Pearson	11th	2022
	Reference Books		
1.	Charles H. Roth Jr., Fundamentals of Logic Design, Wadsworth Publishing	5th	2005
2.	John P Hayes, Computer Architecture and Organization, McGraw Hill	3rd	2017

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER III

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 302** Course Title: **Data structures with C**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25 25** **SEE 50**
5. Credits: **3**
6. Semester: **III**
7. Category of Course: **DC**
8. Pre-requisite:

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Describe the concept of Data Structures and assess how the choice of data structures impacts the performance of programs CO2: Compare and contrast merits and demerits of various data structures in terms of time and memory complexity. CO3: Identify and propose appropriate data structure for providing the solution to the real world problems. CO4: Implement operations like searching, insertion, deletion, traversing mechanism etc. on various data structures CO5: Be familiar with advanced data structures such as balanced search trees, hash tables, AVL trees, priority queues, ADT etc. CO6: To augment merits of particular data structures on other data structure to develop innovation in subject of study.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

SL. NO.	Contents	Contact Hours
1	**Unit 1:** **Introduction:** Basic Terminology, Pointer and dynamic memory allocation, Elementary Data Organization, Data Structure operations, Algorithm	**10**

	Complexity and Time-Space trade-off Arrays**:** Array Definition, Representation and Analysis, Single and Multidimensional Arrays, address calculation, application of arrays, Array as Parameters, Ordered List, Sparse Matrices. Stacks:Array. Representation and Implementation of stack, Operations on Stacks: Push & Pop, Array Representation of Stack, Linked Representation of Stack, Operations Associated with Stacks, Application of stack: Conversion of Infix to Prefix and Postfix Expressions, Evaluation of postfix expression using stack. Recursion: **Recursive** definition and processes, recursion in C, example of recursion, Tower of Hanoi Problem, tail recursion.	
2	**Unit 2:** **Queues:** Array and linked representation and implementation of queues, Operations on Queue: Create, Add, Delete, Full and Empty. Circular queue, Dequeue, and Priority Queue**.** **Linked list**: Representation and Implementation of Singly Linked Lists, Two-way Header List, Traversing and Searching of Linked List, Overflow and Underflow, Insertion and deletion to/from Linked Lists, Insertion and deletion Algorithms, Doubly linked list, Linked List in Array, Polynomial representation and addition, Generalized linked list.	**10**
3	**Unit 3:** **Trees**: Basic terminology, Binary Trees, Binary tree representation, algebraic Expressions, Complete Binary Tree. Extended Binary Trees, Array and Linked Representation of Binary trees, Traversing Binary trees, Threaded Binary trees. Traversing Threaded Binary trees, Huffman algorithm & Huffman tree**.** **Searching and Hashing**: Sequential search, binary search, comparison and analysis, Hash Table, Hash Functions, Collision Resolution Strategies, Hash Table Implementation	**9**
4	**Unit 4:** ***Sorting****:* Insertion Sort, Bubble Sorting, Quick Sort, Two Way Merge Sort, Heap Sort, Sorting on Different Keys, Practical consideration for Internal Sorting. **Binary Search Trees**: Binary Search Tree (BST), Insertion and Deletion in BST, Complexity of Search Algorithm, Path Length, AVL Trees	**9**
5	**Unit 5:** **File Structures**: Physical Storage Media File Organization, Organization of records into Blocks, Sequential Files, Indexing and Hashing, Primary indices, Secondary indices, B+ Tree index Files, B Tree index Files, Indexing and Hashing Comparisons, Graph, Traversal(DFS,BFS) ,Minimum spanning tree	**8**
	Total	**46**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**

	Textbooks		
1.	Horowitz and Sahani, “Fundamentals of data Structures”, Galgotia Publication Pvt. Ltd., New Delhi.	2^{nd}	**2008**
2	R. Kruse etal, “Data Structures and Program Design in C”, Pearson Education Asia,	2^{nd}	**2006**
3	A. M. Tenenbaum, “Data Structures using C & C++”, Prentice-Hall of India Pvt. Ltd., New Delhi.	2^{nd}	2014
4	K Loudon, “Mastering Algorithms with C”, Shroff Publisher & Distributors Pvt. Ltd.	1^{st}	2000
5	Bruno R Preiss, “Data Structures and Algorithms with Object Oriented Design Pattern in C++”, Jhon Wiley & Sons, Inc.	1^{st}	1998
6	Adam Drozdek, “Data Structures and Algorithms in C++”, Thomson Asia Pvt	4^{th}	2013

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER III

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 307** Course Title: **Object Oriented Programming with C++**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **III**
7. Category of Course: **DC**
8. Pre-requisite: **Subject Name with Code**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Demonstrate the C++ Program uses data types, operators, expressions, array, strings and functions. CO2: Implement Constructors (Parameterized, Copy), this pointer, friend function, dynamic objects, arrays of objects. CO3: Illustrate the Operator Overloading of +, -, preincrement, postincrement, << and >>. CO4: Implement the single, multiple, multilevel and hybrid inheritance in C++. CO5: Illustrate function overloading, Overriding and virtual functions. CO6: Carry out exception handling techniques and provide solutions to storage related problems using STL.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	**Contents**	**Contact Hours**
1	**Unit 1:** **Introduction:** Need of object-oriented programming, Overview of C++, Header Files and Namespaces, Sample C++ program, Different data types, operators, expressions, and statements, arrays and strings, pointers & user-defined types function components, argument passing, inline functions, recursive functions.	10

2	**Unit 2:** **Classes & Objects:** Class Specification, Objects, Scope resolution operator, Access members, defining member functions, Data hiding, Constructors, Parameterized constructors, Destructors, Static data members, Friend functions, passing objects as arguments, Returning objects, Arrays of objects, Dynamic objects, Pointers to objects, Copy constructors, This Pointer. **Operator overloading:** Fundamentals of Operator Overloading, Overloading Binary Operators and unary operators, Operator overloading using friend functions such as +, -, pre-increment, post-increment, overloading of << and >>.	9
3	**Unit 3:** **Inheritance:** Necessity of inheritance, Types of inheritance with examples, Base Class and Derived class, Public, private and protected access modifiers, inheriting multiple base classes, working of Constructors and Destructors in Inheritance, Passing parameters to base class constructors, Virtual base classes	9
4	**Unit 4:** **Virtual functions and Polymorphism**: Polymorphism, function overloading, Overriding Methods, Virtual function, Calling a Virtual function through a base class reference, Pure virtual functions, Abstract classes, Virtual Destructors, Early and late binding	9
5	**Unit 5:** **I/O System Basics and STL:** C++ stream classes, I/O manipulators, fstream and the File classes, basic file operations, function templates Exception Handling: Exception handling fundamentals, Throwing an Exception, Catching an Exception, Re-throwing an Exception, An exception example. **STL:** An overview, containers, vectors, lists, maps, Algorithms	9
	Total	**46**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	Herbert Schildt,The Complete Reference C++, McGraw Hill	4th	2017
2	Balagurusamy E,Object oriented Programming with C++	8th	2020
	Reference Books		
1.	Paul Deitel and Harvey Deitel, C++: How to Program, Pearson	10th	2016

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER III

Name of Department: - Computer Science and Engineering

1. Subject Code: **TMA 316** Course Title: **Discrete Structures and Combinatorics**
2. Contact Hours: **L:** **3** **T**: **1** **P**: **0**
3. Examination Duration (Hrs): **Theory** **3** **Practical** **0**
4. Relative Weight: **CIE** **25** **MSE** **25** **ESE** **50**
5. Credits: **4**
6. Semester: **III**
7. Category of Course: **DC**
8. Pre-requisite: TMA101 Engineering Mathematics-I

   TMA201 Engineering Mathematics-II

9.**Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Be able to specify and manipulate basic mathematical objects such as sets, functions, and relations . Demonstrate an understanding of partial order relations and Lattices. CO2: Understand the basics of discrete probability and number theory, and be able to apply the methods from these subjects in problem solving. CO3: Produce convincing arguments, conceive and/or analyze basic mathematical proofs and discriminate between valid and unreliable arguments. CO4: Discriminate, identify and prove the properties of groups and subgroups CO5: Be able to apply basic counting techniques to solve combinatorial problems CO6: Demonstrate different traversal methods for trees and graphs. Model problems in Computer Science using graphs and trees.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

SL. NO.	**Contents**	**Contact Hours**
1	**Unit 1:** **Relations and Functions:** Review of Sets,	**11**

	Relations - properties, equivalence relation, matrix and Graph representation, Closure operations Functions, Types of functions, Invertability, Composition of functions and Inverse functions,Partially ordered Sets and Lattices. Lattice Properties, Lattices as Boolean Algebra	
2	**Unit 2:** **Probability Theory** Basics of Probability, Conditional Probability; Random Variables, probability mass and density function, commutative distribution function, expected values, mean, variance and standard deviation, Distributions: Binomial. Poisson, normal, uniform,, exponential,	**9**
3	**Unit 3:** **Fundamentals of Logic:** Basic Connectives and Truth Tables, Logical Equivalence – The Laws of Logic, Logical Implication – Rules of Inference. The Use of Quantifiers, **Methods of Proof:** Different methods of proof – Direct Proof, Indirect Proof, Counter examples, Principle of Induction.	**9**
4	**Unit 4:** **Groups:** Definitions, Examples, and Elementary Properties, Homomorphism, Isomorphism, permutation groups and cyclic Groups, subgroups, cosets, and Lagrange's Theorem **Counting:** Set cardinality and counting, Sum and Product Rules, Inclusion Exclusion Principles, Pigeonhole principle, permutations and combinations, Basics of recurrence relations and, generating Functions	**10**
5	**Unit 5:** **Graphs and Trees** Fundamentals of Graphs Graph types – undirected, directed, weighted; -Representing graphs and graph isomorphism -connectivity-Euler and Hamilton paths, Isomorphism Tree properties, traversal techniques;	**9**
	Total	**48**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Kenneth H. Rosen:" Discrete Mathematics and its Applications", , McGraw Hill,.	6th Edition	2007
2	JayantGanguly: "A Treatise on Discrete Mathematical Structures", Sanguine-Pearson,.	2nd	2011
	Reference Books		
1.	D.S. Malik and M.K. Sen: "Discrete Mathematical Structures: Theory and Applications", Thomson,.	2nd	2004
2	Thomas Koshy:" Discrete Mathematics with Applications", Elsevier,.	1st	2005, Reprint 2008
3	Ralph P. Grimaldi:" Discrete and Combinatorial Mathematics" Pearson Education,.	5th	2004

4	S.B.Singh, Jaikishor and Ekata, “Discrete Mathematics”, Khanna Publication,.	3rd	2011

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER III

Name of Department: - Computer Science and Engineering

1. Subject Code: **PCS-308** Course Title: **Logic Design & Computer Organization Lab**
2. Contact Hours: **L:** **0** **T**: **1** **P**: **2**
3. Examination Duration (Hrs): **Theory** **0** **Practical** **3**
4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
5. Credits: **2**
6. Semester: **3**
7. Category of Course: **DC**
8. Pre-requisite: Basic Electronics Lab

9. **Course Outcome:**	After completion of the course the students will be able to**:** CO1: **Understand** various logic gates and digital circuits. CO2: **Identify** various digital ICs and understand its operation. CO3: **Design** elementary digital circuits under real and simulated environment. CO4: **Simulate** various logic circuits using simulation tool.

10. **Details of the Course:**

Sl. No.	List of problems for which student should develop program and execute in the Laboratory	Contact Hours
1.	To realize two and three variable Boolean functions using basic gates and universal gates digital IC.	2
2.	To design and test a half/full adder circuit using digital IC gates.	2
3.	To design and test a half/full subtractor circuit using IC gates.	2
4.	To design, implement and test the function F(A,B,C,D) = m(1,3,5,7,9,15) + d(4,6,12,13) using a NOR-OR implementation.	2
5.	To design and test RS, JK, D and T flip flops using logic gates.	2
6.	To design and test shift registers using flip-flops.	2
7.	To design and test an asynchronous up/down counter.	2
8.	To design, implement and test Boolean functions using a multiplexer.	2
9.	To design and simulate the implementation of Binary to Gray code conversion and vice versa using OrCAD/PSPICE.	2
10.	To design and simulate the implementation of 4-bit binary adder-subtractor circuit using OrCAD/PSPICE.	2

11.	To design and simulate the implementation of 2-bit binary multiplier circuit using OrCAD/PSPICE.	2
12.	To design and simulate the implementation of Ring and Johnson counter using OrCAD/PSPICE.	2
13.	To design and simulate Booths Algorithm using Verilog HDL.	2
14.	To design and simulate 32-bit Floating-Point multiplier using Verilog HDL.	2
15.	To design and simulate 8-bit ALU using Verilog HDL.	2
	Total	**30**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	M. Morris Mano, Michael D. Ciletti, Digital Design: With an Introduction to the Verilog HDL, VHDL, and System Verilog, Pearson	6th	2018
	Reference Books		
1.	John P Hayes, Computer Architecture and Organization, McGraw Hill	3rd	2017

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER III

Name of Department: - Computer Science and Engineering

1.	Subject Code:	**PCS 302**		Course Title:	**Data structures Lab**			
2.	Contact Hours:	**L:**	**0**	**T**:	**1**	**P**:	**2**	
3.	Examination Duration (Hrs):	**Theory**	**0**	**Practical**	**3**			
4.	Relative Weight:	**CIE**	**25**	**MSE**	**25**	**SEE**	**50**	
5.	Credits:	**2**						
6.	Semester:	**3**						
7.	Category of Course:	**DC**						
8.	Pre-requisite:	**TCS101, TCS 201**						

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Implement Stack, Queues using array in C programming language. CO2: Create Linked lists (single, double, circular) and perform various operations on Linked lists and implement Stack, Queue using Linked list in C programming language. CO3: Create Binary Search tree and perform operations such as traversal, deletion and execute Linear, Binary search, hashing and simple graph structure. CO4: Implement the sorting algorithm (Bubble, insertion, selection, merge, quick) and compare the performance of these algorithms

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	**List of problems for which student should develop program and execute in the Laboratory**	**Contact Hours**
16.	**Array :** a) Write a C program to find out the sum all even elements from an array. b) Write a C program to find out union of two given arrays. c) Write a C program to find out intersection of two given arrays. d) Write a C program to store N elements into the array and the reverse the contents of that array.	
17.	a. Write a C program to find element with maximum value from an array.	

	b. Write a C program to create a dynamic array. c. Write a C program to Implementation Stack Using Array.	
18.	a. Write a C program to Implementation queue Using Array. b. Write a C program to convert infix expression into postfix expression. c. Write a C program to evaluate any postfix expression.	
19.	a. Link list: b. Create a Single Linked List with pointers left & right where new nodes are always added after the right. Then user will input a key that should be searched in the linked list & the element having the key value should be deleted & linked list should be updated. If elements is not found then a message "Unsuccessful Search" should be displayed.	
20.	a. Write a program to insert string in linked list in alphabetical order. b. Write a program to search a node from a linked list. c. Doubly Linked List: Write a C program to implement doubly linked list with following operations. **i)Insert ii) delete ii) display.**	
21.	a) Circular linked list: Write a C program to implement Circular. b) linked list with following operations. i)Insert ii) delete ii) display.	
22.	a. Write a C program to implement Stack Using inked List. b. Write a program to implement queue using double pointers. c. Write a C program to implement Queue Using Linked List.	
23.	**Tree and Graphs:** a) Write a C program to create Binary search tree and perform following operations on it. **i)Insert node ii) Delete node iii) Search node**. Execute simple graph traversals algorithms (DFS and BFS) .	
24.	**SORTING TECHNIQUES and SEARCHING TECHNIQUES** a) Write a C program to sort an array using Bubble Sort technique. b) Write a C program to sort an array using selection sort technique. c) Write a C program to sort an array using Insertion sort technique.	
25.	d) Write a C program to sort an array using Merge Sort technique. e) Write a C program to sort an array using Quick Sort technique. f) Write a C program to implement Linear Search. g) Write a C program to implement Binary Search. h) Write a C program to implement Hashing.	
	Total	

11. Suggested Books:

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint

	Textbooks		
1.	Ellis Horowitz and Sartaj Sahni, Fundamentals of Data Structures in C, Universities Press	2nd	2014
2.	Data Structures Through C, Yashavant Kanetkar	3rd	**2019**
	Reference Books		
1.	Seymour Lipschutz, Data Structures Schaum's Outlines, McGraw Hill	1st	2014
2.	Data Structures Using C A Practical Approach for Beginers		**2021**

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER III

Name of Department: - Computer Science and Engineering

1. Subject Code: **PCS 307** Course Title: **OOP WITH C++ LAB**
2. Contact Hours: **L: 0** **T: 1** **P: 2**
3. Examination Duration (Hrs): **Theory** **Practical**
4. Relative Weight: **CIE 50** **MSE 25** **SEE 50**
5. Credits: **2**
6. Semester: **III**
7. Category of Course: **DC**
8. Pre-requisite: **PCS 101, PCS 102**

9. **Course Outcome**:**	After completion of the course the students will be able to:
	CO1: Evaluate the basic difference between object-oriented programming and procedural language and their data types.
	CO2: Implement the programs using C++ features such as object creation, compile time polymorphism, inheritance, abstraction, encapsulation etc.
	CO3: Design and solve programs that incorporates the use of object-oriented techniques such as abstract classes, pure virtual functions, and constructors.
	CO4: Create programs based on the concepts of virtual base classes, virtual functions and STL to solve real time problems

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	List of problems for which student should develop program and execute in the Laboratory	Contact Hours
1.	An electricity board charges the following rates to domestic users to discourage large consumption of energy. For the first 100 units: - 60 P per unit For the next 200 units: -80 P per unit Beyond 300 units: -90 P per unit All users are charged a minimum of Rs 50 if the total amount is more than Rs 300 then an additional surcharge of 15% is added.	

Implement a C++ program to read the names of users and number of units consumed and display the charges with names

2. Construct a C++ program that removes a specific character from a given string and return the updated string.

Typical Input: computer science is the future

Typical Output: compuer science is he fuure

3. Implement a C++ program to find the non-repeating characters in string.

Typical Input: graphic era university

Typical Output: c g h n p s t u v y

4. You are given an array of elements. Now you need to choose the best index of this array. An index of the array is called best if the special sum of this index is maximum across the special sum of all the other indices. To calculate the special sum for any index you pick the first element that is and add it to your sum. Now you pick next two elements i.e., and and add both of them to your sum. Now you will pick the next elements, and this continues till the index for which it is possible to pick the elements. Find the best index and in the output print its corresponding special sum. Note that there may be more than one best index, but you need to only print the maximum special sum.

Input

First line contains an integer as input. Next line contains space separated integers denoting the elements of the array

Output

In the output you have to print an integer that denotes the maximum special sum

Input/Output Format	
Typical Input	**Expected Output**
5 1 3 1 2 5	8
10 2 1 3 9 2 4 -10 -9 1 3	9

5. Implement a C++ program to demonstrate the concept of data abstraction using the concept of Class and Objects

6. Define a class Hotel in C++ with the following specifications

Private members

- Rno Data member to store room number
- Name Data member to store customer name
- Tariff Data member to store per day charges
- NOD Data member to store number of days of stay
- CALC() Function to calculate and return amount as NOD*Tariff ,and if the value of days* Tariff >10000,

	then total amount is 1.05* days*Tariff. **Public members** • Checkin() Function to enter the content Rno, Name, Tariff and NOD • Checkout() Function to display Rno, Name, Tariff, NOD and Amount (amount to be displayed by calling function) CALC()	
7.	Implement a Program in C++ by defining a class to represent a bank account. Include the following: **Data Members** ● Name of the depositor ● Account number ● Type of account (Saving, Current etc.) ● Balance amount in the account **Member Functions** ● To assign initial values ● To deposit an amount ● To withdraw an amount after checking the balance ● To display name and balance	
8.	Anna is a contender for valedictorian of her high school. She wants to know how many students (if any) have scored higher than her in the exams given during this semester. Create a class named Student with the following specifications: ➢ An instance variable named scores holds a student's 5 exam scores. ➢ A void input () function reads 5 integers and saves them to scores. ➢ An int calculateTotalScore() function that returns the sum of the student's scores. **Input Format** In the void Student::input() function, you must read 5 scores from standard input and save them to your scores instance variable. **Output Format** In the int Student::calculateTotalScore() function, you must return the student's total grade (the sum of the values in scores). The code in the editor will determine how many scores are larger than Anna's and print that number to the console. **Sample Input** The first line contains n, the number of students in Anna's class. The n subsequent lines contain each student's 5 exam grades for this semester. 3 30 40 45 10 10	

<table>
<tr><td></td><td>40 40 40 10 10

50 20 30 10 10

Sample Output

1</td><td></td></tr>
<tr><td>9.</td><td>Construct a Program in C++ to show the working of function overloading(compile time polymorphism) by using a function named calculate Area () to calculate area of square, rectangle and triangle using different signatures as required.</td><td></td></tr>
<tr><td>10</td><td>Create a class called Invoice that a hardware store might use to represent an invoice for an item sold at the store. An Invoice should include four pieces of information as instance.

Data Members -
partNumber (type String)
partDescription (type String)
quantity of the item being purchased (type int)
price_per_item (type double)
Your class should have a constructor that initializes the four instance variables. Provide a set and a get method for each instance variable. In addition, provide a method named getInvoiceAmount() that calculates the invoice amount (i.e., multiplies the quantity by the price per item), then returns the amount as a double value. If the quantity is not positive, it should be set to 0. If the price per item is not positive,it should be set to0.0. Write a test application named invoiceTest that demonstrates class Invoice’s capabilities.</td><td></td></tr>
<tr><td>11</td><td>Imagine a tollbooth with a class called TollBooth. The two data items are of type unsigned int and double to hold the total number of cars and total amount of money collected. A constructor initializes both of these data members to 0. A member function called payingCar( )increments the car total and adds 0.5 to the cash total. Another function called nonPayCar( ) increments the car total but adds nothing to the cash total. Finally a member function called display( )shows the two totals. Include a program to test this class. This program should allow the user to push one key to count a paying car and another to count a non paying car. Pushing the ESC key should cause the program to print out the total number of cars and total cash and then exit.</td><td></td></tr>
<tr><td>12</td><td>Create a class called Time that has separate int member data for hours, minutes and seconds. One constructor should initialize this data to 0, and another should initialize it to fixed values. A member function should display it in 11:59:59 format. A member function named add() should add two objects of type time passed as arguments. A main ( ) program should create two initialized values together, leaving the result in the third time variable. Finally it should display the value of this third variable.</td><td></td></tr>
</table>

13	Create class SavingsAccount. Use a static variable annualInterestRate to store the annual interest rate for all account holders. Each object of the class contains a private instance variable savingsBalance indicating the amount the saver currently has on deposit. Provide method calculateMonthlyInterest() to calculate the monthly interest by multiplying the savingsBalance by annualInterestRate divided by 12.This interest should be added tosavingsBalance. Provide a static method modifyInterestRate() that sets the annualInterestRate to a new value. Write a program to test class SavingsAccount. Instantiate two savingsAccount objects, saver1 and saver2, with balances of Rs2000.00 and Rs3000.00, respectively. Set annualInterestRate to 4%, then calculate the monthly interest and print the new balances for both savers. Then set the annualInterestRate to 5%, calculate the next month’s interest and print the new balances for both savers	
14	Create a class Complex having two int type variable named real & img denoting real and imaginary part respectively of a complex number. Overload +, - , == operator to add, to subtract and to compare two complex numbers being denoted by the two complex type objects	
15	Using the concept of operator overloading. Implement a program to overload the following: a. Unary – b. Unary ++ preincrement, postincrement c. Unary -- predecrement, postdecrement	
16	Using the concept of operator overloading. Implement a program to overload the following: With the help of friend function a. Unary – b. Unary ++ preincrement, postincrement c. Unary -- predecrement, postdecrement	
17	Create a Base class that consists of private, protected and public data members and member functions. Try using different access modifiers for inheriting Base class to the Derived class and create a table that summarizes the above three modes (when derived in public, protected and private modes) and shows the access specifier of the members of base class in the Derived class.	
18	You are given three classes A, B and C. All three classes implement their own version of func. In class A, func multiplies the value passed as a parameter by 2. In class B, func multiplies the value passed as a parameter by 3. In class C, func multiplies the value passed as a parameter by 5.You are given class D such that You need to modify the class D and implement the function update_val which sets D's val to new_val by manipulating the value by only calling the func defined in classes A, B and C.It is guaranteed that new_val has only 2, 3 and 5 as its prime factors. Implement class D's function update_val. This function should update D's val only by calling A, B and C's func.	

	Sample Input new_val = 30 **Sample Output** A's func called 1 times B's func called 1 times C's func called 1 times	
19	Create a class called Student that contains the data members like age, name, enroll_no, marks. Create another class called Faculty that contains data members like facultyName, facultyCode, salary,deptt, age, experience, gender. Create the function display() in both the classes to display the respective information. The derived Class Person demonstrates multiple inheritance. The program should be able to call both the base classes and displays their information. Remove the ambiguity (When we have exactly same variables or same methods in both the base classes, which one will becalled?) by proper mechanism	
20	Implement a real case scenario by a proper C++ code to provide the solution to Diamond Problem in C++	
21	Create a base class called shape. Use this class to store two double type values that could be used to compute the area of figures. Derive two specific classes called triangle and rectangle from base shape. Add to the base class, a member function get_data() to initialize base class data members and another member function display_area() to compute and display the area of figures. Make display_area() as a virtual function and redefine this function in the derived class to suit their requirements. Using these three classes, design a program that will accept dimensions of a triangle or a rectangle interactively and display the area. Remember the two values given as input will be treated as lengths of two sides in the case of rectangles and as base and height in the case of triangle and used as follows: Area of rectangle = x * y Area of triangle = ½ *x*y	
21.	Create a base class called CAL_AREA(Abstract). Use this class to store float type values that could be used to compute the volume of figures. Derive two specific classes called cone, hemisphere and cylinder from the base CAL_AREA. Add to the base class, a member function getdata ( ) to initialize base class data members and another member function display volume( ) to compute and display the volume of figures. Make display volume ( ) as a pure virtual function and redefine this function in the derived classes to suit their requirements. Using these three classes, design a program that will accept dimensions of a cone, cylinder and hemisphere interactively and display the volumes. Remember values given as input will be and used as follows:	

	Volume of cone = $(1/3)\pi r^2 h$ Volume of hemisphere = $(2/3)\pi r^3$ Volume of cylinder = $\pi r^2 h$	
22.	The task is to debug the existing code to successfully execute all provided test files. You are required to extend the existing code so that it handles the std::invalid_argument exception properly. More specifically, you have to extend the implementation of the process_input function. It takes integer n as an argument and has to work as follows: 1.It calls function largest_proper_divisor(n). 2.If this call returns a value without raising an exception, it should print in a single line result=d where d is the returned value. 3.Otherwise, if the call raises an invalid_argument exception, it has to print in a single line the string representation of the raised exception, i.e., its message. 4.Finally, no matter if the exception is raised or not, it should print in a single line returning control flow to the caller after any other previously printed output. **Input Format** The input is read by the provided locked code template. In the only line of the input, there is a single integer n, which is going to be the argument passed to function process input. **Output Format** The output should be produced by the function process_input as described in the statement. **Sample Input** 0 **Sample Output** the largest proper divisor is not defined for n=0 returning control flow to the caller Explanation 1 In the first sample, n = 0, so the call largest_proper_divisor(0) raises an exception. In this case, the function process_input prints two lines. In the first of them, it prints the string representation of the raised exception, and in the second line, it prints returning control flow to the caller. **Sample Input** 9 **Sample Output** result=3	
23.	Templates are the foundation of generic programming, which involves writing code in a way that is independent of any particular type. Write a program that can create a list (create a class list) of given type (int, float, char etc.) and perform insertion and deletion on list object.	
24.	Construct a C++ program to demonstrate different methods of List, Vector and Map in STL (Standard Template Library)	

25.	You are provided with a vector of N integers. Then, you are given 2 queries. For the first query, you are provided with 1 integer, which denotes a position in the vector. The value at this position in the vector needs to be erased. The next query consists of 2 integers denoting a range of the positions in the vector. The elements which fall under that range should be removed. The second query is performed on the updated vector which we get after performing the first query. Input Format The first line of the input contains an integer N. The next line contains N space-separated integers (1-based index). The third line contains a single integer x, denoting the position of an element that should be removed from the vector. The fourth line contains two integers a and b denoting the range that should be erased from the vector inclusive of a and exclusive of b. Output Format Print the size of the vector in the first line and the elements of the vector after the two erase operations in the second line separated by space. Sample Input 6 1 4 6 2 8 9 2 2 4 Sample Output 3 1 8 9 Explanation The first query is to erase the 2nd element in the vector, which is 4. Then, a modified vector is {1 6 2 8 9}, we want to remove the range of 2~4, which means the 2nd and 3rd elements should be removed. Then 6 and 2 in the modified vector are removed and we finally get {1 8 9}	
	Total	

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Herbert Schildt,"The Complete Reference C++", 4^{th} Edition, Tata McGraw Hill, 2003.	4^{th}	2003
2.	Balagurusamy." Object Oriented Programming with C++",8^{th} Edition, Tata McGraw Hill,2020	8^{th}	2020
	Reference Books		
1.	Paul Deitel and Harvey Deitel," C++: How to Program",10 Edition, Pearson	10^{th}	2016

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER III

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 351** Course Title: **Fundamental of Cloud Computing and Bigdata**
2. Contact Hours: **L:** 3 **T**: **P**:
3. Examination Duration (Hrs): **Theory** **Practical**
4. Relative Weight: **CIE** 25 **MSE** 25 **SEE** 50
5. Credits: **3**
6. Semester: **III**
7. Category of Course: **DE**
8. Pre-requisite: NA

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Identify the importance of cloud computing services for the digital ag technologies. CO2: Differentiate the services and deployment models of cloud computing. CO3: Evaluate the case studies of the different types of cloud computing applications. CO4: Analyze the cloud computing services management techniques, providers, and standards. CO5: Distinguish the cloud computing services using Bigdata and big data analytics CO6: Design and deploy a cloud based web application.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No	Contents	Contact Hours
1	**Unit 1:** Introduction to Cloud Computing, Vision, History, Evolution, and Characteristics of Cloud Computing (NIST), Characteristic, Advantages and Disadvantages of Clou	9

	Computing, Cloud computing vs. Cluster computing vs. Grid computing, Importanc of Open Standards for digital age technologies.	
2	**Unit 2:** Working of Cloud Computing, Cloud Computing comparison with traditiona computing architecture (client/server), Impact of Networks, Web Development an User Interface (UI) on Cloud computing. Cloud Deployment Models: Public cloud, Private cloud, Hybrid cloud, Communit cloud.	9
3	**Unit 3:** Cloud Service Models: Infrastructure as a Service (IaaS), Platform as a Servic (PaaS), Software as a Service (SaaS). Infrastructure as a Service (IaaS): IaaS definition, Virtualization, Hypervisors Machine Image, Virtual Machine (VM), Resource Virtualization, Server, Storage Networking, Virtual Machine (resource) provisioning and manageability, Dat centre physical plant/building, Networking firewalls/security, Data storage in clou computing (storage as a service), Amazon Elastic Compute Cloud (EC2), Eucalyptus Open Stack, Case Study of IaaS. Platform as a Service (PaaS): PaaS definition, Service Oriented Architecture (SOA) Cloud Platform and Management, Development tools, database management, busines analytics, Operating systems, Google App Engine, Microsoft Azure, and Salesforce Case Study of PaaS. Software as a Service (SaaS): SaaS definition, Web services, Web 2.0, Case Study o SaaS.	9
4	**Unit 4:** Introduction to Big Data, Characteristics, Architectures, Technologies, Applications Advantages and Disadvantages of Big Data, Tools and Techniques applied in Big Data Association rule learning, Classification tree analysis, Genetic algorithms, Machin learning, Regression analysis, Sentiment analysis, Social network analysis, Differenc between big data and big data analytics. Introduction to Big Data analytics, Data Analysis Techniques: A/B testing, Data fusio and data integration, Data mining, Machine learning, Natural language processin (NLP), Statistics. Case study of Big Data.	9
5	**Unit 5:** Foundations Services of AWS: Savings, Security, Compliance and DRaaS Development Operations. AWS Services: Amazon Lambda, Amazon Relationa Database Service (Amazon RDS), Amazon S3, Amazon CloudFront, Amazon Glacier and Amazon SNS. Service Management in Cloud Computing: Service Level Agreements (SLAs), Billin & Accounting. Economics of Cloud Computing: SWOT Analysis and Value Proposition, Genera Cloud Computing Risks, (Performance, Network Dependence, Reliability, Outages Safety Critical Processing Compliance and Information Security. Design and Deploy an Online Video Subscription Application on the Cloud.	9
	Total	**45**

11. **Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Rajkumar Buyya, Cloud Computing Principles and Paradigms Wiley,	1st	2013
2	Kannammal, Fundamentals of Cloud Computing, Cengage Learning,	1st	2015
3	Cloud Computing Bible, Barrie Sosinsky, Wiley-India,	1st	2011
	Reference Books		
1.	Jared Dean, Bigdata Data Mining and Machine Learning Wiley,	1st	2014
2	Vince Reynolds, Bigdata for Beginners, Create space Independent Publishing Platform,	1st	2016

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER III

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 392** Course Title: **Introduction to Cryptography**
2. Contact Hours: **L: 3** **T**: **P**:
3. Examination Duration (Hrs): **Theory** **Practical**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **III**
7. Category of Course: **DE**
8. Pre-requisite: NA

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1:Classify security vulnerabilities involved in data communication over Internet and makeuse of classical algorithms to address the vulnerabilities. CO2: Apply symmetric block ciphers to secure data transmission and storage CO3: Analyze the various public key cryptographic systems and usage of hashing CO4 Appreciate the design of Public Key algorithms, mathematical background and make useof the same for data communication and message authentication CO5: Categorize types of viruses, worms, intrusion and decide measures to counter thethreats. CO6: Understand the legal aspects related to Cybercrime, Intellectual Property, Privacy,Ethical Issues.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	**Contents**	**Contact Hours**
1	**Unit – 1:** Introduction: Computer Security Concepts: The OSI SecurityArchitecture, Security Attacks, Security Services, Security Mechanisms, a Model for Network Security, Standards Cryptography fundamentals and terminology; Cryptanalysis and Brute-Force Attack, Fundamental techniques of cryptography Substitution and Transposition; Classical Ciphers; Basics of Steganography.	8
2	**Unit – 2:** Modern Cryptography: Symmetric Encryption and MessageConfidentiality:	9

	Symmetric Encryption Principles, Fiestal structure. Symmetric Block Encryption Algorithms, Simple DES, double DES, Stream Ciphers and RC4, Random and Pseudorandom Numbers.	
3	**Unit – 3:** Symmetric key distribution using symmetric encryption: A Key Distribution Scenario, Session Key Lifetime, A Transparent Key Control Scheme, Decentralized Key Control, Controlling Key UsageMathematical Background for cryptography: prime number, Euclidean algorithm for GCD, Extended Euclidean algorithm for multiplicative inverse, Euler's totient function, their programming implementation.	10
4	**Unit 4:** Public-Key Cryptography: Public-Key Encryption Structure, Applications for Public-Key Cryptosystems, Requirements for Public-Key Cryptography, The RSA Public-Key Encryption Algorithm. Message Authentication: Approaches to Message Authentication, Authentication Using Conventional Encryption, Message Authentication without Message Encryption, MD5 Hash Algorithm.	9
5	**Unit 5:** System Security: Intruders, Intrusion Detection, Password Management, Types of Malicious Software, Viruses, Virus Countermeasures, Worms and Principles of Firewalls Legal and Ethical Aspects: Cybercrime and Computer Crime, Intellectual Property, Privacy, Ethical Issues.	8
	Total	**44**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	William Stallings, Network Security Essentials Applications and Standards, ,Pearson Education,	6th	2018
2	William Stallings , Cryptography and Network Security, Pearson Education,	7th	2017
	Reference Books		
1.	Behrouz Forouzan , Cryptography and Network Security, McGraw Hill,	3rd	2015
2	Atul Kahate, "Cryptography and Network Security", McGraw Hill Education,,	3rd	2017

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER III

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 331** Course Title: **Fundamental of IoT**
2. Contact Hours: **L:** 3 **T**: 0 **P**: 0
3. Examination Duration (Hrs): **Theory** 3 **Practical** 0
4. Relative Weight: **CIE** 25 **MSE** 25 **SEE** 50
5. Credits: 3
6. Semester: III
7. Category of Course: **DE**
8. Pre-requisite: NA

9.**Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Explain the terms used in IoT. CO2: Describe key technologies in Internet of Things. CO3: Identify components needed to provide a solution for certain applications. CO4: Analyze security requirements in an IoT system. CO5: Design wireless sensor network architecture and its framework along with WSN applications. CO6: Understand business models for the Internet of Things.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

SL. NO.	**Contents**	**Contact Hours**
1	**Unit 1:** **INTRODUCTION** Introduction to Internet of Things: History of IoT, About IoT, Overview and Motivations, Examples of Applications, Internet of Things Definitions and Frameworks: IoT Definitions, IoT Architecture, General Observations, ITU-T Views, Working Definition, IoT Frameworks, Basic Nodal Capabilities.	**8**
2	**Unit 2:** **FUNDAMENTAL IoT MECHANISMS AND KEY TECHNOLOGIES** Identification of IoT Objects and Services, Structural Aspects of the IoT, Environment Characteristics, Traffic Characteristics, Scalability, Interoperability, Security and Privacy, Open Architecture, Key IoT Technologies, Device Intelligence, Communication Capabilities, Mobility Support, Device Power, Sensor Technology, RFID Technology, Satellite Technology.	**10**

3	**Unit 3:** **RADIO FREQUENCY IDENTIFICATION TECHNOLOGY** RFID: Introduction, Principle of RFID, Components of an RFID system, Issues EPCGlobal Architecture Framework: EPCIS & ONS, Design issues, Technological challenges, Security challenges, IP for IoT, Web of Things. Wireless Sensor Networks: History and context, WSN Architecture, the node, Connecting nodes, Networking Nodes, Securing Communication WSN specific IoT applications, challenges: Security, QoS, Configuration, Various integration approaches, Data link layer protocols, routing protocols and infrastructure establishment.	**10**
4	**Unit 4:** **RESOURCE MANAGEMENT IN THE INTERNET OF THINGS** Clustering, Software Agents, Clustering Principles in an Internet of Things Architecture, Design Guidelines, and Software Agents for Object Representation, Data Synchronization. Identity portrayal, Identity management, various identity management models: Local, Network, Federated and global web identity, user-centric identity management, device centric identity management and hybrid-identity management, Identity and trust.	**10**
5	**Unit 5:** **INTERNET OF THINGS PRIVACY, SECURITY AND GOVERNANCE** Vulnerabilities of IoT, Security requirements, Threat analysis, Use cases and misuse cases, IoT security tomography and layered attacker model, Identity establishment, Access control, Message integrity, Non-repudiation and availability, Security model for IoT. Internet of Things Application: Smart Metering Advanced Metering Infrastructure, e-Health Body Area Networks, City Automation, Automotive Applications, Home Automation, Smart Cards.	**10**
	Total	**48**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Willy Publications	1^{st}	**2013**
2	Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things", ISBN 978-3- 642-19156-5 e-ISBN 978-3-642-19157-2, Springer	1^{st}	**2011**
3	Parikshit N. Mahalle&Poonam N. Railkar, "Identity Management for Internet of Things", River Publishers, ISBN: 978-87-93102-90-3 (Hard Copy), 978-87-93102-91-0 (ebook).	1^{st}	2015

	Reference Books		
1.	HakimaChaouchi, “The Internet of Things Connecting Objects to the Web” ISBN : 978-1- 84821-140-7, Willy Publications	1^{st}	2010
2	Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things: Key Applications and Protocols, ISBN: 978-1-119-99435-0, 2 nd Edition, Willy Publications	1^{st}	**2015**
3	Daniel Kellmereit, Daniel Obodovski, “The Silent Intelligence: The Internet of Things”,. Publisher: Lightning Source Inc; ISBN-10: 0989973700, ISBN-13: 978-0989973700.	1^{st}	**2014**
4	Fang Zhaho, Leonidas Guibas, “Wireless Sensor Network: An information processing approach”, Elsevier, ISBN: 978-81-8147-642-5.	1^{st}	**2055**

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER III

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS- 341** Course Title: **Python Programming for Computing**
2. Contact Hours: **L:** **T**: **0** **P**: **0**
3. Examination Duration (Hrs): **Theory** **3** **Practical** **0**
4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
5. Credits: **4**
6. Semester: **3rd**
7. Category of Course: **DE**

8. Pre-requisite: TCS 101, TCS 201

9. **Course Outcome**:**	After completion of the course the students will be able to**:** **CO1:** Describe the principles of structured programming and be able to describe, design, implement, and test structured programs using currently accepted methodology. **CO2:** Explain what an algorithm is and its importance in computer programming. **CO3:** Recognize and construct common programming idioms: variables, loop, branch, subroutine, and input/output. **CO4:** Define and demonstrate the use of the built-in data structures 'list' and 'dictionary'. **CO5:** Apply idioms to common problems such as text manipulation, web page building, and working with large sets of numbers. **CO6:** Design and implement a program to solve a real-world problem using the language idioms, data structures, and standard library.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	**Contents**	**Contact Hours**
1	**Unit 1:** **Introduction:** Introduction to Python: Importance of Python, Installing and working with Python in Windows, Linux and Mac, Using Python as calculator, Comments, how to define main function in Python. The concept of data types - Variables, Arithmetic Operators and Expressions **String manipulations** - Subscript Operator, Indexing, slicing a string, Converting strings to numbers and vice versa, split function. Control flow - if statements, for and while loops, nested loops, Short-	9

	circuit (lazy evaluation), range () function, break and continue statements, pass statements	
2	**Unit 2:** **Data Structures:** Lists - Basic list operations, Replacing, inserting, removing an element; Searching and sorting a list, Methods of list objects, using lists as Stacks and Queues, List, and nested list Comprehensions. Tuple, Sets, Difference between list and tuple Dictionary - adding and removing keys, accessing, and replacing values, traversing dictionaries	9
3	**Unit 3** **File and Exception Handling in Python** Reading config files in python, Writing log files in python, Understanding read functions, read (), readline() and readlines(), Understanding write functions, write() and writelines(), Manipulating file pointer using seek, Programming using file operations Exception Handling - Exceptions, why use exceptions, raising an exception, try and except, try, except and else clause; try and finally	11
4	**Unit 4:** Regular Expressions and Python Packages Regular Expressions - re module, searching a string (match and search), Finding a string (findall), Break string into substrings (split), Replace part of a string (sub) Python packages: Simple programs using the built-in functions of packages matplotlib, NumPy, Pandas	9
5	**Unit 5:** **Python Functions and OOP Concepts** Python functions and modules - OS and SYS modules, defining python functions, calling a function, function arguments, Lambda, and map function, Importing python module. Classes and OOP - Class definition syntax, objects, class, and instance variables, Inheritance and multiple inheritance, Polymorphism, Overloading, Overriding, Data Hiding	10
	Total	**48**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	Kenneth A. Lambert, “The Fundamentals of Python: First Programs”, Cengage Learning.,	1st	**2011**
2.	Think Python: How to think like a Computer Scientist	2nd	**2015**
3.	Python Programming using Problem Solving Approach	1st	**2017**

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER III

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 332** Course Title: Fundamental of Information Security and Blockchain
2. Contact Hours: **L:** 3 **T**: **P**:
3. Examination Duration (Hrs): **Theory** **Practical**
4. Relative Weight: **CIE** 25 **MSE** 25 **SEE** 50
5. Credits: **4**
6. Semester: **III**
7. Category of Course: **DE**
8. Pre-requisite: NA

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Explain information security and blockchain CO2: Know the working of information security techniques CO3: Analyze the different information security protocols CO4 Use Blockchain to implement information security protocols CO5 Apply information security techniques in different applications CO6: Develop blockchain enabled information security protocols

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit – 1:** **Introduction to information security** What is information security, why we need information security, the zero trust model, overview of ethical hacking Protection against- unauthorised modification, unauthorised deletion and unauthorised access, different types of user authentication techniques, access control techniques Pillars of information security - confidentiality, availability and integrity Steps to fix a cyber crime - Identify cyber threats, analyse and evaluate threat, treatment Type of hackers - white hat, grey hat, black hat Penetration testing and its phases - reconnaissance, scanning, gaining access, maintaining access, covering tracks	9
2	**Unit – 2:** **Linux Basics and Scripting for Information Security**	8

	Bash, linux commands, man page, adding and deleting, users and adding them to sudo group, switching users, creating, copying, moving and removing file, writing and appending text to a file, file permissions, working with editors, grep, cut command, starting and stopping services Introduction to bash scripting- basics of bash or shell scripting, conditional statements, loops, manipulating files Introduction to python - Basics of python, conditional statements, loops, list, tuple, dictionary, functions	
3	**Unit – 3:** **Basics of Network and Web Security** TCP 3-way handshake, netcat - The Swiss Army Knife of TCP/IP Connections, use netcat to Listen on a port, pushing a command shell back to listener, transfer files, ICMP and Ping command Cross site scripting (XSS) attack, Phishing, Spear Phishing, Sql Injection Attack, Wireshark - A Packet Sniffing Tool	10
4	**Unit 4:** Overview of blockchain- Overview of blockchain, structure of a block, block header, block identifiers: block header hash and block height, genesis block, linking of blocks, merkle trees, and use of merkle root in payment verification	10
5	**Unit 5:** Blockchain mechanisms: Details of distributed ledger, smart contracts, bitcoins networks, mining process, consensus algorithms, proof of work, proof of stake, proof of weight, proof of capacity.	8
	Total	**45**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Georgia Weidman,“Penetration Testing: A Hands-on Introduction to Hacking”, No Starch Press,	1st	2020
2	George Icahn, “Blockchain: the complete guide to understanding blockchain technology”,	1st	2020
3	Antony lewis, “The basics of bitcoins and blockchains: an introduction to cryptocurrencies and the technology that powers them”	3rd	2020
	Reference Books		
1.	Andreas M. Antonopoulos, “Mastering Bitcoin: unlocking digital cryptocurrencies”, O'Reilly Media,	2nd	2017
2	Roger Wattenhofer, “Distributed Ledger Tehnology, The science of the Blockchain”, Inverted Forest Publishing,	2nd	2017
	Antonopoulos, Andreas M. and Wood, Gavin. Mastering Ethereum. O’Reilly Media,.	2nd	2018

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER III

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS-343** Course Title: Mathematical Foundations for Artificial Intelligence
2. Contact Hours: **L:** **3** **1** **0**
3. Examination Duration (Hrs): **Theory** **3** **tical** **0**
4. Relative Weight: **CIE** **25** **MSE** **25** **50**
5. Credits: **4**
6. Semester: **III**
7. Category of Course: **DC**
8. Pre-requisite: **TMA 101 Engineering Mathemaics I**, **TMA 201 Engineering Mathemaics II**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Understand the basic concepts of Linear Algebra such as System of Linear Equation, Matrices, Vector Space, Rank, etc. CO2: Understand the basic principles of probability, Bayes theorem, understand the definitions of discrete, continuous, and joint random variables, compute the mean, variance and covariance of random variables. CO3: Solve problems on matrix decompositions such as Choleskey Decomposition, Eigen Decomposition and Diagonalization, Singular Value Decomposition CO4: Describe the vector calculus concepts such as differentiation of Univariate Function, Partial Differentiation and Gradients. CO5: Analyze various mathematical concepts, that are required to build AI & ML models. CO6: Create an AI & ML models by applying the concepts of mathematics such as Linear Algebra, Analytical Geometry, Matrix, Calculus, Probability, etc.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate*

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** **Linear Algebra:** System of Linear Equation**,** Matrices, Solving system of Linear Equation, Vector Spaces, Linear Independences, Basis and Rank, Linear Mappings, Affine Space.	10

2	**Unit 2:** **Analytic Geometry:** Norms, Inner Products, Lengths and Distances, Angles and Orthogonality, Orthonormal basis, Orthogonal Compliment, Inner Product of Function, Orthogonal Projections, Rotations.	10
3	**Unit 3:** **Matrix Decomposition** Determinant and Trace, Eigen Values and Eigen Vectors, Choleskey Decomposition, Eigen Decomposition and Diagonalization, Singular Value Decomposition, Matrix Approximation, Matrix Pylogency	10
4	**Unit 4:** **Vector Calculus** Differentiation of Univariate Function, Partial Differentiation and Gradients, Gradients of Vector-Valued Functions, Gradients of Matrices, Linearization and Multivariate Taylor Series	10
5	**Unit 5:** Probability and Distribution Discrete and Continuous Probability, Sum Rule, Product Rule, Bayes' Theorem, Gaussian Distribution, Change of Variables/Inverse Transform	10
	Total	**50**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Marc Peter Deisenroth , A. Aldo Faisal, Cheng Soon Ong, MATHEMATICS FOR MACHINE LEARNING, Cambridge University Press	1st	2020
2.	Jay Dawani, Hands-On Mathematics for Deep Learning: Build a solid mathematical foundation for training efficient deep neural networks, Packt Publishing Limited	1st	2020
	Reference Books		
1.	Tamoghna Ghosh , Shravan Kumar Belagal Math, Practical Mathematics for AI and Deep Learning, BPB Publications	1st	2022

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER III

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 344** Course Title: **Probability and Random Processes**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3** **0**
6. Semester: **3**
7. Category of Course: **DE**
8. Pre-requisite: **TMA 101 Engineering Mathematics I, TMA 102 Engineering Mathematics II**

9. **Course Outcome**:**	After completion of the course the students will be able to: CO1: To provide necessary basic concepts in probability and random processes for applications such as random signals, linear systems in communication engineering. CO2: To understand the basic concepts of probability, one-dimensional and two-dimensional random variables and to introduce some standard distributions applicable to engineering which can describe real life phenomenon. CO3: To understand the basic concepts of random processes which are widely used in IT fields. CO4: To understand the concept of correlation and spectral densities. CO5: To understand the significance of linear systems with random inputs.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate*

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** PROBABILITY AND RANDOM VARIABLES Probability – Axioms of probability – Conditional probability – Baye's theorem - Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions.	9
2	**Unit 2:** TWO - DIMENSIONAL RANDOM VARIABLES distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random	9

	variables – Central limit theorem (for independent and identically distributed random variables).	
3	**Unit 3:** RANDOM PROCESSES Classification Stationary process – Markov process - Markov chain - Poisson process – Random telegraph process.	9
4	**Unit 4:** CORRELATION AND SPECTRAL DENSITIES Auto correlation functions – Cross correlation functions – Properties – Power spectral density – Cross spectral density – Properties.	9
5	**Unit 5:** LINEAR SYSTEMS WITH RANDOM INPUTS Linear time invariant system – System transfer function – Linear systems with random inputs – Auto correlation and cross correlation functions of input and output.	9
	Total	**45**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Oliver C. Ibe, “Fundamentals of Applied Probability and Random Processes", Elsevier, Indian Reprint	1st	2007
2	Peebles. P.Z., "Probability, Random Variables and Random Signal Principles", Tata McGraw Hill	4th	2017
	Reference Books		
1.	Yates. R.D. and Goodman. D.J., "Probability and Stochastic Processes", Wiley India	3rd	2021
2.	Stark. H., and Woods. J.W., "Probability and Random Processes with Applications to Signal Processing", Pearson Education	3rd	2002

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER III

Name of Department: - Computer Science and Engineer

1. Subject Code: **TCS-324** Course T... **Information Security Foundations**
2. Contact Hours: **L:** 3 **T**: 0 **P**: 0
3. Examination Duration (Hrs): **T**3 **P** 0 **al**
4. Relative Weight: **CIE** 25 **MSE** 25 **SEE** 50
5. Credits: 3
6. Semester: 3
7. Category of Course: **DE**
8. Pre-requisite: **Fundamental of Computers (TCS 101), Programming for problem solving (TCS 201)**

9. **Course Outcome:**	After completion of the course the students will be able to**:** CO1: Explain symmetric and asymmetric key cryptosystems. CO2: Know the working of cryptography techniques. CO3: Analyze the different types of cryptosystems. CO4: Use cryptographic techniques to implement information security protocols. CO5: Apply cryptographic techniques in different applications. CO6: Develop symmetric and asymmetric key cryptosystems.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate*

10. **Details of the Course:**

Sl. No.	**Contents**	**Contact Hours**
1	**Unit 1:** **Introduction to information security** What is information security, why we need information security, the zero trust model, overview of ethical hacking Protection against- unauthorized modification, unauthorized deletion and	10

	unauthorized access, different types of user authentication techniques, access control techniques Pillars of information security - confidentiality, availability and integrity Steps to fix a cyberc rime - Identify cyber threats, analyze and evaluatethreat, treatment Type of hackers - white hat, grey hat, black hat Penetration testing and its phases - reconnaissance, scanning, gaining access, maintaining access, covering tracks. SSL and Transport layer security.	
2	**Unit 2:** **Basics of cryptography** What is cryptography, what is confidentiality, data integrity, authentication, and nonrepudiation, applications of cryptography - chip based payment cards, digital currencies, computer passwords, digital communications, plaintext, cipher-text, cipher - characteristics of a good cipher, encryption, decryption, Key - significance of key length, symmetric and asymmetric key cryptography, cryptanalysis, OSI security architecture- security attacks, security services, security mechanisms	10
3	**Unit 3:** **Mathematics applied in information security** Concept of divisibility, prime numbers, importance of prime numbers in cryptography, euclid theorem for GCD, extended euclidean algorithm, modular arithmetic, random number generators, deterministic and nondeterministic random number generators, XOR, bit shifts, euler's totient theorem, chinese remainder theorem.	8
4	**Unit 4:** **Symmetric key cryptosystem** Secret Key (symmetric) cryptography - stream and block ciphers, additive and multiplicative ciphers, rail fence technique, playfair cipher, hill cipher, vernam cipher, Vigenère Cipher, RC4 algorithm, DES, 2DES, 2-3DES, 3DES, AES, block cipher modes of operations.	10
5	**Unit 5:** **Asymmetric key cryptosystem, digital signature, and message integrity** RSA, Diffie Hellman key exchange protocol, Elliptic curve cryptography (ECC), ElGamal encryption system. DSS algorithm, RSADS algorithm, ECDSA algorithm, Message integrity, hash functions, MAC functions, HMAC	8
	Total	**46**

11**. Suggested Books:**

S.No	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	William Stallings, “Cryptography and Network Security: Principles and Practice”, Pearson publication, 2020.	**8th**	**2020**
	Reference Books		

1.	Charles P. Pfleeger, Shari Lawrence Pfleeger, Jonathan Margulies, “Security in Computing”, 5th Edition, Prentice Hall.	**5th**	**2015**
2.	William Stallings, “Network Security Essentials: Applications and Standards”, Prentice Hall.	**6^{th}**	**2016**

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER III

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS-342** Course Title: **Introduction to Statistical Data Science**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 25**
5. Credits: **3**
6. Semester: **3**
7. Category of Course: **DE**
8. Pre-requisite: Primary knowledge of statistics and statistical tools

9. **Course Outcome**:**	After completion of the course the students will be able to: CO1: Critically analyze statistical methodologies in order to assess best practice guidance when applied to real-world problems in specific contexts CO2: Investigate and evaluate key concepts of statistics and data science techniques and assess when to apply such techniques in practical situations CO3: Contextualize, implement statistical models using different statistical tools CO4: Develop the ability to build and assess data-based models. CO5: Understand fundamental principles of statistics and data science applications and technologies in order to provide strategies to address processing of datasets with a variety of characteristics. CO6: Apply knowledge about algorithms for statistical analysis, machine learning or data extraction in new areas within data science.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** Introduction to data science: Introduction to modern data analysis, Data science components, Data Science Applications. Fundamental Statistics- Probability Distribution: Introduction to Probability, Probability Distribution (Continuous and discrete- Normal, Bernoulli, Binomial, Negative Binomial, Geometric and Poisson distribution)	**10**

2	**Unit 2:** Discrete random variables, Continuous random variable, Markov-chain Monte Carlo, Descriptive Statistics- Sample covariance, Sample covariance matrix, Outlier.	**10**
3	**Unit 3:** Concepts of Correlation, Regression, Linear square estimation, Simple Linear Regression, Multiple Regression	**9**
4	**Unit 4:** Naïve Bayes' Theorem, Bayesian classification, Central Limit theorem, Data Exploration & preparation, Confidence Interval, The hypothesis-testing, Z-Score.	**8**
5	**Unit 5:** Parametric Testing: t-Test and Z-Test, Non-parametric Testing: ANOVA and chi-Square	**10**
	Total	**47**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	Douglas C. Montgomery , George C. Runger , Applied Statistics and Probability for Engineers, Wiley	6th	2016
2.	M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, Academic Press	4th	2009
3.	James D. Miller , Statistics for Data Science, Packt Publishing Limited	1st	2017
	Reference Books		
1.	Dr. D.C. Agarwal & Dr. Pradeep K. Joshi, Probability & Statistics for Data Science, Shree Sai Prakashan	1st	2022
2.	Dr. Mark Gardener, "Beginning R: The Statistical Programming Language", John willey& Sons	1st	2012

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER IV

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS-408** Course Title: **Programming in Java**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE. 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **IV**
7. Category of Course: **DC**
8. Pre-requisite: TCS 307 Object oriented Programming with C++

9. **Course Outcome**:**	CO1. Explain the Java programming features and develop programs to demonstrate the same. CO2. Make use of object-oriented concepts to develop applications CO3. Classify exceptions and demonstrate applications for file handling and multithreading. CO4. Analyze collection framework and develop applications using GUI. CO5. Compare and utilize collection framework for programming applications. CO6. Design applications for event handling and accessing databases using Java features.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** **Introduction to Java:** Importance and features of Java, Concepts of Java Virtual machine (JVM) Keywords, Constants, Variables and data types, operators and expressions, Control statements, Conditional statements, loops and iterations, Wrapper classes, Scanner Class: Scanner class methods (next(),nextLine() etc. **Concept of class:** Class definition, adding variables and methods, creating objects, constructors, defining methods, calling methods, Arrays,String Handling in java(String, StringBuffer classes)	10
2	**Unit 2:** **Object Oriented Programming concepts:** Inheritance, super classes, multilevel hierarchy, abstract and final classes, overloading and overriding **Packages and interfaces:** Packages, Defining Packages, Using Packages, import and static import, Access protection.	9

	Interface: Defining Interfaces, abstract methods declarations, implementing interfaces, extended interfaces, interface references.	
3	**Unit 3: Exception handling:** Exception Types, Exception class, RuntimeException Class, Error Class, Checked and uncheced Exceptions, Defining new exceptions; Handling: try, catch and finally; throw statement, throws clause. **Input/Output**:Basics, Byte and Character Streams, reading and writing from console and file. **Multithreaded programming:** Java thread model, synchronization, messaging, thread class, Runnable interface, inter thread communication, Producer/ consumer problems, Wait () and notify ().	9
4	**Unit 4: Collection and Generic Framework:** Introduction to Collection and Generic Framework: Object class and typesafety, Generics, Interfaces Iterator, List, Set, ArrayList, LinkedList HashSet and ArrayDeque classes **AWT & Swing**: Introduction to AWT and Swings, Swings advantages over AWT, Swing applications, Swing Controls : JButton ,JLabel , JCheckBox , JRadioButton , JList , JComboBox, JTextFiled, JTextArea , JScrollBar, JTable, Graphics in swing	9
5	**Unit 5: Event Handling:**Event delegation model, classes, Event Listener Interfaces, Adapter classes. **Java Database Connectivity (JDBC):**The Concept of JDBC, JBDC drivers(Type1 Driver,Type4 Driver), Connection interface, Statement interface, ResultSet interface, Creating and executing SQL statements.	9
	Total	**46**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Patrick Naughton and Herbert Schildt, “Java 2 The Complete Reference”, , McGraw Hill Education	9th	**2017**
2	E. Balaguruswamy, “Programming with Java a Primer”, Tata McGraw Hill	6th	**2019**
	Reference Books		
1.	Core Java-Head First Publication	3rd	2018
2.	Cay S Horstmann and Gary Cornell, “Core Java Volume –I and II”, Sun Microsystems,		**2019**

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER IV

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS-402** Course Title: **Finite Automata and Formal Languages**
2. Contact Hours: **L: 3** **T: 1** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **4**
6. Semester: **IV**
7. Category of Course: **DC**
8. Pre-requisite: TMA 101 / 201 Engineering Mathematics

9. **Course Outcome**:**	CO1. Understand the concept of abstract machines and their power to recognize languages. CO2. Formulate DFA, RE and FA with output. CO3. Design CFG and check the language is not CFL. CO4. Design PDA and convert n-PDA into D-PDA. CO5. Design and be familiar with Turing machines and computability. CO6: Formulate finite machines, push down automata and Turing machines for automated functioning of devices.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	Introduction; Alphabets, Strings and Languages; Automata and Grammars, Deterministic finite Automata (DFA)-Formal Definition, Simplified notation: State transition graph, Transition table, Language of DFA, Nondeterministic finite Automata (NFA), NFA with epsilon transition, Language of NFA, Equivalence of NFA and DFA, Minimization of Finite Automata, Myhill-Nerode Theorem.	**10**
Unit - II	Regular expression (RE), Definition, Operators of regular expression and their precedence, Algebraic laws for Regular expressions, Regular expression to FA, DFA to Regular expression, Arden Theorem, Non Regular Languages, Pumping Lemma for regular Languages. Application of Pumping Lemma, Closure properties of	**10**

	Regular Languages, Decision properties of Regular Languages, FA with output: Moore and Mealy machine, Equivalence of Moore and Mealy Machine, Applications and Limitation of FA.	
Unit – III	Context free grammar (CFG) and Context Free Languages (CFL): Definition, Examples, Derivation, Derivation trees, Ambiguity in Grammar, Useless symbols, Simplification of CFGs, Normal forms for CFGs: CNF and GNF, Closure proper ties of CFLs, Decision Properties of CFLs, Pumping lemma for CFLs, Applications and Limitation of CFL and CFG.	**9**
Unit – IV	Push Down Automata (PDA): Description and definition, Instantaneous Description, Language of PDA, Acceptance by Final state, Acceptance by empty stack, Deterministic PDA, Equivalence of PDA and CFG, CFG to PDA and PDA to CFG, Two stack PDA.	**10**
Unit – V	Turing machines (TM): Basic model, definition and representation, Instantaneous Description, Language acceptance by TM, Variants of Turing Machine, TM as Computer of Integer functions, Universal TM, Church's Thesis, Recursive and recursively enumerable languages, Halting problem, Introduction to Undecidability, Undecidable problems about TMs. Post correspondence problem (PCP), Modified PCP, Introduction to recursive function theory.	**8**
	Total	**47**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	J. Hopcroft, R. Motwani, and J. Ullman. Introduction to Automata Theory, Languages, and Computation, 3rd edition, 2007, Pearson/Addison-Wesley.	3rd	2007
2	KLP Mishra and N. Chandrasekaran, "Theory of Computer Science: Automata, Languages and Computation", PHI Learning Private Limited, Delhi India.	3rd	2006
	Reference Books		
1.	Michael Sipser, Introduction to the Theory of Computation, 3rd edition (or 1st edition), 2013, Cengage Learning	1st	2013
2.	P. Linz. Introduction to Formal Languages and Automata, 6th edition, 2017, Jones and Barlett.	6th	2017

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER IV

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS-403** Course Title: **Microprocessors**
2. Contact Hours: **L:** **3** **0** **0**
3. Examination Duration (Hrs): **Theory** **3** **Practical** **0**
4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
5. Credits: **3**
6. Semester: **IV**
7. Category of Course: **DC**
8. Pre-requisite: TEC-101 Basic Electronics, TCS-301-Logic design

9. **Course Outcome**:**	After completion of the course the students will be able to**:** **CO1**: Remember the concept of microcomputer system. **CO2**: Understand microprocessor 8085, 8086 and microcontroller 8051 hardware. **CO3**: Apply the concepts of assembly language programming of 8085 and 8086 to fulfil different tasks. **CO4:** Examine the application of 8085 and 8086 microprocessor with interrupt system, real time timer and counter. **CO5:** Test different interfacing ICs and memory for defined tasks with 8085 and 8086 microprocessor. **CO6:** Integrate the knowledge of 8085, 8086and 8051 in various embedded systems.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	**Contents**	**Contact Hours**
1	**Unit1: Microprocessor Architecture:** Introduction to Microprocessor and Microcomputer Architecture, Brief Evolution of Microprocessor, 8085 Register Organization, Internal architecture, Pins & Signals, 8085 Interrupts.	10
2	**Unit 2: Programming with 8085:** Programming model of 8085, 8085 instructions set, Addressing modes, Instruction Timing & Execution, Assembly language Programs using Instruction of 8085. Stack and subroutine.	10
3	**Unit 3: Interfacing with 8085, Memory Interfacing**: Interfacing EPROM&RAM memories. Address Decoding, Memory & I/O mapped I/O,	10

	Programmable Interfaces: - 8255, 8251, 8253, 8259, Overview of DMA & DMA controller, ADC and DAC interfacing.	
4	**Unit 4: Intel 8086 (16 bit processor):** 8086 Architecture, Physical address, segmentation, memory organization, Instruction set of 8086, Addressing Modes, Pins &Signals, 8086 Interrupts. Simple Assembly Language Programs using Instruction of 8086.	10
5	**Unit 5: 8051 Microcontroller:** Microprocessor Vs Microcontroller, Embedded Systems, 8051 Architecture- Registers, Pin diagram, I/O ports functions, Memory organization. Interrupts of 8051.	08
	Total	**48**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	Ramesh Gaonkar, Microprocessor Architecture, Programming, and Applications with the 8085, Penram International Publication (India) Pvt. Ltd	6th	2013
2	A. K. Ray & K. M. Bhurchandi, Advanced Microprocessors and peripherals, Tata McGraw Hill	3rd	2012
3.	Muhammad Ali Mazidi, Janice Gillispie Mazidi, The 8051 Microcontroller & Embedded System, Pearson / PHI publication	2nd	2007
	Reference Books		
1.	Douglas V. Hall, Microprocessors and Interfacing, Tata McGraw Hill	3rd	2012
2.	Barry B. Brey, The Intel Microprocessors Architecture Programming and interfacing, Pearson	8th	2012

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER IV

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 409** Course Title: **Design and Analysis of Algorithms**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **IV**
7. Category of Course: **DC**
8. Pre-requisite: TCS-302 Data Structures with C, Any programming language

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Understand various asymptotic notations to analyze time and space complexity of algorithms. CO2: Analyze the various paradigms for designing efficient algorithms using concepts of design and conquer, greedy and dynamic programming techniques. CO3: Provide solutions to complex problems using the concept of back tracking and branch and bound techniques. CO4: Apply algorithm design techniques to predict the complexity of certain NP complete problems. CO5: Implement Dijkstra's, Bellman-ford, Prims, Kruskal's algorithms to solve the real world problems like traveling salesman problem, job sequencing, packet routing etc CO6: Apply pattern matching algorithms like Rabin Karp Algorithm, Brute-force techniques etc to find a particular pattern.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

SL. NO.	**Contents**	**Contact Hours**
1	**Unit 1:** **Asymptotic Notations and Searching Algorithms** **Introduction to Algorithms -** What is an Algorithm, Rate of growth, Commonly used rate of growths, Types of analysis, Asymptotic Notations, Master theorem	**8**

	Searching - Linear search (sorted and unsorted), Iterative and recursive binary search, Tower of Hanoi and solving its recursion, Fibonacci and solving its recursion	
2	**Unit 2:** **Sorting Algorithms** **Sorting -** Bubble sort, Insertion sort, selection sort, quick sort, randomized quick sort, merge sort, heap sort, counting sort, External sorting **Divide sorting algorithms into following types -** online sort, stable sort, in place sort, Comparison of sorting algorithms on the basis of number of swaps, by number of comparisons, recursive or iterative nature, time and space complexity	**10**
3	**Unit 3:** **Graph Algorithms** Representation of Graphs, Breadth-first search (BFS), depth-first search (DFS), topological sort, Difference between BFS and DFS **Data structures for disjoint sets -** Finding cycle in a graph, Finding strongly connected components **Minimum spanning trees -** Kruskal and Prim algorithms (Greedy Algorithms) **Single source shortest paths -** Dijkstra (Greedy Approach) and Bellman ford (Dynamic Programming) algorithms **All pair shortest paths -** The Floyd Warshall algorithm	**12**
4	**Unit 4:** **Algorithm Design Techniques - Greedy and Dynamic Programming** **Greedy algorithms -** Activity selection problem, Job sequencing problem, Huffman codes, fractional knapsack problem **Dynamic Programming -** Overlapping substructure property, Optimal substructure property, Tabulation vs Memoization, Fibonacci numbers, 0/1 Knapsack problem, Longest common subsequence, Matrix chain multiplication	**10**
5	**Unit 5:** **Hashing, String Matching and NP-Completeness** **Hashing Data Structure -** Introduction to Hashing, Hash function, Collision and collision handling, Collision handling - Chaining, Open addressing **String Matching -** Naive string-matching algorithm, The Rabin-Karp algorithm, The Knuth-Morris-Pratt algorithm **NP-Completeness -** Importance of NP-completeness, P, NP, NP Complete and NP hard problems, Polynomial time and polynomial time verification, The subset-sum problem, The traveling salesman problem	**10**
	Total	**50**

11. Suggested Books:

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Thomas H. Cormen, Charles E. Leiserson, Ronal L. Rivest, Clifford Stein:” Introduction to Algorithms”, 2nd Edition, PHI,	2nd	2006.
	Reference Books		
1.	Donald E.Knuth:”The Art of Computer Programming: Volume 1: Fundamental Algorithms”,3rd Edition	3rd	1998

2	Ellis Horowitz, Sartaj Sahni, SanguthevarRajasekaran:" Fundamentals of Computer Algorithms", 2nd Edition, University press,.	2nd	2007
3	Anany Levitin: "Introduction to the Design & Analysis of Algorithms", 2nd Edition, Pearson Education,.	2nd	2007

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER IV

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 451** Course Title: **Virtualization and Cloud Computing**
2. Contact Hours: **L:** **3** **T**: **0** **P**: **0**
3. Examination Duration (Hrs): **Theory** **3** **Practical** **0**
4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
5. Credits: **3**
6. Semester: **IV**
7. Category of Course: **DE**
8. Pre-requisite: TCS-351 Fundamental of Cloud Computing and Big data

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Identify the concept of virtualization technique in cloud computing platform. CO2: Demonstrate the use case of the virtual machines. CO3: Analyze the use case of parallel and distributed computing. CO4: Evaluate the architectures of cloud computing. CO5: Assess the viability of developing, deploying, maintaining and securing cloud computing solutions using a variety of resiliency virtualization testing tools. CO6:Create cloud-computing virtualization strategies using virtualization tools to solve identified business needs on behalf of a client.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

SL. NO	Contents	Contact Hours
1	**Unit 1:** **Virtualization** Introduction, Characteristics of Virtualized Environments, Taxonomy of Virtualization Techniques, Execution Virtualization, Types of hardware virtualization: Full virtualization - partial virtualization - para virtualization	**9**

	Application Virtualization, Network Virtualization, Desktop Virtualization, Storage Virtualization, Server Virtualization, Data Virtualization. Virtualization Solution Providers: V2 Cloud, VMware, Citrix, Microsoft, Oracle VM VirtualBox. Advantages and Disadvantages of Virtualization, Examples, Xen: Para virtualization, VMware: Full Virtualization, Microsoft Hyper-V, Case study of Virtualization Technique	
2	**Unit 2:** **Virtual Machines** Virtual machines basics, Process virtual machines: Memory architecture emulation, Instruction emulation, Operating system emulation, Dynamic binary optimization, High level VN architecture, System virtual machines: Resource virtualization (Processors, Memory, Input/Output), Case Study of Intel VT-x	**9**
3	**Unit 3:** **Parallel and Distributed Computing** Eras of Computing, Parallel vs. Distributed Computing, Architectural Styles for Distributed Computing, Models for Inter-Process Communication, Technologies for Distributed Computing, Remote Procedure Call, Distributed Object Frameworks, Service Oriented Computing, Parallel programming, from laptops to supercomputers to the cloud, Parallel architectures and programming languages and models, including shared memory (eg OpenMP on your multicore laptop), distributed memory (MPI and UPC on a supercomputer), GPUs (CUDA and OpenCL), and cloud (MapReduce, Hadoop and Spark). Parallel algorithms and software tools for common computations (eg dense and sparse linear algebra, graphs, structured grids). Tools for load balancing, performance analysis, debugging. How high level applications are built (eg climate modeling). Case study of Parallel and Distributed Computing.	**9**
4	**Unit 4:** **Cloud Computing Architecture** Fundamental Cloud Architectures, Workload Distribution Architecture, Resource Pooling Architecture, Dynamic Scalability Architecture, Elastic Resource Capacity Architecture, Service Load Balancing Architecture, Cloud Bursting Architecture, Elastic Disk Provisioning Architecture, Redundant Storage Architecture. Cloud Computing Reference Architecture (CCRA): Introduction, Benefits of CCRA, Migrating into a Cloud: Introduction, Challenges while migrating to Cloud, Broad approaches to migrating into the cloud, Seven-step model of migration into a cloud, Migration Risks and Mitigation. Case study of Cloud Computing Architecture.	**9**
5	**Unit 5:** **Virtualization Tools and Techniques** Parasoft Virtualize, Mountebank, Hoverfly cloud, MicroFocus Data Simulation Software, CA service Virtualization, Mocklab, Rational Test Virtualization Server, Tricentis Tosca, Docker, Kubernetes, OpenShift, and Istio. Assess the viability of developing, deploying, maintaining and securing cloud computing solutions using a variety of resiliency virtualization testing tools, Create cloud-computing virtualization	**9**

	strategies using virtualization tools to solve identified business needs on behalf of a client, Case study of Virtualization Tools and Techniques. Design and Deploy an Online Healthcare Application on the Cloud.	
	Total	**45 Hrs.**

11. Suggested Books:

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Mastering Cloud Computing by Rajkumar Buyya etc., Published by McGraw Hill,	1st	2017
2	Virtual Machines by James E. Smith, Ravi Nair, Published by MK Publishers,	1st	2005
3	V K Pachghare, Cloud Computing, PHI,		2016
	Reference Books		
1.	Barrie Sosinsky , Cloud Computing Bible, Wiley Publishing Inc.,	1st	2011

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER IV

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 471** Course Title: **Statistical Data Analysis with R**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **IV**
7. Category of Course: **DE**
8. Pre-requisite: TMA101-Engineering Mathematics, TCS-201 Programming for problem solving, TCS 351 Fundamental of Cloud Computing and Big data

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Define the concepts of statistics. CO2: Understand the probability distribution techniques in different applications. CO3: Identify the needs of data preprocessing. CO4: Implement the manipulation and processing of data in R CO5: Apply the concepts of functions in R CO6: Evaluate the use of R in data analytics

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** Statistics: Introduction to Statistics- Descriptive Statistics, Summary Statistics, Basic probability theory, Statistical Concepts (uni-variate and bi-variate sampling, distributions, re-sampling, statistical Inference, prediction error)	9
2	**Unit 2: Probability Distribution:** Introduction to Probability**,** Probability Distribution (Continuous and discrete- Normal, Bernoulli, Binomial, Negative Binomial, Geometric and Poisson distribution) , Bayes' Theorem, Central Limit theorem, Data Exploration & preparation, Concepts of Correlation, Regression, Covariance, Outliers.	10

3	**Unit 3:** Introduction to R and Data Preprocessing: Introduction & Installation of R, R Basics, Finding Help, Code Editors for R, Command Packages, Manipulating and Processing Data in R, Reading and Getting Data into R, Exporting Data from R	10
4	**Unit 4:** Data Objects-Data Types & Data Structure. Viewing Named Objects, Structure of Data Items, Manipulating and Processing Data in R (Creating, Accessing, Sorting data frames, Extracting, Combining, Merging, reshaping data frames), Control Structures	8
5	**Unit 5:** Functions in R (numeric, character, statistical), working with objects, Viewing Objects within Objects, Constructing Data Objects, Building R Packages, Running and Manipulating Packages, Non parametric Tests- ANOVA, chi-Square, t-Test, U-Test, Introduction to Graphical Analysis, Using Plots(Box Plots, Scatter plot, Pie Charts, Bar charts, Line Chart), Plotting variables, Designing Special Plots, Simple Liner Regression, Multiple Regression	10
	Total	**47**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	Dr. Mark Gardener, "Beginning R: The Statistical Programming Language", John willey& Sons, 2012	1st	2012
2.	Gareth James, Daniela Witten, Trevor Hastie and Robert Tibshirani, "An Introduction to Statistical Learning with Applications in R," Springer, Germany,	2nd	2021
	Reference Books		
1.	N.G Das, "Statistical Methods (Combined edition volume 1 & 2)," Mc Graw Hill	1st	2017

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER IV

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 431** Course Title: **Microcontroller and Its Interfacing**
2. Contact Hours: **L: 3** **T**: **0** **P**: **0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **IV**
7. Category of Course: **DE**
8. Pre-requisite: TEC101/201 Basic Electronics Engineering, TCS-308Logic Design and Computer Organization

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Understanding the concept of embedded system. CO2: Assembly language programming of 8051 CO3: Study of Arduino. CO4: Interfacing of different IC with 8051. CO5: Design and develop systems based on 8051 microcontroller and its interfaces. CO6: Understand the working of interrupts

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

S.NO.	Contents	Contact Hours
1	**Unit 1:** MICROCONTROLLER: Difference between Microprocessors and Micro-controllers, Types of Micro-controllers, Memory structure of 8051, Processor Architecture – Harvard v/s Von Neumann, CISC v/s RISC, 8051 Architecture ,Micro-controller Memory types – control storage, variable area, stack, hardware register space, SFR,8051 pin diagram..	10
2	**Unit 2:** 8051 Instruction Set:	9

	Addressing modes, external addressing, Instruction execution, Instruction set – data movement, arithmetic, bit operators, branch, Software development tools like assemblers, simulators, O/P file formats. Assembling and running an 8051 program, 8051 data types, 8051 flag bits and the PSW register, 8051 register banks and stack	
3	**Unit 3:** **PROGRAMMING OF 8051 and INTERRUPTS:** Programming of 8051, I/O bit manipulation. Timer, counter, programming of timer, 8051 interrupts, Interrupts priority in the 8051, and interrupts programming.	9
4	**Unit 4:** **INTRODUCTION TO ARDUINO IDE PLATFORM** Introduction to ATMEGA328 microcontroller and to Arduino IDE, Hardware,Characteristics,Interfacing with different peripheral devices,Debugging hardware errors,Using PWM I/O pins,Interfacing Arduino hardware with Internet of Things	9
5	**Unit 5:** **INTERFACING:** Interfacing with 8051: LCD, Keyboard, ADC, DAC interfacing, Sensor interfacing and Signal Conditioning, Stepper motor and DC motor, Basics of serial communications, 8051 connection to RS-232, 8051 serial port programming assembly.	8
	Total	**45**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Mazidi,"The 8051 Microcontrollers & Embedded Systems", Pearson Education,	1st	2007
	MykePredko ,"Programming and Customizing the 8051 Micro-controller",Tata McGraw-Hill edition	1st	, 2003
	Brad Kendall,"Arduino Make use of:A complete beginner guide",	3rd	2013
	Reference Books		
1.	Kenneth Ayala, "The 8051 Microcontroller", West Publishing Company,	1st	1993
	Julien Bayle,"C-Programming for Arduino" ,	2nd	2013

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER IV

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 492** Course Title: **Fundamental of Cyber Security**
2. Contact Hours: **L** **3** **T**: **0** **P**: **0**
3. Examination Duration (Hrs): **Theory** **3** **Practical** **0**
4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
5. Credits: **3**
6. Semester: **IV**
7. Category of Course: **DE**
8. Pre-requisite: TCS-332 Fundamentals of Information Security and Block Chain, TCS-392 Introduction to Cryptography

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Explain the three pillars of cyber security, types of hackers and penetration testing. CO2: . Implement the scripting concepts used in cyber security. CO3: Use the netcat, ping and wireshark tools to analyze the security of network. CO4: Use the Javascript, php, sql to analyze the web security. CO5: Explain the use of cyber security protocols for cyber threats. CO6: Analyze the security level of web applications.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

SL. NO.	Contents	Contact Hours
1	**Unit 1:** **Introduction to Cyber Security** What is Cyber security, Why we need Cyber security, The Zero Trust Model, Ethical Hacking Protect Against - Unauthorised Modification, Unauthorised Deletion and Unauthorised Access Three pillars of Cyber Security - Confidentiality, Availability and Integrity Steps to fix a crime - Identify Cyber Threats, Analyse and Evaluate Threat, Treatment Type of Hackers - White Hat, Great Hat, Black Hat Penetration Testing and its Phases - Reconnaissance, Scanning, Gaining Access, Maintaining Access, Covering Tracks	**9**
	Unit 2: **Linux Basics and Scripting for Ethical Hacking**	**9**

2	Bash, Linux commands, man page, Adding and deleting, users and adding them to sudo group, switching users, creating, copying, moving and removing file, Writing and appending text to a file, File permissions, working with editors, grep, cut command, Starting and stopping services, Automating tasks with cron jobs **Introduction to Bash Scripting -** Basics of Bash or Shell Scripting, conditional statements, loops, Manipulating files **Introduction to Python** - Basics of Python, conditional statements, loops,list, tuple, dictionary, functions	
3	**Unit 3:** **Networking Basics for Ethical Hacking** **Virtualization -** Installing and configuring virtual machine, Configuration of network - NAT, Bridged and Host only, Dual boot system **TCP/IP -** IPv4 and IPv6, IP Address, Mac Address, Subnets, TCP 3-way handshake, DNS Communication between VMs or Setting up network between machines, **netcat -** The Swiss Army Knife of TCP/IP Connections, use netcat to Listen on a port, pushing a command shell back to listener, transfer files, Ping command **Wireshark -** A Packet Sniffing Tool	**10**
4	**Unit 4:** **Basics of Web and Web Security** **Introduction to Java Script -** Basics of Javascript, Input validation, Cross site scripting (XSS) attack **Introduction to PHP and SQL -** Basics of PHP, Input Validation, Phishing, Spear Phishing, Sql Injection Attack	**9**
5	**Unit 5:** **Introduction to Cyber Threats and System Hacking** **Cyber Threats** - Malware, password attacks, Distributed denial-of-service (DDos), Ransomware attack, Eavesdropping attack (man in the middle attack), Birthday attack, buffer overflow attack, IP and Mac address spoofing, Steganography, Anonymous browsing, Introduction to tor browser, Introduction to VPN, Secure Sockets Layer (SSL), Secure Shell (SSH)	**10**
	Total	**47**

11. Suggested Books:

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Georgia Weidman , "Penetration Testing: A Hands-On Introduction to Hacking," No Starch Press Inc.,	1st	2014.
2	Nina Godbole ,SunitBelapure, "Cyber Security:Understanding Cyber Crimes, Cyber Forensics and Legal Perspectives," Wiley India,.	1st	2011

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER IV

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 421** Course Title: **Fundamental of Statistics and AI**
2. Contact Hours: **L: 3** **T:** **0** **P:** **0**
3. Examination Duration (Hrs): **Theory** **3** **Practical** **0**
4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
5. Credits: **3**
6. Semester: **IV**
7. Category of Course: **DE**
8. Pre-requisite: TMA101/TMA Engineering Mathematics, TCS-341 Python Programming for Computing

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Demonstrate knowledge of statistical and exploratory data analysis data analysis techniques utilized in decision making. CO2: Apply principles of Data Science to the analysis of business problems. CO3: To use Machine Learning Algorithms to solve real-world problems. CO4: To provide data science solution to business problems and visualization. CO5: To learn the basic concepts and techniques of AI and machine learning CO6: To explore the various mechanism of Knowledge and Reasoning used for building expert system

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

SL. NO.	Contents	Contact Hours
1	**Unit 1:** **Introduction to AI** Definition, Problem, State space representation. Intelligent Systems: Categorization of Intelligent System, Components of AI Program, Foundations of AI, Applications of AI, Current trends in AI, Intelligent Agents: Anatomy, structure, Types	10

2	**Unit 2:** **Problem solving** Solving problem by Searching: Problem Solving Agent, Formulating Problems. Uninformed Search Methods: Breadth First Search (BFS), Depth First Search (DFS), Depth Limited Search, Depth First Iterative Deepening (DFID), Informed Search Methods: Greedy best first Search, A* Search, Memory bounded heuristic Search. Local Search Algorithms and Optimization Problems: Hill climbing search Simulated annealing, Local beam search.	9
3	**Unit 3:** **An Introduction to Data Science, Data Processing and Visualization** Definition, working, benefits and uses of Data Science, Data science vs. Business Intelligence, The data science process, Role of a Data Scientist. Data Processing and Visualization**: Data** Formatting, Exploratory Data Analysis, Filtering, and hierarchical indexing using Pandas. Data Visualization: Basic Visualization Tools, Specialized Visualization Tools, Seaborn Creating and Plotting Maps.	9
4	**Unit 4:** **Statistical Data Analysis & Inference** Populations and samples, Statistical modelling, probability distributions, fittings a model, Statistical methods for evaluation, Exploratory Data Analysis, Getting started with R, Manipulating and Processing data in R, working with function in R, working with descriptive Statistics, Working with graph plot in R.	9
8	**Unit 5:** **Statistical Applications** Basic Statistical operations, Linear Regression Analysis, Logistic andExponential Regression, Time Series Analysis, Probability Distribution, ANOVA, Correlation and Covariance.	8
	Total	**45**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Tom M. Mitchell. "Machine Learning" McGraw-Hill,.	1st	2017
2	“Statistical programming in R”, Oxford University Press	1st	2017

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER IV

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 462** Course Title: **Introduction to Big Data**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **4**
6. Semester: **IV**
7. Category of Course: **DE**
8. Pre-requisite: **TCS-342, TCS-302**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Outline the theory of big data, and explain challenges of big data CO2: Understand the types of Big data and its characteristics CO3: Compare Business Intelligence vs Big Data CO4: Get the idea of NoSQL databases, different types of NoSQL/NewSQL datastores CO5: Discuss various types of Big Data analytics CO6: Elaborate a Big Data management architecture

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** **Big Data and its Challenges** Defining Big Data, Characteristics of Big Data, Evolution of Big Data, Traditional Business Intelligence vs Big Data, The Evolution of Data Management, Understanding the Waves of Managing Data, creating manageable data structures, Web and content management, Managing big data. Building a Successful Big Data Management Architecture, beginning with capture, organize, integrate, analyze, and act, Setting the architectural foundation, Performance matters, Traditional and advanced analytics.	**9**
2	**Unit 2:** **Big Data Types and its Sources** Defining Structured Data Exploring sources of big structured data, Understanding the role of relational databases in big data Defining Unstructured Data, exploring sources of unstructured data, Understanding the role of a CMS in big data management. Looking at Real-Time and Non Real-Time Requirements, Putting Big Data Together, managing different	**8**

	data types, integrating data types into a big data environment.	
3	**Unit 3:** **Technology Foundations of Big Data** Exploring the Big Data Stack: - Layer 0: Redundant Physical Infrastructure - Physical redundant networks, Managing hardware: Storage and servers, Infrastructure operations - Layer 1: Security Infrastructure, Interfaces and Feeds to and from Applications and the Internet- Layer 2: Operational Databases. Layer 3: Organizing Data Services and Tools. Layer 4: Analytical Data Warehouses, Big Data Analytics, Big Data Applications.	**9**
4	**Unit 4:** **Introduction to NoSQL and NewSQL** Introduction to NoSQL, Uses, Features and Types, Need, Advantages, Disadvantages and Application of NoSQL, Overview of NewSQL. RDBMSs Are Important in a Big Data Environment. PostgreSQL relational database. Nonrelational Databases. Key-Value Pair Databases - Riak keyvalue database. Document Databases MongoDB, CouchDB . Columnar Databases, HBase columnar database. Graph Databases- Neo4J graph database.	**8**
5	**Unit 5:** **Big Data Analytics** Basic analytics, Advanced analytics, Operationalized analytics, Monetizing analytics. Modifying Business Intelligence Products to Handle Big Data, Studying Big Data Analytics Examples, Terminologies used in Big Data environment.	**8**
	Total	**42**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	**Judith Hurwitz, Alan Nugent , Fern Halper , Marcia Kaufman,** Big Data for Dummies, Wiley	1st	2013
2.	Subhashini Chellappan Seema Acharya, Big Data and Analytics, Wiley	2nd	2019
3.	Big Data, Black Book, Dreamtech Press	1st	2016
	Reference Books		
1.	Michele Chambers, Michael Minelli , Ambiga Dhiraj ,Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses, Wiley	1st	2013

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER IV

Name of Department: - Computer Science and Engineering

1. Subject Code: **PCS-408** Course Title: **Java Programming Lab**
2. Contact Hours: **L: 0** **T: 1** **P: 2**
3. Examination Duration (Hrs): **Theory 0** **Practical 3**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **2**
6. Semester: **IV**
7. Category of Course: **DC**
8. Pre-requisite: PCS-307 OOPS with C++ Lab, TCS 307 Object oriented Programming with C++

9. **Course Outcome****:	After completion of the course the students will be able to: CO1: Understand the object-oriented approach in programming along with the purpose and usage principles of inheritance, polymorphism, encapsulation, and method overloading etc. CO2: Demonstrate ability to test and debug Java programs using IDE. CO3: Analyze, design, and develop small to medium sized application programs that demonstrate professionally acceptable programming standards. CO4: Demonstrate skills of developing event-driven programs using graphical user interfaces. CO5: Demonstrate skills of developing event-driven programs using graphical user interfaces.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	List of problems for which student should develop program and execute in the Laboratory	Contact Hours
22	**Taking input from Command line and convert objects into primitivedata type:** Write a java program to take input as a command line argument. Your name, course, universityrollno and semester. Display the information. Name: UniversityRollNo:Course:	2

	Semester:	
23	**Concepts of Java Control statements, Conditional statements, loops and iterations, Wrapper classes, Scanner Class:** Using the switch statement, write a menu-driven program to calculate the maturity amount of a bank deposit. The user is given the following options: (i) Term Deposit (ii) Recurring Deposit For option (i) accept Principal (p), rate of interest (r) and time period in years (n). Calculate and output the maturity amount (a) receivable using the formula a = p[1 + r / 100]n. For option (ii) accept monthly installment (p), rate of interest (r) and time period in months (n). Calculate and output the maturity amount (a) receivable using the formula a = p * n + p * n(n + 1) / 2 * r / 100 * 1 / 12. For an incorrect option, an appropriate error message should be displayed. [Use Scanner Class to take input]	2
24	Program to find if the given numbers are Friendly pair or not (Amicable or not). **Friendly Pair** are two or morenumbers with a common abundance. **Input & Output format:** • Input consists of **2 integers**. • The first integer corresponds to number 1 andthe second integer corresponds to number 2. If it is a Friendly Pair display **Friendly Pair** or displays Not Friendly Pair. For example,6 and 28 are Friendly Pair. (Sum of divisors of 6)/6 = (Sum of divisors of 28)/28. Steps to check whether the given numbers are friendly pair or not ▪ Input the numbers num1 and num2. ▪ Initialize sum1 = sum2 = 0. ▪ sum1 = sum of all divisors of num1. ▪ sum2 = sum of all divisors of num2. ▪ If (sum1 == num1) and (sum2 == num2), then print "Abundant Numbers". ▪ Else, print "Not Abundant Numbers". Program to check whether the given numbers are friendly pair or not	2
25	Program to replace all 0's with 1 in a given integer. Given an integer as an input, all the 0's in the number has to be replaced with 1. For example, consider the following number Input: 102405 **Output: 112415** **Input: 56004** **Output: 56114** Steps to replace all 0's with 1 in a given integer	2

	• Input the integer from the user. • Traverse the integer digit by digit. • If a '0' is encountered, replace it by '1'. • Print the integer.	
26	**Array in Java:** Printing an array into Zigzag fashion. Suppose youwere given an array of integers, and you are told to sort the integers in a zigzag pattern. In general, in a zigzag pattern, the first integer is less than the second integer, which is greater than the third integer, which is less than the fourth integer, and so on. Hence, the converted array should be in the form of $e1 < e2 > e3 < e4 > e5 < e6$. **Test cases: Input 1:** 7 4 3 7 8 6 2 1 **Output 1:** 3 7 4 8 2 6 1 **Input 2:** 4 1 4 3 2 **Output 2:** 1 4 2 3	2
27	The problem to rearrange positive and negative numbers in an array . Method: This approach moves all negative numbers to the beginning and positive numbers to the end butchanges the order of appearance of the elements of the array. Steps: 1. Declare an array and input the array elements. 2. Start traversing the array and if the current element is negative, swap the current elementwith the first positive element and continue traversing until all the elements have been encountered. 3. Print the rearranged array. Test case: • Input: 1 -1 2 -2 3 -3 Output: -1 -2 -3 1 3 2	2
28	Program to find the saddle point coordinates in a given matrix. A saddle point is an element of the matrix,which is the minimum element in its row and the maximum in its column.	2

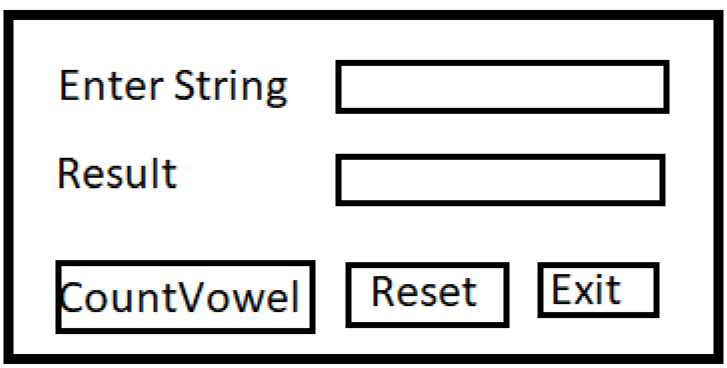
	For example, consider the matrix given belowMat [3][3] 1 2 3 4 5 6 7 8 9 Here, 7 is the saddle point because it is the minimum element in its row and maximum element in its column. Steps to find the saddle point coordinates in a givenmatrix. 1. Input the matrix from the user. 2. Use two loops, one for traversing the row andthe other for traversing the column. 3. If the current element is the minimum element inits row and maximum element in its column, then return its coordinates. Else, continue traversing.	
29	**String Handling in Java (using String and StringBuffer class):** Program to find all the patterns of 0(1+)0 in the given string. Given a string containing 0's and 1's, find the total number of 0(1+)0 patterns in the string and output it. 0(1+)0 - There should be at least one '1' between the two 0's. For example, consider the following string. **Input:** 01101111010 **Output:** 3 **Explanation: 0110**1111010 - count = 1	2
30	Write a java program to delete vowels from given string using StringBuffer class	2
31	**Class definition, creating objects and constructors:** Write a java program to create a class named 'Bank ' with the following data members: • Name of depositor • Address of depositor • Account Number • Balance in account **Class 'Bank' has a method for each of the following:** 1. Generate a unique account number for each depositor. 2. For first depositor, account number will be 1001, for second depositor it will be 1002 and so on 3. Display information and balance of depositor 4. Deposit more amount in balance of any depositor 5. Withdraw some amount from balance deposited. 6. Change address of depositor	2

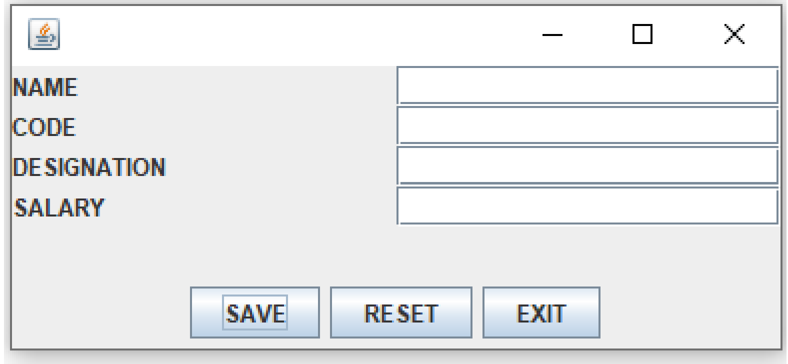
	After creating the class, do the following operations. 1. Enter the information (name, address, account number, balance) of the depositors. Number of depositors is to be entered by the user. 2. Print the information of any depositor. 3. Add some amount to the account of any depositor and then display final information of that depositor. 4. Remove some amount from the account of any. depositor and then display final information of that depositor. 5. Change the address of any depositor and then display the final information of that depositor. 6. Randomly repeat these processes for some other bank accounts.	
32	Define a class **Word Example** having the followingdescription: Data members/instance variables: private String strdata: to store a sentence. **Parameterized Constructor WordExample(String)** : Accept a sentence which may be terminated by either'.', '? 'or'!' only. The wordsmay be separated by more than one blank space and are in UPPER CASE. **Member Methods:** **void countWord():** Find the number of wordsbeginning and ending with a vowel. **void placeWord():** Place the words which begin andend with a vowel at the beginning, followed by the remaining words as they occur in the sentence	2
33	**Method overloading (Compile time Polymorphism):** Write a Java program to create a class called **ArrayDemo** and overload arrayFunc() function. **void arrayFunc(int [], int)** To find all pairs of elements in an Array whose sum is equal to a givennumber : Array numbers= [4, 6, 5, -10, 8, 5, 20], target=10 **Output :** Pairs of elements whose sum is 10 are :4 + 6 = 10 5 + 5 = 10 -10 + 20 = 10 **void arrayFunc(int A[], int p, int B[], int q)** Giventwo sorted arrays A and B of size p and q, Overload method arrayFunc() to merge elements of A with B bymaintaining the sorted order i.e. fill A with first p smallest elements and fill B with remaining elements. Example: Input :	2

	int[] A = { 1, 5, 6, 7, 8, 10 } int[] B = { 2, 4, 9 } Output: Sorted Arrays: A: [1, 2, 4, 5, 6, 7] B: [8, 9, 10] **(Use Compile time Polymorphism MethodOverloading)**	
34	**Method overriding (Runtime Polymorphism), Abstract class and Abstract method, Inheritance, interfaces:** Write a java program to calculate the area of a rectangle, a square and a circle. Create an abstract class 'Shape' with three abstract methods namely rectangleArea() taking two parameters, squareArea() and circleArea() taking one parameter each. Now create another class 'Area' containing all the three methods rectangleArea(), squareArea() and circleArea() for printing the area of rectangle, square and circle respectively. Create an object of class Area and call all the three methods. **(Use Runtime Polymorphism)**	2
35	Write a java program to implement abstract class andabstract method with following details: **Create a abstract Base Class TemperatureData members:** double temp; **Method members:** void setTempData(double) abstact void changeTemp() **Sub Class Fahrenheit (subclass of Temperature) Data members**: double ctemp; **method member:** Override abstract method changeTemp() to convert Fahrenheit temperature into degree Celsius by using formula C=5/9*(F-32) and display converted temperature Sub Class Celsius (subclass of Temperature) **Data member:** double ftemp; **Method member:** Override abstract method changeTemp() to convert degree Celsius into Fahrenheit temperature by using formula F=9/5*c+32 and display converted temperature	2
36	Write a java program to create an interface that consists of a method to display **volume ()** as an abstract method and redefine this method in the derived	2

	classes to suit their requirements. Create classes called **Cone**, **Hemisphere** and **Cylinder** that implements the interface. Using these three classes, design a program that will accept dimensions of a cone, cylinder and hemisphere interactively and display the volumes. Volume of cone = (1/3)πr2h Volume of hemisphere = (2/3)πr3 Volume of cylinder = πr2h	
37	Write a java program to accept and print the employee details during runtime. The details will include employee id, name, dept_ Id. The program should raise an exception if user inputs incomplete or incorrect data. The entered value should meet the following conditions: a. First Letter of employee name should be in capital letter. b. Employee id should be between 2001 and 5001 c. Department id should be an integer between 1 and 5. If the above conditions are not met, then the application should raise specific exception else should complete normal execution.	2
38	Create a class MyCalculator which consists of a single method power (int, int). This method takes two integers, n and p, as parameters and finds np. If either n or p is negative, then the method must throw an exception which says, "n and p should be non- negative". **Input Format** Each line of the input contains two integers, n and p. Output Format Each line of the output contains the result, if neither of n and p is negative. Otherwise, the output contains "n and p should be non- negative". **Sample Input** 3 5 2 4 0 0 -1 -2 -1 3 **Sample Output** 243 16 java.lang.Exception: n and p should not be zero. java.lang.Exception: n or p should not be negative. java. lang. Exception: n or p should not be negative. **Explanation** In the first two cases, both n and p are positive. So, the power function returns the answer correctly.	2

	In the third case, both n and p are zero. So, the exception, "n and p should not be zero." is printed. In the last two cases, at least one out of n and p is negative. So, the exception, "n or p should not be negative." is printed for these two cases.	
39	**File Handling in Java:** Write a java file handling program to count and display the number of palindromes present in a text file "myfile.txt". Example: If the file "myfile.txt" contains the following lines, My name is NITIN Hello aaa and bbb wordHow are You ARORA is my friendOutput will be => 4	2
40	**Multithreaded programming**: Write a program MultiThreads that creates two threads-one thread with the name CSthread and the other thread named ITthread. Each thread should display its respective name and execute after a gap of 500 milliseconds. Each thread should also display a number indicating the number of times it got a chance to execute.	
41.	Write a java program for to solve producer consumer problem in which a producer produces a value and consumer consume the value before producer generate the next value	2
42	**Collection and Generic Framework:** Write a method removeEvenLength that takes an ArrayList of Strings as a parameter and that removesall the strings of even length from the list. **(Use ArrayList)**	
43	Write a method swapPairs that switches the order of values in an ArrayList of Strings in a pairwise fashion. Your method should switch the order of the first two values, then switch the order of the next two, switch the order of the next two, and so on. For example, if the list initially stores these values: {"four", "score", "and", "seven", "years", "ago"} your method should switch the first pair, "four", "score", the second pair, "and", "seven", and the third pair, "years", "ago", to yield this list: {"score", "four", "seven", "and", "ago", "years"} If there are an odd number of values in the list, the final element is not moved. For example, if the original list had been: {"to", "be", "or", "not", "to", "be", "hamlet"} It would again switch pairs of values, but the final value, "hamlet" would not be moved, yielding this list: {"be", "to", "not", "or", "be", "to", "hamlet"}	2

44	Write a method called alternate that accepts two Listsof integers as its parameters and returns a new List containing alternating elements from the twolists, in the following order: • First element from first list • First element from second list • Second element from first list • Second element from second list • Third element from first list • Third element from second list If the lists do not contain the same number of elements, the remaining elements from the longer list should be placed consecutively at the end. For example, for a first list of (1, 2, 3, 4, 5) and a second list of (6, 7, 8, 9, 10, 11, 12), a call of alternate (list1, list2) should return a list containing (1, 6, 2, 7, 3, 8, 4, 9, 5, 10, 11, 12). Do not modify the parameter lists passed in.	2
45	**AWT & Swing, Event Handling:** Write a GUI program to develop an application that receives a string in one text field, and count number ofvowels in a string and returns it in another text field, when the button named “CountVowel” is clicked. When the button named “Reset” is clicked it will resetthe value of textfield one and Textfield two. When the button named “Exit” is clicked it will closed the application. 	2
46	**Java Database Connectivity (JDBC):** **Create a database of employee with the following fields.** • **Name** • **Code** • **Designation** • **Salary**	2

	 a) Write a java program to create GUI java application to take employee data from the TextFields and store it in database using JDBC connectivity. b) Write a JDBC Program to retrieve all the records from the employee database.	
	Total	**48**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Patrick Naughton and Herbert Schildt, “Java 2 The Complete Reference”, McGraw Hill Education	9th	2017
	E. Balaguruswamy, “Programming with Java a Primer”, Tata McGraw Hill	6th	**2019**
	Reference Books		
1.	Core Java-Head First Publication	3rd	2018
	Cay S Horstmann and Gary Cornell, “Core Java Volume –I and II”, Sun Microsystems,	Standard edition	**2019**

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER IV

Name of Department: - Computer Science and Engineering

1. Subject Code: **PCS-403** Course Title: **Microprocessors lab**
2. Contact Hours: **L: 0** **T: 1** **P: 2**
3. Examination Duration (Hrs): **Theory 0** **Practical 3**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **2**
6. Semester: **4**
7. Category of Course: **DC**
8. Pre-requisite: PEC151/251 Basic Electronics Engineering Lab, PCS 308 Logic design lab

9. **Course Outcome**:**	After completion of the course the students will be able to**:** **CO1**: Remember 8085 and 8086 instruction set. **CO2**: Understand different assembly language programs on microprocessor-based microcomputer kit. **CO3:** Apply the programming concepts to test and debug assembly language programs in the laboratory. **CO4:** Assemble various devices and memories with microprocessor for any defined task.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate*

10. **Details of the Course:**

Sl. No.	List of problems for which student should develop program and execute in the Laboratory	Contact Hours
1.	Write program in 8085 to swap two 8-bit numbers.	2
2.	Write a program in 8085 to move a block of data bytes from one location to another location.	1
3.	Write programs in 8085 to perform addition & subtraction of 8-bit number with carry / borrow.	1
4.	Write a program in 8085 for addition of 16 bits numbers with carry.	1
5.	Write a program for multiplication of two 8-bit numbers in 8085.	1
6.	Write an ALP in 8085 to add two 8-bit BCD data.	1
7.	(a) Write an ALP in 8085 to find larger number between two numbers. (b) Write an ALP in 8085 to find smaller number between two numbers.	2
8.	Write an ALP in 8085 to find largest /smallest in a series of n number.	1
9.	Write a program to find square root of a number in 8085.	1
10.	Write a program for division of two 8 bit numbers in 8085.	1

11.	Write a program in 8085 to count number of ones in an 8 bit number.	1
12.	Write a program in 8085 to find sum of digits of an 8 bit number.	1
13.	(a) Write a program in 8086 to add two 16-bit numbers given by the user. (b) Write a program in 8086 to subtract two 16-bit numbers given by the user.	**2**
14.	(a) Write a program in 8086 to multiply two 8-bit data. (b) Write a program in 8086 to divide: 8-bit data by 8-bit data.	**2**
15.	Write a program in 8086 to find the largest no. from an array of n numbers stored in an array.	1
16.	Write a program in 8086 to add and subtract two 8-bit BCD numbers.	1
17.	Write a program in 8086 to convert a BCD number to its Binary code equivalent.	1
18.	Write a program in 8086 to perform sorting of given set of numbers.	1
19.	Write a program in 8086 to convert a Binary number to its gray code equivalent.	1
20.	Write a program in 8086 to convert a BCD number to its ASCII code equivalent.	1
	Total	**24**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Ramesh Gaonkar, Microprocessor Architecture, Programming, and Applications with the 8085, Penram International Publication (India) Pvt. Ltd	6th	2013
2.	A. K. Ray & K. M. Bhurchandi, Advanced Microprocessors and peripherals, Tata McGraw Hill	3rd	2012
	Reference Books		
1.	Douglas V. Hall, Microprocessors and Interfacing, Tata McGraw Hill	3rd	2012
2.	Barry B. Brey, The Intel Microprocessors Architecture Programming and interfacing, Pearson	8th	2012

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER IV

Name of Department: - Computer Science and Engineering

1. Subject Code: **PCS-409** Course Title: **Design and Analysis of Algorithms Lab**
2. Contact Hours: **L:** **0** **T**: **1** **P**: **2**
3. Examination Duration (Hrs): **Theory** **1** **Practical** **2**
4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
5. Credits: **2**
6. Semester: **IV**
7. Category of Course: **DC**
8. Pre-requisite: PCS-302 Data Structures Lab, Any programming language

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Analyze algorithmic time and space complexity using asymptotic notations. CO2: Design efficient algorithms utilizing techniques such as divide and conquer, greedy, and dynamic programming. CO3: Solve complex problems using backtracking and branch-and-bound techniques. CO4: Predict the complexity of NP-complete problems and propose algorithmic approaches. CO5: Apply Dijkstra's, Bellman-Ford, Prim's, and Kruskal's algorithms to real-world problems. CO6: Implement pattern matching algorithms like Rabin-Karp and brute-force techniques for pattern identification.:

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	**List of problems for which student should develop program and execute in the Laboratory**	**Contact Hours**
1	Week 1: Note: Input, output format for problem I, II and III is same and is given at the end of this exercise.	2

I. Given an array of nonnegative integers, design a linear algorithm and implement it using a program to find whether given key element is present in the array or not. Also, find total number of comparisons for each input case. (Time Complexity = O(n), where n is the size of input)

Sample I/O Problem - 1:

Input: Output:
3 Present 6
8 Present 3
34 35 65 31 25 89 64 30 Not Present 6
89
5
977 354 244 546 355
244
6
23 64 13 67 43 56
63

II. Given an already sorted array of positive integers, design an algorithm and implement it using a program to find whether given key element is present in the array or not. Also, find total number of comparisons for each input case. (Time Complexity = O(nlogn), where n is the size of input).

III. Given an already sorted array of positive integers, design an algorithm and implement it using a program to find whether a given key element is present in the sorted array or not. For an array arr[n], search at the indexes arr[0], arr[2], arr[4],. ,arr[2k] and so on. Once the interval (arr[2k] <
key < arr[2k+1]) is found, perform a linear search operation from the index 2k to find the element key. (Complexity < O(n), where n is the number of elements need to be scanned for searching): Jump Search

Input format:
The first line contains number of test cases, T. For each test case, there will be three input lines. First line contains n (the size of array).
Second line contains n space-separated integers describing array.
Third line contains the key element that need to be searched in the array.

Output format:
The output will have T number of lines.
For each test case, output will be “Present” if the key element is found in the array, otherwise “Not Present”.
Also for each test case output the number of comparisons required to search the key.

Sample I/O Problem - 2, 3:

Input: Output:

<table>
<tr><td></td><td>3 Present 3
5 Not Present 4
12 23 36 39 41 Present 3
41
8
21 39 40 45 51 54 68 72
69
10
101 246 438 561 796 896 899 4644 7999 8545
7999</td><td></td></tr>
<tr><td>2</td><td>Week 2:

I. Given a sorted array of positive integers containing few duplicate elements, design an algorithm and implement it using a program to find whether the given key element is present in the array or not. If present, then also find the number of copies of given key. (Time Complexity = O(log n))

Input format:
The first line contains number of test cases, T. For each test case, there will be three input lines. First line contains n (the size of array).
Second line contains space-separated integers describing array.
Third line contains the key element that need to be searched in the array.

Output format:
The output will have T number of lines.
For each test case T, output will be the key element and its number of copies in the array if the key element is present in the array otherwise print “ Key not present”.

Sample I/O Problem I:
Input: Output:
2 981 - 2
10 75 - 3
235 235 278 278 763 764 790 853 981 981
981
15
1 2 2 3 3 5 5 5 25 75 75 75 97 97 97
75

II. Given a sorted array of positive integers, design an algorithm and implement it using a program to find three indices i, j, k such that arr[i] + arr[j] = arr[k].

Input format:
The first line contains number of test cases, T. For each test case, there will be two input lines. First line contains n (the size of array).
Second line contains space-separated integers describing array.</td><td>2</td></tr>
</table>

<table>
<tr>
<td></td>
<td>Output:
The output will have T number of lines.
For each test case T, print the value of i, j and k, if found else print “No sequence found”.

Sample I/O Problem II:
Input: Output:
3 No sequence found.
5 2, 7, 8
1 5 84 209 341 1, 6, 9
10
24 28 48 71 86 89 92 120 194 201
15
64 69 82 95 99 107 113 141 171 350 369 400 511 590 666

III. Given an array of nonnegative integers, design an algorithm and a program to count the number of pairs of integers such that their difference is equal to a given key, K.

Input format:
The first line contains number of test cases, T. For each test case, there will be three input lines. First line contains n (the size of array).
Second line contains space-separated integers describing array. Third line contains the key element.

Output format:
The output will have T number of lines.
For each test case T, output will be the total count i.e. number of times such pair exists.

Sample I/O Problem III:
Input: Output:
2 2
5 4
1 51 84 21 31
20
10
24 71 16 92 12 28 48 14 20 22
4</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Week 3:

I. Given an unsorted array of integers, design an algorithm and a program to sort the array using insertion sort. Your program should be able to find number of comparisons and shifts (shifts - total number of times the array elements are shifted from their place) required for sorting the array.

Input Format:</td>
<td>1</td>
</tr>
</table>

The first line contains number of test cases, T. For each test case, there will be two input lines. First line contains n (the size of array).
Second line contains space-separated integers describing array.

Output Format:
The output will have T number of lines.
For each test case T, there will be three output lines. First line will give the sorted array.
Second line will give total number of comparisons.
Third line will give total number of shift operations required.

Sample I/O Problem I:
Input: Output:
3 -31 -23 32 45 46 65 76 89
8 comparisons = 13
-23 65 -31 76 46 89 45 32 shifts = 20
10 21 32 34 46 51 54 65 76 78 97
54 65 34 76 78 97 46 32 51 21 comparisons = 28
15 shifts = 37
63 42 223 645 652 31 324 22 553 -12 54 65 86 46 325 -12 22 31 42 46 54 63 65 86 223 324 325 553 645 652
comparisons = 54
shifts = 68

II. Given an unsorted array of integers, design an algorithm and implement a program to sort this array using selection sort. Your program should also find number of comparisons and number of swaps required.

Input Format:
The first line contains number of test cases, T. For each test case, there will be two input lines. First line contains n (the size of array).
Second line contains space-separated integers describing array.

Output Format:
The output will have T number of lines.
For each test case T, there will be three output lines. First line will give the sorted array.
Second line will give total number of comparisons. Third line will give total number of swaps required.

Sample I/O Problem II:
Input: Output:
3 -21 -13 12 45 46 65 76 89
8 comparisons = 28
-13 65 -21 76 46 89 45 12 swaps = 7
10 21 32 34 46 51 54 65 76 78 97
54 65 34 76 78 97 46 32 51 21 comparisons = 45
15 swaps = 9

	63 42 223 645 652 31 324 22 553 12 54 65 86 46 325 12 22 31 42 46 54 63 65 86 223 324 325 553 645 652 comparisons = 105 swaps = 14 III. Given an unsorted array of positive integers, design an algorithm and implement it using a program to find whether there are any duplicate elements in the array or not. (use sorting) (Time Complexity = O(n log n)) Input Format: The first line contains number of test cases, T. For each test case, there will be two input lines. First line contains n (the size of array). Second line contains space-separated integers describing array. Output Format: The output will have T number of lines. For each test case, output will be 'YES' if duplicates are present otherwise 'NO'. Sample I/O Problem III: Input: Output: 3 NO 5 YES 28 52 83 14 75 NO 10 75 65 1 65 2 6 86 2 75 8 15 75 35 86 57 98 23 73 1 64 8 11 90 61 19 20	
4	Week 4: I. Given an unsorted array of integers, design an algorithm and implement it using a program to sort an array of elements by dividing the array into two subarrays and combining these subarrays after sorting each one of them. Your program should also find number of comparisons and inversions during sorting the array. Input Format: The first line contains number of test cases, T. For each test case, there will be two input lines. First line contains n (the size of array). Second line contains space-separated integers describing array. Output Format: The output will have T number of lines. For each test case T, there will be three output lines. First line will give the sorted array. Second line will give total number of comparisons. Third line will give total number of inversions required. Sample I/O Problem I: Input: Output: 3 21 23 32 45 46 65 76 89	1

8 comparisons = 16
23 65 21 76 46 89 45 32 inversions =
10 21 32 34 46 51 54 65 76 78 97
54 65 34 76 78 97 46 32 51 21 comparisons = 22
15 inversions =
63 42 223 645 652 31 324 22 553 12 54 65 86 46 325 12 22 31 42 46 54 63 65 86 223 324 325 553 645 652
comparisons = 43
inversions =

II. Given an unsorted array of integers, design an algorithm and implement it using a program to sort an array of elements by partitioning the array into two subarrays based on a pivot element such that one of the sub array holds values smaller than the pivot element while another sub array holds values greater than the pivot element. Pivot element should be selected randomly from the array. Your program should also find number of comparisons and swaps required for sorting the array.

Input Format:

The first line contains number of test cases, T. For each test case, there will be two input lines. First line contains n (the size of array).
Second line contains space-separated integers describing array.

Output Format:
The output will have T number of lines.
For each test case T, there will be three output lines. First line will give the sorted array.
Second line will give total number of comparisons. Third line will give total number of swaps required.

Sample I/O Problem II:
Input: Output:
3 21 23 32 45 46 65 76 89
8 comparisons = 14
23 65 21 76 46 89 45 32 swaps = 10
10 21 32 34 46 51 54 65 76 78 97
54 65 34 76 78 97 46 32 51 21 comparisons = 29
15 swaps = 21
63 42 223 645 652 31 324 22 553 12 54 65 86 46 325 12 22 31 42 46 54 63 65 86 223 324 325 553 645 652
comparisons = 45
swaps = 39

III. Given an unsorted array of integers, design an algorithm and implement it using a program to find Kth smallest or largest element in the array. (Worst case Time Complexity = O(n))

Input Format:
The first line contains number of test cases, T. For each test case, there will be three input lines. First line contains n (the size of array).
Second line contains space-separated integers describing array. Third line contains K.

<table>
<tr>
<td></td>
<td>Output Format:
The output will have T number of lines.
For each test case, output will be the Kth smallest or largest array element. If no Kth element is present, output should be “not present”.

Sample for Kth smallest:
Input: Output:
3 123
10 78
123 656 54 765 344 514 765 34 765 234
3
15
43 64 13 78 864 346 786 456 21 19 8 434 76 270 601
8</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Week 5:

I. Given an unsorted array of alphabets containing duplicate elements. Design an algorithm and implement it using a program to find which alphabet has maximum number of occurrences and

print it. (Time Complexity = O(n)) (Hint: Use counting sort)

Input Format:
The first line contains number of test cases, T. For each test case, there will be two input lines. First line contains n (the size of array).
Second line contains space-separated integers describing array.

Output:
The output will have T number of lines.
For each test case, output will be the array element which has maximum occurrences and its total number of occurrences.
If no duplicates are present (i.e. all the elements occur only once), output should be “No Duplicates Present”.

Sample I/O Problem I:
Input: Output:
3 a – 3
10 No Duplicates Present
a e d w a d q a f p l - 4
15
r k p g v y u m q a d j c z e
20</td>
<td>2</td>
</tr>
</table>

g t l l t c w a w g l c w d s a a v c l

II. Given an unsorted array of integers, design an algorithm and implement it using a program to find whether two elements exist such that their sum is equal to the given key element. (Time Complexity = O(n log n))

Input Format:

The first line contains number of test cases, T. For each test case, there will be two input lines. First line contains n (the size of array).

Second line contains space-separated integers describing array. Third line contains key

Output Format:

The output will have T number of lines.

For each test case, output will be the elements arr[i] and arr[j] such that arr[i]+arr[j] = key if exist otherwise print 'No Such Elements Exist".

Sample I/O Problem II:

Input: Output:

2 10 40

10 No Such Element Exist

64 28 97 40 12 72 84 24 38 10

50

15

56 10 72 91 29 3 41 45 61 20 11 39 9 12 94

302

III. You have been given two sorted integer arrays of size m and n. Design an algorithm and implement it using a program to find list of elements which are common to both. (Time Complexity = O(m+n))

Input Format:

First line contains m (the size of first array).

Second line contains m space-separated integers describing first array. Third line contains n (the size of second array).

Fourth line contains n space-separated integers describing second array.

	Output Format: Output will be the list of elements which are common to both. Sample I/O Problem III: Input: Output: 7 10 10 34 55 34 76 10 39 85 10 55 12 30 55 34 72 10 34 10 89 11 30 69 51	
6	Note: Consider the following input format in the form of adjacency matrix for graph based questions (directed/undirected/weighted/unweighted graph). Input Format: Consider example of below given graph in Figure (a). A boolean matrix AdjM of size V X V is defined to represent edges of the graph. Each edge of graph is represented by two vertices (start vertex u, end vertex v). That means, an edge from u to v is represented by making AdjM[u,v] and AdjM[v,u] = 1. If there is no edge between u and v then it is represented by making AdjM[u,v] = 0. Adjacency matrix representation of below given graph is shown in Figure (b). Hence edges are taken in the form of adjacency matrix from input. In case of weighted graph, an edge from u to v having weight w is represented by making AdjM[u,v] and AdjM[v,u] = w. Input format for this graph is shown in Figure (c). First input line will obtain number of vertices V present in graph. After first line, V input lines are obtained. For each line i in V, it contains V space separated boolean integers representing whether an edge is present between i and all V. Figure (a) Figure (b) Figure (c) Week 6: I. Given a (directed/undirected) graph, design an algorithm and implement it using a program to find if a path exists between two given vertices or not. (Hint: use DFS) Input Format: Input will be the graph in the form of adjacency matrix or adjacency list. Source vertex number and destination vertex number is also provided as an input. Output Format: Output will be 'Yes Path Exists' if path exists, otherwise print 'No Such Path Exists'. Sample I/O Problem I:	3

	II. Given a graph, design an algorithm and implement it using a program to find if a graph is bipartite or not. (Hint: use BFS) Input Format: Input will be the graph in the form of adjacency matrix or adjacency list. Output Format: Output will be 'Yes Bipartite' if graph is bipartite, otherwise print 'Not Bipartite'. Sample I/O Problem II: III. Given a directed graph, design an algorithm and implement it using a program to find whether cycle exists in the graph or not. Input Format: Input will be the graph in the form of adjacency matrix or adjacency list. Output Format: Output will be 'Yes Cycle Exists' if cycle exists otherwise print 'No Cycle Exists'. Sample I/O Problem III:	
7	Week 7: Note: Input, output format along with sample input output for problem I and II is same and is provided at the end of problem II. I. After end term examination, Akshay wants to party with his friends. All his friends are living as paying guest and it has been decided to first gather at Akshay's house and then move towards party location. The problem is that no one knows the exact address of his house in the city. Akshay as a computer science wizard knows how to apply his theory subjects in his real life and came up with an amazing idea to help his friends. He draws a graph by looking in to location of his house and his friends' location (as a node in the graph) on a map. He wishes to find out shortest distance and path covering that distance from each of his friend's location to his house and then whatsapp them this path so that they can reach his house in minimum time. Akshay has developed the program that implements Dijkstra's algorithm but not sure about correctness of results. Can you also implement the same algorithm and verify the correctness of Akshay's results? (Hint: Print shortest path and distance from friends' location to Akshay's house) II. Design an algorithm and implement it using a program to solve previous question's problem using Bellman- Ford's shortest path algorithm. Input Format: Input will be the graph in the form of adjacency matrix or adjacency list. Source vertex number is also provided as an input.	3

Output Format:
Output will contain V lines.
Each line will represent the whole path from destination vertex number to source vertex number along with minimum path weigth.

Sample I/O Problem I and II:

Input:	Output:
5	1 : 0
0 4 1 0 0	2 3 1 : 3
0 0 0 0 4	3 1 : 1
0 2 0 4 0	4 3 1 : 3
0 0 0 0 4	5 2 3 1 : 7
0 0 0 0 0	
1	

III. Given a directed graph with two vertices (source and destination). Design an algorithm and implement it using a program to find the weight of the shortest path from source to destination with exactly k edges on the path.

Input Format:
First input line will obtain number of vertices V present in the graph.
Graph in the form of adjacency matrix or adjacency list is taken as an input in next V lines.

Next input line will obtain source and destination vertex number. Last input line will obtain value k.

Output Format:
Output will be the weigth of shortest path from source to destination having exactly k edges. If no path is available then print "no path of length k is available".

Sample I/O Problem III:

Input:	Output:
4	Weight of shortest path from (1,4) with 2 edges : 9
0 10 3 2	
0 0 0 7	
0 0 0 6	
0 0 0 0	
1 4	
2	

8

Week 8:

Note: Input, output format along with sample input output for problem I and II is same and is provided at the end of problem II.

I. Assume that a project of road construction to connect some cities is given to your friend. Map of these cities and roads which will connect them (after construction) is provided to him in the form of a graph. Certain amount of rupees is associated with construction of each road. Your friend has to calculate the minimum budget required for this project. The budget should be designed in such a way that the cost of connecting the cities should be minimum and number of roads required to connect all the cities should be minimum (if

3

	there are N cities then only N-1 roads need to be constructed). He asks you for help. Now, you have to help your friend by designing an algorithm which will find minimum cost required to connect these cities. (use Prim's algorithm) II. Implement the previous problem using Kruskal's algorithm. Input Format: The first line of input takes number of vertices in the graph. Input will be the graph in the form of adjacency matrix or adjacency list. Output Format: Output will be minimum spanning weight Sample I/O Problem I and II: Input: Output: 7 Minimum Spanning Weight: 39 0 0 7 5 0 0 0 0 0 8 5 0 0 0 7 8 0 9 7 0 0 5 0 9 0 15 6 0 0 5 7 15 0 8 9 0 0 0 6 8 0 11 0 0 0 0 9 11 0 III. Assume that same road construction project is given to another person. The amount he will earn from this project is directly proportional to the budget of the project. This person is greedy, so he decided to maximize the budget by constructing those roads who have highest construction cost. Design an algorithm and implement it using a program to find the maximum budget required for the project. Input Format: The first line of input takes number of vertices in the graph. Input will be the graph in the form of adjacency matrix or adjacency list. Output Format: Out will be maximum spanning weight. Sample I/O Problem III: Input: Output: 7 Maximum Spanning Weight: 59 0 0 7 5 0 0 0 0 0 8 5 0 0 0 7 8 0 9 7 0 0 5 0 9 0 15 6 0 0 5 7 15 0 8 9 0 0 0 6 8 0 11 0 0 0 0 9 11 0	
9	Week 9: I. Given a graph, Design an algorithm and implement it using a program to implement Floyd- Warshall all pair shortest path algorithm. Input Format: The first line of input takes number of vertices in the graph.	2

Input will be the graph in the form of adjacency matrix or adjacency list. If a direct edge is not present between any pair of vertex (u,v), then this entry is shown as AdjM[u,v] = INF.

Output Format:
Output will be shortest distance matrix in the form of V X V matrix, where each entry (u,v) represents shortest distance between vertex u and vertex v.

Sample I/O Problem I:

Input:	Output:
5	Shortest Distance Matrix:
0 10 5 5 INF	0 10 15 5 15
INF 0 5 5 5	INF 0 5 5 5
INF INF 0 INF 10	INF INF 0 15 10
INF INF INF 0 20	INF INF INF 0 20
INF INF INF 5 0	INF INF INF 5 0

II. Given a knapsack of maximum capacity w. N items are provided, each having its own value and weight. You have to Design an algorithm and implement it using a program to find the list of the selected items such that the final selected content has weight w and has maximum value. You can take fractions of items,i.e. the items can be broken into smaller pieces so that you have to carry

only a fraction xi of item i, where 0 ≤xi≤ 1.

Input Format:
First input line will take number of items N which are provided.
Second input line will contain N space-separated array containing weights of all N items. Third input line will contain N space-separated array containing values of all N items.
Last line of the input will take the maximum capacity w of knapsack.

Output Format:
First output line will give maximum value that can be achieved.
Next Line of output will give list of items selected along with their fraction of amount which has been taken.

Sample I/O Problem II:

Input:	Output:
6	Maximum value : 22.33
6 10 3 5 1 3	item-weight
6 2 1 8 3 5	5-1
16	6-3
	4-5
	1-6
	3-1

III. Given an array of elements. Assume arr[i] represents the size of file i. Write an algorithm and a program to merge all these files into single file with minimum computation. For given two files A and B with sizes m and n, computation cost of merging them is O(m+n). (Hint: use greedy approach)

Input Format:

	First line will take the size n of the array. Second line will take array s an input. Output Format: Output will be the minimum computation cost required to merge all the elements of the array. Sample I/O Problem III: Input: Output: 10 960 10 5 100 50 20 15 5 20 100 10 Solved example: Consider arr[5] = { 10, 5, 100, 50, 20, 15}. As per the brute force approach, first of all merge first two files (having 10 and 5 file size). Cost of merging will be = 10+5=15. List will become {15, 100, 50, 20, 15}. Similarly, again merging first two files (i.e. having 15 and 100 file size). Cost of merging will be = 15+100=115. List will become {115, 50, 20, 15}. For the subsequent steps the list becomes, (165, 20, 15}, {185, 15} and {200}. Therefore total cost of merging = 15+115+165+185+200 = 680. But this is not minimum computation cost. To find minimum cost, consider the order arr[5] = {5, 10, 15, 20, 50, 100}. By applying the same approach, the total cost of merging = 15+30+50+100+200 = 395.	
1	Week 10: I. Given a list of activities with their starting time and finishing time. Your goal is to select maximum number of activities that can be performed by a single person such that selected activities must be non-conflicting. Any activity is said to be non-conflicting if starting time of an activity is greater than or equal to the finishing time of the other activity. Assume that a person can only work on a single activity at a time. Input Format: First line of input will take number of activities N. Second line will take N space-separated values defining starting time for all the N activities. Third line of input will take N space-separated values defining finishing time for all the N activities. Output Format: Output will be the number of non-conflicting activities and the list of selected activities. Sample I/O Problem I: Input: Output: 10 No. of non-conflicting activities: 4 1 3 0 5 3 5 8 8 2 12 List of selected activities: 1, 4, 7, 10 4 5 6 7 9 9 11 12 14 16 II. Given a long list of tasks. Each task takes specific time to accomplish it and each task has a deadline associated with it. You have to design an algorithm and implement it using a program to find maximum number of tasks that can be completed without crossing their deadlines and also find list of selected tasks. Input Format: First line will give total number of tasks n.	2

	Second line of input will give n space-separated elements of array representing time taken by each task. Third line of input will give n space-separated elements of array representing deadline associated with each task. Output Format: Output will be the total number of maximum tasks that can be completed. Sample I/O Problem II: Input: Output: 7 Max number of tasks = 4 2 1 3 2 2 2 1 Selected task numbers : 1, 2, 3, 6 2 3 8 6 2 5 3 III. Given an unsorted array of elements, design an algorithm and implement it using a program to find whether majority element exists or not. Also find median of the array. A majority element is an element that appears more than n/2 times, where n is the size of array. Input Format: First line of input will give size n of array. Second line of input will take n space-separated elements of array. Output Format: First line of output will be 'yes' if majority element exists, otherwise print 'no'. Second line of output will print median of the array. Sample I/O Problem III: Input: Output: 9 yes 4 4 2 3 2 2 3 2 2 2	
	Week 11: I.Given a sequence of matrices, write an algorithm to find most efficient way to multiply these matrices together. To find the optimal solution, you need to find the order in which these matrices should be multiplied. Input Format: First line of input will take number of matrices n that you need to multiply. For each line i in n, take two inputs which will represent dimensions aXb of matrix i. Output Format: Output will be the minimum number of operations that are required to multiply the list of matrices. Sample I/O Problem I: Input: Output: 3 4500 10 30 30 5 5 60	**1**

	Solved Example: Consider a sequence of three matrices A of size 10X30, B of size 30X5, C of size 5X60. Then, (AB)C = (10*30*5) + (10*5*60) = 4500 operations A(BC) = (30*5*60) + (10*30*60) = 27000 operations. Hence the ouput of the program must be 4500 II.Given a set of available types of coins. Let suppose you have infinite supply of each type of coin. For a given value N, you have to Design an algorithm and implement it using a program to find number of ways in which these coins can be added to make sum value equals to N. Input Format: First line of input will take number of coins that are available. Second line of input will take the value of each coin. Third line of input will take the value N for which you need to find sum. Output Format: Output will be the number of ways. Sample I/O Problem II: Input: Output: 4 5 2 5 6 3 10 Solved Example: Let coin value set is C = {2,3,6,5} and the value N = 10. There are five solutions: {2,2,2,2,2}, {2,2,3,3}, {2,2,6}, {2,3,5} and {5,5}. Hence the output is 5. III.Given a set of elements, you have to partition the set into two subsets such that the sum of elements in both subsets is same. Design an algorithm and implement it using a program to solve this problem. Input Format: First line of input will take number of elements n present in the set. Second line of input will take n space-separated elements of the set. Output Format: Output will be 'yes' if two such subsets found otherwise print 'no'. Sample I/O Problem III: Input: Output: 7 yes 1 5 4 11 5 14 10 Solved Example: Let set is S = {1, 5, 4, 11, 5, 14, 10}. Sum of the elements = 1+5+4+11+5+14+10 = 50. Now dividing the set into two halves such that sum of elements of both the subsets = (50/2) = 25. Therefore, subsets are {1, 5, 5, 14} and {4, 11, 10}.	
	Week 12: I.Given two sequences, Design an algorithm and implement it using a program to find the length of longest subsequence present in both of them. A	**2**

subsequence is a sequence that appears in the same relative order, but not necessarily contiguous.

Input Format:
First input line will take character sequence 1. Second input line will take character sequence 2.

Output Format:
Output will be the longest common subsequence along with its length.

Sample I/O Problem I:

Solved Example: Consider two input strings “AGGTAB” and “GXTXAYB. Then the length of longest common subsequence is 4 i.e. for subsequence “GTAB”.

II.Given a knapsack of maximum capacity w. N items are provided, each having its own value and weight. Design an algorithm and implement it using a program to find the list of the selected items such that the final selected content has weight <= w and has maximum value. Here, you cannot break an item i.e. either pick the complete item or don't pick it. (0-1 property).

Input Format:
First line of input will provide number of items n.
Second line of input will take n space-separated integers describing weights for all items. Third line of input will take n space-separated integers describing value for each item.
Last line of input will give the knapsack capacity.

Output Format:
Output will be maximum value that can be achieved and list of items selected along with their weight and value.

Sample I/O Problem I:

Input:	Output:
5	Value = 16
2 3 3 4 6	Weights selected : 3 3 4
1 2 5 9 4	Values of selected weights : 2 5 9
10	

III.Given a string of characters, design an algorithm and implement it using a program to print all possible permutations of the string in lexicographic order.

Input Format:
String of characters is provided as an input.

Output Format:
Output will be the list of all possible permutations in lexicographic order.

Sample I/O Problem II:

Input:	Output:
CAB	ABC
	ACB

BAC
BCA
CAB
CBA

Week 13:

I.Given an array of characters, you have to find distinct characters from this array. Design an algorithm and implement it using a program to solve this problem using hashing. (Time Complexity = O(n))

Input Format:
First line of input will give the size n of the character array.
Second line of input will give n space-separated elements to character array.

Output Format: Output will be the list of characters present in the array in alphabetical order and frequency of each character in the array.

Sample I/O Problem I:

II.Given an array of integers of size n, design an algorithm and write a program to check whether this array contains duplicate within a small window of size k < n.

Input Format:
First input line contains number of test cases T. For each test case T, there will be three input lines. First line contains size n of array.
Second input line contains n space-separated array elements. Third input line contains value k.

Output Format:
Output will have T number of lines.
For each test case, output will be “Duplicate present in window k” if the duplicate element is found in the array, otherwise “Duplicate not present in window k”.

Sample I/O Problem II:

Input:	Output:
2	Duplicate not present in window 3.
10	Duplicate present in window 4.
1 2 3 4 1 2 3 4 1 2	
3	
12	
1 2 3 1 2 3 1 2 3 1 2 3	
4	

III.Given an array of nonnegative integers, Design an algorithm and implement it using a program to find two pairs (a,b) and (c,d) such that a*b = c*d, where a, b, c and d are distinct elements of array.

Input Format:
First line of input will give size of array n.
Second line of input will give n space-separated array elements.

2

<table>
<tr><td></td><td>Output Format:
First line of output will give pair (a,b) Second line of output will give pair (c,d).

Sample I/O Problem III:
Input: Output:
10 4 2
31 23 4 1 39 2 20 27 8 10 1 8</td><td></td></tr>
<tr><td></td><td>Week 14:

I.Given a number n, write an algorithm and a program to find nth ugly number. Ugly numbers are those numbers whose only prime factors are 2, 3 or 5. The sequence 1, 2, 3, 4, 5, 6, 8, 9, 10, 12, 15, 16, 18, 20, 24,. is sequence of ugly numbers.

Input:
First line of input will give number of test cases T. For each test case T, enter a number n.

Output:
There will be T output lines.
For each test case T, Output will be nth ugly number.

Sample I/O Problem I:

II.Given a directed graph, write an algorithm and a program to find mother vertex in a graph. A mother vertex is a vertex v such that there exists a path from v to all other vertices of the graph.

Input:
Graph in the form of adjacency matrix or adjacency list is provided as an input.

Output:
Output will be the mother vertex number. Solved Example: Consider a directed graph: In this graph, vertex 0 is mother vertex.</td><td>1</td></tr>
<tr><td></td><td>Total</td><td>24</td></tr>
</table>

11. **Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Thomas H. Cormen, Charles E. Leiserson, Ronal L. Rivest, Clifford Stein:" Introduction to Algorithms", 2nd Edition, PHI,	2nd	2006.
	Reference Books		
1.	Donald E.Knuth:"The Art of Computer Programming: Volume 1: Fundamental Algorithms",3rd Edition	3rd	1997
2	Ellis Horowitz, Sartaj Sahni, SanguthevarRajasekaran:" Fundamentals of Computer Algorithms", 2nd Edition, University press,.	2nd	2007

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER IV

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 442** Course Title: **Automated Reasoning**
2. Contact Hours: **L:** **3** **T**: **0** **P**: **0**
3. Examination Duration (Hrs): **Theory** **3** **Practical** **0**
4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
5. Credits: **3**
6. Semester: **4**
7. Category of Course: **DE**
8. Pre-requisite: **TCS 344 Probability and Random Process**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: represent mathematical and other knowledge using logical formalism CO2: understand the history of formalizing mathematical knowledge CO3: know and understand the advantages and limitations of the main approaches and techniques in automated reasoning of mathematical knowledge CO4: apply different automated reasoning techniques to new problems

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate*

10.**Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1**: Introduction and motivation: Role of logic in Computer Science, problem representation. Basic notions: language, models, interpretations, validity, proof, decision problems in logic. decidability.	8
2	**Unit 2:** Propositional logic: Syntax, semantics, proof systems, Validity, satisfiability and unsatisfiability, soundness and completeness.	8
3	**Unit 3:** Mechanization: truth tables, normal forms, semantic tableau, resolution, proof by contradiction, example. First order predicate logic theory: Quantifiers, first order models, validity and satisfiability, semantic tableaux.	8
4	**Unit 4:** Normal forms, skolemization: Elimination of quantifiers, unification, resolution and various resolution strategies, equality axioms and para-modulation. Horn formulas and programs.	8
5	**Unit 5:** Prolog as a restricted resolution-based theorem prover. Undecidability and incompleteness in logic, compactness Theorem.	8

		Total	**40**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1	Michael Huth and Mark Ryan, “Logic in Computer Science: Modelling and Reasoning about Systems”, Cambridge University Press	2nd	2005
2	Arindama Singh, “Logics for Computer Science”, Prentice Hall of India.	2nd	2020
	Reference Books		
1.	M. Ben-Ari, “Mathematical Logic for Computer Science”, Springer	3rd	2012
2	Elliott Mendelson , “Introduction to Mathematical Logic”, CRC Press	6th	2015

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER IV

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 493** Course Title: **Introduction to cryptography and PKC**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **4th**
7. Category of Course: **DE**
8. Pre-requisite: TCS 332 Fundamental of Information Security and Blockchain.

9. **Course Outcome**:**	After completion of the course the students will be able to: **CO1** Explain symmetric and asymmetric key cryptosystems. **CO2**: Know the working of cryptography techniques. **CO3**: Analyze the different types of cryptosystems. **CO4:** Use cryptographic techniques to implement information security protocols. **CO5:** Apply cryptographic techniques in different applications. **CO6:** Develop symmetric and asymmetric key cryptosystems.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate*

10.Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
1	**Unit-I** **Basics of cryptography** What is cryptography, what is confidentiality, data integrity, authentication, and nonrepudiation, applications of cryptography - chip based payment cards, digital currencies, computer passwords, digital communications, plaintext, cipher-text, cipher - characteristics of a good cipher, encryption, decryption, Key - significance of key length, symmetric and asymmetric key cryptography, cryptanalysis, OSI security architecture- security attacks, security services, security mechanisms	**10**

2.	**Unit-II** **Mathematics for cryptography** Concept of divisibility, prime numbers, importance of prime numbers in cryptography, euclid theorem for GCD, extended euclidean algorithm, modular arithmetic, random number generators, deterministic and nondeterministic random number generators, XOR, bit shifts, euler's totient theorem, chinese remainder theorem	8
3.	**Unit-III** **Symmetric key cryptosystem** Secret Key (symmetric) cryptography - stream and block ciphers, additive and multiplicative ciphers, rail fence technique, playfair cipher, hill cipher, vernam cipher, Vigenère Cipher, RC4 algorithm, DES, 2DES, 2-3DES, 3DES, AES, block cipher modes of op	10
4.	**Unit-IV** **Asymmetric key cryptosystem** RSA, Diffie Hellman key exchange protocol, Elliptic curve cryptography (ECC), ElGamal encryption system	8
5.	**Unit-V** **Digital signature and message integrity mechanisms** DSS algorithm, RSADS algorithm, ECDSA algorithm, Message integrity, hash functions, MAC functions, HMAC, secure electronic transaction, useof ECDSA in blockchain implementation	10
	TOTAL	**46**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	William Stallings, "Cryptography and Network Security: Principles and Practice", Pearson publication, 2020	7th	2016
	Reference Books		
1.	Charles P. PFleeger, Shari Lawrence Pfleeger, Jonathan Margulies, "Security in Computing ", 5th Edition, Prentice Hall	5th	2018
2.	Roger Wottenhofer, " Distributed Ledger Technology, The science of Blockchain", Invested Forest Publishing (2e), 2017	2nd	2017

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER IV

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 426** Course Title: **Information Security and Risk Management**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **4**
7. Category of Course: **DE**
8. Pre-requisite: **Information Security foundations and programming**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** **CO1**Information Security and Risk Management **CO2**: Information Security and Risk Management **CO3**: Analyze the different types of information security risk management techniques. **CO4:** Use information security risk management techniques to implement informationsystems. **CO5** Apply information security risk management techniques in different applications. **CO6:** Develop information security risk management techniques.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate*

10. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs

Unit-I	**Overview of information security and cryptography** What is information security, why we need information security, zero trust model Protection against- unauthorised modification, unauthorised deletion and unauthorised access, different types of user authentication techniques, access control techniques Pillars of information security - confidentiality, availability and integrity What is cryptography, what is confidentiality, data integrity, authentication, and nonrepudiation, applications of cryptography, network security model, plaintext, ciphertext, cipher - characteristics of a good cipher, encryption, decryption, Key - significance of key length, symmetric and asymmetric key cryptography, cryptanalysis, OSI security architecture- security attacks, security services, security mechanisms	10
Unit-II	**Risk management and analysis** Overview of risk management, risk identification, identifying the assets, threats and vulnerabilities, risk control strategies, selection of a risk control strategy, planning for risk analysis, performing risk analysis and assessment	8
Unit-III	**Information security planning and implementations** Information security policy, standards and practices, information security blueprint, security education, training and awareness program, project management for information security, technical topics of implementation, nontechnical aspects of implementation	8
Unit-IV	**Disaster recovery and risk monitoring** What is disaster in information security, disaster recovery planning, disaster recovery plan, risk monitoring, requirement of risk monitoring, various phases of risk monitoring	8
Unit-V	**Vulnerabilities and security assessment** What is vulnerability, sources of vulnerabilities, vulnerability assessment, system security policy, building a security policy, security requirement specification, threat identification, threat models (Dolev Yao model and CK adversary model), threat analysis, vulnerability identification and assessment, security certification, security monitoring and auditing	8
	TOTAL	46

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	William Stallings, “Cryptography and Network Security: Principles and Practice”, Pearson publication, 2020	8th	2020
2	Michael E. Whitman and Herbert J. Mattord , Principles of Information Security, (2e), Thomson Learning, 2007	2nd	2007
3.	NIIT, Introduction to Information Security Risk Management, PHI, 2004	2nd	2004

4	Joseph Migga Kizza , A Guide to Computer Network Security, Springer-Verlag London Limited.	3rd	2013
	Reference Books		
1.	Charles P. Pfleeger, Shari Lawrence Pfleeger, Jonathan Margulies, “Security in Computing”, 5th Edition, Prentice Hall.	5th	1989

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER IV

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS-484** Course Title: **Biometric Security**
2. Contact Hours: **L:** **T**: **0** **P**: **0**
3. Examination Duration (Hrs): **Theory** **3** **Practical** **0**
4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
5. Credits: **03**
6. Semester: 4
7. Category of Course: **DC**
8. Pre-requisite: **Mathematical Foundations for Artificial Intelligence (TCS343)**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Basic information on the fundamental physical and organic science. CO2: Understand designing standards of biometric frameworks. CO3: Understand biometric frameworks and be able to examine and design for essential biometric framework applications. CO4: Understand various Biometric security issues. CO5: Describe Cryptography security CO6: Understanding of Fuzzy model

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate*

10.**Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** Introduction- Authentication systems, Development of biometric authentication. Basic terms, biometric data, biometric characteristics, biometric features, biometric templates and references. Expected properties of biometric identifiers. Basics in biometric errors estimation. Enrolment, verification and identification. Applications of Biometrics.	09
2	**Unit 2:** Fingerprints and Hand Geometry: Technical description, Characteristics, Competing technologies, Strengths–Weaknesses, Deployment. Face and Voice Recognition: Technical description, Characteristics, Strengths-Weaknesses, Deployment.	09
3	**Unit 3:** Biometric System Security: Secure transfer of biometric data. Secure storage, use of smart cards, principles of match-off-card and match-on-card	10

	techniques. Biometrics in the cloud. Points of attack. Privacy models. Spoofing: Static and dynamic liveness features. Liveness detection in biometrics. Selected liveness detection techniques, frequency analysis for paper printouts detection.	
4	**Unit 4:** Protection: Overview of principles from cryptography to secure fuzzy data. Template protection strategies: feature protection, key-binding, key-generating, hybrids.	08
5	**Unit 5:** Overview of fuzzy vaults, fuzzy commitment, fuzzy extractors and revocable bio tokens. Bio cryptographic infrastructures for secure template management.	08
	Total	**44**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Jiankun Hu, David Chek Ling Ngo, Andrew Beng Jin Teoh, "Biometric Security", Cambridge Scholars Publishing		2015
2.	Khalid Saeed, Jerzy Pejas, Romuald Mosdorf. "Biometrics, Computer Security Systems and Artificial Intelligence Application, Springer.		**2010**
3.	John D. Woodward, Jr. Nicholas M. Orlans Peter T. Higgins, "Biometrics", dream tech		2003
	Reference Books		
1.	1. John Chirillo and Scott Blaul," Implementing Biometric Security", Wiley Eastern Publications, 2005		2005

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 501** Course Title: **System Software**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: V
7. Category of Course: **DC**
8. Pre-requisite: TCS-402 Finite Automata and Formal Languages

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Define system software and differentiate system software with other software's. CO2: Assess the working of Assembler, Loader/Linker and Macroprocessor. CO3: Understand the concept of passes in translators. CO4: Determine the purpose of linking, and types of linking. CO5: Develop the system software according to machine limitations. CO6: Compare and Contrast the various text editors.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

SL. NO.	Contents	Contact Hours
1	**Unit 1:** **Machine Architecture:** Introduction, System Software and its relation to Machine Architecture, Simplified Instructional Computer (SIC), Architecture of SIC Machine , SIC Programming Examples	**9**
2	**Unit 2:** **Assemblers:** Basic Assembler Functions, A Simple SIC Assembler, Algorithm and Data Structures for Assemblers, Machine Dependent Assembler Features - Instruction Formats & Addressing Modes, Program Relocation. Machine Independent Assembler Features – Literals, Symbol-Definition Statements, Expression, Program Blocks, Control Sections and Programming Linking, Assembler Design Operations - One-Pass Assembler, Multi-Pass Assembler	**9**
3	**Unit 3:** **Loaders and Linkers:** Basic Loader Functions - Design of an Absolute Loader, A Simple Bootstrap Loader, Machine-Dependent Loader Features – Relocation,	**10**

	Program Linking, Algorithm and Data Structures for a Linking Loader; Machine-Independent Loader Features - Automatic Library Search, Loader Options, Loader Design Options - Linkage Editor, Dynamic Linkage, Bootstrap Loaders **Editors and Debugging Systems:** Text Editors - Overview of Editing Process, User Interface, Editor Structure, Interactive Debugging Systems - Debugging Functions and Capabilities, Relationship With Other Parts Of The System, User-Interface Criteria	
4	**Unit 4:** **Macro Processor:** Basic Macro Processor Functions - Macro Definitions and Expansion, Macro Processor Algorithm and Data Structures, Machine-Independent Macro Processor Features - Concatenation of Macro Parameters, Generation of Unique Labels, Conditional Macro Expansion, Keyword Macro Parameters, Macro Processor Design Options, General-Purpose Macro Processors, Macro Processing Within Language Translators	**8**
5	**Unit 5:** **Lex and Yacc :**Lex and Yacc - The Simplest Lex Program, Recognizing Words With LEX, Symbol Tables, Grammars, Parser-Lexer Communication, The Parts of Speech Lexer, A YACC Parser, The Rules Section, Running LEX and YACC, LEX and Hand- Written Lexers, Using LEX - Regular Expression, Examples of Regular Expressions, A Word Counting Program, Parsing a Command Line. Using YACC – Grammars, Recursive Rules, Shift/Reduce Parsing, What YACC Cannot Parse, A YACC Parser - The Definition Section, The Rules Section, Symbol Values and Actions, The LEXER, Compiling and Running a Simple Parser, Arithmetic Expressions and Ambiguity, Variables and Typed Tokens.	**10**
	Total	**46**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks/ Reference Books		
1.	Leland.L.Beck: “ System Software: an introduction to systems programming”, 3rd Edition, Addison-Wesley,.	3rd	1997
2	John.R.Levine,” Tony Mason and Doug Brown: Lex and Yacc”, O'Reilly, SPD,.	1st	1998

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

1. Name of Department: - Computer Science and Engineering
2. Subject Code: **TCS 502** Course Title: **Operating Systems**
3. Contact Hours: **L:** **3** **T**: **0** **P**: **0**
4. Examination Duration (Hrs): **Theory** **3** **Practical** **0**
5. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
6. Credits: **3**
7. Semester: **4**
8. Category of Course: **DC**
9. Pre-requisite: **TCS 301, TCS 302, TCS 404**

9. **Course Outcome **:**	After completion of the course the students will be able to**:** CO1 Understand the concept and design issues associated with an operating system. CO2: Identify the problems related to process management, synchronization and apply learned methods to solve basic problems. CO3. Explain the basics of memory management and the use of virtual memory in modern operating systems. CO4. Understand the concept deadlock avoidance, prevention, and detections techniques. CO5: Implementation of process management, memory management and file management using system calls. CO6: Analyze the data structures and algorithms used for developing an operating system.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

Sl. No.	**Contents**	**Contact Hours**
1	**Introduction to Operating Systems, UNIX:** What operating systems do; Operating System structure; Operating System Services; User - Operating System interface; System calls; Types of system calls; Operating System structure; Unix command: Command Structure, Internal and External commands, filters; vi editor.	8
2	**Process Management:** Process concept; Operations on processes; Multithreading models; Threading issues. Process Scheduling: Basic concepts; Scheduling criteria; Scheduling algorithms; Multiple-Processor scheduling; Thread scheduling. **Process Synchronization:** Inter-process communication; Synchronization: The Critical section problem; Peterson's solution; Synchronization hardware; Semaphores; Classical problems of synchronization.	10

3	**Deadlocks:** Deadlocks: System model; Deadlock characterization; Methods for handling deadlocks; Deadlock prevention; Deadlock avoidance; Deadlock detection and recovery from deadlock. **Memory Management:** Memory Management Strategies: Background; Swapping; Contiguous memory allocation; Paging; Structure of page table; Segmentation. Virtual Memory Management: Background; Demand paging; Page replacement; Allocation of frames; Thrashing	10
4	**File System, Implementation of File System**: File System: File concept; Access methods; Directory structure; Protection. File system structure; Directory implementation; Allocation methods; Free space management. Secondary Storage Structures: Mass storage structures; Disk structure; Disk scheduling; Disk management; Swap space management. Protection: Goals of protection, Principles of protection, Access matrix.	8
5	**File System, Implementation of File System:** File System: File concept; Access methods; Directory structure; Protection. File system structure; Directory implementation; Allocation methods; Free space management. **Secondary Storage Structures:** Mass storage structures; Disk structure; Disk scheduling; Disk management; Swap space management. Protection: Goals of protection, Principles of protection, Access matrix.	8
	Total	**44**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	Abraham Silberschatz, Peter Baer Galvin, Greg Gagne: Operating System Principles, 7th edition, Wiley India, 2006.	7st	2006
2.	Abraham Silberschatz, Peter Baer Galvin, Greg Gagne: Operating System Principles, 7th edition, Wiley India, 2006.	7th	2006
3.	Unix concepts and applications – Sumitabha Das	1st	2005
	Reference Books		
1.	Andrew S Tanenbaum: Operating Systems: Design and Implementation, 3rd edition, Prentice Hall, 2006	3rd	2006
2.	Stuart E. Madnick, John Donovan: Operating Systems, Tata McGraw Hill, 2008		2008

10.

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS-503** Course Title: **Database Management System**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **5th**
7. Category of Course: **DC**
8. Pre-requisite: **TCS 302, TCS 404**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** **CO1:** Understand the different issues involved in the design and implementation of a database system. **CO2:** Study the physical and logical database designs, database modeling, relational, hierarchical, and network models. **CO3:** Understand and use data manipulation language to query, update, and manage a database. **CO4:** Develop an understanding of essential DBMS concepts such as: database security, integrity, concurrency. **CO5:** Design and build a simple database system and demonstrate competence with the fundamental tasks involved with modeling, designing, and implementing a DBMS. **CO6:** Evaluate a business situation and designing & building a database application

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** **Introduction:** An overview of DBMS; Advantages of using DBMS approach; Database systems vs File Systems, Database system concepts and architecture Data models, schemas, and instances; Three-schema architecture and data independence; Database languages and interfaces; The database system environment; Centralized and client-server architectures; Classification of Database Management systems.	9
2	**Unit 2:** **Entity-Relationship Model:** Using High-Level Conceptual Data Models for Database Design; An Example Database Application; Entity Types, Entity Sets, Attributes and Keys; Relationship types, Relationship Sets,	9

	Roles and Structural Constraints; Weak Entity Types; Refining the ER Design; ER Diagrams, Naming Conventions and Design Issues; Relationship types of degree higher than two.	
3	**Relational Model and Relational Algebra:** Relational Model Concepts; Relational Model Constraints and Relational Database Schemas; Update Operations, Transactions and dealing with constraint violations; Unary Relational Operations: SELECT and PROJECT; Relational Algebra and Calculus Operations from Set Theory; Binary Relational Operations: JOIN and DIVISION; Additional Relational Operations. Examples of Queries in Relational Algebra; Relational Database Design Using ER- to-Relational Mapping. **SQL – 1:** SQL Data Definition and Data Types; Specifying basic constraints in SQL; Schema change statements in SQL; Basic queries in SQL; More complex SQL Queries. **Insert, Delete and Update statements in SQL;** Specifying constraints as Assertion and Trigger; Views (Virtual Tables) in SQL; Additional features of SQL; Database programming issues and techniques; Embedded SQL, Dynamic SQL; Database stored procedures**.** **Optimization of SQL Queries through Indexes, Concepts of NoSQL.**	11
4	**Unit 4: Database Design – 1:** Informal Design Guidelines for Relation Schemas; Functional Dependencies; Normal Forms Based on Primary Keys; General Definitions of Second and Third Normal Forms; Boyce-Codd Normal Form Properties of Relational Decompositions; Algorithms for Relational Database Schema Design; Multivalued Dependencies and Fourth Normal Form; Join Dependencies and Fifth Normal Form; Inclusion Dependencies; Other Dependencies and Normal Forms	9
5	**Unit 5:** **Transaction Management: The ACID Properties;** Transactions and Schedules; Concurrent Execution of Transactions; Lock- Based Concurrency Control; Performance of locking; Transaction support in SQL; Introduction to crash recovery; 2PL, Serializability and Recoverability; Lock 9Management; Log Files; Checkpointing; Recovering from a System Crash; Media Recovery	10
	Total	**48**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	McGraw-Hill. Date K., Swamynathan S. An Introduction to Database Systems. Eight Edition. Pearson.	2nd	**2012**
2.	Elmasri R. and Navathe S.B., Fundamentals of Database Systems.	2^{nd}	**2012**

3.	Fifth Edition.Pearson. Singh S.K., Database Systems-Concepts, Designs and Application. 2nd Edition. Pearson	2nd	**2011**
4.	Date, C.J. Introduction to Database Systems (Vol I & II) 8th Edition. Addison- Wesley.	8th	**2004**
	Reference Books		
1.	Silberschatz A. Korth H. F. Sudarshan S., Database System Concepts. Sixth Edition	1st	**2014**

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Name of Department: - Computer Science and Engineering

1. Subject Code: **TMA 502** Course Title: **Computer Based Numerical and Statistical Technique**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **5**
7. Category of Course: **DC**
8. Pre-requisite: TMA 101, TMA 201

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Develop the notation of errors, finding of errors, roots and apply them in problem solving in concern subject. CO2: Understand the methods of interpolation techniques and apply them. CO3: Elaborate the basics of numerical differentiation and integration and implement them. CO4: Explain the concepts of differential equation. CO5: Elaborate the basics of correlation and regression, curve fitting and be able to apply the methods from these subjects in problem solving. CO6: Examine statistical techniques and able to relate these to real problems.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** Introduction to Numbers and their accuracy, Computer Arithmetic, Mathematical preliminaries, Errors and their Computation, General error formula, Order of Approximation. **Solution of Algebraic and Transcendental Equation:** Bisection Method, Iteration method, Secant Method, Newton Raphson method, Rate of convergence and their algorithms. **Solution of system of linear equations:** Gauss Elimination method, Gauss Jordan method and Gauss Seidel method and their algorithms.	**10**
2	**Unit 2: Interpolation:** Introduction to Finite Differences, Difference tables, Polynomial Interpolation: Newton's forward and backward formula, Central difference formulae: Gauss forward and backward	**09**

	formula. Interpolation with unequal intervals: Lagrange's interpolation, Newton divided difference formula and their algorithms.	
3	**Unit 3: Numerical Differentiation and Integration:** Numerical Differentiation for Interpolation Formulae, General Quadrature formula, Trapezoidal rule, Simpson's 1/3 and 3/8 rule and their algorithms. **Numerical Solution of Differential Equations:** Euler's explicit and implicit methods, modified Euler's method, Runge-Kutta Method, Solution of Boundary Value Problem by Finite Difference Method and their algorithms.	**09**
4	**Unit 4: Statistical Computation:** Introduction to Method of least squares, Curve Fitting of different types of curves. Data fitting with Cubic spline Interpolation.	**08**
5	**Unit 5: Correlation and Regression Analysis:** Introduction of correlation and regression, Correlation coefficient and it's application in computer science, Linear and Nonlinear Regression, Multiple Regression.	**09**
	Total	**45**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers/Place of Publication**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	Gupta C. B. Singh S. R. and Kumar Mukesh "Engineering Mathematics for Semesters III and IV" McGraw Hill Education,	First edition	2016
2.	Rajaraman V, "Computer Oriented Numerical Methods", Pearson Education.	First edition	2020
	Reference Books		
1.	Sastry, S. S, "Introductory Methods of Numerical Analysis", Pearson Education.	Second	2009
2.	Jain, Iyengar and Jain, "Numerical Methods for Scientific and Engineering Computations", New Age Int.	Fourth	2003
3.	Steven C Chapra, "Applied Numerical Methods with Matlab".	Second	2007

12	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Name of Department: - Computer Science and Engineering

1.	Subject Code:	**PCS-503**		Course Title:	**Database Management System Lab**	
2.	Contact Hours:	**L:** 0	**T:** 1	**P:** 2		
3.	Examination Duration (Hrs):	**Theory** 0		**Practical** 3		
4.	Relative Weight:	**CIE** 25	**MSE** 25	**SEE** 50		
5.	Credits:	**2**				
6.	Semester:	**5th**				
7.	Category of Course:	**DC**				
8.	Pre-requisite:	**TCS 302, TCS 404**				

9. **Course Outcome**:**	**After completion of the course the students will be able to:**
	CO1: Students get practical knowledge on designing and analysis of conceptual model and mapping of conceptual model to relational database systems. **CO2:** Design and implement SQL queries using DDL and DML concepts for updation and managing a database. **CO3:** Design and implement advance SQL queries such as relational constraints, joins, set operations, aggregate functions, and views. **CO4:** Design and implement queries using optimization techniques. **CO5:** Application of transaction control language (TCL), data control language (DCL) in SQL to evaluate practical implications of DBA such as transaction, recovery, and security.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

Sl. No.	List of problems for which student should develop program and execute in the Laboratory	Contact Hours
1.	**Problem Statement 1:** Granting Permissions: Data Control Language (DCL) Commands: Grant/Revoke.	2
2.	**Problem Statement 2:** Creation of database/tables for different applications (DDL commands): Creating tables (without constraints)	2
3.	**Problem Statement 3:**	2

	Creation of database/tables for different applications (DDL commands): Creating tables (with Column level and Table level constraints)	
4.	**Problem Statement 4:** Inserting data into database (DML Commands): updating / deleting records in a table.	2
5.	**Problem Statement 5:** TCL command: saving (commit) and undoing (rollback)	2
6.	**Problem Statement 6:** Data retrieval (DR) command: Fetching data from database using SELECT, FROM and WHERE command (Projection and Selection)	2
7.	**Problem Statement 7:** Perform the following: Altering a Table, Dropping/ Truncating/ renaming Tables, backing up/ restoring a database	2
8.	**Problem Statement 8:** For a given set of relational schemas, create tables and perform the following: Simple queries; Simple queries with aggregate functions (group by and having clause).	2
9.	**Problem Statement 9:** Queries involving, Date functions, string functions (character manipulations and case manipulation functions)	2
10.	**Problem Statement 10:** Math functions, CASE, DECODE, Implicit and explicit typecasting functions.	2
11.	**Problem Statement 11:** Join Queries: Inner join, Equi-join, natural join, Outer join (LEFT-OUTER JOIN, RIGHT OUTER JOIN and FULL OUTER JOIN)	3
12.	**Problem Statement 12:** Subqueries-with IN clause, with EXISTS clause	2
13.	**Problem Statement 13:** For a given set of relation tables perform the following: Creating Views (with and without Check options), Dropping a view, Selecting data from a view.	3
14.	**Problem Statement 14:** For a given set of relation tables perform the following: Creating Views (with and without Check options), Dropping a view, Selecting data from a view.	2
15.	**Problem Statement 15:** Generate primary key values with Sequence.	2

16.	**Problem Statement 16:** optimization of queries with Indexes	2
17.	**Problem Statement 17:** Applying **SYNONYMS** on database objects.	2
18.	**Problem Statement 18:** Introduction to Dynamic SQL	2
19.	**Problem Statement 19:** Introducing Triggers on data objects	3
20.	**Problem Statement 20:** Introducing Procedures on data objects for optimization of queries	3
	Total	**40**

11**. Suggested Books:**

S. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Text Books		
1.	RamezElmasri, Shamkant, B. Navathe, “Database Systems”, Pearson Education, 7Th Edition.	**7th**	**2015**
3.	M L Gillenson, “Introduction to Database Management”, Wiley Student Edition	**2nd**	**2012**
	Reference Books		
1.	Mary Beth Roeser: [1Oracle® Database] SQL Language Reference 12c Release 1 (12.1) E41329-25	**2nd**	**2017**

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 552** Course Title: Cloud-Based Application Development and Management
2. Contact Hours: **L:** 3 **T:** 0 **P:** 0
3. Examination Duration (Hrs): **Theory** 3 **Practical** 0
4. Relative Weight: **CIE** 25 **MSE** 25 **SEE** 50
5. Credits: **3**
6. Semester: **5**
7. Category of Course: **DE**
8. Prerequisite: **TCS-451**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Recognize the cloud based application development platforms and economic benefits. CO2: Analyze the use case of various cloud service provider's applications and platforms. CO3: Apply the advanced cloud computing application's concepts. CO4: Analyze the use case of cloud-based application deployment and management concepts. CO5: Explore the use case of various cloud platforms, offered services and security aspects. CO6: Develop and deploy the cloud based server-side application using Node.js and the front-end using React.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

SL. NO.	Contents	Contact Hours
1	**Unit 1:** **Fundamental of Cloud Based Applications** Cloud Data centers, Software stack, Virtualization, software defined networks and storage, cloud storage, and programming models, Clouds Based Application development motivating factors, benefits, challenges, service models, SLAs and security. Concepts behind data center design and management, Economic and technological benefits of the cloud paradigm.	**9**
2	**Unit 2:** **Cloud Platforms in Industry**	**9**

	Amazon Web Services: Compute Services, Storage Services, Communication Services. Google App Engine: Architecture, Core Concepts, Application Life Cycle, Cost Model, Observations. Microsoft Azure: Azure Core Concepts, SQL Azure, Azure Compute and Storage, Azure Database and Networking, Monitoring and Managing Azure Solutions. IBM Cloud (Kyndryl), Salesforce, Heroku, Alibaba Cloud, Oracle Cloud, Tencent Cloud, OVHcloud, DigitalOcean, and Linode (Akamai). Case study on available Cloud Platforms in Industry.	
3	**Unit 3:** **Advanced Cloud Computing** Energy Efficiency in Clouds, Green Cloud Computing Architecture, Market based Management of Clouds, Market-Oriented Cloud Computing, Reference Model for MOCC. Federated Clouds/Intercloud: Definition, Characterization, Cloud Federation Stack, Technologies for Cloud Federation. Third Party Cloud Services, MetaCDN, Spot Cloud, Cloud Authentication Protocols, Cloud Security Threats with Cloud Apps. Virtualized CPU, memory and I/O resources, network (SDN) and storage (SDS), Key role of virtualization to enable the cloud. Cloud storage concepts like data distribution, durability, consistency and redundancy. Case study on Advanced Cloud Computing services.	**9**
4	**Unit 4:** **Cloud Management** Fundamentals of Cloud Management, Management Services, Cloud properties, Multi-tier Application Deployment in Clouds, Challenges, Requirements, Service Level Agreements (SLAs),Billing& Accounting. Cloud Policy and Governance: Risk Management and Regulatory Practices. Cloud Analytics and Cost Metrics. Case study on Cloud Management Services, Distributed file systems, NoSQL databases, object storage using HDFS, CephFS, HBASE, MongoDB, Cassandra, DynamoDB, S3, and Swift.	**9**
5	**Unit 5:** **Cloud Based Secured Applications Development** Current trends in cloud computing i.e. IoT, Big Data, Machine Learning. Cloud Infrastructure Security, Network level security, Host level security, Application level security, Access management and control. MapReduce, Spark and GraphLab programming models, Develop and deploy the cloud based server-side application using Node.js and the front-end using React, Case Study on Open Source and Commercial Clouds applications: Amazon EC2, Amazon S3,Amazon Redshift, GitHub Repository, AWS IoT Core, AWS IoT Device Defender, AWS IoT Device Management, AWS IoT FleetWise, AWS IoT SiteWise, AWS IoT Events, AWS IoT TwinMaker, AWS IoT Analytics, Azure IoT Hub, Azure IoT Central, Azure Digital Twins, Azure IoT Edge, Azure Percept, Azure Sphere, and Azure RTOS. Design and Deploy a Restaurant Application to Cloud.	**9**
	Total	**45 Hrs.**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Mastering Cloud Computing by Rajkumar Buyya, Vecchiola & Selvi (Published by McGraw Hill Education Pvt. Ltd),	1st	2013.
2	Cloud Management & Security by Imad. M. Abbadi (WILEY Publication	3rd	2014.
	Reference Books		
1.	Cloud Computing – A Hands-On Approach by Arshdeep Bahga, Vijay Madisetti.	1st	2014

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 571** Course Title: **Big Data Visualization**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **V**
7. Category of Course: **DE**
8. Pre-requisite: **Fundamental of Cloud Computing and Bigdata TCS 351**

9. **Course Outcome**:**	After completion of the course, the students will be able to: CO1: Create and adapt visualizations to represent complex data sets and emphasize targeted concepts for effective communication CO2: Analyze and interpret large volumes of data to identify patterns, trends, and insights. CO3: Apply data visualization techniques to communicate complex data sets effectively. CO4: Develop skills in storytelling with data, effectively conveying narratives through visual representations. CO5: Demonstrate proficiency in using tools and technologies for big data visualization. CO6: Use leading open-source and commercial software packages (Tableau) to create and publish visualizations that enable clear interpretations of big, complex, and real-world data

*** Describe the specific knowledge, skills, or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1: Techniques for visual data representations:** Data Visualization, Information Visualization, Concept Visualization, Strategic Visualization, Metaphor Visualization, and Compound Visualization. **Visualization design objectives**: Methodology, Establishing intent, The visualization's function-explain, explore, exhibit; Tone-analytical and abstract, key factors in a visualization project, The eight hats of data visualization design	10
2	**Unit 2: Demonstrating Editorial Focus**: Importance of editorial focus, Preparing and familiarizing of data, Refining the editorial focus, Using visual	10

	analysis to find stories **Conceiving and Reasoning**: Preparing data, Refining, The Visualization anatomy - Data Representation: choosing correct visualization method, physical properties of data, degree of accuracy in interpretation, creating an appropriate design metaphor, choosing the final solution; The Visualization anatomy-Data presentation: Interactivity, Annotation, and Arrangement;	
3	**Unit 3: Taxonomy of Data Visualization**: Choosing appropriate chart type: Dot plot, Column chart, Floating bar, pixelated bar chart, Histogram, Slopegraph, Radial chart, Glyph chart, Sankey diagram, Area size chart; Assessing hierarchies and part-to-whole relationships: Pie chart, Stacked bar chart, Square pie, Treemap, Circle packing diagram, Bubble hierarchy, Tree Hierarchy; Showing changes over time: Line chart, Sparklines, Area chart, Horizon chart, Stacked area chart, Candlestick chart, Barcode chart, Flow map; Plotting connections and relationships: Scatter plot, Bubble plot, Scatter plot matrix, Heatmap, Parallel sets, Radial network, Network Diagram; Mapping geospatial data: Choropleth map, dot plot map, Bubble plot map, Isarithmic map	9
4	**Unit 4: Tools for data visualization:** Tableau, Google Charts, Datawrapper, Chartio, IBM Watson Analytics, and Sisense	9
5	**Unit 5: Data Visualization through Tableau**: Tableau basics, connecting Tableau to various datasets, creating bar charts, area charts, maps, scatterplots, pie charts, and tree maps; Create Interactive Dashboards, storylines, Joins, Data Blending, Table calculations, parameters, Dual axis charts, Export results from Tableau to other software, Work with time-series data, Creating data extracts, Aggregation, Granularity and Level of detail, Adding filters, create data hierarchies, Adding actions to dashboards	8
	Total	**46**

11. Suggested Books:

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Andy Kirk, Data Visualization: a successful design process, Packt Publishing	1st	2015
	Reference Books		
1.	Tamara Munzer, Visualization Analysis and Design, CRC Press	2nd	2014

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 531** Course Title: **Communication models and protocols**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **ESE 50**
5. Credits: **3**
6. Semester: **V**
7. Category of Course: **DE**
8. Pre-requisite: NA

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Understand the common network communication primitives as part of programming tasks in various languages. CO2: Discuss the various Protocols used in Communication CO3: Analyze more complex protocol engineering and network management tasks CO4: Understand terminology, concepts, and technologies required for telecommunication in local area networks (LANs) and on the global Internet CO5: Describe and analyze the Data Encoding and Transmission techniques. CO6: Use of network management tools

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

S.NO.	**Contents**	**Contact Hours**
1	**Unit 1:** Introduction and Overview:Key elements of communications and networking, Layered protocol model, Network edge, End systems, access networks, links, Network core, Packet switching, circuit switching, network structure, Multiplexing, Delay, loss and throughput in networks, Protocol layers, service models, Networks under attack: security, History.	**9**
2	**Unit 2:**	**9**

	Application Layer: Principles of network applications, Web and HTTP, FTP, Electronic Mail, SMTP, POP3, IMAP, DNS, P2P applications, Video streaming and content distribution networks, Ethereal (network packet sniffer), Socket programming with UDP and TCP	
3	**Unit 3:** Data Encoding and Transmission: Data encoding and transmission concepts, Digital data transmission over digital signal: NRZ encoding, Multilevel binary encodings, Biphase encodings, Scrambling techniques, Digital data transmission over analog signal: Public telephone system, Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), Performance of digital to analog modulation schemes, Quadrature Amplitude Modulation (QAM), Analog data transmission over digital signal: Digitization, Pulse Code Modulation, Non-linear encoding, Delta modulation, Analog data transmission over analog signal: Asynchronous transmission, Synchronous transmission, Ethernet link layer frame example.	**10**
4	**Unit 4:** Data Link Control: Introduction and services, Error detection and correction, Multiple access protocols, LANs, Addressing & ARP, Ethernet, Switches, VLANs, PPP, Link virtualization, MPLS, Data center networking, Web request processing.	**8**
5	**Unit 5:** Wireless and Mobile Networks Wireless, Wireless links, characteristics, CDMA, IEEE 802.11 wireless LANs (“Wi-Fi”), Cellular Internet Access: Architecture, Standards (e.g., 3G, LTE), Mobility, Principles: addressing and routing to mobile users, Mobile IP, Handling mobility in cellular networks, Mobility and higher-layer protocols	**9**
	Total	**45**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	1.Douglas E. Comer,” Internetworking with TCP/IP Volume One - 6th Edition” Publisher is Pearson, © 2014	6th	2014
	2. Protocol specifications (RFCs) and other readings will also be assigned	1st	**2008**
	Reference Books		
1.	Seymour Lipschutz, Data Structures Schaum's Outlines, McGraw Hill	1st	2014

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 591** Course Title: **Computer System Security**
2. Contact Hours: **L:** **3** **T**: **0** **P**: **0**
3. Examination Duration (Hrs): **Theory** **3** **Practica** **0**
4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
5. Credits: **3**
6. Semester: **V**
7. Category of Course: **DE**
8. Pre-requisite: **TCS-491**

9. **Course Outcome**:**	After completion of the course, the students will be able to: CO1: Explain different security threats and attacks. CO2: Know the working of different attacks and security protocols. CO3: Analyze the different security protocols. CO4: Use programming to implement security protocols. CO5: Use programming to implement security protocols. CO6: Develop system security protocols

*** Describe the specific knowledge, skills, or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** **Introduction to System security:** Control hijacking attacks buffer overflow, integer overflow, bypassing browser memory protection, Sandboxing and Isolation, Tools and techniques for writing robust application software, Security vulnerability detection tools, and techniques program analysis (static, concolic and dynamic analysis), Privileges, access control, and Operating System Security, Exploitation techniques, and Fuzzing	10
2	**Unit 2:** **Software security:** Vulnerabilities, Attacks, and Countermeasures: Privileged programs (Set-UID programs) and vulnerabilities & Privilege Separation, Buffer Overflow vulnerability and defences, Return-to-libc attack, Race, Condition vulnerability	10

	and attack, Dirty COW attack, Format String vulnerability and attack, Shellshock attack, Heartbleed attack Interactivity, Annotation, and Arrangement;	
3	**Unit 3:** **Web Security:** Same origin Policy, Cross site scripting attack, Cross site request forgery attack, Sql Injection attack, Clickjacking attack, Content Security Policies (CSP) in web, Web Tracking, Session Management and User Authentication, Session Integrity, Https, SSL/TLS, Threat Modelling	10
4	**Unit 4:** **Smartphone Security**: Android vs. ioS security model, threat models, information tracking, rootkits, Access control in Android operating system, Rooting android devices, Repackaging attacks, Attacks on apps, Whole- disk encryption, hardware protection, Viruses, spywares, and keyloggers and malware detection	9
5	**Unit 5:** **Hardware and system security**: Meltdown Attack, spectre attack, Authentication and password, Access control concept, Access control list, Capability, Sandboxing, Threats of Hardware Trojans and Supply Chain Security, Side Channel Analysis based Threats, and attacks. Issues in Critical Infrastructure and SCADA Security.	6
	Total	**45**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	Security in Computing, Book by Charles P Pfleeger and Shari Lawrence Pfleeger, V edition	5th	**2015**
2.	Cryptography and Network Security: Principles and Practice, Book by William Stallings, VII edition	7th	**2017**
	Reference Books		

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 509** Course Title: **Machine Learning**
2. Contact Hours: **L: 3** **T:** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **V**
7. Category of Course: **DE**
8. Pre-requisite: Design and Analysis of Algorithm, Fundamental of Statistics and AI (TCS 421 / Statistical Data Analysis with R (TCS 471), Discrete Structures and Combinatorics (TMA 316)

9. **Course Outcome**:**	After completion of the course the students will be able to**:** **CO1:** Acquire concepts and methods in statistical machine learning **CO2:** Analyze fundamental principles of machine learning algorithms **CO3**: Understand machine learning motivated by case-studies **CO4:** Investigate and evaluate key topics in machine learning algorithms for data science industry

*** Describe the specific knowledge, skills, or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** **Machine learning foundation** Review of logic and knowledge system - language, axiom, hypothesis, theorem, logic & types, what is ML, Inductive bias in ML, AI pyramid, Pattern classification pipeline, Linear algebra in ML, Probabilistic logic and statistical inference (Random expt./ variable, CDF, WLLN, Bayes, Markov & Chernoff bound, Hypothesis testing and performance indices - ROC, Estimation - detection, Optimality of Bayes, bias-variance, underfit-overfit, entropy as Information, Cover's packing lemma, Curse of dimensionality, **Case study:** Wealth – optimal payoffs in portfolios (stock market)	14
2	**Unit 2:** **Unsupervised Learning** Clustering, Clustering methods – Partition vs. Hierarchical, k-Means and k-Medoids, Hierarchical: Agglomerative & Divisive, Error Analysis in Clustering, Ensemble - clustering, **Case study:** Clustering in Health care, Causal cluster, Graph cluster	8

3	**Unit 3:** **Supervised Learning** Main objectives and types of Supervised methods (Parametric, Semi parametric, Non-parametric), Linear Regression and Weiner filter, Grammar based/ Inductive learning - Decision Trees – CART, ID-3, Pruning metrics for tree; D-tree examples, Linear SVM (basics and V-C bound), k-NN rule and examples, Learning as Factorization, Ensemble learning: Bagging, Boosting**. Case studies:** covered for mentioned Supervised learning techniques.	10
4	**Unit 4:** **Reinforcement & Interaction Learning** Basic model of Reinforcement Learning as game (Agent, Critic, Environment), Optimal policy & Q – values, Bellman equation, **Case studies** on R Learning Active learning, Deep Reinforcement, Transfer learning with examples, Federated Machine Learning with examples.	8
5	**Unit 5:** **Special topics in Machine Learning** Sentiment Mining: NLP pipeline process, Data Analytics – Big data and Hadoop model, Business Analytics – Competitive Machine Learning, ANN building blocks (problem solving), Deep learning, Feed forward, Backpropagation, C-NN, Recurrent-NN.	8
	Total	**48**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	Pattern classification – R, Duda, P. Hart and D. Stork, Wiley Publisher	2nd.	2007
2.	The Elements of Statistical Learning – J. Friedman, R. Tibshirani and T. Hastie, Springer Publisher	3rd.	2017
3.	Pattern Recognition and Machine Learning – C. Bishop, Springer Publisher	2nd.	2016
4.	Deep Learning – A. Courville, I. Goodfellow, Y. Bengio, MIT Press	2nd.	2016
	Reference Textbooks		
1.	Machine Learning – Tom M. Mitchell, Mc Graw Hill Publisher	1st	2017
2.	Introduction to Machine Learning – E. Alpaydin, PHI Publisher	3rd.	2015
3.	Elements of Information Theory – T M. Cover, J A. Thomas, Wiley Publisher	2nd.	2006

12.	**Mode of Internal Evaluation**	Seminar – presentation on topic in ML & internal viva **OR** Simulation of ML method with real dataset & internal viva

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 562** Course Title: **Introduction to Artificial Intelligence and Data Science**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs.): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **5**
7. Category of Course: **DC**
8. Pre-requisite: **TCS 342, TCS 462**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Understand the concepts of Artificial Intelligence and Data Science with their related terminologies. CO2: Analyze and Apply various programming skills for understanding Data nature and its requirements. CO3: Analyze and apply various modelling techniques for basic data Analytics. CO4: Demonstrate Problem Solving using AI algorithms. CO5: Understand, Apply and Demonstrate different techniques and tools for Data Analysis. CO6: Analyze Real World Case Studies on Applications of Data Science.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 01:** Data Science History, Data Science and Related Terminologies, Types of Analytics, Applications of Data Science, Data Science Process Models. Introduction to AI, History and Foundation of AI, Intelligence, and it's type, Categorization of Artificial Intelligent based System, Agents & Environments, Applications, and Current trends in AI	**10**
2	**Unit 02:** Introduction to Data, Types, Data Preprocessing, Understanding Data Requirements, Dealing with Erroneous/Missing Values,	**10**

	Standardizing Data, Steps involved in EDA using Python Programming/R. Knowledge and Reasoning in AI: Knowledge based Agents, Syntax and Semantics, Forward Chaining, Backward Chaining, Knowledge Engineering, Belief Network	
3	**Unit 3:** Introduction to Modelling Techniques, Supervised Learning Algorithms- Regression, Classification, and Unsupervised Learning Algorithms- Clustering, Association Rule Mining Feature Selection, Dimensionality Reduction, Independent and Dependent Variables, Relationship between Variables: Correlation, Multicollinearity, Factor Analysis, Treatment of Outliers	**10**
4	**Unit 4:** Problem Solving Agent, Formulating Problems, Example Problems, Uninformed Search Methods, Informed Search Method, Local Search Methods, Genetic algorithms, Adversarial Search	**10**
5	**Unit 5:** Applications of Analytics in Healthcare, Applications of Analytics in Agriculture, Applications of Analytics in Business, Applications of Analytics in Sports, Forms of Learning, Introduction to Expert Systems, Expert System Architecture, Capstone Project	**8**
	Total	**48**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Education	6th	2018
2.	N. P. Padhy, Artificial Intelligence and Intelligent Systems, Oxford	1st	2005
3	B.Uma Maheshwari, R.Sujatha, Introduction to Data Science, Wiley	1st	2021
4	Jake VanderPlas, Python Data Science Handbook, O'Reilly	1st	2022
	Reference Books		
1.	Stuart J. Russell and Peter Norvig, Artificial Intelligence a Modern Approach, McGraw Hill	3rd	2009

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Name of Department: - Computer Science and Engineering

1.	Subject Code:	TCS-563	Course Title: **Multi-Modal Data Processing and Learning**
2.	Contact Hours:	**L:** 3 **T:** 0 **P:** 0	
3.	Examination Duration (Hrs):	**Theory** 3 **Practical** 0	
4.	Relative Weight:	**CIE** 25 **PRS** 0 **MSE** 25 **SEE** 50 **PRE** 0	
5.	Credits:	3	
6.	Semester:	5	
7.	Category of Course:	DE	
8.	Pre-requisite:		

9. **Course Outcome**:**	After completion of the course the students will be able to: CO1: To discuss multimodal data and its applications CO2: To apply text processing techniques in the relevant applications CO3: To analyze various speech processing approaches CO4: To create a model based on digital image and video processing CO5: To analysis data of imbalance for multimodal design CO6: To compare various types of processing such as Text process, Speech processing, Image and Video processing

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** **Introduction:** Introduction to Multimodal data and applications, Challenges of multimodal data, Data collection & cleaning.	**8**
2	**Unit 2:** **Text Processing:** Text normalization, Lemmatization, Morphology, Subword tokenization; Text processing and statistics: TFIDF, BM-25, Zipf's law, Hipf's law; Language models and smoothing techniques; Vector space models.	**9**
3	**Unit 3:** Speech Processing: Speech production and perception, Acoustic and articulatory phonetics; Short-term analysis: Need and windowing, Energy, Zero-crossing rate, Autocorrelation function, Fourier transform, Spectrogram; Short-term synthesis: Overlap-add method; Cepstrum analysis: Basis and development, mel-cepstrum.	**9**

4	**Unit 4:** Digital Image and Video Processing: Point processing, Neighborhood processing, Enhancement, Edge detection, Segmentation, Feature descriptors, Restoration, Morphological operations, Image transforms, Spatial and temporal data handling.	**9**
5	**Unit 5:** Multi-modal data synchronization and fusion: Data understanding and quality estimation, meta data filtering, amount of data estimation for multimodal design, data synchronization and fusion, imbalance data analysis for multimodal design.	**8**
	Total	**43**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	R. C. Gonzalez, R. E. Woods, *Digital Image Processing*, Pearson, Prentice-Hall	1st	2008
2.	R. Klette, *Concise Computer Vision: An Introduction Into Theory And Algorithms*, Springer	1st	2014
3.	L. R. Rabiner, R. W. Schafer, *Introduction To Digital Speech Processing*, Now Publishers Inc	1st	2007
4.	A But, A Miasnikov, G Ortolani, Multimodal Deep Learning With Tensorflow: Translate Mathematics Into Robust Tensorflow Applications With Python, Packt Publishing Limited	1st	2019
5.	M Yang, B Rosenhahn, V Murino, Multimodal Scene Understanding: Algorithms, Applications And Deep Learning, Academic Press Inc	1st	2019
	Reference Books		
1.	D. Jurafsky, J.H. Martin, *Speech And Language Processing*, (Online Available At Https://Web.Stanford.Edu/~Jurafsky/Slp3/)	3rd	2022
2.	J-P Thiran, F Marqués And H Bourlard, Multimodal Signal Processing: Theory And Applications For Human-Computer Interaction, Academic Press	1st	2009

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS-549** Course Title: **Data Science: Visualization with Tableau Specialization**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **5**
7. Category of Course: **DE**
8. Pre-requisite:

9. **Course Outcome**:**	After completion of the course the students will be able to: CO1: Clean up, format and analyze data to prepare for interactives CO2: Design visualizations that represent the relationships contained in complex data sets and adapt them to highlight the ideas we want to communicate CO3: Use principles of human perception and cognition in visualization design. CO4: Identify the statistical analysis needed to validate the trends present in data visualizations. CO5: Critically evaluate visualizations and suggest improvements and refinements. CO6: Use leading open source and commercial software packages (Tableau) to create and publish visualizations that enable clear interpretations of big, complex and real world data

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**UNIT 01:** **Context of Data Visualization**: Visualization as a discovery tool, Bedrock of visualization as a discovery tool, Visualizing the past, Different Data Visuals for Different Needs, The classic case of London 1855 cholera epidemic and how it changed the face of visualization, The 20th Century advancements, Computer-based Visualization, The Power of Human Perception, Different Data Calls for Different Views, Leveraging Composition and Interactivity, Using Data to Tell Stories	**10**

	Visualization design objectives: Methodology, Establishing intent, The visualization's function-explain, explore, exhibit; Tone-analytical and abstract, key factors in a visualization project, The eight hats of data visualization design	
2	**UNIT 02:** **Demonstrating Editorial Focus**: Importance of editorial focus, Preparing and familiarizing of data, Refining the editorial focus, Using visual analysis to find stories **Conceiving and Reasoning**: Preparing data, Refining, The Visualization anatomy - Data Representation: choosing correct visualization method, physical properties of data, degree of accuracy in interpretation, creating an appropriate design metaphor, choosing the final solution; The Visualization anatomy- Data presentation: Interactivity, Annotation and Arrangement;	**10**
3	**Unit 03:** **Taxonomy of Data Visualization**: Choosing appropriate chart type: Dot plot, Column chart, Floating bar(Gantt chart), pixelated bar chart, Histogram, Slopegraph, Radial chart, Glyph chart, Sankey diagram, Area size chart; Assessing hierarchies and part-to-whole relationships: Pie chart, Stacked bar chart, Square pie, Tree map, Circle packing diagram, Bubble hierarchy, Tree Hierarchy; Showing changes over time: Line chart, Sparklines, Area chart, Horizon chart, Stacked area chart, Candlestick chart (or box and whiskers plot, OHLC chart), Barcode chart, Flow map; Plotting connections and relationships: Scatter plot, Bubble plot, Scatter plot matrix, Heatmap, Parallel sets, Radial network, Network Diagram; Mapping geo-spatial data: Choropleth map, dot plot map, Bubble plot map , Isarithmic map	**9**
4	**Unit 04:** **Collaborative Visual Analysis**: Supporting Asynchronous Collaborative Information Visualization, Designing for social data analysis, Design considerations for collaborative visual analytics **Constructing and Evaluating the Design Solution**: Nested model for visualization design and validation, Challenge of information visualization evaluation, Visualization software, applications and programs; Charting and statistical analysis tools, programming environments, tools for mapping, The construction process, Approaching the finishing line, Post-launch evaluation, Developing the capabilities	**9**

5	**Unit 05:** **Data Visualization through Tableau**: Tableau basics, connecting tableau to various datasets, creating bar charts, area charts, maps, scatterplots, pie charts, tree maps; Create Interactive Dashboards, storylines, Joins, Data Blending, Table calculations, parameters, Dual axis charts, Export results from Tableau to other software, Work with timeseries data, Creating data extracts, Aggregation, Granularity and Level of detail, Adding filters, create data hierarchies, Adding actions to dashboards	**8**
	Total	**46**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Andy Kirk, “Data Visualization: a successful design process”, Packt Publishing, 2012	1st	2012
	Reference Books		
1.	Tamara Munzer, “Visualization Analysis and Design”, CRC Press	1st	2014

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS-582** Course Title: **Introduction to AI & ML**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **5**
7. Category of Course: **DC**
8. Pre-requisite:

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Ability to compare different AI algorithms in terms of design issues, computational complexity, and assumptions CO2: Apply basic search techniques and AI algorithms for problem solving CO3: Identify the machine learning algorithms which are more appropriate for various types of learning tasks in various domains CO4: Analyse and Differentiate various classification approaches CO5: Implement machine learning algorithms on real datasets CO6: The student will learn about the basic concepts of ANN and CNN

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** Introduction to AI: Definitions, Foundations AI, History of AI, Intelligent Agents, Structure of Intelligent Agents, Environments; Problem solving Agents, Problem Formulation, Search Strategies, Constraint Satisfaction Search, Informed search Methods	8
2	**Unit 2:** Knowledge representation and reasoning: Agents that Reason Logically, Propositional Logic and Inference, First-Order Logic, Inference in First-Order Logic Planning and Learning: Introduction to Planning, Types, Learning from observations, Forms of Learning, Inductive Learning, Learning decision trees, Reinforcement Learning	8
3	**Unit 3:** Data Preprocessing, Machine Learning process, Feature scaling, Simple Linear Regression, Multiple Linear Regression, Polynomial	8

	Regression, Support Vector Regression, Decision Tree Regression, Evaluating the Regression Models Performance	
4	**Unit 4:** Logistic Regression, K-Nearest Neighbors, Support Vector Machine, Decision Tree Classification, Random Forest Classification	8
5	**Unit 5:** K-Means clustering, Hierarchical Clustering, Apriori, Eclat, Artificial Neural Networks, Activation Function, Gradient Descent, Stochastic Gradient Descent, Backpropagation, Convolutional Neural Networks	8
	Total	**40**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Laurence Moroney, AI and Machine Learning for Coders, O'REILLY Media	1st	2020
2.	Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, Pearson Education India	3rd	2015
3.	Elaine Rich, Kevin Knight and Shivashankar B. Nair, Artificial Intelligence, McGraw-Hill Education	3rd	2017
	Reference Books		
1.	Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, Pearson Education India	1st	2015
2.	Devroye L., Gyorfi L., Lugosi G., A Probabilistic Theory of Pattern Recognition, Springer	1st	1996

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 543** Course Title: **Knowledge Representation**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **5**
7. Category of Course: **DE**
8. Pre-requisite: TCS 409, Design Analysis and Algorithm, TCS 343 Mathematical Foundations for Artificial Intelligence

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Use logic programming and knowledge representation languages for modelling simple application domains in Artificial Intelligence CO2: Apply reasoning mechanisms in knowledge representation languages to test the correctness of models and to formulate more expressive queries. CO3: Design ontology-based knowledge systems with reasoning mechanism; integrate with other systems for building applications. CO4: Understand the entire process of how to design, construct, and query a knowledge graph to solve real-world problems.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

Sl. No.	Contents	Contact Hours
1	Principles of knowledge representation, Propositional Logic- Proof Systems, Natural Deduction, Tableau Method, Resolution Method. First Order Logic Syntax and Semantics, Unification, Forward Chaining, Horn Fragments of First Order Logic.	10
2	Rule based systems, The Rete Algorithm, Rete example, Programming rule Based Systems, Description Logics, Reasoning in Description Logics, Structure Matching, Classification, Extensions of DL	9
3	The ALC Language, Ontology Representation languages, Ontology Languages- RDF, RDFS-Rule Interchange Format, Logic programming	9

	with OWL: OWL-Building OWL ontology- SPARQL- RDF/OWL ontology processing using Graph databases	
4	Non monotonic logics 4 hours Classical vs non-monotonic logic. Ways to achieve non-monotonicity-Stable Model Semantics querying Semantic Nets and Frames.	8
5	Discussions on Contemporary Issues in knowledge representation	6
	Total	**42**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Franz Baader, Ian Horrocks, Carsten Lutz, Uli Sattler, An Introduction to Description Logic, Cambridge University Press	1st	2017
2.	Ronald Brachman & Hector Levesque, Knowledge Representation and Reasoning, Morgan Kaufmann	1st	2004
3.	Frank van Harmelen, Vladimir Lifschitz and Bruce Porter (Eds), Handbook of Knowledge Representation Foundations of Artificial Intelligence	1st	2008
4.	Ian Robinson, Jim Webber, Emil Eifrem, Graph Databases, O'Reilly Media	2nd	2015
	Reference Books		
1.	Pascal Hitzler, Markus Kroetsch, and Sebastian Rudolph, Foundations of Semantic Web Technologies, Chapman & Hall/ CRC Textbooks in Computing	1st	2009

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Name of Department: - Computer Science and Engineering

1. Subject Code:	TCS 542		Course Title:		Introduction to Artificial Intelligence		
2. Contact Hours:	L:	3	T:	1	P:	0	
3. Examination Duration (Hrs.):	Theory	3	Practical	0			
4. Relative Weight:	CIE	25	PRS	0	SEE	50	
5. Credits:	3						
6. Semester:	V						
7. Category of Course:	DC						

8. Pre-requisite: TCS 343 Mathematical Foundations for Artificial Intelligence

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO 1: Understand the basics of the theory and practice of Artificial Intelligence. CO 2: Learn the basics of Artificial Intelligence programming. CO 3: Understand various searching techniques use to solve the AI problems. CO 4: Apply knowledge representation techniques and problem solving strategies to common AI applications. CO 5: Build self-learning and research skills to tackle a topic of interest on his/her own or as part of a team. CO 6: Apply the knowledge of AI and agents in developing multidisciplinary real world projects

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1: Introduction** What is AI? , Foundation of AI, State space representation. Intelligent Systems: Categorization of Intelligent System, Components of AI Program, Types of AI, Foundations of AI, Applications of AI, Current trends in AI, Intelligent Agents: Anatomy, structure, Types.	8
2	**Unit 2: Problem Solving** Solving problem by Searching: Problem Solving Agent, Formulating Problems. Uninformed Search Methods: Breadth First Search (BFS), Depth First Search	10

	(DFS), Depth Limited Search, Depth First Iterative Deepening (DFID), Informed Search Methods: Greedy best first Search, A* Search, Memory bounded heuristic Search. Local Search Algorithms and Optimization Problems: Hill climbing search Simulated annealing, Local beam search	
3	**Unit 3: Uncertain Knowledge and Reasoning** Acting under uncertainty, Basic Probability Notation, Inference using full joint distributions, Bayes Rule and its use.	8
4	**Unit 4: Knowledge Representation** First order predicate calculus, Horn Clauses, Introduction to PROLOG, Semantic NetsPartitioned Nets, Minskey frames, Case Grammar Theory, Production Rules KnowledgeBase, The Inference System, Forward & Backward Deduction	10
5	**Unit 5: Expert System and Programing Language** Expert System Existing Systems (DENDRAL, MYCIN), domain exploration, Meta Knowledge, Expertise Transfer, Self Explaining System Programming Language: Introduction to programming Language, LISP, PROLOG	12
	Total	**48**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	G F. Luger, Artificial Intelligence: Structures and Strategies for Complex Problem Solving,	6th	2021
2.	Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, PHI	1st	1990
3	Eileen Mc Daniel, Stephen McDaniel, The Accidental Analyst: Show Your Data Who's Boss Freak Analytics	1st	2012
	Reference Books		
1.	Stuart J. Russell and Peter Norvig, Artificial Intelligence a Modern Approach, McGraw Hill	3rd	2009

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Name of Department: - Computer Science and Engineering

1. Subject Code: **PCS 542** Course Title: **Artificial Intelligence Lab**
2. Contact Hours: **L:** **0** **T**: **1** **P**: **2**
3. Examination Duration (Hrs): **Theory** **0** **Practical** **3 hr**
4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
5. Credits: **2**
6. Semester: **V**
7. Category of Course: **DC**
8. Pre-requisite: TCS 409 Design and Analysis of Algorithm, TCS 341Python programming for computing

9. **Course Outcome****:	After completion of laboratory the students will be able to**:** **CO1:** Implement methods in AI **CO2:** Analyze AI algorithms and applications

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

S. N.	Contents	Contact Hours
1	To program problem-solving by path traversal search over graph using BFS, DFS, UFS	2
2	To program problem-solving by path traversal using A* algorithm (Informed Search)	2
2	To use lobe.ai user interface and perform manual labeling, training and testing for supervised object recognition in Image	2
3	To understand and develop basic KR (Knowledge Representation) tools from practical AI problem definitions: KR methods	2

4	To take two - category input data file and use thresholding to design binary classifier for dataset 1 dimensional, 2 dimensional dataset	2
5	To register and use monkeylearn.com and create model, train and classify sentiments that lead to sentiment prediction using corpus of hotel reviews as part of NLU	2
6	To register and use Teachable machine (Google API) and perform multiple class / pose analysis and classification.	2
7	To use quillbot.com and study basic machine transcription roles in summarization: as NLP application	2
8	To use quillbot.com and study basic machine transcription roles in grammar checker (syntax): as NLP application	2
9	To use quillbot.com and study basic machine transcription roles in paraphrasing: as NLP application	2
10	Program probabilistic model given: it is Friday and that a student is absent is 3 %. Since there are 5 school days in a week, the probability that it is friday is 20 %. What is the probability that a student is absent given that today is friday. Program Bayesian rule in python to get the result.	2
11	To extract intra-day stock market data for 4 stocks and write program that: plots the values, develops linear regression, derive mean and correlation.	2
12	To program best fit distributions for at least 2 discrete distributions and estimate mean and variance for the dataset.	2
13	To program best fit distributions for at least 2 continuous distributions and estimate mean and variance for the dataset.	2
14	To program method using Z score, DB for detection of Outliers in dataset	2
15	To study role of correlation as strong, weak and moderate between underlying features as function of sample size	2

16	To develop knowledge discovery and association rule map for healthcare dataset	2

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 511** Course Title: **Computer Networks**
2. Contact Hours: **L:** 3 **T**: **0** **P**: **0**
3. Examination Duration (Hrs): **Theory** **3** **Practical** **0**
4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
5. Credits: 3
6. Semester: **V**
7. Category of Course: **DC**
8. Pre-requisite: **TCS 101,** Fundamental of Computer & Introduction to Programming

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Apply and Characterize computer networks from the view point of components and from the view point of services. CO2: Display good understanding of the flow of a protocol in general and a network protocol in particular CO3: Evaluate and Select the most suitable Application Layer protocol (such as HTTP, FTP, SMTP, DNS, BitTorrent) as per the requirements of the network application and work with available tools to demonstrate the working of these protocols. CO4: Design a Reliable Data Transfer Protocol and incrementally develop solutions for the requirements of Transport Layer CO5: Describe the essential principles of Network Layers and use IP addressing to create subnets for any specific requirements CO6: Evaluate and select the appropriate technology to meet Data Link Layer requirements and design a framework to implementing TCP/IP protocol suite.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	**Contents**	**Contact Hours**
1	**Unit 1:** Introduction: Computer Networks and the Internet, Overall view: As components and as services; What is a protocol, what is a network protocol, Access Networks and Physical Media, Circuit and Packet Switching, Internet Backbone, Delays: Processing, Queuing, Transmission and Propagation delays, The Layered Architecture: Protocol Layering, The OSI Reference Model and the TCP/IP protocol stack, History of Computer Networking, and the Internet.	11
2	**Unit 2:** Application Layer: Principles and Architectures of Network Applications, Client and Server processes, the idea of socket, Transport services available to Application Layer especially in the internet Application Layer Protocols: The Web and http: Persistent and Nonpersistent connections, http message format, cookies, proxy server, conditional GET, File Transfer Protocol, Email: smtp, mail message formats, mail access protocols: pop3, imap, MIME, DNS: Services, How it works, Root, Top-Level and Authoritative DNS servers, Resource Records, DNS messages A simple introduction to p2p file distribution: BitTorrent	11
3	**Unit 3:** Transport Layer: Introduction and Services, The Transport layer in internet, Difference between Connection Oriented and Connectionless services, UDP: Segment structure, checksum in UDP, stop-and-wait, Go Back N, Selective Repeat, TCP: Connection Establishment, TCP header, Sequence and acknowledgement numbers, Round Trip Time, Flow Control, Congestion, Control.	6

	Transport Layer: Introduction and Services, The Transport layer in internet, Difference between Connection Oriented and Connectionless services UDP: Segment structure, checksum in UDP	
4	**Unit 4:** Network Layer: Introduction, Packet Forwarding and Routing, Difference between Virtual Circuits and Datagram networks, The internals of a router: Input ports, output ports, switching architecture The Internet Protocol(IP), Datagram format, IP fragmentation, IPv4, addressing, subnets, CIDR, classful addressing, DHCP, Network Address Translation(NAT), Universal Plug and Play as a provider of NAT, Internet Control Message Protocol(ICMP), IPv6 Header, Moving from IPv4 to IPv6: tunnelling. Routing Algorithms: Introduction, global vs decentralized routing, The Link State(LS) Routing Algorithm, The Distance Vector (DV) Routing Algorithm, Hierarchical Routing, Introduction to Routing in the Internet: RIP, OSPF, BGP; Introduction to Broadcast and Multicast Routing.	6
5	**Unit 5:** Link Layer and Local Area Networks: Introduction to Link Layer and its services, Where Link Layer is implemented? Error detection and correction techniques: Parity checks, Checksum, CRC; Multiple Access protocols: Channel Partitioning, Random Access (Slotted Aloha, Aloha, CSMA), Taking Turns; Link Layer Addressing: MAC addresses, ARP, Ethernet, CSMA/CD, Ethernet Technologies, Link Layer Switches, Switches vs Routers, VLANS	10
	Total	**45**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Computer Networking: “A Top Down Approach (5th edition)”, Ross and Kurose, Pearson/Addison-Wesley	7th	2017
	Reference Books		
1.	Andrew Tanenbaum and David Wetherhall, “Computer Networks”, Prentice Hall	5th	2010
2.	Peterson and Davie, “Computer Networks: A System Approach”, Elsevier	4th	2007
3.	Forouzan, “Data Communication and Networking”, McGraw Hill	5th	2013
4.	William Stallings: “Data and Computer Communication”, Pearson Education, 2007	8th	2007

5.	Nader F. Mir:" Computer and Communication Networks", Pearson Education.	1st	2007

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER Vth

Name of Department: - Computer Science and Engineering

1. Subject Code: **PCS 511** Course Title: **Computer Networks Lab**
2. Contact Hours: **L: 0** **T: 0** **P: 2**
3. Examination Duration (Hrs): **Theory 0** **Practical 3**
4. Relative Weight: **PRS 25** **MSE 25** **PRE 50**
5. Credits: **2**
6. Semester: **5th**
7. Category of Course: **DC**
8. Pre-requisite: Computer networks

9. **Course Outcome**:**	**After completion of the course the students will be able to:** **CO1:** Understand various components that make up a computer network, including routers, switches, hubs, servers, and clients and learn about the basic commands used troubleshooting. **CO2:** Design UTP cable for cross and direct connection using crimping tool. **CO3:** Implement the common network protocols such as TCP/IP, UDP, HTTP, DNS, DHC and FTP Understand how these protocols function and their role in facilitating communication between devices using network simulation tool like Packet tracer. **CO4:** Apply the static and dynamic routing concepts in the network core and monitoring network traffic using Wireshark and develop skills in troubleshooting network connectivity issues. **CO5:** Design network applications using UDP and TCP socket programing concepts and network design principles and test these applications using real or virtual network devices.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	List of problems for which student should develop program and execute in the Laboratory	Contact Hours
1.	**Problem Statement 1:** Familiarization of Network Environment, Understanding and using network utilities: ipconfig, netstat, ping, telnet, ftp, traceroute etc.	2
2.	**Problem Statement 2:** Familiarization with Transmission media and tools: Co-axial cable, UTP cable, Crimping tool, Connectors etc. Preparing the UTP cable for cross and direct connection using crimping tool.	2
3.	**Problem Statement 3:** Installation and introduction of simulation tool. **(Packet Tracer)**	2
4.	**Problem Statement 4:** To configure a basic network topology consisting of routers, switches, and end devices such as PCs or laptops. Configure IP addresses and establish connectivity between devices. **(Using packet Tracer)**	2
5.	**Problem Statement 5:** To configure a DHCP server on a router or a dedicated DHCP server device. Assign IP addresses dynamically to devices on the network and verify successful address assignment. **(Using packet Tracer)**	2
6.	**Problem Statement 6:** To configure a local DNS server to resolve domain names within a network. **(Using packet Tracer)**	2

7.	**Problem Statement 7:** To analyze complete TCP/IP protocol suite layer's headers using **Wire Shark**	2
8.	**Problem Statement 8:** Static Routing: Configure static routes on multiple routers to enable communication between different networks. Test the connectivity by pinging between hosts in different networks. **(Using packet Tracer)**	2
9.	**Problem Statement 9:** Dynamic Routing (RIP): Configure routers to use the Routing Information Protocol (RIP) for dynamic routing. Enable RIP on the interfaces connected to different networks and verify that routes are being learned and propagated. Test the connectivity between hosts in different networks. **(Using packet Tracer)**	2
10.	**Problem Statement 10:** Dynamic Routing (OSPF): Configure routers to use the Open Shortest Path First (OSPF) routing protocol. Set up OSPF on the routers and advertise network information. Verify that OSPF is establishing neighbor relationships and propagating routes. Test connectivity between hosts in different networks. **(Using packet Tracer)**	2
11.	**Problem Statement 11:** TCP Client-Server Communication: Implement a TCP client program that sends a message to a TCP server program. Implement the corresponding TCP server program that receives the message and displays it. Test the communication between the client and server by exchanging messages **(Using 'C' Language)**	2
12.	**Problem Statement 12:** UDP Client-Server Communication: Implement a UDP client program that sends a message to a UDP server program. Implement the corresponding UDP server program that receives the message and displays it **(Using 'C' Language)**	2
1.	**Optional programs for advanced learner** **Problem Statement 1:**	2

	File Transfer using TCP: Implement a TCP server program that listens for incoming connections. Implement a TCP client program that sends a file to the server. The server should receive the file and save it on the local machine. Verify the successful transfer by comparing the original file with the received file	
2.	**Problem Statement 2:** Chat Application using TCP: Implement a TCP client program for a chat application. Implement the corresponding TCP server program. Multiple clients should be able to connect to the server and exchange messages. Test the chat application by simulating multiple clients communicating with each other.	2
3.	**Problem Statement 3:** DNS Lookup using UDP: Implement a UDP client program that sends a domain name to a DNS server. Implement the corresponding DNS server program that resolves the domain name to an IP address. The server should send the resolved IP address back to the client. Test the program by performing DNS lookups for different domain names	2
4.	**Problem Statement 4:** HTTP Server using TCP: Implement a TCP server program that acts as an HTTP server. The server should be able to handle HTTP requests and send back appropriate HTTP responses. Test the server by accessing it through a web browser and requesting different resources.	2
5.	**Problem Statement 5:** Virtual LANs (VLANs): Create multiple VLANs and configure inter-VLAN routing using a router or Layer 3 switch. Assign hosts to different VLANs and test communication between hosts in different VLANs.	2
6.	**Problem Statement 6:**	2

	Access Control Lists (ACLs): Implement access control lists on routers to control traffic flow based on source/destination IP addresses, port numbers, or protocols. Test the ACLs by allowing or denying specific types of traffic between hosts.	
7.	**Problem Statement 7:** Network Address Translation (NAT): Configure Network Address Translation on a router to translate private IP addresses to public IP addresses and vice versa. Test connectivity between hosts with private IP addresses and hosts on the public internet.	2
	Total	38

11**. Suggested Books:**

S. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Text Books		
1.	Behrouz A. Forouzan, "Data Communications and Networking with TCPIP Protocol Suite, 6/e", McGraw Hill	**6th**	**2022**
	Reference Books		
1.	Ross and Kurose, Computer Networking: "A Top-Down Approach (5th edition)", Pearson/Addison-Wesley	**5th**	**2017**

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 597** Course Title: **Computer System**

2. Contact Hours: **L:** **3** **T**: **0** **P**: **0**

3. Examination Duration (Hrs): **Theory** **3** **Practical** **0**

4. Relative Weight: **CIE** **25** **MSE** **25** **50**

5. Credits: **3**

6. Semester: **5th**

7. Category of Course: **DE**

8. Pre-requisite: TCS-492 Fundamental of Cyber Security

9. **Course Outcome**:**	After completion of the course, the students will be able to: CO1: Explain different security threats and attacks. CO2: Know the working of different attacks and security protocols. CO3: Analyze the different security protocols. CO4: Use programming to implement security protocols. CO5: Use programming to implement security protocols. CO6: Develop system security protocols

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

Sl. No.	**Contents**	**Contact Hours**
1	**Introduction to System security:** Control hijacking attacks buffer overflow, integer overflow, bypassing browser memory protection, Sandboxing and Isolation, Tools and techniques for writing robust application software, Security vulnerability detection tools, and techniques program analysis (static, concolic and dynamic analysis), Privileges, access control, and Operating System Security, Exploitation techniques, and Fuzzing	10
2	**Software security:** Vulnerabilities, Attacks, and Countermeasures: Privileged programs (Set-UID programs) and vulnerabilities & Privilege Separation, Buffer Overflow vulnerability and defences, Return-to-libc attack, Race, Condition vulnerability and attack, Dirty COW attack, Format String vulnerability and attack, Shellshock attack, Heartbleed attack Interactivity, Annotation, and Arrangement;	10
3	**Web Security:** Same origin Policy, Cross site scripting attack, Cross site request forgery attack, Sql Injection attack, Clickjacking attack, Content Security Policies (CSP) in web, Web Tracking, Session Management and User Authentication, Session Integrity, Https, SSL/TLS, Threat Modelling	10
4	**Smartphone Security**: Android vs. ioS security model, threat models, information tracking, rootkits, Access control in Android operating system, Rooting android devices, Repackaging attacks, Attacks on apps, Whole- disk encryption, hardware protection, Viruses, spywares, and keyloggers and malware detection	9
5	**Hardware and system security**: Meltdown Attack, spectre attack, Authentication and password, Access control concept, Access control list, Capability, Sandboxing, Threats of Hardware Trojans and Supply Chain Security, Side Channel Analysis based Threats, and attacks. Issues in Critical Infrastructure and SCADA Security.	6
	Total	**45**

11. **Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Security in Computing, Book by Charles P Pfleeger and Shari Lawrence Pfleeger, V edition	5th	**2011**
2.	Cryptography and Network Security: Principles and Practice, Book by William Stallings, VII edition	7th	**1998**
	Reference Books		

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Name of Department: - Computer Science and Engineering

1. Subject Code: **PCS-597** Course Title: **Computer System Security Lab**
2. Contact Hours: **L:** **0** **T:** **1** **P:** **2**
3. Examination Duration (Hrs): **Theory** **0** **Practical** **3**
4. Relative Weight: **PRS** **25** **MSE** **25** **SEE** **50**
5. Credits: **2**
6. Semester: **5th**
7. Category of Course: **DC**
8. Pre-requisite:

9. **Course Outcome**:**	**After completion of the course the students will be able to:** 1. Explain different security threats and attacks 2. Know the working of different attacks and security protocols

	3. Analyse the different security protocols 4. Use programming to implement security protocols 5. Apply security mechanisms to secure various applications 6. Develop system security protocols

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.Details of the Course:

Ex. No.	NAME OF THE PROGRAM	Hours
1.	Practical demonstration of buffer overflow vulnerability and attack. Also write down the solutions available to mitigate the buffer overflow attack.	2
2.	Practical demonstration of race condition and vulnerability and attack. What are possible solutions for race condition vulnerability.	2
3.	Practical demonstration of dirty cow vulnerability and attack.	2
4.	Installation and demonstration of burp suite tool.	2
5.	Installation and demonstration of metasploit tool.	2
6.	Practical demonstration of XSS using burp suite tool.	2
7.	Practical demonstration of CSRF vulnerability and attack. What are the possible solutions for CSRF?	2
8.	Practical demonstration of SQL injection vulnerability and attack. What are the possible solutions for SQLi?	2
9.	Installation and demonstration of wireshark tool.	2
10.	Practical demonstration of HTTPs using the wireshark tool.	2
11.	Practical demonstration of ICMP using the wireshark tool.	2
12.	Case study of hardware security and attacks like Stuxnet and hardware trojan.	2
13.	Case study of side channel attack.	2
	Total	26

11.Suggested Books:

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Security in Computing, Book by Charles P Pfleeger and Shari Lawrence Pfleeger, V edition	5th	**2011**
2.	Cryptography and Network Security: Principles and Practice, Book by William Stallings, VII edition	7th	**1998**
	Reference Books		

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 556** Course Title: **Blockchain for IoT systems**
2. Contact Hours: **L:** **3** **T**: **0** **P**: **0**
3. Examination Duration (Hrs): **Theory** **3** **Practical** **0**
4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
5. Credits: **3**
6. Semester: **5**
7. Category of Course: **DC**
8. Pre-requisite: **Fundamental of IoT (TCS 331), Fundamental of Cyber Security (TCS 391)**

9. **Course Outcome**:**	After completion of the course the students will be able to: CO1: Explain blockchain and its uses. CO2: Know the mechanisms of IoT-based systems CO3: Identify the needs of data preprocessing. CO3: Know the mechanisms of IoT-based systems. CO4. Use blockchain in the designing of IoT-based systems. CO5: Apply blockchain to different IoT-based application frameworks. CO6: Implement IoT-based secure application frameworks.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**UNIT-1** **Introduction of IoT** Overview of IoT, Motivations, Applications of IoT, Internet of Things IoT Architecture, IoT Frameworks, Vulnerabilities of IoT, Security requirements, Threat analysis, IoT security tomography and layered attacker model, Security model for IoT.	8
2	**UNIT-2** **Security and blockchain** Threats and threat models, data confidentiality, data integrity, authentication and access control, non-repudiation and availability, overview of blockchain, what is block, data structure of the blockchain, structure of a block, block header, block identifiers: block header hash, genesis block, linking of blocks, merkle trees, and use of merkle root.	8
3	**UNIT-3** **Cryptography in blockchain** Concept of divisibility, prime numbers, importance of prime numbers in cryptography, euclid theorem for GCD, extended euclidean algorithm, modular arithmetic, random number generators, deterministic and nondeterministic random number generators, XOR, bit shifts, euler's totient theorem, chinese remainder theorem, RSA, Diffie Hellman key exchange protocol, Elliptic curve cryptography (ECC), ElGamal encryption system. DSS algorithm, RSADS algorithm, ECDSA algorithm, Message integrity, hash functions, MAC functions, HMAC	12

4	**UNIT-4** **Blockchain technology** Use of ECDSA in blockchain implementation, use of merkle root in payment verification, use of hash functions to chain blocks, use of digital signatures to sign transactions, differences between ethereum and bitcoin, block format, mining algorithm, Proof of Work (PoW), Proof of Stake (PoS), Delegated Proof of Stake (DPoS), Proof of Burn (PoB), Byzantine Fault Tolerance (BFT), account management, contracts and transactions, decentralized applications using ethereum proof-of-stake (PoS) algorithm, smart construct, structure of a smart contact, use of a smart contract, remix platform, blockchain implementation through smart contact.	10
5	**UNIT-5** **Blockchain enabled IoT security.** Applications and uses of blockchain enabled IoT security, Challenges, and issues of blockchain enabled IoT security, blockchain in banking, use of blockchain in e-commerce, marketing, and logistic operations, blockchain in IoT ecosystem, blockchain in IoT-based smart healthcare applications, use of blockchain in IoT-enabled smart farming, blockchain in transportation system and future research aspects.	10
	Total	**48**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	William Stallings, “Cryptography and Network Security: Principles and Practice”, Pearson publication, 2020.	**1st**	**2020**
2.	William Stallings, “Cryptography and Network Security: Principles and Practice”, Pearson publication, 2020.	**2nd**	**2020**
3.	Harshita Patel, Ghanshyam Singh Thakur, “Blockchain Applications in IoT Security”, 1st Edition, IGI Global, 2020.	**1st**	**2020**
	Reference Books		
1.	Sudhir K. Sharma, Bharat Bhushan, Parma N. Astya, Narayan C. Debnath, "Blockchain Applications for	**1st**	**2021**

	Secure IoT Frameworks: Technologies Shaping the Future," Bentham books, 2021.		
2.	William Stallings, "Network Security Essentials: Applications and Standards", 6th Edition, Prentice Hall, 2016	**6th**	**2016**

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS-592** Course Title: **Block chain Technology and its application**
2. Contact Hours: **L:** **3** **T**: **0** **P**: **0**
3. Examination Duration (Hrs): **Theory** **3** **Practical** **0**
4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
5. Credits: **3**
6. Semester: **5th**
7. Category of Course: **DE**

8. Pre-requisite: **TCS 302 Data Structure with C, TCS 332 Fundamental of Information security and Block Chain**

9. **Course Outcome**:**	After completion of the course the students will be able to: **CO1:** Explain blockchain technology and its immutable property. **CO2:** Know the working of distributed ledger. **CO3:** Analyze the different consensus protocols. **CO4:** Use Ethereum to implement Blockchain. **CO5:** Apply blockchain techniques in different applications. **CO6:** Develop blockchain based frameworks to secure a communication environment

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

Sl. No.	Contents	Contact Hours
1	Introduction to blockchain- Overview of blockchain, structure of a block, block header, block identifiers: block header hash and block height, genesis block, linking of blocks, merkle trees, and use of merkle root in payment verification	10
2	Application of cryptography to blockchain- Overview of ECDSA, DSA and RSADS, use of hash functions to chain blocks, use of digital signatures to sign transactions	9
3	Distributed ledger- Introduction to distributed systems, fault tolerance and paxos, byzantine agreement, authenticated agreement, eventual consistency & bitcoin consistency- availability and partitions, bitcoin, smart contracts, weak consistency, distributed storage, consistent hashing mechanism	8
4	**Blockchain mining and consensus-**Overview of various consensus algorithms, decentralized consensus, independent verification of transactions, mining nodes, aggregating transactions into blocks, constructing the block header, successfully mining of block, validating a new block, assembling and selecting chains of blocks, consensus attacks**,** DoS attack on blockchain, changing the consensus rules, soft fork signaling with block version	10
5	Ethereum- Differences between ethereum and bitcoin, block format, mining algorithm, proof-of-stake (PoS) algorithm, account management, contracts and transactions, decentralized applications using ethereum proof-of-stake (PoS) algorithm, contracts, and transactions. Applications of blockchain technology- Blockchain in banking and marketing, smart contracts, blockchain of Internet of Things, blockchain in healthcare, Future Research directions of blockchain technology	8
	Total	**45**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	George Icahn, “Blockchain: the complete guide to understanding blockchain technology”, 2020.	4^{th}	**2020**

2.	Antony lewis, "The basics of bitcoins and blockchains: an introduction to cryptocurrencies and the technology that powers them" 2020.	5th	**2018**
	Reference Books		
1.	Andreas M. Antonopoulos, "Mastering Bitcoin: unlocking digital cryptocurrencies", O'Reilly Media,(2e) 2017.	2nd	**2017**
2.	Roger Wattenhofer, "Distributed Ledger Technology, The science of the Blockchain", Inverted Forest Publishing, (2e), 2017	2nd	**2017**
12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam	

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 601** Course Title: **Compiler Design**
2. Contact Hours: **L:** **3** **T**: **0** **P**: **0**
3. Examination Duration (Hrs): **Theory** **3** **Practical** **0**
4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
5. Credits: **3**
6. Semester: **VI**
7. Category of Course: **DC**
8. Pre-requisite: **TCS 402, TCS 302**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Understand the various phases and fundamental principles of compiler design like lexical, syntactical, semantic analysis, code generation and optimization. CO2: Compare and contrast various parsing techniques such as SLR, CLR, LALR etc. CO3: Use annotated tree to design the semantic rules for different aspects of programming language. CO4: Implement lexical analyzer and parser by using modern tools like Flex and Bison. CO5: Examine patterns, tokens & regular expressions for solving a problem in the field of data mining. CO6: Design a compiler for concise programming language.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

SL. NO.	Contents	Contact Hours
1	**Unit 1:** **Introduction, Lexical analysis:** Compilers; Analysis of Source Program; The Phases of a Compiler; Cousins of the Compiler; The grouping of phases; Compiler- Construction toolsz Lexical analysis: The Role of Lexical Analyzer; Input Buffering; Specifications of Tokens; Recognition of Tokens.	**9**
2	**Unit 2:** **Syntax Analysis – 1:** The Role of the Parser; Context-free Grammars; Writing a Grammar; Top-down Parsing; Bottom-up Parsing. Operator-Precedence Parsing; LR Parsers; Using ambiguous grammars; Parser Generators	**9**
3	**Unit 3:** **Syntax-Directed Translation:** Syntax-Directed definitions; Constructions of Syntax Trees; Bottom-up evaluation of S-attributed definitions; L-attributed definitions; Top-down translation. **Run-Time Environments :** Source Language Issues; Storage Organization; Storage-allocation strategies, Storage-allocation in C; Parameter passing	**8**
4	**Unit 4:** **Intermediate Code Generation:** Intermediate Languages; Declarations; Assignment statements; Boolean Expressions; Case statements; Back patching; Procedure calls. **Code Generation:** Issues in the design of Code Generator; The Target Machine; Run-time Storage Management; Basic blocks and Flow graphs; Next-use information; A Simple Code Generator; Register allocation and assignment; The dag representation of basic blocks; Generating code from dags.	**9**
5	**Unit 5:**	**9**

	Code Optimization, Compiler Development: Code Optimization: Introduction; The principal sources of optimization; Peephole optimization; Optimization of basic blocks; Loops in flow graphs. Compiler Development: Planning a compiler; Approaches to compiler development; the compiler development environment; Testing and maintenance.	
	Total	**44**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Alfred V Aho, Ravi Sethi, Jeffrey D Ullman: "Compilers-Principles, Techniques and Tools", Pearson Education,	2nd	2013
	Reference Books		
1.	Charles N. Fischer, Richard J. leBlanc, Jr.:" Crafting a Compiler with C", Pearson Education,.	1st	1991
2	Andrew W Apple: "Modern Compiler Implementation in C", Cambridge University Press,.	1st	1997
3	Kenneth C Louden: "Compiler Construction Principles & Practice", Thomson Education,.	1st	1997

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 611** Course Title: **Software Engineering**
2. Contact Hours: **L:** **3** **T**: **0** **P**: **0**
3. Examination Duration (Hrs): **Theory** **3** **Practical** **0**
4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
5. Credits: **3**
6. Semester: **6**
7. Category of Course: **DC**
8. Pre-requisite: **Basics of Programming**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Understand Software Development Life Cycle and importance of engineering the software. CO2: Development of efficient software requirement specification for desired product. CO3: Compare various software development methodologies ad conclude on their applicability in developing specific type of product. CO4: Construct an efficient design specification document for attainment of user desired product. CO5: Develop applications using the concepts of various phases of software development life cycle. CO6: Study various software testing techniques and identify their relevance to developing a quality software.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

SL. NO.	Contents	Contact Hours
1	**Unit 1:** Introduction:What is Software Engineering and its history, Software Crisis, Evolution of a Programming System Product, Characteristics of Software, Brooks' No Silver Bullet, Software Myths Software Development Life Cycles: Software Development Process, The Code-and-Fix model, The Waterfall model, The Evolutionary Model, The Incremental Implementation, Prototyping, The Spiral Model, Software Reuse, Critical Comparisons of SDLC models, An Introduction to Non-Traditional Software Development Process: Rational Unified Process, Rapid Application Development, Agile Development Process	**10**
2	**Unit 2:** **Requirements:** Importance of Requirement Analysis, User Needs, Software Features and Software Requirements, Classes of User Requirements: Enduring and Volatile; Sub phases of Requirement Analysis, Functional and Non-functional requirements; Barriers to Eliciting User Requirements, The software requirements document and SRS standards, Requirements Engineering, Case Study of SRS for a Real Time System Tools for Requirements Gathering: Document Flow Chart, Decision Table, Decision Tree; Structured Analysis: DFD, Data Dictionary, Introduction to non-traditional Requirements Analysis Tools: FSM, Statecharts and Petrinets;	**9**
3	**Unit 3:** **Software Design:** Goals of Good Software Design, Design Strategies and Methodologies, Data Oriented Software Design, Structured Design: Structure	**8**

	Chart, Coupling, Cohesion,, Modular Structure, Packaging; Object Oriented Design, Top-Down and Bottom-Up Approach, Design Patterns Software Measurement and Metrics: Various Size Oriented Measures: Halestead's Software Science, Function Point (FP) Based Measures, Cyclomatic Complexity Measures: Control Flow Graphs. **Development:** Selecting a Language, Coding Guidelines, Writing Code, Code Documentation	
4	**Unit 4:** **Testing:** Testing Objectives, Unit Testing, Integration Testing, Acceptance Testing, Regression Testing, Testing for Functionality and Testing for Performance, Top-Down and Bottom-Up Testing Strategies: Test Drivers and Test Stubs, Structural Testing (White Box Testing), Functional Testing (Black Box Testing), Test Data Suit Preparation, Alpha and Beta Testing of Products. Static Testing Strategies: Formal Technical Reviews (Peer Reviews), Walk Through, Code Inspection, Compliance with Design and Coding Standards, Automated Testing	**10**
5	**Unit 5:** **Software Maintenance and Software Project Management**: Software as an Evolutionary Entity, Need for Maintenance, Categories of Maintenance:Preventive, Corrective and Perfective Maintenance, Cost of Maintenance, Software Re-Engineering, Reverse Engineering. Software Configuration Management Activities, Change Control Process, Software Version Control, An Overview of CASE Tools. Estimation of Various Parameters such as Cost, Efforts, Schedule/Duration, Constructive Cost Models (COCOMO), Resource Allocation Models, Software Risk Analysis and Management. Software Quality Assurance: SQA Plans, ISO 9000 models, SEI-CMM Model	**8**
	Total	**45**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	R. S. Pressman," Software Engineering: A Practitioners Approach", McGraw Hill.	7th	**2010**
2	P.K.J. Mohapatra," Software Engineering (A Lifecycle Approach)", New Age International Publishers		**2010**
	Reference Books		
1.	Ian Sommerville," Software Engineering", Addison Wesley.	9th	2011
2	Pankaj Jalote:" An Integrated Approach to Software Engineering", Narosa Publishing House.		**2005**
3	Carlo Ghezzi, M. Jarayeri, D. Manodrioli," Fundamentals of Software Engineering", PHI Publication.	2nd	**2003**
4	Rajib Mall," Fundamentals of Software Engineering", PHI Publication.	5th	**2018**

5	Pfleeger, "Software Engineering", Macmillan Publication.	3rd	**2006**
6	Ian Sommerville," Software Engineering", Addison Wesley.	9th	**2011**

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS-604** Course Title: **Computer Networks I**
2. Contact Hours: **L: 3** **T**: **0** **P**: **0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **VI**
7. Category of Course: **DC**
8. Pre-requisite: **TCS 101, TCS 102**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Apply and Characterize computer networks from the view point of components and from the view point of services. CO2: Display good understanding of the flow of a protocol in general and a network protocol in particular CO3: Evaluate and Select the most suitable Application Layer protocol (such as HTTP, FTP, SMTP, DNS, BitTorrent) as per the requirements of the network application and work with available tools to demonstrate the working of these protocols. CO4: Design a Reliable Data Transfer Protocol and incrementally develop solutions for the requirements of Transport Layer CO5: Describe the essential principles of Network Layers and use IP addressing to create subnets for any specific requirements CO6: Evaluate and select the appropriate technology to meet Data Link Layer requirements and design a framework to implementing TCP/IP protocol suite.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

Sl. No.	**Contents**	**Contact Hours**
1	**Unit 1:** Introduction: Computer Networks and the Internet, Overall view: As components and as services; What is a protocol, what is a network protocol, Access Networks and Physical Media, Circuit and Packet Switching, Internet Backbone, Delays: Processing, Queuing, Transmission and Propagation delays, The Layered Architecture: Protocol Layering, The OSI Reference Model and the TCP/IP protocol stack, History of Computer Networking, and the Internet.	11
2	**Unit 2:** Application Layer: Principles and Architectures of Network Applications, Client and Server processes, the idea of socket, Transport services available to Application Layer especially in the internet Application Layer Protocols: The Web and http: Persistent and Nonpersistent connections, http message format, cookies, proxy server, conditional GET, File Transfer Protocol, Email: smtp, mail message formats, mail access protocols: pop3, imap, MIME, DNS: Services, How it works, Root, Top-Level and Authoritative DNS servers, Resource Records, DNS messages A simple introduction to p2p file distribution: BitTorrent	11
3	**Unit 3:** Transport Layer: Introduction and Services, The Transport layer in internet, Difference between Connection Oriented and Connectionless services, UDP: Segment structure, checksum in UDP, stop-and-wait, Go Back N, Selective Repeat, TCP: Connection Establishment, TCP header, Sequence and	6

	acknowledgement numbers, Round Trip Time, Flow Control, Congestion, Control. Transport Layer: Introduction and Services, The Transport layer in internet, Difference between Connection Oriented and Connectionless services UDP: Segment structure, checksum in UDP	
4	**Unit 4:** Network Layer: Introduction, Packet Forwarding and Routing, Difference between Virtual Circuits and Datagram networks, The internals of a router: Input ports, output ports, switching architecture The Internet Protocol(IP), Datagram format, IP fragmentation, IPv4, addressing, subnets, CIDR, classful addressing, DHCP, Network Address Translation(NAT), Universal Plug and Play as a provider of NAT, Internet Control Message Protocol(ICMP), IPv6 Header, Moving from IPv4 to IPv6: tunnelling. Routing Algorithms: Introduction, global vs decentralized routing, The Link State(LS) Routing Algorithm, The Distance Vector (DV) Routing Algorithm, Hierarchical Routing, Introduction to Routing in the Internet: RIP, OSPF, BGP; Introduction to Broadcast and Multicast Routing.	6
5	**Unit 5:** Link Layer and Local Area Networks: Introduction to Link Layer and its services, Where Link Layer is implemented? Error detection and correction techniques: Parity checks, Checksum, CRC; Multiple Access protocols: Channel Partitioning, Random Access (Slotted Aloha, Aloha, CSMA), Taking Turns; Link Layer Addressing: MAC addresses, ARP, Ethernet, CSMA/CD, Ethernet Technologies, Link Layer Switches, Switches vs Routers, VLANS	10
	Total	**45**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Computer Networking: “A Top Down Approach (5th edition)”, Ross and Kurose, Pearson/Addison-Wesley	7th	**2017**
	Reference Books		
1.	Andrew Tanenbaum and David Wetherhall, “Computer Networks”, Prentice Hall	6th	2022
2.	Peterson and Davie, “Computer Networks: A System Approach”, Elsevier	5th	2011
3.	Forouzan, “Data Communication and Networking”, McGraw Hill	5th	2017
4.	William Stallings: “Data and Computer Communication”, Pearson Education, 2007	8th	2007

5.	Nader F. Mir:" Computer and Communication Networks", Pearson Education.	1st	2007

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS693** Course Title: **Full stack web development**
2. Contact Hours: **L:** **3** **T**: **0** **P**: **0**
3. Examination Duration (Hrs): **Theory** **3** **Practical** **0**
4. Relative Weight: **CIE** **25** **PRS** **25** **MSE** **50**
5. Credits: **3**
6. Semester: **VI**
7. Category of Course: **DC**
8. Pre-requisite: **TCS 408, TCS 503**

9. **Course Outcome**:**	After completion of the course the students will be able to**:**
	CO1: Apply HTML and CSS effectively to create interactive websites.
	CO2: Implement client-side scripting using JavaScript to design dynamic websites.
	CO3: Develop XML, AJAX and Jquery based web applications.
	CO4: Implement server-side scripting using PHP.
	CO5: Design PHP application with Database connectivity.
	CO6: Ability to design and deploy simple web applications using MVC architecture.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	**Contents**	**Contact Hours**
1	**Unit 1:** **HTML** Basics of HTML, formatting and fonts, commenting code, color, hyperlink, lists, tables, images, forms, XHTML, Meta tags, Character entities, frames and frame sets, Browser architecture and Web site structure. Overview and features of HTML5. **CSS** Need for CSS, introduction to CSS, basic syntax and structure, using CSS, type of CSS, background images, colors and properties, manipulating texts, using fonts, borders and boxes, margins, padding lists, positioning using CSS, Introduction to Bootstrap.	8
2	**Unit 2:** JavaScript: Client-side scripting with JavaScript, variables, functions, conditions, loops and repetition, Pop up boxes. Advance JavaScript: JavaScript and objects, JavaScript own objects, the DOM and web browser environments, Manipulation using DOM, forms and validations, JSON.	8
3	**Unit 3:** **XML**: Introduction to XML, uses of XML, simple XML, XML key components, DTD and Schemas. **Ajax** : Introduction to Ajax , XMLHttpRequest Methods and Properties, JavaScript code for Ajax , Implementing Ajax techniques with a server scripting language , Handling the Response, Ajax with JSon **JQuery**: jQuery Introduction, Install and Use jQuery Library, jQuery Syntax, Ajax with jQuery, Load method, jQuery get and getJson methods.	10
4	**Unit 4:** **PHP** XAMPP Server Configuration, Introduction and basic syntax of PHP, decision and looping with examples, PHP and HTML, Arrays, Functions, Browser control and detection, string, Form processing, Files. Advance Features: Cookies and Sessions, Basic commands with PHP examples, Connection to server, creating database, selecting a database, listing database, listing	10

	table names, creating a table, inserting data, altering tables, queries, deleting database, deleting data and tables.	
5	**Unit 5:** MERN Web Application Deployment, Content Management System (CMS). MERN Stack: MongoDB: Overview , Environment, Data Modelling, Database Operations. Express: Installing ExpressJS, Environment, Routing React: React Intro, , React Lifecycle, Building Forms using React, states and components. Node: Install node, simple server, HTML and JSON Response.	12
	Total	**48**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	Learning PHP, MySQL, JavaScript, CSS & HTML5: A Step-byStep Guide to CreatingDynamic Websites by Robin Nixon	3rd	2014
2.	Full Stack JavaScript: Learn Backbone.js, Node.js and MongoDB. Copyright © 2015 BYAZAT MARDAN	2nd	2018
3.			
	Reference Books		
1.	**Fritz Schneider, Thomas Powell, JavaScript – The Complete Reference, 2017, 3rd Edition, McGraw Hill.**	3rd	2017
2.	**Steven Holzener, PHP – The Complete Reference,2017, 1st Edition, Mc-Graw Hill**	1st	2017
3.	**Learning PHP, MySQL & JavaScript: With jQuery, CSS & HTML5 by Robin Nixon**	1st	2015
4	Paul Deitel, Harvey Deitel, Abbey Deitel, Internet & World Wide Web - How to Program, 2020 6th edition, Pearson Education.	6th	2020

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Name of Department: - Computer Science and Engineering

1. Subject Code: **PCS-601** Course Title: **Compiler Design Lab**
2. Contact Hours: **L: 0** **T**: **1** **P**: **2**
3. Examination Duration (Hrs): **Theory** **0** **Practical** **3**
4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
5. Credits: **2**
6. Semester: **6**
7. Category of Course: **DC**
8. Pre-requisite: **TCS 402, PCS 251**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** **CO1:** Construct lexical analyzer and parser layout by using modern tools like Flex and Bison. **CO2:** Explore the different finite automata problems with the help of tools. **CO3:** Compare and contrast various parsing techniques such as SLR, CLR, LALR with the help of bison tool. **CO4**: Analyze the syntax rules by designing the syntax trees from different aspects of programming languages.

*** Describe the specific knowledge, skills, or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	**List of problems for which student should develop program and execute in the Laboratory**	**Contact Hours**
1.	Design a LEX Code to count the number of lines, space, tab-meta character, and rest of characters in each Input pattern.	
2.	Design a LEX Code to identify and print valid Identifier of C/C++ in given Input pattern.	
3.	Design a LEX Code to identify and print integer and float value in given Input pattern.	
4.	Design a LEX Code for Tokenizing (Identify and print OPERATORS, SEPERATORS, KEYWORDS, IDENTIFERS) in the C-fragment:	
5.	Design a LEX Code to count and print the number of total characters, words, white spaces in given ‘Input.txt’ file.	
6.	Design a LEX Code to replace white spaces of ‘Input.txt’ file by a single blank character into ‘Output.txt’ file.	
7.	Design a LEX Code to remove the comments from any C-Program given at run-time and store into ‘out.c’ file.	
8.	Design a LEX Code to extract all html tags in the given HTML file at run time and store into Text file given at run time.	
9.	Design a DFA in LEX Code which accepts string containing even number of ‘a’ and even number of ‘b’ over input alphabet {a, b}.	
10.	Design a DFA in LEX Code which accepts string containing third last element ‘a’ over input alphabet {a, b}.	
11.	Design a DFA in LEX Code to Identify and print Integer & Float Constants and Identifier.	
12.	Design YACC/LEX code to recognize valid arithmetic expression with operators +, -, * and /.	
13.	Design YACC/LEX code to evaluate arithmetic expression involving operators +, -, * and / without operator precedence grammar & with operator precedence grammar.	

		Total	

11. **Suggested Books:**

S N	Name of Authors/Books/Publishers	Edition	Year of Publication Reprint
	Textbooks		
1.	Charles N. Fischer, Richard J. leBlanc, Jr.:" Crafting a Compiler with C", Pearson Education, 1991.	2nd	**2012**
2.	Andrew W Apple: "Modern Compiler Implementation in C", Cambridge University Press, 1997.	2nd	**2012**
3.	Kenneth C Louden: "Compiler Construction Principles & Practice", Thomson Education, 1997.	6th	**2011**
	Reference Books		
1.	Alfred V Aho, Ravi Sethi, Jeffrey D Ullman: "Compilers-Principles, Techniques and Tools", Pearson Education, 2007	5th	**2014**

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Name of Department: - Computer Science and Engineering

1. Subject Code: **PCS 604** Course Title: **Computer Networks Lab**
2. Contact Hours: **L:** **0** **T**: **0** **P**: **2**
3. Examination Duration (Hrs): **Theory** **0** **Practical** **3**
4. Relative Weight: **CIE** **0** **PRS** **25** **MSE** **25** **SEE** **0** **PRE** **50**
5. Credits:
6. Semester: **6th**
7. Category of Course: **DC**
8. Pre-requisite: Computer Networks

9. **Course Outcome**:**	**After completion of the course the students will be able to:** **CO1:** Understand various components that make up a computer network, including routers, switches, hubs, servers, and clients and learn about the basic commands used troubleshooting. **CO2:** Design UTP cable for cross and direct connection using crimping tool. **CO3:** Implement the common network protocols such as TCP/IP, UDP, HTTP, DNS, DHC, FTP and NAT Understand how these protocols function and their role in facilitating communication between devices using network simulation tool like Packet tracer. **CO4:** Apply the static and dynamic routing concepts in the network core and monitoring network traffic using Wireshark and develop skills in troubleshooting network connectivity issues. **CO5:** Design network applications using UDP and TCP socket programing concepts and network design principles and test these applications using real or virtual network devices.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	List of problems for which student should develop program and execute in the Laboratory	Contact Hours
1.	**Problem Statement 1:** Familiarization of Network Environment, Understanding and using network utilities: ipconfig, netstat, ping, telnet, ftp, traceroute etc.	2
2.	**Problem Statement 2:** Familiarization with Transmission media and tools: Co-axial cable, UTP cable, Crimping tool, Connectors etc. Preparing the UTP cable for cross and direct connection using crimping tool.	2
3.	**Problem Statement 3:** Installation and introduction of simulation tool. **(Packet Tracer)**	2
4.	**Problem Statement 4:** To configure a basic network topology consisting of routers, switches, and end devices such as PCs or laptops. Configure IP addresses and establish connectivity between devices. **(Using packet Tracer)**	2
5.	**Problem Statement 5:** To configure a DHCP server on a router or a dedicated DHCP server device. Assign IP addresses dynamically to devices on the network and verify successful address assignment. **(Using packet Tracer)**	2
6.	**Problem Statement 6:** To configure a local DNS server to resolve domain names within a network. **(Using packet Tracer)**	2

7.	**Problem Statement 7:** NAT (Network Address Translation): Set up NAT on a router to translate private IP addresses to public IP addresses for outbound internet connectivity. Test the translation and examine how NAT helps conserve IPv4 address space. **(Using packet Tracer)**	2
8.	**Problem Statement 8:** Network Troubleshooting: Simulate network issues such as connectivity problems, incorrect configurations, or routing failures. Use **Packet Tracer's** simulation mode to diagnose and troubleshoot the network.	2
9.	**Problem Statement 9:** To monitor network traffic using **Wire Shark**	2
10.	**Problem Statement 10:** To analyze complete TCP/IP protocol suite layer's headers using **Wire Shark**	2
11.	**Problem Statement 11:** TCP Client-Server Communication: Implement a TCP client program that sends a message to a TCP server program. Implement the corresponding TCP server program that receives the message and displays it. Test the communication between the client and server by exchanging messages **(Using 'C' Language)**	2
12.	**Problem Statement 12:** UDP Client-Server Communication: Implement a UDP client program that sends a message to a UDP server program. Implement the corresponding UDP server program that receives the message and displays it **(Using 'C' Language)**	2
1.	**Optional programs for advanced learner** **Problem Statement 1:** File Transfer using TCP: Implement a TCP server program that listens for incoming connections.	

	Implement a TCP client program that sends a file to the server. The server should receive the file and save it on the local machine. Verify the successful transfer by comparing the original file with the received file	
2.	**Problem Statement 2:** Chat Application using TCP: Implement a TCP client program for a chat application. Implement the corresponding TCP server program. Multiple clients should be able to connect to the server and exchange messages. Test the chat application by simulating multiple clients communicating with each other.	
3.	**Problem Statement 3:** DNS Lookup using UDP: Implement a UDP client program that sends a domain name to a DNS server. Implement the corresponding DNS server program that resolves the domain name to an IP address. The server should send the resolved IP address back to the client. Test the program by performing DNS lookups for different domain names	
4.	**Problem Statement 4:** HTTP Server using TCP: Implement a TCP server program that acts as an HTTP server. The server should be able to handle HTTP requests and send back appropriate HTTP responses. Test the server by accessing it through a web browser and requesting different resources.	

11**. Suggested Books:**

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

	Text Books	
1.	Behrouz A. Forouzan, “Data Communications and Networking with TCPIP Protocol Suite, 6/e”, McGraw Hill	**2022**
	Reference Books	
1.	Ross and Kurose, Computer Networking: “A Top-Down Approach (5th edition)”, Pearson/Addison-Wesley	**2017**

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Name of Department: - Computer Science and Engineering

1. Subject Code: **PCS693** Course Title: **Web Programming Lab**
2. Contact Hours: **L:** **0** **T**: **1** **P**: **2**
3. Examination Duration (Hrs): **Theory** **0** **Practical** **3**
4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
5. Credits: **2**
6. Semester: **VI**
7. Category of Course: **DC**
8. Pre-requisite: **Subject Name with Code**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Design basic websites using HTML and Cascading Style Sheets. CO2: Develop dynamic web pages with validation using Java Script objects and by applying different event handling mechanisms. CO3: Develop modern interactive web applications using PHP, XML and MySQL CO4: Understand client(JS) and server-side(PHP) scripting and their applicability

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	**List of problems for which student should develop program and execute in the Laboratory**	**Contact Hours**
1.	**Basic Html Tags:** To create a simple html file to demonstrate the use of different tags.	
2.	**Html Tags (List, Table) :** To create a simple html file to demonstrate the use of different tags.	
3.	**Html Tags (Form)**	
4.	**Frames & iFrames :** To create an html page with different types of frames such as floating frame, navigation frame & mixed frame.	
5.	**Map:** To create an html page with different types of image map such as circle, rect , poly & mixed map.	
6.	CSS: **Inline, Internal and External Style sheets** To create an html file by applying the different styles using inline, external & internal style sheets.	
7.	**Input Output In JavaScript:** To create an HTML page to explain input and output using a calculator with the use of various predefined functions and objects in Javascript.	
8.	**Window Object methods alert() , prompt() , confirm(), open(), close() , print():**To create an html page to explain the use of various predefined functions in window object in java script.	
9.	**Event Handling - Background Color Change:** To create an html page to change the background color for every click of a button using javascript.	
10.	**Event Handling - calendar for the month and year by combo box:** To create an html page with 2 combo box populated with month & year, to display the calendar for the selected month & year from combo box using javascript.	
11.	**Window object method setInterval, clearInterval:** To create an html page with three button START PAUSE and RESET for controlling stopwatch.	
12.	**PHP XAMPP Server:** Install and configure PHP, web server, MYSQL (XAMPP), Write a program to print “Welcome to PHP”, Create a php	

	program to find odd or even number from given number. Write a php program to find maximum of three numbers.	
13.	**PHP Basic** : Write a program to enter TWO numbers and print the Swap Numbers using PHP Example.	
14.	**Form Handling in PHP:** Write a PHP Program to demonstrate the variable function: gettype() and settype(),Write a PHP Program to demonstrate the variable unction: isset() ,Write a PHP Program to demonstrate the variable unction: unset()	
15.	**Session Handling Using PHP: Create login page using session variables**	
16.	**Cookies Management:** Write PHP program to implement a cookie and session based counter. Create Cookies variable using PHP, Display the cookies variable using PHP.	
17.	File Uploading Using PHP (To Understand File Uploading in PHP) : Create PHP To upload the user input file and using constraints file type, file size.	
18.	**PHP with MySQL:** Write a PHP program to connect to a database and retrieve data from a table and show the details in a neat format , a simple application to Enter data into database, Develope a simple application to Update, Delete table data from database.	
19.	**File Handling Using PHP:** Write a php program to Read from existing file., Write a php program to Write a file.	

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Learning PHP, MySQL, JavaScript, CSS & HTML5: A Step-byStep Guide to CreatingDynamic Websites by Robin Nixon	3rd	2014
2.	Full Stack JavaScript: Learn Backbone.js, Node.js and MongoDB. Copyright © 2015 BYAZAT MARDAN	2nd	2018
	Reference Books		
1.	Fritz Schneider, Thomas Powell, JavaScript – The Complete Reference, 2017, 3rd Edition, McGraw Hill.	3rd	2017
2.	Steven Holzener, PHP – The Complete Reference,2017, 1st Edition, Mc-Graw Hill	1st	2017
3.	Learning PHP, MySQL & JavaScript: With jQuery, CSS & HTML5 by Robin Nixon	1st	2015
4.	Paul Deitel, Harvey Deitel, Abbey Deitel, Internet & World Wide Web - How to Program, 2020 6th edition, Pearson Education.	6th	2020

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 691** Course Title: **Image Processing and Computer Vision**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **6th**
7. Category of Course: DE
8. Pre-requisite: TCS 301, Any Programming Language

9. **Course Outcome**:**	After completion of the course the students will be able to**:** **CO1:** Understand the principals the Image Processing terminology used to describe features of images. **CO2:** Understand the mathematical foundations for digital manipulation of images **CO3:** Design, code and test digital image processing applications using MATLAB. **CO4:** Analyze a wide range of problems and provide solutions related to the design of imageprocessing systems through suitable algorithms, structures, diagrams, and other appropriate methods. **CO5:** Plan and undertake a major individual image processing project. **CO6:** Write programs in Matlab for digital manipulation of images; image acquisition; preprocessing; segmentation.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** **INTRODUCTION TO IMAGE PROCESSINGAND COMPUTER VISION:** Pixels, Intensity, Coordinate Conventions, Sampling and Quantization, Histogram Analysis, Videos, Image Processing Pipeline, Image Processing and Computer Vision Research Areas: Low-level, Mid-Level and High-Level Vision. INTRODUCTION TO MATLAB / OCTAVE:Basic Opeartions, Image / Video handling, Flow Control, Vectorization. INTRODUCTION TO PYTHON:Basic Opeartions, Lists, Tuples, Strings, Dictionaries, Flow Control, Numpy, Image/Video handling, OpenCV, PIL, Orange.	9
2	**Unit 2: IMAGE PROCESSING / LOW-LEVEL VISION:** Image Enhancement in Spatial Domain, Image Enhancement in Frequency Domain, Edge Detection, Image Restoration, Color Image Processing, Wavelet Transform, Image Compression, Morphological Image Processing, Color Image Processing, Stereo Vision, Motion Analysis, Local and Image Features, Visual Saliency	9
3	**Unit 3: MID-LEVEL VISION:** Hough Transform, Otsu Thresholding, k-means, GraphCut, GrabCut, Normalized Cut, Watersheds, Skeleton Extraction, Object Proposals, Cosegmentation, Background Subtraction in Videos, Motion History Image	11
4	**Unit 4: HIGH-LEVEL VISION:** Image Classification, Object Localization, Object Recognition, Object Detection, CNN, AlexNet, VGG, GoogleNet, DenseNet, FCN for Semantic Segmentation, YOLO, Image Captioning, generative adversarial networks	9
5	**Unit 5:** **APPLICATIONS OF IMAGE PROCESSING AND COMPUTER VISION:** Video Surveillance Systems, Medical Diagnosis, Facial recognition system, Automatic activity recognition system, Fire detection System, traffic sign detection and recognition	10
	Total	**48**

11. **Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Digital Image Processing, by R. C. Gonzalez, R. E. Woods and S. L. Eddins , Publisher: Pearson.	4th Edition	**2017**
2.	Digital Image Processing using Matlab, by R. C. Gonzalez, R. E. Woods and S. L. Eddins , Publisher: Pearson.	2nd	**2017**
3.	Deep Learning for Computer Vision, by Rajalingappaa Shanmugamani, Publisher: O Reilly	1st	**2018**
	Reference Books		
1.	Deep Learning with Keras by Antonio Gulli, Sujit Pal, Publisher: O Reilly	1st	**2017**
2.	Programming Computer Vision with Python", Jan Salem, Publisher: O Reilly	1st	**2012**

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 651** Title: **DevOps on Cloud**
2. Contact Hours: **L:** **3** **T**: **0** **P**: **0**
3. Examination Duration (Hrs): **Theory** **3** **Practical** **0**
4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
5. Credits: **3**
6. Semester: **VI**
7. Category of Course: **DE**

8. Pre-requisite: **Students should have a strong technology background, an understating of cloud infrastructure and skill with a scripting language to master this course.**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Define and understand ideas of DevOps. CO2: Describe and demonstrate how DevOps relate to working in the cloud. CO3: Describe and demonstrate how DevOps tools work together. CO4: Use a public/private cloud environment as a framework to examine the ideas of DevOps. CO5: Examine some use cases, deployment, test automation, continuous delivery, and the public/private cloud toolsets for DevOps.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	**Contents**	**Contact Hours**
1	**Unit 1:**An introduction to DevOps, Gain insights of the DevOps environment, DevOps Vs Agile, DevOps Ecosystem.	**9**
2	**Unit 2:** Version Control with Git, Install GIT and work with remote repositories, GIT workflows, Branching and Merging in Git. Understand the importance of Continuous Integration, Introduction to Jenkins, Jenkins management. Build and automation of Test using Jenkins and Maven.	**9**
3	**Unit 3:**Continuous Testing, learn and Install Selenium, create test cases in Selenium, Integrate Selenium with Jenkins, Continuous Deployment.	**10**
4	**Unit 4:**Introduction to Docker, understanding images and containers, Docker Ecosystem, Introduction to Docker Networking, Monolith and Microservices, features of Microservices Architecture, Advantages of Microservices.	**8**
5	**Unit 5:**Introduction of Kubernetes, Kubernetes Architecture, Docker Swarm and Kubernetes, Application deployment using Docker and Kubernetes.	**8**
	Total	**44**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	The Visible Ops Handbook by Kevin Behr, Gene Kim and George Spafford, IT Process Institute	1st	2004
2.	DevOps for Developers by Michael Hüttermann.	1st	2012
3.	The Goal: A Process of Ongoing Improvement by Eliyahu M. Goldratt, Jeff Cox Author, David Whitford (Other Contributor)	1st	2008

4	Devops: a comprehensive beginners guide to learn devops step by step, Ethan Thorpe, ISBN-10 : 1081563672	1st	2019
5.	Material provided by the instructor	1st	2007
	Reference Books		
1.	**Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation by Jez Humble and David Farley**	3rd	2010
2.	**The Phoenix Project by Gene Kim, Kevin Behr, George Spafford**	3rd	2013

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 671** Course Title: **Bigdata Storage and Processing**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **VI**
7. Category of Course: **DE**

8. Pre-requisite: TCS-351 Fundamental of Cloud Computing and Bigdata,

TCS-571 Bigdata Visualization

9. **Course Outcome**:**	After completion of the course, the students will be able to: CO1: Understand the concepts and significance of big data, including its capture, management, organization, and analysis CO2: Utilize the HDFS command line interface to interact with the file system, manage data nodes, and work with the data flow. CO3: Describe the concept of MapReduce, its features, types, and formats, and comprehend the workflow of a MapReduce job. CO4: Set up a Hadoop cluster, considering system requirements, and understand the different installation mode CO5: Analyze and manage big data using Hadoop ecosystem tools and techniques, such as HDFS, MapReduce, and NoSQL databases. CO6: Apply critical thinking and problem-solving skills to address technological challenges associated with big data and propose appropriate solutions.

*** Describe the specific knowledge, skills, or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** Big Data Overview: Understanding Big Data, Capturing Big Data, Benefitting from big data, management of big data, Big Data Architecture and Characteristics, Organizing big data, Technological Challenges from big data.	10
2	**Unit 2:** Hadoop Distributed File System (HDFS), HDFS design, HDFS concepts: Data node, name node, Command line interface, File system, Data flow, limitations	10
3	**Unit 3:** Hadoop I/O: Data integrity, compression, serialization, File based data structures, Concept of Map Reduce, features, types, and formats, Working of Map Reduce: Shuffle and sort, Task execution, Job tracker, task tracker	9
4	**Unit 4:** Setting up a Hadoop cluster: Basic system requirements, installation and cluster formation, Modes of installation: the standalone, pseudo-distributed, and distributed, purpose of different modes of installations and applications	9
5	**Unit 5:** Hadoop Eco System and YARN: Hadoop ecosystem components, schedulers, fair and capacity, Hadoop 2.0 Features NoSQL Databases:- RDBMS Vs. NoSQL, Types of No SQL Databases, Architecture of NoSQL Databases, CAP Theorem,	8
	Total	**46**

11. **Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Tom White, Hadoop: A definitive guide, 3/e o'reilley	3rd	2012
	Reference Books		
1.	Fei Hu, Big Data: Storage, Sharing and Security, CRC Press, Taylor, and Francis.	1st	2016

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid-Term Exam / End-Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 619** Course Title: **Network and System security**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **VI**

DE

7. Category of Course:

8. Pre-requisite: **TCS 591**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Understand the basics of computer security CO2: Elaborate the cryptographic techniques. CO3: Discuss the transport layer security CO4: Find the pros and cons of various key distribution methods CO5: Analyze the wireless Network security CO6: Find the level of system security

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

SL. NO.	Contents	Contact Hours
1	**Unit 1:** **Introduction** Computer Security Concepts, The OSI Security Architecture, Security Attacks, Security Services, Security Mechanisms, Models for network security, standards.	**9**
2	**Unit 2:** **Cryptography** **Symmetric Encryption and Message Confidentiality** Symmetric Encryption Principles, Symmetric Block Encryption Algorithms, Random and Pseudorandom Numbers, Stream Ciphers and RC4, Cipher Block Modes of Operation. **Public-Key Cryptography and Message Authentication 61** Approaches to Message Authentication, Secure Hash Functions, Message Authentication Codes, Public-Key Cryptography Principles, Public-Key Cryptography Algorithms, Digital Signatures	**9**
3	**Unit 3:** **Network security Application - I** **Key Distribution and User Authentication** Symmetric Key Distribution Using Symmetric Encryption, Kerberos, Key Distribution Using Asymmetric Encryption, X.509 Certificates, Public-Key Infrastructure, Federated Identity Management **Transport-Level Security** Web Security Considerations, Secure Socket Layer and Transport Layer Security, Transport Layer Security, HTTPS, Secure Shell (SSH)	**10**

4	**Unit 4:** **Network security Application - II** **Wireless Network Security** IEEE 802.11 Wireless LAN Overview, IEEE 802.11i Wireless LAN Security, Wireless Application Protocol Overview, Wireless Transport Layer Security, WAP End-to-End Security **Electronic Mail Security** Pretty Good Privacy, S/MIME, DomainKeys Identified Mail, **IP Security** IP Security Overview, IP Security Policy, Encapsulating Security Payload, Combining Security Associations, Internet Key Exchange, Cryptographic Suites	**8**
5	**Unit 5:** **System Security** **Intruders** Intruders, Intrusion Detection, Password Management, **Malicious Software** Types of Malicious Software, Viruses, Virus Countermeasures, Worms, Distributed Denial of Service Attacks. **Firewalls** The Need for Firewalls, Firewall Characteristics, Types of Firewalls, Firewall Basing, Firewall Location and Configurations, **Legal and Ethical Aspects** Cybercrime and Computer Crime, Intellectual Property, Privacy, Ethical Issues	**10**
	Total	**46**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	W. Stallings, “Network Security Essentials”, Prentice Hall,	6th	2017
2	Reference:-Ch. P. Pfleeger, S. L. Pfleeger,“ *Security in Computing”, 4th Edition* Prentice Hall,	4th	2006
	Reference Books		

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Name of Department: - Computer Science and Engineering

1.	Subject Code:	**TCS 641**		Course Title:	**Virtual Reality**		
2.	Contact Hours:	**L:**	**3**	**T:** **0**	**P:** **0**		
3.	Examination Duration (Hrs):	**Theory**	**3**	**Practical**	**0**		
4.	Relative Weight:	**CIE**	**25**	**MSE**	**25**	**SEE**	**50**
5.	Credits:	**3**					
6.	Semester:	**VI**					
7.	Category of Course:	**DE**					

8. Pre-requisite: NA

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Demonstrate an understanding of techniques, processes, technologies and equipment used in virtual reality CO2: Identify appropriate design methodologies for immersive technology development, especially from a physiological perspective CO3: Exploit the characteristics of human visual perception in Virtual Reality techniques CO4: Provide rendering to VR specific problems CO5: Effectively categorize the benefits/shortcomings of available VR technology platforms. CO6: Discuss the use of geometry in virtual reality

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

S.NO.	**Contents**	**Contact Hours**
1	**Unit 1:** **Introduction**: Goals, VR definitions, Birds-eye view (general, hardware, software, sensation and perception), Applications of VR, Technical framework, Mixed and Augmented Reality **Geometry of Virtual Worlds**: Geometric modeling, Transforming models, Matrix algebra, 2D and 3D rotations, Axis-angle representations, Quaternions, Converting and multiplying rotations, Homogeneous transforms, Eye Transforms, Canonical view transform, Viewport Transform	**8**
2	**Unit 2:** **Light and Optics:** Interpretations of light, Refraction, Simple lenses, Diopters, Imaging properties of lenses, Lens aberrations, Photoreceptors, Sufficient resolution for VR, Light Intensity, Eye movements for VR, Neuroscience of vision	**9**
3	**Unit 3:** **Visual Perception and Tracking Systems**: Depth perception, Motion Perception, Frame rates and displays, Orientation Tracking, Tilt drift correction, Yaw drift correction, Tracking with a camera, Perspective n-point problem, Filtering, Lighthouse approach	**9**
4	**Unit 4:** **Visual Rendering**: Shading models, rasterization, Pixel shading, VR specific problems, Distortion shading, Post-rendering image wrap	**9**
5	**Unit 5:** **Audio**: Physics and physiology, Auditory perception, Auditory Localization, Rendering, Spatialization and display, Combining other senses, Spatial Sound	**8**

	Interfaces: Locomotion, Manipulation, System Control, Social Interaction, VR Engines and Other Aspects of VR, Evaluation of VR systems	
	Total	**43**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Grigore C. Burdea , Philippe Coiffet, "Virtual Reality Technology", Wiley-IEEE press	2^{nd}	**2003**
2	Marschner, Shirley "Fundamentals of Computer Graphics", 4th Edition, CRC Press	4th	2016
3	LaValle "Virtual Reality", Cambridge University Press,	1^{st}	2016
4	"Virtual Reality", Steve Lavalle (online open book)	1^{st}	2016
	Reference Books		
1.	1. K. S. Hale and K. M. Stanney, "Handbook on Virtual Environments", 2nd edition, CRC Press, 2015	2nd	2015
2	George Mather," Foundations of Sensation and Perception:" Psychology Press	1^{st}	**2007s**

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 662** Course Title: **Machine Learning**
2. Contact Hours: **L:** **3** **T**: **0** **P**: **0**
3. Examination Duration (Hrs): **Theory** **3** **Practical** **0**
4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
5. Credits: **3**
6. Semester: **VI**
7. Category of Course: **DC**

8. Pre-requisite: Design and Analysis of Algorithm, Fundamental of Statistics and AI (TCS 421 / Statistical Data Analysis with R (TCS 471), Discrete Structures and Combinatorics (TMA 316)

9. **Course Outcome**:**	After completion of the course the students will be able to**:** **CO1:** Acquire concepts and methods in statistical machine learning **CO2:** Analyze fundamental principles of machine learning algorithms **CO3**: Understand machine learning motivated by case-studies **CO4:** Investigate and evaluate key topics in machine learning algorithms for data science industry

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1: Machine learning foundation** Review of logic and knowledge system - language, axiom, hypothesis, theorem, logic & types, what is ML, Inductive bias in ML, AI pyramid, Pattern classification pipeline, Linear algebra in ML, Probabilistic logic and statistical inference (Random expt./ variable, CDF, WLLN, Bayes, Markov & Chernoff bound, Hypothesis testing and performance indices - ROC, Estimation - detection, Optimality of Bayes, bias-variance, underfit-overfit, entropy as Information, Cover's packing lemma, Curse of dimensionality, **Case study:** Wealth – optimal payoffs in portfolios (stock market)	14
2	**Unit 2: Unsupervised Learning** Clustering, Clustering methods – Partition vs. Hierarchical, k-Means and k-Medoids, Hierarchical: Agglomerative & Divisive, Error Analysis in Clustering, Ensemble - clustering, **Case study:** Clustering in Health care, Causal cluster, Graph cluster	8
3	**Unit 3: Supervised Learning** Main objectives and types of Supervised methods (Parametric, Semi parametric, Non-parametric), Linear Regression and Weiner filter, Grammar based/ Inductive learning - Decision Trees – CART, ID-3, Pruning metrics for tree; D-tree examples, Linear SVM (basics and V-C bound), k-NN rule and examples, Learning as Factorization, Ensemble learning: Bagging, Boosting**. Case studies:** covered for mentioned Supervised learning techniques.	10
4	**Unit 4: Reinforcement & Interaction Learning** Basic model of Reinforcement Learning as game (Agent, Critic, Environment), Optimal policy & Q – values, Bellman equation, **Case**	8

	studies on R Learning Active learning, Deep Reinforcement, Transfer learning with examples, Federated Machine Learning with examples.	
5	**<u>Unit 5:</u> Special topics in Machine Learning** Sentiment Mining: NLP pipeline process, Data Analytics – Big data and Hadoop model, Business Analytics – Competitive Machine Learning, ANN building blocks (problem solving), Deep learning, Feed forward, Backpropagation, C-NN, Recurrent-NN.	8
	Total	**48**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	Pattern classification – R, Duda, P. Hart and D. Stork, Wiley Publisher	2nd.	2007
2.	The Elements of Statistical Learning - J. Friedman, R. Tibshirani and T. Hastie, Springer Publisher	3rd.	2017
3.	Pattern Recognition and Machine Learning - C. Bishop, Springer Publisher	2nd.	2016
4.	Deep Learning - A. Courville, I. Goodfellow, Y. Bengio, MIT Press	2nd.	2016
	Reference Textbooks		
1.	Machine Learning - Tom M. Mitchell, Mc Graw Hill Publisher	1st	2017
2.	Introduction to Machine Learning - E. Alpaydin, PHI Publisher	3rd.	2015
3.	Elements of Information Theory - T M. Cover, J A. Thomas, Wiley Publisher	2nd.	2006

12.	**Mode of Internal Evaluation**	Seminar – presentation on topic in ML & internal viva **<u>OR</u>** Simulation of ML method with real dataset & internal viva

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Name of Department: - Computer Science and Engineering

PCS 662	**Machine Learning Lab**

1. Subject Code: Course Title:

2. Contact Hours: **L:** [ ] **T:** 1 **P:** 2

3. Examination Duration (Hrs): **Theory** [ ] **Practical** **2 hr**

4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**

5. Credits: **2**

6. Semester: **VI**

7. Category of Course: **DC**

8. Pre-requisite: Design and Analysis of Algorithm, Python programming or C++ programming or Java Programming

9. **Course Outcome**:**	After completion of laboratory the students will be able to**:** **CO1:** Implement methods in statistical machine learning **CO2:** Analyze data and machine learning algorithms **CO3**: Understand machine learning motivated by case-studies

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

S. N.	**Contents**	**Contact Hours**
1	To implement various similarity functions for attribute tuples stored as .csv file - Euclidean, Manhattan, Cosine.	2
2	To use lobe.ai user interface and perform manual labeling, training and testing for supervised object recognition in Image	2
3	To understand and develop basic KR (Knowledge Representation) Tools from practical AI problem definitions: KR methods	2
4	To take two - category input file and use thresholding to design binary classifier for 1 feature, for 2 feature dataset	2
5	To register and use monkeylearn.com and create model, train and classify sentiments that lead to sentiment prediction using corpus of hotel reviews as part of NLU	2

6	To register and use Teachable machine (Google API) and perform multiple class / pose analysis and classification.	2
7	To use quillbot.com and study basic machine transcription roles in summarization: as NLP application	2
8	To use quillbot.com and study basic machine transcription roles in grammar checker (syntax): as NLP application	2
9	To use quillbot.com and study basic machine transcription roles in paraphrasing: as NLP application	2
10	To create multiple clusters using PoS (parts of speech) data by reading input text file	2
11	To create multiple clusters from column data entries of .csv file using k-means algorithm	2
12	To create multiple clusters by using hierarchical clustering - Agglomerative based on .csv file	2
13	To use healthcare dataset and form scatter plot with observed statistical measures	2
14	To import tabular data for related clinical parameters and program a basic linear regression model	2
15	Program probabilistic model given: it is Friday and that a student is absent is 3 %. Since there are 5 school days in a week, the probability that it is friday is 20 %. What is the probability that a student is absent given that today is friday. Program Bayesian rule in python to get the result.	2
16	To extract intra-day stock market data for 4 stocks and write program that: plots the values, develops linear regression, derive mean and correlation.	2
17	To write program that can import training samples for 3 labels and perform k-NN for new queries and quantify error performance	2

1	**Unit 1**: Basic Concepts: Formulation of mathematical programming problems; Classification of optimization problems; Optimization techniques – classical and	10

	advanced techniques Optimization using Calculus: Convexity and concavity of functions of one and two variables; Optimization of function of multiple variables subject to equality constraints; Lagrangian function; Optimization of function of multiple variables subject to equality constraints; Hessian matrix formulation	
2	**Unit 2:** Linear Programming: Standard form of linear programming (LP) problem; Canonical form of LP problem; Assumptions in LP Models; Graphical method for two variable optimization problem; Motivation of simplex method, Simplex algorithm and construction of simplex tableau; Revised simplex method; Duality in LP; Primal dual relations; Dual Simplex Method; Sensitivity or post optimality analysis; bounded variables	10
3	**Unit 3:** Dynamic Programming: Representation of multistage decision process; Types of multistage decision problems; Concept of sub optimization and the principle of optimality	8
4	**Unit 4:** Integer Programming: Integer linear programming; Branch and Bound algorithm; Concept of cutting plane method; Mixed integer programming; Solution algorithms.	8
5	**Unit 5:** Advanced Topics in Optimization: Direct and indirect search methods; Heuristic and Meta-Heuristic Search methods; Multi objective optimization.	8
	Total	

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	S.S. Rao, "Engineering Optimization: Theory and Practice", New Age International Publishers	3rd	2013
2	H.A. Taha, "Operations Research: An Introduction", Pearson Education	10th	2019
3	Ravindran, K. M. Ragsdell and G. V. Reklaitis, "Engineering Optimization: Methods and Applications", Wiley India	2nd	2006
	Reference Books		
1.	R. Fletcher, "Practical Methods of Optimization", Wiley India	2nd	2009
2.	K. Deb, "Optimization for Engineering Design", Prentice Hall India	2nd	2012

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS-663** Course Title: **Big Data Analytics: Tools and Techniques**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **VI**
7. Category of Course: **DE**
8. Pre-requisite: Introduction to Big Data (TCS-462),
   Big Data Visualization (TCS-571),
   Data Base Management Systems (TCS-503),
   Programming in Java (TCS-408),

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Investigate Hadoop related tools for Big Data Analytics and perform basic Hadoop Administration CO2: Analyse the technological foundations for Big data with Hadoop and design of Hadoop distributed file system CO3: Understand the concept of MapReduce workflow CO4: Develop program using Hive and Apache Pig for large data processing CO5: Outline the theory of big data, and explain applications of big data CO6: Build Big Data Analytics application to solve real world problem

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** **Introduction to Hadoop:** Introduction to Hadoop, Distributed Computing Challenges, Hadoop Features, Hadoop Distributed File System (HDFS), Hadoop Versions, Hadoop Installation, HDFS basic commands, Overview of Hadoop Ecosystem, RDMS vs Hadoop	9
2	**Unit 2:** **Introduction to MapReduce Programming:** Introduction to MapReduce Framework, Mapper, Reducer, Combiner, Partitioner, Searching, Sorting, Compression, Sample programs on MapReduce, Techniques to optimize MapReduce Jobs	8
3	**Unit 3: Hive and Apache Pig** **Hive:** Introduction to Hive, Hive Architecture, Hive Data Types, Hive Query Language, User Defined Functions, Sample Programs **Apache Pig:** Introduction to Pig, Pig Latin Overview, Data Types in Pig, Pig Operators, User Defined Functions, Sample Programs	8
4	**Unit 4:** **Spark:** Introduction to Spark, Features of Spark, Spark Architecture, Spark Components, Spark RDD, Spark in-built functions, Sample Programs	9
5	**Unit 5: Apache Flume, Sqoop and Big Data Applications** **Flume:** Introduction to Apache Flume, Flume Architecture, Data Flow, Environment, Sample Exercise **Sqoop:** Introduction to Sqoop, Sqoop Features, Sqoop Architecture, Sqoop integration with Hadoop, Data import and export using Sqoop, Sqoop vs Flume, Sample Exercise **Big Data Applications:** Healthcare, Agriculture, Education, Media and Entertainment, Travel, Retail, etc.	8
	Total	**42**

11. **Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Subhashini Chellappan Seema Acharya, Big Data and Analytics, Wiley	2nd	2019
2.	Big Data, Black Book, Dreamtech Press	1st	2016
3.	Raj Kamal, Big Data Analytics, Introduction to Hadoop, Spark, and Machine-Learning, McGraw Hill Education	1st	2019

	Reference Books		
1.	Hadoop: The Definitive Guide, Tom White, O'Reilly	4th	2015
2.	Michele Chambers, Michael Minelli , Ambiga Dhiraj ,Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses, Wiley	1st	2013

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS-682** Course Title: **Advanced Machine Learning**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 0** **SEE 25**
5. Credits: **3**
6. Semester: **6**
7. Category of Course: **DC**
8. Pre-requisite:

9. **Course Outcome**:**	After completion of the course the students will be able to: CO1: Understand and analyze the basic terminologies of Machine Learning CO2: Understand the Parametric and non_parametric methods CO3: Understand the concepts of various Kernel methods CO4: Evaluate the working of different kernel and classifier models CO5: Understand the different Graphical and Mixture Model techniques CO6: Analyse and Differentiate various learning approaches

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours

1	**Unit 1:** Probability Theory, Overview of supervised learning, curse of dimensionality, Decision Theory, Information Theory, Mini-Max Theory, Bayesian Vs non-Bayesian approaches, Classification, Regression, Desnsity estimation, Bias-variance, Lasso, MLE	8
2	**Unit 2:** Parametric versus non-Parametric methods, Generalized Linear Models, Model selection, Hidden Markov Models, Linear smoothers, Density estimation: cross-validation, Histogram, Kernel density estimation, Bootstrap and sub-sampling, Non-parametric Bayes	8
3	**Unit 3:** Kernel Methods and Machines: Dual representations, Kernel construction, Selecting the width of the kernel, Kernel density estimation and classification, Radial basis functions and kernel, Gaussian processes, Maximum margin classifiers, Relevance vector machines	8
4	**Unit 4:** Graphical and Mixture Models: Bayesian networks: Generative models, Linear-Gaussian models; Conditional independence: D-separation; Markov random fields: Factorization properties, Relation to directed graphs; Inference in graphical models: Inference on a chain, Trees, Factor graphs, Sumproduct & max-sum properties, Loopy belief propagation; K-means clustering, Mixtures of Gaussians, EM, An alternative view of EM	8
5	**Unit 5:** Other Learning Methods: Unsupervised learning, Semi-supervised learning, Reinforcement learning, Ensemble learning, Online learning, Active learning	8
	Total	**40**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer	3rd	2016
2.	Stephen Marsland, Machine Learning: An Algorithc Perspective, CRC Press	2nd	2014
	Reference Books		
1.	Wasserman L., All of Statistics: A Concise Course in Statistical Inference, Springer	1st	2010
2.	Devroye L., Gyorfi L., Lugosi G., A Probabilistic Theory of Pattern Recognition, Springer	1st	1996

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Name of Department: - Computer Science and Engineering

1.	Subject Code:	**PCS 682**		Course Title:	**Advanced Machine Learning Lab**		
2.	Contact Hours:	**L:**	**0**	**T:**	**1**	**P:**	**2**
3.	Examination Duration (Hrs):	**Theory**	**0**	**Practical**	**3**		
4.	Relative Weight:	**CIE**	**25**	**MSE**	**25**	**SEE**	**25**
5.	Credits:	**2**					
6.	Semester:	**6**					
7.	Category of Course:	**DC**					

8. Pre-requisite: TCS-307 Object Oriented Programming with C++, PCS 582- ALML Lab

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Understand the mathematics behind Machine Learning Model CO2: Understand how Markov Model Work CO3: Understand functioning of Convolutional Neural Network model CO4: Understand the Regression and classification, associativity rules.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

Sl. No.	**List of problems for which student should develop program and execute in the Laboratory**	**Contact Hours**
1.	Implemention of Polynomial Regression in python	2

2.	Implementation of Support Vector Regression in python	2
3.	Write a python program to Implement Decision Tree and Random Forest Regression Algorithm	2
4.	Write a program to demonstrate the working of the Naïve Bayes algorithm	2
5.	Build an Association Rule Learning Model by implementing the Apriori and Eclat Algorithm	2
6.	Write a program to implement the Upper Confidence Bound (UCB) and Thomson Sampling Reinforcement Learning in python	2
7.	Write a python program to Implement Convolutional Neural Network Model	2
8.	Write a program to implement the Principal Compoment Analysis.	2
9.	Write a python program to Implement and Demonstrate Linear Discriminant Analysis	2
10.	Write a python program to Implement the Hidden Markov Model	2
	Total	20

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	Michael Learn, Python Programming, Mikcorp Limited	2nd	2021
2.	Vijay Kumar Sharma, Vimal Kumar, Swati Sharma, and Shashwat Pathak, Python Programming: A Practical Approach, CRC Press	2nd	2021
	Reference Books		
1.	Gowrishankar S., Veena A., Introduction to Python Programming, CRC Press	1st	2018

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Name of Department: - Computer Science and Engineering

1.	Subject Code:	**TCS 643**		Course Title:	**Theory of Optimization**		
2.	Contact Hours:	**L:**	**3**	**T**:	**0**	**P**:	**0**
3.	Examination Duration (Hrs):	**Theory**	**3**	**Practical**	**0**		
4.	Relative Weight:	**CIE**	**25**	**MSE**	**25**	**SEE**	**50**
5.	Credits:	**3**					
6.	Semester:	**6**					
7.	Category of Course:	**DE**					
8.	Pre-requisite:	**Linear Algebra, Calculus**					

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: develop a knowledge in the field of optimization techniques and their basic concepts, principles and algorithms. CO2: understand fundamentals of linear programming, Integer programming and Dynamic programming. CO3: apply the theory of optimization methods for modelling various types of decision-making problems. CO4: solve the mathematical results and numerical algorithms of optimization theory to concrete Engineering problems

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1**: Basic Concepts: Formulation of mathematical programming problems; Classification of optimization problems; Optimization techniques – classical and advanced techniques Optimization using Calculus: Convexity and concavity of functions of one and two variables; Optimization of function of multiple variables subject to equality constraints; Lagrangian function; Optimization of function of multiple variables subject to equality constraints; Hessian matrix formulation	10
2	**Unit 2:** Linear Programming: Standard form of linear programming (LP) problem; Canonical form of LP problem; Assumptions in LP Models; Graphical method for two variable optimization problem; Motivation of simplex method, Simplex algorithm and construction of simplex tableau; Revised simplex method; Duality in LP; Primal dual relations; Dual Simplex Method; Sensitivity or post optimality analysis; bounded variables	10
3	**Unit 3:** Dynamic Programming: Representation of multistage decision process; Types of multistage decision problems; Concept of sub optimization and the principle of optimality	8
4	**Unit 4:** Integer Programming: Integer linear programming; Branch and Bound algorithm; Concept of cutting plane method; Mixed integer programming; Solution algorithms.	8
5	**Unit 5:** Advanced Topics in Optimization: Direct and indirect search methods; Heuristic and Meta-Heuristic Search methods; Multi objective optimization.	8
	Total	

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	S.S. Rao, "Engineering Optimization: Theory and Practice", New Age International Publishers	3rd	2013
2	H.A. Taha, "Operations Research: An Introduction", Pearson Education	10th	2019
3	Ravindran, K. M. Ragsdell and G. V. Reklaitis, "Engineering Optimization: Methods and Applications", Wiley India	2nd	2006
	Reference Books		

1.	R. Fletcher, “Practical Methods of Optimization”, Wiley India	2nd	2009
2.	K. Deb, “Optimization for Engineering Design”, Prentice Hall India	2nd	2012

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 679** Course Title: **Network and System security**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **VI**
7. Category of Course: **DE**
8. Pre-requisite: **TCS 591**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Understand the basics of computer security CO2: Elaborate the cryptographic techniques. CO3: Discuss the transport layer security CO4: Find the pros and cons of various key distribution methods CO5: Analyze the wireless Network security CO6: Find the level of system security

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

SL. NO.	Contents	Contact Hours
1	**Unit 1:** **Introduction** Computer Security Concepts, The OSI Security Architecture, Security Attacks, Security Services, Security Mechanisms, Models for network security, standards.	**9**
2	**Unit 2:** **Cryptography** **Symmetric Encryption and Message Confidentiality** Symmetric Encryption Principles, Symmetric Block Encryption Algorithms, Random and Pseudorandom Numbers, Stream Ciphers and RC4, Cipher Block Modes of Operation. **Public-Key Cryptography and Message Authentication 61** Approaches to Message Authentication, Secure Hash Functions, Message Authentication Codes, Public-Key Cryptography Principles, Public-Key Cryptography Algorithms, Digital Signatures	**9**
3	**Unit 3:** **Network security Application - I** **Key Distribution and User Authentication** Symmetric Key Distribution Using Symmetric Encryption, Kerberos, Key Distribution Using Asymmetric Encryption, X.509 Certificates, Public-Key Infrastructure, Federated Identity Management **Transport-Level Security** Web Security Considerations, Secure Socket Layer and Transport Layer Security, Transport Layer Security, HTTPS, Secure Shell (SSH)	**10**
4	**Unit 4:** **Network security Application - II** **Wireless Network Security** IEEE 802.11 Wireless LAN Overview, IEEE 802.11i Wireless LAN Security, Wireless Application Protocol Overview, Wireless Transport Layer Security, WAP End-to-End Security **Electronic Mail Security** Pretty Good Privacy, S/MIME, DomainKeys Identified Mail, **IP Security** IP Security Overview, IP Security Policy, Encapsulating Security Payload, Combining Security Associations, Internet Key Exchange, Cryptographic Suites	**8**
5	**Unit 5:** **System Security** **Intruders** Intruders, Intrusion Detection, Password Management, **Malicious Software**	**10**

	Types of Malicious Software, Viruses, Virus Countermeasures, Worms, Distributed Denial of Service Attacks. **Firewalls** The Need for Firewalls, Firewall Characteristics, Types of Firewalls, Firewall Basing, Firewall Location and Configurations, **Legal and Ethical Aspects** Cybercrime and Computer Crime, Intellectual Property, Privacy, Ethical Issues	
	Total	**46**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	W. Stallings, "Network Security Essentials", Prentice Hall,	6th	2017
2	Reference:-Ch. P. Pfleeger, S. L. Pfleeger," *Security in Computing", 4th Edition* Prentice Hall,	4th	2006
	Reference Books		

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Name of Department: - Computer Science and Enginee

1. Subject Code: **PCS 679** Course **Network and System Security Lab**

2. Contact Hours: **L: 0** **T: 1** **P: 2**

3. Examination Duration (Hrs): **Th 0** **Pr 3**

4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**

5. Credits: **2**

6. Semester: **6**

7. Category of Course: **DC**

8. Pre-requisite**: Java Programming Language (TCS 408), Database Management System (TCS 503)**

9. **Course Outcome**:**	After completion of the course the students will be able to: CO1: Explain different threats and attacks on network and system. CO2: Know the working of different cryptographic schemes. CO3: Analyze the security of networks and systems. CO4: Use programming to implement various security algorithms. CO5: Apply security mechanisms to secure networks and systems. CO6: Develop Networks and System Security Protocols.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	List of problems for which student should develop program and execute in the Laboratory	Contact Hours
1	Write down a program for the encryption and decryption procedure of affine cipher scheme.	3
2	Write down a program for the encryption and decryption procedure of hill cipher scheme.	3
3	Write down a program for the encryption and decryption procedure of rail fence technique.	3
4	Write down a program for the encryption and decryption procedure of RSA algorithm.	3
5	Write down a program for the signature generation and verification procedures of RSADS algorithm.	3
6	Write down a program for the signature generation and verification procedures of DSA algorithm.	3
7	Design and implement a secure communication system, in which you have to use symmetric key cryptography for the bulk data encryption. Use the RSA algorithm for the encryption of shared secret key. Use RSADS algorithm for the signature generation and verification. Further use SHA256 algorithm for the calculation of the message digest value.	3
8	Use sample data of network anomalies and attacks, i.e., NSL-KDD and predict about the various possibilities of attacks. You have to try this exercise with the different machine learning algorithms.	3
9	Implement a simple security protocol that does encryption/ decryption using a public key cryptographic algorithm through the scyther tool.	3
10	Implement the following problem using the scyther tool: (i) Sender and receiver use symmetric key cryptography for the bulk data secure exchange. (ii) Use the RSA algorithm for the encryption of shared secret keys. (iv) Use RSADS algorithm for signature generation and verification. (v) Further use SHA256 algorithm for the calculation of the message digest value. (vi) Use various random secret values, pseudo identities and timestamp values to get protection against the MITM attack, impersonation attack and replay attack.	3

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	W. Stallings," Network Security Essentials". Prentice Hall, 2003.	**6th**	**2003**
	Reference Books		
1.	Ch. P. Pfleeger, S. L. Pfleeger „Security in Computing", 4th Edition Prentice Hall, 2006	**4th**	**2006**

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS-692** Cours Title: **Block chain Platforms**
2. Contact Hours: **L:** **3** **T**: **0** **P**: **0**
3. Examination Duration (Hrs): **Theory** **3** **Practical** **0**
4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
5. Credits: **3**
6. Semester: **6th**
7. Category of Course: **DE**
8. Pre-requisite: TCS 332 **Fundamental of Information Security and Blockchain,TCS 493 Introduction of Cryptography and PKC, TCS 592 Blockchain technology and its applications**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Explain blockchain technology and its platforms. CO2: Know the working of blockchain platforms. CO3: Analyze the mechanism of various blockchain platforms. CO4: Use different blockchain platforms to implement blockchain. CO5: Apply security mechanism to secure the networks and system. CO5: Apply blockchain platforms in different applications. CO6: Develop blockchain platforms.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	Blockchain mining - types of blockchain, mechanism of blockchain, verification of transactions, mining nodes, aggregating transactions into blocks, constructing the block header, successfully mining of block, validating a new block, assembling and selecting chains of blocks, consensus attacks	6
2	Consensus algorithms: Details of following consensus algorithms, Proof-of-Work (PoW), Proof-of-Stake (PoS), Proof-of-Activity (PoA) Proof-of-Importance (PoI), Proof-of-Capacity (PoC), Proof-of-Burn (PoB), Proof-of-Weight (PoWeight)	8
3	Advanced consensus algorithms: Details of following consensus algorithms, Delegated Proof-of-Stake (DPoS), Proof of Elapsed Time (PoET), Practical Byzantine Fault Tolerance (PBFT), Simplified Byzantine Fault Tolerance (SBFT), Delegated Byzantine Fault Tolerance (DBFT)	10
4	Blockchain platforms: Ethereum, Hyperledger Fabric,Multichain,Hydrachain,Ripple,R3 Corda, BigChainDB,Open-chain	16
5	Applications of blockchain platforms: Applications of blockchain platforms in various domain, smart contract, smart cities, smart healthcare system	**6**
	Total	**46**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	George Icahn, “Blockchain: the complete guide to understanding blockchain technology”, 2020.	4th	2020
2.	Antony lewis, “The basics of bitcoins and blockchains: an introduction to cryptocurrencies and the technology that powers them” 2020	3rd	2020
3.	Imran Bashir, “Mastering Blockchain: Distributed ledger technology, decentralization, and smart contracts explained”, 2nd edition, Packt publishing.	2nd	

	Reference Books		
1.	Andreas M. Antonopoulos, "Mastering Bitcoin: unlocking digital cryptocurrencies", O'Reilly Media,(2e) 2017.	2nd	2017
2.	Roger Wattenhofer, "Distributed Ledger Technology, The science of the Blockchain", Inverted Forest Publishing,(2e), 2017	2nd	2017
3.	Antonopoulos, Andreas M. and Wood, Gavin. Mastering Ethereum. O'Reilly Media, 2018.	1st	2018

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS-703** Course Title: **Computer Networks II**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **VII**
7. Category of Course: **DC**
8. Pre-requisite: **TCS-604(Computer Networks-I)**

9. **Course Outcome**:**	After completion of the course the students will be able to: CO1: Analyze Global and Centralized Routing protocols and utilize tools (such as NS2) to examine routing protocols of LS and DV types CO2: Evaluate and select the appropriate technology to meet Data Link Layer requirements CO3: Specify the devices, components and technologies to build a cost-effective LAN CO4: Appreciate issues for supporting real time and multimedia traffic over public network CO5: Identify the availability strategies in a Network Management System that will improve network availability and limit the effects of failures

	CO6: Implement client server applications with TCP/UDP Socket Programming

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** Routing Algorithms: Introduction, global vs decentralized routing, The Link State(LS) Routing Algorithm, The Distance Vector (DV) Routing Algorithm, Hierarchical Routing, Routing in the Internet: RIP, OSPF, BGP; Introduction to Broadcast and Multicast Routing	9
2	**Unit 2:** Link Layer and Local Area Networks: Introduction to Link Layer and its services, Where Link Layer is implemented? Error detection and correction techniques: Parity checks, Checksum, CRC; Multiple Access protocols: Channel Partitioning, Random Access (Slotted Aloha, Aloha, CSMA), Taking Turns; Link Layer Addressing: MAC addresses, ARP, Ethernet, CSMA/CD, Ethernet Technologies, Link Layer Switches, Switches vs Routers, VLANS	10
3	**Unit 3:** Multimedia Networking: Introduction, Streaming Stored Audio and Video, Real Time Streaming Protocol (RTSP), Making the Best of the Best Effort Services, Protocols for Real Time Interactive Applications: RTP, RTCP, SIP, H.323; Providing multiple classes of service.	9
4	**Unit 4:** Network Management: What it is, Infrastructure of Network Management, The Internet standard Management Framework, SNMP	9
5	**Unit 5:** Network Programming: Sockets-Address structures, TCP sockets, creating sockets, bind, listen, accept, fork and exec function, close function; TCP client server: Echo server, normal startup, terminate and signal handling, server process termination, crashing and rebooting of server, host shutdown; Elementary UDP sockets: UDP echo server, lack of flow control with UDP	8
	Total	**45**

11. **Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	“Computer Networking A Top Down Approach, Kurose and Ross”, 5th edition, Pearson	7th	2017
	Reference Books		

1.	Douglas E. Comer, Pearson ,"Internetworking with TCP/IP Volume 1 and 2 ".	6th	2012

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS-704** Course Title: **Advanced Computer Architecture**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **7th**
7. Category of Course: **DC**

8. Pre-requisite: TCS 404

9. **Course Outcome**:**	After completion of the course the students will be able to**:** **CO1**: Discuss the classes of computers, and new trends and developments in computer architecture. **CO2**: Study advanced performance enhancement techniques such as pipelines, dynamic scheduling branch predictions, caches. **CO3**: Compare and contrast the modern computer architectures such as RISC, Scalar, and multi-CPU systems. **CO4**: Critically evaluate the performance of different CPU architecture. **CO5**: Improve the performance of applications running on different CPU architectures. **CO6**: Develop applications for high performance computing systems

*** Describe the specific knowledge, skills, or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

SN	Contents	Hours
1	**Unit-1** **Basics of Computing**: Computer Architecture and Technology Trends, Moore's Law and its Applications, Classification of parallel computers, Performance based Computing, The Myopic View of Computer Architecture, Trends in Technology, Energy, Power and Cost, Dependability, Processor Speed, Cost, Power Consumption, Fabrication Yield **Performance Metrics and Evaluation**: Measuring Performance, Benchmark Standards, Amdahl's Law, Lhadma's Law	9
2	**Unit-2** **Memory Hierarchy Design**: Basics of Memory Hierarchy, Coherence and locality properties, Cache memory organizations, Advanced Optimization of Cache Performance, Memory Technology and Optimization, Cache Coherence and Synchronization Mechanism, Virtual Memory, Virtual Machines	10
3	**Unit-3** **Pipeline**: Linear pipeline processor, nonlinear pipeline processor, Instruction pipeline Design, Dynamic instruction scheduling, Branch Handling techniques, branch prediction, Arithmetic Pipeline Design Data, and resource Dependences, **Performance Issues in Pipeline**: Pipeline Hazards, Data Hazards Branch hazards and Resource Hazards	10
4	**Unit-4** **Instruction Level Parallelism**: Concepts and Challenges, Basic Compiler techniques for exploiting ILP, Reducing the branch penalty with advanced branch predictions, overcoming data hazards with dynamic scheduling, exploiting ILP using multiple issues state scheduling	8
5	**Unit-5** **Multiprocessor architecture**: Taxonomy of parallel architectures. Centralized shared-memory, distributed shared-memory architecture, Message passing vs Shared Memory **Thread and Process Level Parallel Architecture**: Instruction Level Data Parallel Architecture, SIMD Architecture, Fine Grained and Coarse-Grained Associative and Neural Architecture, Data Parallel Pipelined and Systolic Architectures, Vector Architectures	8
	Total	**45**

11. **Suggested Books:**

SN	Name of Authors/Books/Publishers	Edition	Year of Publication Reprint
	Textbooks		

1.	Kai Hwang," Advance Computer Architecture" TMH 5. Quinn, "Parallel Computing: Theory & Practice", TMH	2nd	**2012**
2.	Matthew," Beginning Linux Programming", SPD/WROX	2nd	**2012**
3.	Hennessy and Patterson," Computer Architecture: A Quantitative Approach", Elsevier	1st	**2011**
4.	Dezso and Sima," Advanced Computer Architecture", Pearson	2nd	**2004**
	Reference Books		
1.	Quinn, "Parallel Programming in C with MPI and Open MP", TMH	1st	**2014**

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Name of Department: - Computer Science and Engineering

1. Subject Code: TRM-701 Course Title: Research Methodology and IPR
2. Contact Hours: **L:** **3** **T**: **0** **P**: **0**
3. Examination Duration (Hrs): **Theory** **3** **Practical** **0**
4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
5. Credits: **3**
6. Semester: **VII**
7. Category of Course: **DC**
8. Pre-requisite: NA

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Understand research problem formulation CO2: Analyze research related information CO3: Follow research ethics CO4: Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity. CO5: Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular. CO6: Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of

	new and better products, and in turn brings about, economic growth and social benefits.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations	9
2	**Unit 2:** Effective literature studies approaches, analysis Plagiarism, Research ethics.	8
3	**Unit 3:** Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.	9
4	**Unit 4:** Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.	9
5	**Unit 5:** Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.	12
	Total	**47**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Stuart Melville, Wayne Goddard, Research Methodology: An Introduction for Science & Engineering Students, Juta & Co. Ltd.	1st	1996
2.	Wayne Goddard, Stuart Melville, Research methodology: An introduction, Juta Academic	2nd	2014
3.	Ranjit Kumar, Research Methodology: A Step by Step Guide for Beginners, Pearson India	2nd	2005

4.	Halbert, Resisting Intellectual Property, Taylor & Francis Ltd ,	1st	2007
	Reference Books		
1.	Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", Wolters Kluwer Law and Business	2nd	2016
2.	T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand	1st	2008

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 750** Course Title: **Cloud Orchestration and Load Balancing**
2. Contact Hours: **L:** **3** **T**: **0** **P**: **0**
3. Examination Duration (Hrs): **Theory** **3** **Practical** **0**
4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
5. Credits: **3**
6. Semester: **7**
7. Category of Course: **DE**
8. Pre-requisite: TCS-351 Fundamental of Cloud Computing and Bigdata
   TCS-451 Virtualization and Cloud Computing
   TCS-552 Cloud Based Application Development and Management

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Apply the concepts of cloud automation, orchestration, load balancing and resource scheduling management techniques. CO2: Demonstrate the cloud orchestration and automation tools in the cloud services.

	CO3: Distinguish cloud management techniques in the cloud services. CO4: Evaluate Heat Orchestration Services for cloud services deployment. CO5: Evaluate the different orchestration and automation tools and services to achieve a performing cloud-based web-service. CO6: Design and deploy a cloud-based web-service that uses the RESTful API

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** Introduction to automation, orchestration, and load balancing, Identify the need of automation, orchestration and load balancing of cloud resources, Resource scheduling mechanism in the cloud. Students will develop and evaluate scaling and load balancing solutions, work with cloud storage systems, and develop applications in several programming paradigms.	9
2	**Unit 2:** Cloud orchestration tools: AWS CloudFormation, IBM Cloud Orchestrator, RedHat Ansible, Microsoft Azure Automation, Terraform, Kubernetes, Cloudify, and Morpheus. DC/OS container orchestration, Mesos Containers, Docker Containers. Cloud infrastructure automation tools: Chef Automate, Google Cloud Deployment Manager, Puppet Enterprise, Red Hat Ansible Automation Platform, VMware vRealize Automation.	9
3	**Unit 3:** Cloud management techniques such as Cloud instances at scale, Cloud software deployment considerations such as scaling strategies, load balancing, fault tolerance, accounting for tail latencies and optimizing for cost. Case study of the following cloud services: IBM Cloud Orchestrator, Ingram Micro Cloud Orchestrator, Microsoft Azure Automation, IT Automation with AWS Lambda, AWS Systems Manager Automation, Microsoft Cycle Computing, Morpheus, OpenStack Heat orchestration engine, Saltstack, Zymr.	9
4	**Unit 4:** Heat orchestration service, Heat orchestration Template (HoT), Architecture, Main execution flow, Scheduling and fault tolerance concepts in the MapReduce programming model, Cloud programming models (MapReduce, Storm, Spark, GraphLab, Spark Streaming and Samza), OpenStack Heat Orchestration Service.	9
5	**Unit 5:** RESTful API, Benefits of RESTful APIs, RESTful API client request, RESTful API authentication methods, Design and deploy a cloud based web-service that	9

	uses the REST interface to respond to queries that require running an analytics job on a large data set which is stored in a database. The web-services are evaluated through a load generator for a fixed time period (several hours) by measuring the cost of cloud resources used and their system's performance (throughput). Design and Deploy Smart Traffic Management System Application to Cloud.	
	Total	45 Hrs.

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	Barrie Sisisky, "Cloud Computing Bible" ,Published by Wiley Publishing, Inc.		**2010**
2	Felipe Gutierrez ,"Spring Cloud Data Flow: Native Cloud Orchestration Services for Microservice"	1	**2021**
3	Adnan Ahmed Siddiqui, "OpenStack Orchestration", Packt Publishing Ltd		2015
4	"Practical Load Balancing: Ride the Performance Tiger (Expert's Voice in Networking)", A press	1	2012

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 771** Course Title: **Natural Language Processing**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **7**
7. Category of Course: **DE**
8. Pre-requisite: Machine Learning

9. **Course Outcome**	After completion of the course the students will be able to**:** CO1: Understand basics of Natural Language Processing (NLP) CO2: Analyze and Evaluate NLP models CO3: Understand neural language models for NLP CO4: Apply Recurrent neural network models in NLP CO5: Understand transformers and self-attention models for NLP CO6: Apply deep learning to create interesting NLP applications

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** Introduction to Natural Language Processing. Ambiguity in Languages. Applications of NLP (Motivation). Traditional vs deep learning-based NLP. Introduction to traditional NLP libraries: NLTK, Wordnet**.** Regular expressions, Basic Steps of NLP: Tokenization, Stemming, Lemmatization. Converting text to features, n-grams, corpora, text normalization, smoothing, Bag of Words (BoW) model	10
2	**Unit 2:** vector space model, cosine similarity, tf-idf term weighting and its variations, text classification, example of spam classifier using Naïve Bayes. Sentiment classification. Logistic Regression. Evaluation measures: Precision, Recall, F-score. Test sets and Cross-validation. Static word embeddings: word2vec, GloVe.	10
3	**Unit 3:** Neural language models, Feedforward Neural Language Modeling, Training neural nets: loss function, computing the gradient, computation graphs, backward differentiation on computation graphs. Training the neural language model. Sequence labeling for Parts of Speech (POS) and Named Entities: English word classes, PoS tagging, named entities and named entity tagging, Recurrent Neural Networks (RNNs) for NLP, LSTM	10
4	**Unit 4:** RNNs: inference in RNNs, training. RNNs as language models: training RNN language model, RNNs for other NLP tasks: sequence labeling, sequence classification, generation with RNN-based language models. Stacked and Bidirectional RNN architectures, LSTM: gated units, layers and networks. Encoder-Decoder models, Attention	10
5	**Unit 5:** Self-attention networks: Transformers, transformer blocks, multi-head attention, modelling word order: positional embeddings. Transformers as language models. Bidirectional transformer encoders. Transfer learning through fine-tuning. NLP applications: machine translation, question answering, chatbots and dialog systems	8
	Total	**48**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Daniel Jurafsky, James H. Martin, Speech and Language Processing,	Third edition	2023
2.	Uday Kamath, John Liu and James Whitaker, Deep Learning for NLP and Speech Recognition	First edition	2019
	Reference Books		

1.	Steven Bird, Ewan Klein and Edward Loper, Natural Language Processing with Python	First edition	2009

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 731** Course Title: **Computer Forensics**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **VII**
7. Category of Course: **DE**
8. Pre-requisite: **NA**

9. **Course Outcome**:**	After completion of the course the students will be able to: CO1: Understand the importance of a systematic procedure for investigation of data found on digital storage media that might provide evidence of wrong-doing. CO2: Identify and document potential security breaches of computer data that suggest violations of legal, ethical, moral, policy and/or societal standards CO3: Use tools for faithful preservation of data on disks for analysis and find data that may be clear or hidden on a computer or another device CO4: Work with computer forensics tools used in data analysis, such as searching, absolute disk sector viewing and editing, recovery of files, password cracking, etc.

	CO5: Present the results of forensics analysis as an expert. CO6: Discuss the Cyber Laws and Cyber Crimes.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

SL. NO.	Contents	Contact Hours
1	**Unit 1:** **Cyber Crimes, Laws and Cyber Forensics:** Introduction to IT laws & Cyber Crimes, The World and India **Cyber Forensics Investigation**: Introduction to Cyber Forensic Investigation, Investigation Tools, eDiscovery, Digital Evidence Collection, Evidence Preservation, E-Mail Investigation, E-Mail Tracking, IP Tracking, E-Mail Recovery, Encryption and Decryption methods, Search and Seizure of Computers, Recovering deleted evidences, Password Cracking	**9**
2	**Unit 2:** **Digital Forensics Fundamentals:** Introduction to Incident response, digital forensics stepwise procedure, Computer/network/Internet forensic and anti-forensics , Unix/Linux incident response, Unix/Linux forensics investigation steps and technologies, Memory forensics, Windows incident response tools , Windows forensics tools **Data and Evidence Recovery-** Introduction to Deleted File Recovery, Formatted Partition Recovery, Data Recovery Tools, Data Recovery Procedures and Ethics, Preserve and safely handle original media, Document a "Chain of Custody", Complete time line analysis of computer files based on file creation, file modification and file access, Recover Internet Usage Data, Recover Swap Files/Temporary Files/Cache Files, Introduction to Encase Forensic Edition, Forensic Tool Kit (FTK) etc, Use computer forensics software tools to cross validate findings in computer evidence-related cases, Dump Analysis, Browser forensics, Multimedia forensics, Taking RAM dump and Volatile Memory Analysis	**9**
3	**Unit 3:** **Software Security:** Memory Layout, Buffer Overflow, Code Injection, Other Memory Exploits, Format String Vulnerabilities, Defenses against low-level exploits: Memory Safety, Type Safety, Avoiding Exploitation, Return Oriented Programming, Control Flow Integrity, Secure Coding; Web Security: Basics, SQL Injection, Countermeasures, Session Hijacking, Cross Site Scripting, Program Analysis **Image Analysis**: Using software to analyze an image, Searching image for evidence, File carving	**10**

4	**Unit 4:** **Hardware Security:** Digital System Specification, Watermarking, Good Watermarks, Fingerprinting, Hardware metering, Physical Attacks and Countermeasures, Modular Exponentiation (ME) Basics, ME in Cryptography, ME Implementation and Vulnerability, Montgomery Reduction	**8**
5	**Unit 5:** **Analysis and Validation:** Types of Investigation Software, Validating Forensics Data, Data Hiding Techniques, Performing Remote Acquisition, Network Forensics, Email Investigations, Cell Phone and Mobile Devices Forensics, Virtual Machin Forensics, Cloud forensics, Live forensics **Case Studies:** Blackmailing, Credit-Card fraud, Hosting Obscene Profiles, Illegal money transfer, Fake Travel Agent	**8**
	Total	**44**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Bill Nelson, Amelia Phillips, Frank Enfinger, Christopher Steuart, —"Computer Forensics and Investigations", Cengage Learning, India Edition,	6th	2020
2	MarjieT.Britz, "Computer Forensics and Cyber Crime": An Introduction", 3rd Edition, Prentice Hall	3rd	2013
	Reference Books		
1.	Kenneth C.Brancik —"Insider Computer Fraud Auerbach Publications Taylor"; Francis Group	1st	2019
2	"CEH official Certfied Ethical Hacking Review Guide", Wiley India Edition,	1st	2015

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 761** Course Title: **Cloud Infrastructure Services**
2. Contact Hours: **L:** **T**: **0** **P**: **0**
3. Examination Duration (Hrs): **Theory** **3** **Practical** **0**
4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
5. Credits: **3**
6. Semester: **7**
7. Category of Course: **DE**
8. Pre-requisite: **TCS604, TCS651**

9. **Course Outcome**:**	After completion of the course the students will be able to: CO1: Demonstrate basics of cloud infrastructure. CO2: Distinguish the insight of cloud infrastructure. CO3: Distinguish different components of service oriented architecture. CO4: Evaluate the insight of the cloud storage. CO5: Evaluate the case study of the cloud infrastructure services. CO6: Design and deploy the cloud infrastructure services.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

SL. NO.	Contents	Contact Hours
1	**Unit - I** **Introduction to Cloud Infrastructure** Cloud Evolution, Cloud Services, Cloud Deployment Types, Main Challenges of Cloud Infrastructure, Cloud Reference Model, Cloud Management, Cloud Structure, Infrastructure Components, Cloud Layers, Cloud Relations, Cloud Dynamics, Data Types	**9**
2	**Unit - II** Exploring Cloud Infrastructures Managing the Cloud - Administrating the Clouds , Management responsibilities , Lifecycle management , Cloud Management Products ,Emerging Cloud Management Standards, DMTF cloud management standards, Cloud Commons and SMI ,Infrastructure Security : Network Level , Host Level , Application Level	**9**
3	**Unit – III** **Understanding Services Oriented Architecture** SOA : Introduction , Event driven SOA , SOA 2.0 , Enterprise Service Bus , Service catalogues, Defining SOA Communications , Managing & Monitoring SOA , SOA Security , Relating SOA & Cloud Computing	**10**
4	**Unit – IV** Exploring Cloud Infrastructure Services Overview of cloud Infrastructure Services, Measuring the Digital Universe: Cloud storage in the Digital Universe, Cloud storage definition, Provisioning Cloud Storage: Unmanaged cloud storage, Managed cloud storage, creating cloud storage systems, Virtual storage containers, Exploring Cloud Backup Solutions: Backup types, Cloud backup features, Cloud attached backup, Cloud Storage Interoperability: Cloud Data Management Interface (CDMI), Open Cloud Computing Interface (OCCI).	**9**
	Unit – V	**8**

5	Case Study: AWS Cloud Infrastructure Services AWS networking and databases: Virtual private clouds, Cloud models, Private DNS servers (Route 53)), Relational database service – DynamoDB, ElastiCache, Redshift. Case Study: AZURE Cloud Infrastructure Services Azure Virtual Machines, Azure Kubernetes Service (AKS), Azure Red Hat OpenShift, Azure Arc, Azure Stack HCI, Azure Stack Edge, Azure Stack Hub, Azure IoT	
	Total	**45**

11. **Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Barrie Sisisky,"Cloud Computing Bible", Published by Wiley Publishing, Inc.	1st	**2011**
2	Berners Lee, Godel and Turing, "Thinking on the Web" - Wiley inter science,	1st	2008.
3	Peter Mika, "Social Networks and the Semantic Web", Springer,	2nd	2007.
4	Thomas ,"Cloud Computing: Concepts, Technology & Architecture" ,Erl Published May	1st	2013
5	David S. Linthicum ,"Cloud Computing and SOA Convergence in your Enterprise, a step by step guide	2nd	2009

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TIT 721** Course Title: **Business Intelligence**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **7**
7. Category of Course: **DE**
8. Pre-requisite: TCS 509,TCS 571, TCS 671

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Understand the frameworks of Business Intelligence CO2: Categorize the structured, semi structured and unstructured data CO3: Create the schemas for data warehouse CO4: Perform the multi-dimensional data modeling CO5: Use of different visualization techniques CO6: Use of Business Intelligence for ERP

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** Business view of Information Technology Application Business Enterprise Organization, its functions, and core business process, Baldrige Business Excellence Framework: - Leadership, Strategic Planning, Customer Focus, Measurement, Analysis and Knowledge Management Workforce Focus, Process Management, Key Purpose of using IT in Business, Enterprise Application (ERP/CRM etc) and Bespoke IT Application.	9
2	**Unit 2:** Types of Digital Data, getting to know structured data, characteristics of structured data, were does structured data come from? Hassle free Retrieval Getting to know unstructured data, were does unstructured data comes from? How to manage unstructured data? How to store unstructured data? Solutions to storage challenges of unstructured data, how to extract information from stored unstructured data? UIMA: A possible solution for unstructured data Getting to know semi structured data, where does semi structured data come from? How to manage semi structured data, modeling semi structured data (OEM), How to extract information from semi structured data, XML: A solution for semi structured data Management.	9
3	**Unit 3:** Introduction to OLTP and OLAP OLTP:- Queries that an OLTP system can process, Advantage of an OLTP system, Challenges of an OLTP system, The queries that OLTP cannot answer. OLAP:-one dimension data, two-dimension data, three-dimension data, should we go beyond the third dimension, queries that an OLAP system can process, Advantage of an OLAP system Different OLAP Architecture: -MOLAP, ROLAP, HOLAP Data Models for OLTP and OLAP, Role of OLAP tools in the BI Architecture, OLAP operations on multidimensional data.	9
4	**Unit 4:** BI component framework: - Business layer, Administration and operational layer, Implementation layer. Who is BI for? - BI for Management, Operational BI, BI for process Improvement, BI to improve customer experience. Business Intelligence Application: -Technology Solutions, Business solutions. BI roles and Responsibility: -BI program team roles, BI project team roles, Best practice in BI/DW, Popular BI tools.	9

	Need for Data Warehouse, what is a Data Mart, Goals of a Data Warehouse. Multidimensional data modeling: - Data Modeling Basics, Types of Data model, Data Modeling Techniques, Fact table, Dimension table, Dimensional modeling life cycle.	
5	**Unit 5:** Measure, Metrics, KPIs, and Performance Management Understanding Measure and performance, Measurement system terminology, Fact based Decision Making and KPIS, KPI usage in companies. Basics of Enterprise Reporting: - Report standardization and presentation practices, Enterprise reporting characteristics in OLAP world, Balance score cards, Dashboards, how do you create Dashboards, Scorecards Vs Dashboards. BI and Cloud Computing, Business Intelligence for ERP systems	9
	Total	**45**

11. **Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Fundamentals of Business Analytics by R.N. Prasad and Seema Acharya, Wiley India	2nd	2016

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 756** Course Title: **Human Computer Interaction**
2. Contact Hours: **L:** 3 **T:** 0 **P:** 0
3. Examination Duration (Hrs): **Theory** 3 **Practical** 0
4. Relative Weight: **CIE** 25 **MSE** 25 **SEE** 50
5. Credits: 3
6. Semester: 7
7. Category of Course: **DE**
8. Pre-requisite: Fundamentals of Computer architecture

9. **Course Outcome****:	After completion of the course the students will be able to**:** CO1: Explain the capabilities of both humans and computers from the viewpoint of human information processing. CO2: Describe typical human–computer interaction (HCI) models, styles, and various historic HCI paradigms. CO3: Apply an interactive design process and universal design principles to designing HCI systems. CO4: Describe and use HCI design principles, standards, and guidelines. CO5: Analyze and identify user models, user support, socio-organizational issues, and stakeholder requirements of HCI systems. CO6: Discuss tasks and dialogs of relevant HCI systems based on task analysis and dialog design.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	**Contents**	**Contact Hours**
1	**Unit 1:** **Introduction:** Importance of user Interface – definition, importance of good design. Benefits of good design. A brief history of Screen design. The graphical user interface – popularity of graphics, the concept of direct manipulation, graphical system, Characteristics, Web user – Interface popularity, characteristics- Principles of user interface	8
2	**Unit 2:** **Design process** – Human interaction with computers, importance of human characteristics human consideration, Humaninteraction speeds, understanding business junctions	8
3	**Unit 3:** **Screen Designing**: Design goals – Screen planning and purpose, organizing screen elements, ordering of screen data and content – screen navigation and flow – Visually pleasing composition – amount of information – focus and emphasis – presentation information simply and meaningfully. information retrieval on web – statistical graphics – Technological consideration in interface design	9
4	**Unit 4:** Windows – New and Navigation schemes selection of window, selection of devicesbased and screen-based controls. Components – text and messages, Icons and increases – Multimedia, colors, uses problems, choosing colors.	9
5	**Unit 5:** Software tools – Specification methods, interface – Building Tools. Interaction Devices – Keyboard and function keys – pointing devices – speech recognition digitization and generation – image and video displays. – drivers	8

		Total	**41**

11. **Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	"The essential guide to user interface design", Wilbert O Galitz, Wiley DreamaTech.	2nd	2016
2.	"Designing the user interface". 3rd Edition Ben Shneidermann , Pearson Education Asia.	3rd	2009
	Reference Books		
1.	"Human – Computer Interaction". ALAN DIX, JANET FINCAY, GRE GORYD, ABOWD, RUSSELL BEALG, PEARSON.	3rd	2003

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 722** Course Title: **Data Warehousing and Data Mining**
2. Contact Hours: **L:** **3** **T**: **0** **P**: **0**
3. Examination Duration (Hrs): **Theory** **3** **Practical** **0**
4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
5. Credits: **3**
6. Semester: **VII**
7. Category of Course: **DE**
8. Pre-requisite: Excellent knowledge of Database Management Systems

9. **Course Outcome:**	After completion of the course the students will be able to**:** CO1: Describe the fundamental concepts, benefits and problem areas associated with data warehousing. CO2: Understand the various architectures and main components of a data warehouse. CO3: Identify the issues that arise when implementing a data warehouse. CO4: Examine the techniques applied in data mining. CO5: Compare and contrast OLAP and data mining as techniques for extracting knowledge from a data warehouse. CO6: Develop the association rules for mining

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** Data Warehousing: Overview, Definition, Delivery Process, Difference between Database System and Data Warehouse, Multi Dimensional Data Model, Data Cubes, Stars, Snow Flakes, Fact Constellations, Concept hierarchy, Process Architecture, 3 Tier Architecture, Data Marting	9
2	**Unit 2:** Aggregation, Historical information, Query Facility, OLAP function and Tools. OLAP Servers, ROLAP, MOLAP, HOLAP, Data Mining interface, Security, Backup and Recovery, Tuning Data Warehouse, Testing Data Warehouse	8
3	**Unit 3:** Overview, Motivation (for Data Mining), Data Mining-Definition & Functionalities, Data Processing, Form of Data Preprocessing, Data Cleaning: Missing Values, Noisy Data,(Binning, Clustering, Regression, Computer and Human inspection), Inconsistent Data, Data Integration and Transformation. Data Reduction:-Data Cube Aggregation, Dimensionality reduction, Data Compression, Numerosity Reduction, Clustering, Discretization and Concept hierarchy generation	9
4	**Unit 4:** Concept Description: - Definition, Data Generalization, Analytical Characterization, Analysis of attribute relevance, Mining Class comparisons, Statistical measures in large Databases. Measuring Central Tendency, Measuring Dispersion of Data, Graph Displays of Basic Statistical class Description, Mining Association Rules in Large Databases, Association rule mining, mining Single-Dimensional Boolean Association rules from Transactional Databases– Apriori Algorithm, Mining Multilevel Association rules from Transaction Databases and Mining Multi-Dimensional Association rules from Relational Databases	8
5	**Unit 5:** Classification & Prediction, Issues regarding Classification and prediction, Decision tree, Bayesian Classification, Classification by Back	9

	propagation, Multilayer feed-forward Neural Network, Back propagation Algorithm, Classification methods K-nearest neighbor classifiers, Genetic Algorithm. Cluster Analysis: Data types in cluster analysis, Categories of clustering methods, Partitioning methods. Hierarchical Clustering- CURE and Chameleon, Density Based Methods-DBSCAN, OPTICS, Grid Based Methods- STING, CLIQUE, Model Based Method –Statistical Approach, Neural Network approach, Outlier Analysis	
	Total	**43**

11. **Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Jiawei Han, Micheline Kamber, Jian Pei, "Data Mining: Concepts and Techniques", Morgan Kaufmann	3rd	2011
2.	M.H Dunham, "Data Mining: Introductory and Advanced Topics", Pearson Education	1st	2006
	Reference Books		
1.	A. Berson, S.Smith, "Data Warehousing, Data Mining, and OLAP, McGraw Hill Education	1st	1997

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 723** Course Title: **Distributed Systems**
2. Contact Hours: **L:** 3 **T:** 0 **P:** 0
3. Examination Duration (Hrs): **Theory** 3 **Practical** 0
4. Relative Weight: **CIE** 25 **MSE** 25 **SEE** 50
5. Credits: **3**
6. Semester: **VII**
7. Category of Course: **DE**
8. Pre-requisite: **TCS 604**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Characterize Distributed Systems and understand the Theoretical Foundations for Distributed Systems CO2: Evaluate various distributed mutual exclusion algorithms CO3: Demonstrate knowledge of deploying different distributed deadlock algorithms in various models of distributed systems. CO4: Determine the appropriate use of different Agreement protocols CO5: Identify the state of a distributed system to apply the appropriate context of commit protocols CO6: Utilize real life DFS (NFS4 and GFS) to examine work of distributed file systems

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

SL. NO.	**Contents**	**Contact Hours**
1	**Unit 1:** Characterization of Distributed Systems: Introduction, Examples of distributed Systems, Resource sharing Theoretical Foundation for Distributed System: Limitation of Distributed system, absence of global clock, shared memory, Logical clocks, Lamport's& vector logical clocks, Causal ordering of messages, Birman-Schiper-Stephenson protocol, Global State: Chandy-Lamport algorithm, Termination detection: Huang's Algorithm	**9**
2	**Unit 2:** Distributed Mutual Exclusion: Classification of distributed mutual exclusion, Requirements of mutual exclusion algorithms, Performance metric for distributed mutual exclusion algorithms. Non-Token Based Algorithms: Lamport, Ricart-Agrawala, Rouicarol-Carvalho; Quorum Based Algorithms: Maekawa; Token-Based Algorithms: Suzuki-Kasami Leader Election in a Ring: LeLann& Chang-Robert's Algorithm, Hirshberg-Sinclair Algorithm	**10**
3	**Unit 3:** Distributed Deadlock Detection: system model, Wait for Graphs, Deadlock handling strategies, Centralized dead lock detection, Path pushing algorithms, Chandy's et all edge chasing algorithm. Agreement Protocols: Introduction, System models, classification of Agreement Problem, Byzantine agreement problem, Consensus problem, Interactive consistency Problem, Byzantine Agreement problem, Application of Agreement problem	**8**
4	**Unit 4:** Commit Protocols: Distributed Transactions, Transaction System Architecture, System Failure modes, Two Phase commit protocol, Handling of Failures: Site failure, Coordinator failure, Network Partition, Recovery and Concurrency Control, Three Phase Commit protocol	**9**

	Self Stabilization: Definition, Randomized Self Stabilization, Probabilistic Self stabilization, Issues in design of self-stabilization algorithms, Dijkstra's self-stabilizing token ring	
5	**Unit 5:** Distributed file systems: Design Goals, DFS architecture, Naming Schemes, Mounting Remote Directories, Caching to improve performance, Design issues of cache, cache location, Cache update policies, Cache consistency, Sharing semantics in DFS, Stateless vs Stateful service NFS, Basic NFS architecture, Caching in NFS3, NFS v4 improvements, NFSv4 details: Compounding, Open/Close, Locking, Caching, Open Delegation, Recalling Delegation, Replication and Security Case Study: Google File System(GFS): Design constraints, Architectural Design, GFS Architecture, Single Master Design, Chunk Size, Metadata, System Interactions, Write process, Consistency Model, Master Operations, Locking Operations, Replica Placements, Garbage collection, Fault Tolerance and Diagnosis	**10**
	Total	**46**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Singhal & Shivaratri, "Advanced Concept in Operating Systems", McGraw Hill	1st	**2007**
2	Coulouris, Dollimore, Kindberg, "Distributed System: Concepts and Design", Pearson Ed.	4th	**2008**
3	Gerald Tel, "Distributed Algorithms", Cambridge University Press LaxmiPublicationa (P) Ltd., New Delhi.	2nd	2000

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 799** Course Title: **Software verification validation and testing**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **7**
7. Category of Course: **DE**

8. Pre-requisite: **TIT 501**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Demonstrate the application of verification and validation tasks and their outcomes during the software life cycle. CO2: Apply various verification and validation techniques based on various characteristics of the system/software (safety, security, risk, etc). CO3: Differentiate between the overall role of verification and validation and the specific role of software/system testing. CO4: Compare and Contrast the theoretical and practical limitations to software verification and validation analysis. CO5: Apply appropriate planning and scoping to a verification and validation effort based on the needs of the software system being developed. CO6: Develop a software verification and validation plan that reflects an understanding of verification and validation objectives, and appropriate problem/risk identification and tracking.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

SL. NO.	**Contents**	**Contact Hours**
1	**Unit 1:** **Introduction:** What is software testing and why it is so hard?, Error, Fault, Failure, Incident, TestCases, Testing Process, Limitations of Testing, No absolute proof of correctness, Overview of Graph Theory.	**11**
2	**Unit 2:** **Functional Testing:** Boundary Value Analysis, Equivalence Class Testing, Decision Table Based Testing, Cause Effect Graphing Technique. **Structural Testing:** Path testing, DD-Paths, Cyclomatic Complexity, Graph Metrics, Data Flow Testing, Mutation testing.	**12**
3	**Unit 3:** **Reducing the number of test cases:** Prioritization guidelines, Priority category, Scheme, Risk Analysis, Regression Testing, Slice based testing	**12**
4	**Unit 4:** **Testing Activities:** Unit Testing, Levels of Testing, Integration Testing, System Testing, Debugging, Domain Testing.	**10**
5	**Unit 5:** **Object Oriented Testing:** Issues in Object Oriented Testing, Class Testing, GUI Testing, Object Oriented Integration and System Testing.**Testing Tools:** Static Testing Tools, Dynamic Testing Tools, Characteristics of Modern Tools.	
	Total	**45**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	William Perry, “Effective Methods for Software Testing”, John Wiley & Sons, New York,.	3rd	2006
2	CemKaner, Jack Falk, Nguyen Quoc, “Testing Computer Software”, Second Edition, Van Nostrand Reinhold, New York,.	2nd	1993
3	Boris Beizer, “Software Testing Techniques”, Second Volume, Second Edition, Van Nostrand Reinhold, New York,	2nd	1990.
4	Louise Tamres, “Software Testing”, Pearson Education Asia,	1st	2002
	Reference Books		
1.	Roger S. Pressman, “Software Engineering – A Practitioner’s Approach”, Fifth Edition, McGraw-Hill International Edition, New Delhi,	8th	2019
2	Boris Beizer, “Black-Box Testing – Techniques for Functional Testing of Software and Systems”, John Wiley & Sons Inc., New York,.	1st	1995
3	K.K. Aggarwal & Yogesh Singh, “Software Engineering”, New Age International Publishers, New Delhi,.	1st	2003
4	Marc Roper, “Software Testing”, McGraw-Hill Book Co., London,.	2nd	1994
5	Gordon Schulmeyer, “Zero Defect Software”, McGraw-Hill, New York,.	3rd	1990
6	Watts Humphrey, “Managing the Software Process”, Addison Wesley Pub. Co. Inc., Massachusetts,.	1st	1989
7	Boris Beizer, “Software System Testing and Quality Assurance”, Van Nostrand Reinhold, New York, .	1st	1984
8	Glenford Myers, “The Art of Software Testing”, John Wiley & Sons Inc., New York,.	1st	1979

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS781** Course Title: **Deep Learning**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **7**
7. Category of Course: **DE**
8. Pre-requisite: **Fundamental of Machine Learning (TCS333)**

   Python Programming (TCS434)

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: To understand the fundamental concepts and principles of deep learning. CO2: To evaluate and use the most important concepts and the methods in the area ML and deep learning. CO3: Examine modern practical deep networks. CO4: Know deep Learning Research Areas. CO5: Use software libraries of deep learning CO6: Use deep learning models.

. *** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** Introduction to deep learning: basics of Machine Learning, Machine Learning vs Deep Learning, deep learning process, neural network,	8
2	**Unit 2:** Modern practical deep networks: Deep Feed forward Networks, Regularization for Deep Learning, Optimization for Training Deep Models, Convolutional Networks, Variants of CNN: DenseNet, PixelNet	9
3	**Unit 3:** Popular CNN Architectures: ResNet, AlexNet, Sequence Modeling: Recurrent and Recursive Nets, Practical Methodology, Applications, Transfer learning Techniques,	9

4	**Unit 4:** Deep Learning Research: Linear Factor Models, Auto-encoders, Representation Learning, Structured Probabilistic Models for Deep Learning, Monte Carlo Methods, Confronting the Partition Function, Approximate Inference Deep Generative Models.	8
5	**Unit 5:** Deep Learning Platforms and Software Libraries: What is a Deep Learning Platform? H2O.ai, Data GraphLab, Deep Learning Libraries, Theano, Caffe, TensorFlow	10
	Total	**44**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	Ellis Horowitz and Sartaj Sahni, Fundamentals of Data Structures in C, Universities Press	1st	2014
2.	Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017.	1st	2017
3.	Umberto Michelucci "Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks" Apress, 2018.	1st	2018
4.	Giancarlo Zaccone, Md. Rezaul Karim, Ahmed Menshawy "Deep Learning with TensorFlow: Explore neural networks with Python", Packt Publisher, 2017.	2nd	2017
	Reference Books		
1.	Deep Learning A Practitioner's Approach Josh Patterson and Adam Gibson O'Reilly Media, Inc.2017	2nd	2017

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Name of Department: - Computer Science and Engineering

1.	Subject Code:	**TCS-734**	Course Title: Robotic Process Automation Design and Development
2.	Contact Hours:	**L:** **3**	**T**: **0** **P**: **0**
3.	Examination Duration (Hrs):	**Theory** **3**	**Practical** **0**
4.	Relative Weight:	**CIE** **25**	**MSE** **25** **SEE** **50**
5.	Credits:	**3**	
6.	Semester:	**7**	
7.	Category of Course:	**DE**	
8.	Pre-requisite:	Design and Analysis of Algorithms (TCS-409), Programming for Problem Solving (TCS-201)	

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: To Understand the basic concepts of RPA CO2: To Describe various components and platforms of RPA CO3: To Describe the different types of variables, control flow and data manipulation techniques CO4: To Understand various control techniques and OCR in RPA CO5: To Describe various types and strategies to handle exceptions CO6: To Discuss the benefits of RPA

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate*

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** RPA Foundations- What is RPA – Flavors of RPA- History of RPA- The Benefits of RPA- The downsides of RPA- RPA Compared to BPO, BPM and BPA – Consumer Willingness for Automation- The Workforce of the Future- RPA Skills-On-Premise Vs. the Cloud- Web Technology- Programming Languages and Low Code- OCR-Databases-APIs- AI-Cognitive Automation- Agile, Scrum, Kanban and Waterfall0 DevOps- Flowcharts.	10
2	**Unit 2:**	8

	RPA Platforms- Components of RPA- RPA Platforms-About Ui Path- About UiPath - The future of automation - Record and Play - Downloading and installing UiPath Studio -Learning Ui Path Studio- - Task recorder - Step-by-step examples using the recorder.	
3	**Unit 3:** Sequence, Flowchart, and Control Flow-Sequencing the workflow-Activities-Control flow, various types of loops, and decision making-Step-by-step example using Sequence and Flowchart-Step-by-step example using Sequence and Control flow-Data Manipulation-Variables and Scope-CollectionsArguments – Purpose and use-Data table usage with examples-Clipboard management-File operation with step-by-step example-CSV/Excel to data table and vice versa (with a step-by-step example).	9
4	**Unit 4:** Taking Control of the Controls- Finding and attaching windows- Finding the control- Techniques for waiting for a control- Act on controls – mouse and keyboard activities- Working with UiExplorerHandling events- Revisit recorder- Screen Scraping- When to use OCR- Types of OCR available- How to use OCR- Avoiding typical failure points.	9
5	**Unit 5:** Exception Handling, Debugging, and Logging- Exception handling- Common exceptions and ways to handle them- Logging and taking screensHOT-Debugging techniques- Collecting crash dumps- Error reporting- Future of RPA	9
	Total	**45**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Tom Taulli , The Robotic Process Automation Handbook : A Guide to Implementing RPA Systems, Publisher : Apress	1st	2020
2.	Alok Mani Tripathi, Learning Robotic Process Automation, Publisher: Packt Publishing Release	1st	2018
	Reference Books		
1.	Frank Casale, Rebecca Dilla, Heidi Jaynes, Lauren Livingston, “Introduction to Robotic Process Automation: a Primer”, Institute of Robotic Process Automation.	1st	2015
2.	Richard Murdoch, Robotic Process Automation: Guide To Building Software Robots, Automate Repetitive Tasks & Become An RPA Consultant	1st	2018
3.	Srikanth Merianda,Robotic Process Automation Tools, Process Automation and their benefits: Understanding RPA	1st	2018

	and Intelligent Automation, Consulting Opportunity Holdings Llc		

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 795** Course Title: **Cryptography and Network Security**
2. Contact Hours: **L:** **3** **T**: **0** **P**: **0**
3. Examination Duration (Hrs): **Theory** **3** **Practical** **0**
4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
5. Credits: **3**
6. Semester: **VII**
7. Category of Course: **DE**
8. Pre-requisite: **Subject Name with Code**

9. **Course Outcome **:**	After completion of the course the students will be able to**:** CO1: Classify security vulnerabilities involved in data communication over Internet and make use of classical algorithms to address the vulnerabilities. CO2: Make use of modern block ciphers to secure data transmission and storage CO3: Analyze challenges involved in key distribution and select approach that can be adopted CO4: Analyze strengths of public key algorithms and explore applications in exchange, authentication and hashing of messages. CO5: Appreciate application of algorithms for ensuring access control, authentication, secured transmission of data at different layers. CO6: Appraiserisks related to wireless, web, cloud security and measures to be adopted to secure organizational network.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

SL. NO.	Contents	Contact Hours
1	**Unit 1:** Introduction to security attacks, services and mechanism, introduction to cryptography. Conventional Encryption: Conventional encryption model, classical encryption techniques- substitution ciphers and transposition ciphers, cryptanalysis, stenography, stream and block ciphers.	8

2	**Unit 2:** Modern Block Ciphers: Block ciphers principals, Shannon's theory of confusion and diffusion, Modes of operations of block ciphers: ECB, CBC, OFB, CFB, Advanced Encryption Standard (AES) Traffic confidentiality, Key distribution, random numbers, Pseudo random number generation using Linear Congruential and Blum BlumShub algorithms	**10**
3	**Unit 3:** Prime and relative prime numbers, modular arithmetic, Primality testing, Euclid's Algorithm for GCD and Extended Euclid's Algorithm for Multiplicative inverse Principals of public key crypto systems, RSA algorithm, security of RSA, key management, Diffle-Hellman key exchange algorithm Message Authentication: Requirements, Message Authentication Functions Cryptographic Hash Functions:Applications of Cryptographic Hash Functions, Secure Hash Algorithm (SHA)-512	**8**
4	**Unit 4:** Authentication Applications: Kerberos and X.509 directory authentication service, electronic mail security-S /MIME IP Security: Architecture, Authentication header, Encapsulating security payloads, combining security associations, key management.	**9**
5	**Unit 5:** Wireless Network Security: Wireless Network Threats, Wireless Security Measures, Mobile Device Security, Security Threats and Security Strategy, IEEE 802.11 Wireless LAN Overview, The Wi-Fi Alliance, IEEE 802 Protocol Architecture, IEEE 802.11 Network Components and Architectural Model, IEEE 802.11 Services.**Concept of Wireless LAN security and brief of phases of operation** Web and Cloud Security: Web Security Considerations, Transport Layer Security, HTTPS,Cloud Security risks and Countermeasures; Data protection in cloud. System Security: The Need for Firewalls, Firewall Characteristics, Types of Firewalls	**10**
	Total	**45**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	William Stallings, "Cryptography and Network Security: Principals and Practice", 7th Edition, Pearson,	7th	2017
2	William Stallings, "Network Security Essentials – Applications and Standards", 4th edition, Pearson Education,	4th	2011
	Reference Books		

1.	Behrouz A Forouzan, Debdeep Mukhopadhyay, "Cryptography and Network Security"Mc-GrawHill, 3rd Edition,	3rd	2015
2	Johannes A. Buchmann, "Introduction to Cryptography", Springer-Verlag,	2nd	2012

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 706** Course Title: **Artificial Intelligence**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **VII**
7. Category of Course: **DE**
8. Pre-requisite: **Basics of mathematics and database are required**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Understand the basics of the theory and practice of Artificial Intelligence. CO2: Learn the basics of Artificial Intelligence programming. CO3: Understand various searching techniques use to solve the AI problems. CO4: Apply knowledge representation techniques and problem-solving strategies to common AI applications. CO5: Build self-learning and research skills to tackle a topic of interest on his/her own or as part of a team. CO6: Apply the knowledge of AI and agents in developing multidisciplinary real world projects.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

SL. No.	Contents	Contact Hours
1	**Unit 1:** **Introduction**Introduction to Artificial Intelligence, Simulation of sophisticated & Intelligent Behavior indifferent area, problem solving in games, natural language, automated reasoning visualperception, heuristic algorithm versus solution guaranteed algorithms.	**10**
2	**Unit 2:** **Understanding Natural Languages** Parsing techniques, context free and transformational grammars, transition nets, augmentedtransition nets, Fillmore's grammars, Shanks Conceptual Dependency, grammar free analyzers, sentence generation, and translation.	**9**
3	**Unit 3:** **Knowledge Representation**	**10**

	First order predicate calculus, Horn Clauses, Introduction to PROLOG, Semantic NetsPartitioned Nets, Minskey frames, Case Grammar Theory, Production Rules KnowledgeBase, The Inference System, Forward & Backward Deduction	
4	**Unit 4:** **Expert System** Existing Systems (DENDRAL, MYCIN), domain exploration, Meta Knowledge, Expertise Transfer, Self Explaining System	**9**
5	**Unit 5:** **Pattern Recognition** Introduction to pattern Recognition, Structured Description, Symbolic Description, Machineperception, Line Finding, Interception, Semantic, & Model, Object Identification, SpeechRecognition. **Programming Language:** Introduction to programming Language, LISP, PROLOG	**8**
	Total	**46**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Charnick “Introduction to Artificial Intelligence.” Addision Wesley.	2nd	2010
2.	Rich & Knight, “Artificial Intelligence”.TMH	3rd	2017
3.	Winston, “LISP”, Addison Wesley.	1st	1989
4.	Marcellous, “Expert Systems Programming”, PHI.	1st	1989
	Reference Books		
1.	Charnick “Introduction to Artificial Intelligence.” Addision Wesley.	1st	2010
2.	Rich & Knight, “Artificial Intelligence”.TMH	3rd	2017
3.	Winston, “LISP”, Addison Wesley.	2nd	1989
4.	Marcellous, “Expert Systems Programming”, PHI.	1st	1989

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS-762** Course Title: **NoSQL Database**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **7**
7. Category of Course: **DC**
8. Pre-requisite: **TCS-462, TCS-663**

9. **Course Outcome**:**	After completion of the course the students will be able to: CO1: Demonstrate an understanding of the detailed architecture of Column Oriented NoSQL databases, Document databases, Graph databases. CO2: Make use of the concepts pertaining to all the types of databases CO3: Apply performance tuning on Column-oriented NoSQL databases and Document-oriented NoSQL Databases. CO4: Analyze the structural Models of NoSQL. CO5: Evaluate several applications for location based service and recommendation services. Devise an application using the components of NoSQL. CO6: Develop various applications using NoSQL databases.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** Why NoSQL? The Value of Relational Databases, Getting at Persistent Data, Concurrency, Integration, A (Mostly) Standard Model, Impedance Mismatch, Application and Integration Databases, Attack of the Clusters, The Emergence of NoSQL. **Aggregate Data Models:** Aggregates, Example of Relations and Aggregates, Consequences of Aggregate Orientation, Key-Value and Document Data Models, Column-Family Stores, Summarizing AggregateOriented Databases.	10

	More Details on Data Models: Relationships, Graph Databases, Schemaless Databases, Materialized Views, Modeling for Data Access	
2	**Unit 2:** **Distribution Models:** Single Server, Sharding, Master-Slave Replication, Peer-to-Peer Replication, Combining Sharding and Replication Consistency, Update Consistency, Read Consistency, Relaxing Consistency, The CAP Theorem, Relaxing Durability, Quorums. Version Stamps, Business and System Transactions, Version Stamps on Multiple Nodes	8
3	**Unit 3:** **Map-Reduce:** Basic Map-Reduce, Partitioning and Combining, Composing Map-Reduce Calculations, A Two Stage Map-Reduce Example, Incremental Map-Reduce **Key-Value Databases:** What Is a Key-Value Store, Key-Value Store Features, Consistency, Transactions, Query Features, Structure of Data, Scaling, Suitable Use Cases, Storing Session Information, User Profiles, Preference, Shopping Cart Data, When Not to Use, Relationships among Data, Multioperation Transactions, Query by Data, Operations by Sets	9
4	**Unit 4:** **Document Databases:** What Is a Document Database?, Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, Event Logging, Content Management Systems, Blogging Platforms, Web Analytics or Real-Time Analytics, E- Commerce Applications, When Not to Use, Complex Transactions Spanning Different Operations, Queries against Varying Aggregate Structure	9
5	**Unit 5:** **Graph Databases:** What Is a Graph Database?, Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, Connected Data, Routing, Dispatch, and Location-Based Services, Recommendation Engines, When Not to Use	9
	Total	**45**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	Sadalage, P. & Fowler, NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Pearson Addision Wesley	1st	2012

	Reference Books		
1.	Dan Sullivan, "NoSQL For Mere Mortals", Pearson Education India	1st	2015
2.	Dan McCreary and Ann Kelly, "Making Sense of NoSQL: A guide for Managers and the Rest of us", Manning Publication/Dreamtech Press	1st	2013
3.	Kristina Chodorow, "Mongodb: The Definitive Guide- Powerful and Scalable Data Storage", O'Reilly Publications	2nd	2013

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 763** Course Title: **Social and Web Analytics**
2. Contact Hours: **L:** **3** **T**: **0** **P**: **0**
3. Examination Duration (Hrs): **Theory** **3** **Practical** **0**
4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
5. Credits: **3**
6. Semester: **7**
7. Category of Course: **DE**
8. Pre-requisite: **TCS 341, TCS 462**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Be able to understand social media, web and social media analytics, and their potential impact. CO2: Be able to identify key performance indicators for a given goal, identify data relating to the metrics and key performance indicators. CO3: Be able to design and analyze understand usability metrics, web, and social media metrics. CO4: Be able to use ready-made web analytics tools (Google Analytics) CO5: Be able to understand a statistical programming language (R) and use its graphical development environment (Deduce) for data exploration and analysis. CO6: Be able to create web analytics solutions for Real World Problems

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	**Contents**	**Contact Hours**
1	**Unit 1:** Web and social media (Web sites, web apps, mobile apps and social media), Usability, user experience, customer experience, customer sentiments, web marketing, conversion rates, ROI, brand reputation, competitive advantages , Web analytics and a Web analytics 2.0 framework (clickstream, multiple outcomes analysis, experimentation and testing, voice of customer, competitive intelligence, Insights)	**8**
2	**Unit 2:**	**10**

	Data (Structured data, unstructured data, metadata, Big Data and Linked Data), Lab testing and experiment design (selecting participants, within-subjects or between subjects' study, counter balancing, independent and dependent variable; A/B testing, multivariate testing, controlled experiments) Data analysis basics (types of data, metrics and data, descriptive statistics, comparing means, correlations, nonparametric tests, presenting data graphically)	
3	**Unit 3:** Measuring user experience - Usability metrics (performance metrics, issues-based metrics, self-reported metrics), Planning and performing a usability study (study goals, user goals, metrics and evaluation methods, participants, data collection, data analysis), Typical types of usability studies and their corresponding metrics (comparing alternative designs, comparing with competition, completing a task or transaction, evaluating the impact of subtle changes)	**9**
4	**Unit 4:** Web metrics and web analytics- PULSE metrics (Page views, Uptime, Latency, Seven-day active users) on business and technical issues; HEART metrics (Happiness, Engagement, Adoption, Retention, and Task success) on user behavior issues; On-site web analytics, off-site web analytics, the goal-signal-metric process.	**9**
5	**Unit 5:** Social media analytics – Introduction, Social media KPIs (reach and engagement), Performing social media analytics (business goal, KPIs, data gathering, analysis, measure and feedback), Data analysis language and tools: Ready-made tools for Web and social media analytics (Key Google Analytics metrics, Dashboard, social reports) Statistical programming language (R), its graphical development environment (Deducer) or data exploration and analysis, and its social media analysis packages	**10**
	Total	**49**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	Avinash Kaushik, Web Analytics 2.0: The Art of Online Accountability and Science of Customer Centricity, Sybex	1st	2009

2	Matthew Ganis, Avinash Kohirkar ,Social Media Analytics: Techniques and Insights for Extracting Business Value Out of Social Media, IBM Press	1st	2015
	Reference Books		
1.	Marshall Sponder, Social Media Analytics: Effective Tools for Building, Interpreting, and Using Metrics, McGraw Hill	1st	2014

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 797** Course Title: **Deep Learning**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **7**
7. Category of Course: **DC**
8. Pre-requisite: **Fundamental of Machine Learning (TCS333), Python Programming (TCS434)**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: To understand the fundamental concepts and principles of deep learning. CO2: To evaluate and use the most important concepts and the methods in the area ML and deep learning. CO3: Examine modern practical deep networks. CO4: Know deep Learning Research Areas. CO5: Use software libraries of deep learning CO6: Use deep learning models.

*. ** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** Introduction to deep learning: basics of Machine Learning, Machine Learning vs Deep Learning, deep learning process, neural network,	8
2	**Unit 2:** Modern practical deep networks: Deep Feed forward Networks, Regularization for Deep Learning, Optimization for Training Deep Models, Convolutional Networks, Variants of CNN: DenseNet, PixelNet	9
3	**Unit 3:** Popular CNN Architectures: ResNet, AlexNet, Sequence Modeling: Recurrent and Recursive Nets, Practical Methodology, Applications, Transfer learning Techniques,	9

4	**Unit 4:** Deep Learning Research: Linear Factor Models, Auto-encoders, Representation Learning, Structured Probabilistic Models for Deep Learning, Monte Carlo Methods, Confronting the Partition Function, Approximate Inference Deep Generative Models.	8
5	**Unit 5:** Deep Learning Platforms and Software Libraries: What is a Deep Learning Platform? H2O.ai, Data GraphLab, Deep Learning Libraries, Theano, Caffe, TensorFlow	10
	Total	**44**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Ellis Horowitz and Sartaj Sahni, Fundamentals of Data Structures in C, Universities Press		2014
2.	Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017.		2017
3.	Umberto Michelucci “Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks” Apress, 2018.		2018
4.	Giancarlo Zaccone, Md. Rezaul Karim, Ahmed Menshawy "Deep Learning with TensorFlow: Explore neural networks with Python", Packt Publisher, 2017.		2017
	Reference Books		
1.	Deep Learning A Practitioner’s Approach Josh Patterson and Adam Gibson O’Reilly Media, Inc.2017		2017

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 743** Course Title: **Evolutionary Computation**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **7**
7. Category of Course: **DE**
8. Pre-requisite: **TCS 302 Data Structures with C**

9. **Course Outcome**:**	After completion of the course the students will be able to: CO1: Understand the relations between the most important evolutionary algorithms. CO2: Understand the implementation issues of evolutionary algorithms. CO3: Determine the appropriate parameter settings to make different evolutionary algorithms work well. CO4: Design new evolutionary operators, representations, and fitness functions

*. ** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

Sl. No.	Contents	Contact Hours
1	Introduction to Models and Concept of Computational Intelligence, Social Behavior as Optimization: Discrete and Continuous Optimization Problems, Classification of Optimization Algorithms, Optimization background and terminology: Gradient optimization methods, sampling methods, linear programming, combinatorial optimization. Evolutionary Biology background: Genotype and phenotype, unit of selection, genes and traits, chromosomes, alleles, diploid and haploid, fitness, mutation and recombination.	10
2	Selection, variation and landscapes. The strengths and weaknesses of the evolutionary model. Inductive bias. The No free lunch theorem. Genetic Algorithms: Representation, operators, and standard algorithm. Evolutionary strategies: Evolution in continuous variables. Transformations. Genetic Programming.	8

3	Building blocks and architecture-altering operators. Libraries and Trees. Selection mechanisms: Fitness proportionate, rank, tournament, Stochastic Universal Sampling and Boltzman selection methods. Niching methods. Spatial methods. Artificial landscapes and test functions: The Two-armed bandit problem. Gene Expression Programming, Multi-modal and deceptive functions. Royal roads. N-k landscapes.	8
4	Hierarchical and fractal functions. Pareto evolution. Co-evolution: Multiple populations and single-population co-evolution, Multiobjective evolutionary algorithms: Plasticity and life-time learning. Lamarckian learning, The Baldwin effect. Symbiosis as a source of evolutionary innovation. Macro-mutations, Tabu Search: Tabu Tenure, Cycle Detection & Aspiration Criterion, Reactive Tabu Search.	8
5	Swarm Intelligence Techniques: Particle Swarm Optimization, Ant Colony Optimization, Artificial Bees and Firefly Algorithm, Hybridization and Comparisons of Swarm Techniques, Application of Swarm Techniques in Different Domains and Real-World Problems	8
	Total	

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Melanie Mitchell, “An introduction to genetic algorithms”, MIT Press.	1st	1998
2	A.P. Engelbrecht, “Computational Intelligence: An Introduction”, Wiley.	2nd	2007
	Reference Books		
1.	D. E. Goldberg , “Genetic Algorithm in Search Optimization and Machine Learning”, Pearson Education	1st	2008

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 742** Course Title: **Deep Learning**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **7th**
7. Category of Course: **DC**
8. Pre-requisite: **Fundamental of Machine Learning (TCS333)**
   Python Programming (TCS434)

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: To understand the fundamental concepts and principles of deep learning. CO2: To evaluate and use the most important concepts and the methods in the area ML and deep learning. CO3: Examine modern practical deep networks. CO4: Know deep Learning Research Areas. CO5: Use software libraries of deep learning CO6: Use deep learning models.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** Introduction to deep learning: basics of Machine Learning, Machine Learning vs Deep Learning, deep learning process, neural network,	8
2	**Unit 2:** Modern practical deep networks: Deep Feed forward Networks, Regularization for Deep Learning, Optimization for Training Deep Models, Convolutional Networks, Variants of CNN: DenseNet, PixelNet	9
3	**Unit 3:** Popular CNN Architectures: ResNet, AlexNet, Sequence Modeling: Recurrent and Recursive Nets, Practical Methodology, Applications, Transfer learning Techniques,	9

4	**Unit 4:** Deep Learning Research: Linear Factor Models, Auto-encoders, Representation Learning, Structured Probabilistic Models for Deep Learning, Monte Carlo Methods, Confronting the Partition Function, Approximate Inference Deep Generative Models.	8
5	**Unit 5:** Deep Learning Platforms and Software Libraries: What is a Deep Learning Platform? H2O.ai, Data GraphLab, Deep Learning Libraries, Theano, Caffe, TensorFlow	10
	Total	**44**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
2.	Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017.	1st	2017
3.	Umberto Michelucci "Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks" Apress, 2018.	1st	2018
4.	Giancarlo Zaccone, Md. Rezaul Karim, Ahmed Menshawy "Deep Learning with TensorFlow: Explore neural networks with Python", Packt Publisher, 2017.	1st	2017
	Reference Books		
1.	Deep Learning A Practitioner's Approach Josh Patterson and Adam Gibson O'Reilly Media, Inc.2017	1st	2017

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Name of Department: - Computer Science and Engineering

1.	Subject Code:	**TCS 791**		Course Title:	**Internet Security**		
2.	Contact Hours:	**L:** 3		**T:** 0		**P:** 0	
3.	Examination Duration (Hrs):		**Theory** 3		**Practical** 0		
4.	Relative Weight:	**CIE** 25		**MSE** 25		**SEE** 50	
5.	Credits:	3					
6.	Semester:	7					
7.	Category of Course:	**DC**					

8.Pre-requisite: **Computer Organization TCS 404, Java Programming Language TCS 408**

9. **Course Outcome**:**	After completion of the course, the students will be able to: CO1: Explain the architecture of the Internet. CO2: Know the working of Internet security mechanisms. CO3: Use cryptography to secure various applications. CO4: Analyze various network security mechanisms. CO5: Apply security mechanisms to protect online systems. CO6: Develop Internet security protocols.

*** Describe the specific knowledge, skills, or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

Sl. No.	**Contents**	**Contact Hours**
1	Unit 1: **Introduction and Overview:** Internet Architecture, How the Internet Works (high-level overview), IP address.	5
2	Unit 2: **Internet SecurityMechanism:** Denial-of-Service, Traceback, DoS Defence, Network Intrusion Detection	10

	Systems, Fundamental NIDS Issues,NIDS Evaluation, Scanning (NMAP, Nessus, NetTools, Smart Whois), Anonymity Tor browser	
3	Unit 3: **Cryptography Basics andApplications:** Secret Key encryption, DES, AES, One-way Hash functions, MD5, SHA-1 and SHA-2, collision attacks, Diffie-Hellman Key Exchange, Public-Key Encryption (RSA), Digital Signatures, Public-key Infrastructure (PKI).	10
4	**Unit 4:** **Network SecurityMechanisms:** Ip Tunneling and SSH Tunneling, Virtual Private Networks, Firewalls, Bypassing Firewalls, Transport Layer Security (TLS/SSL), TLS Programming, Packet Sniffer (Wireshark), Man inthe middle attack	9
5	**Unit 5:** **Monitoring systems overnetwork**. Malware attacks, Virus, Worms, Trojans horse, ransomware, keylogger, spyware, bot, botnet, botnet detection, and intrusion detection techniques.	8
	Total	**42**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
1	Cryptography and Network Security - Principles and Practice, Seventh Edition, by William Stallings.	**7th**	**2016**
2.	Firewalls and Internet Security: Repelling the Wily Hacker (Addison-Wesley Professional Computing Series) by William Cheswick, Steven Bellovin, Aviel Rubin.	**2nd**	**2003**
	Reference Books		
1.	Network Security Essentials: Applications and Standards, 4/Ed, by William Stallings.	**4th**	**2011**

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid-Term Exam / End-Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Name of Department: - Computer Science and Engineering

1.	Subject Code:	**TCS-788**		Course Title:	**Information Security and Audit Monitoring**		
2.	Contact Hours:	**L:** 3		**T:** 0		**P:** 0	
3.	Examination Duration (Hrs):			**Theory** 3		**Practical** 0	
4.	Relative Weight:	**CIE** 25		**MSE** 25		**SEE** 50	
5.	Credits:	3					
6.	Semester:	7th					
7.	Category of Course:	**DE**					

8. Pre-requisite: **TCS 492 Fundamental of Cyber Security**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** **CO1**: Explain information security audit. **CO2**: Know the working of information security audit and monitoring. **CO3**: Analyze the various mechanisms of information security audit. **CO4**: Use information security audit and monitoring to prevent the information securityattacks. **CO5**: Apply information security audit and monitoring in various applications. **CO6**: Develop strategies for information security audit and monitoring.

*** Describe the specific knowledge, skills, or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

SN	Contents	Hours
1	**Unit-1** **Overview** What is information security (IS), evaluation of information security, CIA triad, Components of IS, control in IT environment, components of information security management system (ISMS), framework for the development of ISMS, need of information security, threats to information security, risk to information systems, cybercrimes and attacks, information security policy, security life cycle	10
2	**Unit-2** **Risk management and analysis** Overview of risk management, risk identification, identifying the assets, threats and vulnerabilities, risk control strategies, selection of a risk control strategy, planning for risk analysis, performing risk analysis and assessment	8

3	**Unit-3** Security principles, types of information security policies, structure and framework of compressive security policy, policy infrastructure, policy design life cycle and design processes, PDCA model, security policy standards and practices - BS7799, ISO/IEC 17799, ISO 27001. Auditing tools such as ISO 27001 ISMS TOOL KIT, NGS AUDITOR, Windows password auditor, ISO IES 27002 2005 IS AUDIT TOOL	12
4	**Unit-4** **Domains of IT security** Authentication and access control, physical access, Internet access, e-mail, digital signature, outsourcing, software development and acquisition, hardware acquisition, security organization structure.	8
5	**Unit-5** **Auditing and controls** Auditing concepts, information security audit (ISA) need, concept, standards, performance, steps, techniques, methodologies, around and through computer, controls-concept objectives, types, risk, input, process,validation, output, logical access, physical access database, network, environment, BCP, evidence collection, evaluation and reporting methodologies	8
	Total	**46**

11**. Suggested Books:**

S N	Name of Authors/Books/Publishers	Edition	Year of Publication Reprint
	Textbooks		
1.	Michael E. Whitman and Herbert J. Mattord, Principles of Information Security, (2e), Thomson Learning, 2007	2nd	**2007**
2.	Angel R. Otero, "Information Technology Control and Audit", 2018, CRC Press	2nd	**2018**
	Reference Books		
1.	William Stallings, “Network Security Essentials: Applications and Standards”, Prentice Hall.	6th	**2016**

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 793** Course Title: **Cloud Security**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **7^{th}**
7. Category of Course: **DE**
8. Pre-requisite: **TCS351 Fundamental of Cloud Computing and Bigdata**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Understanding the need of cloud security, cloud security reference models and standards. CO2: Understand security & privacy concepts and various cloud security issues. CO3: Identify threat model and attacks in cloud environment. CO4: Understand advanced security concepts. CO5: Understand and analyze intrusion detection techniques. CO6: Implement some intrusion detection tools.

*** Describe the specific knowledge, skills, or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

SL. NO.	Contents	Contact Hours
1	**Unit 1:** **Introduction to Cloud Security** What is Cloud Security?, Motivation for Cloud Security, Reference models and Standards for Security Management, Information Technology Infrastructure Library (ITIL), ISO 27001/27002, CSA Cloud Reference Model with security boundaries, NIST Standards and Guidelines for Cloud Security, NIST Cloud Computing Security Reference Architecture.	08
2	**Unit 2:** **Cloud Security & Privacy: Concepts and Issues** Security Concepts: Confidentiality, Integrity, Authentication, NonRepudiation, Availability, Access control, Defense in depth, Least privilege, Authorization, Cryptography, Auditing, Accountability) , Privacy : What is Privacy ,Key	08

	privacy concerns in Cloud ,Security Management in Cloud , Security aspects at different layers Cloud Security Issues: A Brief Discussion - Application-level, Network-level, Virtualization-level (i.e. Multi-Tenancy), Data Storage-level, Hardware-level, Identity Access Management level, Auditing, Governance and Regulatory Compliance, Cloud and CSP Migration, SLA and Trust level issues etc.)	
3	**Unit 3:** **Threat Model and Virtualization System-Specific Attacks** Threat Model and Virtualization System-Specific Attacks Threat Model and Attack Taxonomy, Virtualization-specific Attacks: VM Escape, Cross-VM Side Channel Attack, Guest hopping, Guest DoS, VM Malware Injection, VM migration attack, VMM DoS, VMM Hyperjacking, VMM Malware Injection, VMM Backdoor	10
4	**Unit 4:** **Advanced Security Concepts** Securing the Cloud , The security boundary ,Security service boundary Security mapping , Securing Data , Brokered cloud storage access , Establishing Identity and Presence ,Identity protocol standards , Windows Azure identity standards , Identity and Access Management: Why IAM, IAM Challenges, Definitions, Architecture &Practice	10
5	**Unit 5:** **Cloud Security Defensive Approaches** Evolution of Cloud-Intrusion Detection System (IDS), Deployment of IDS in Cloud, Intrusion Detection Techniques in Cloud, Brief Discussion on Virtual Machine Introspection and Hypervisor Introspection Techniques	08
	Total	44

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Barrie Sisisky, “Cloud Computing Bible” Published by Wiley Publishing, Inc. Cloud	1st	**2011**
2	“Cloud Security and Privacy” by Tim Mather, Subra, Shahed Latif (Publ. Orielly Media),	1st	2009
3	“Mastering Cloud Computing” by Raj Kumar Buyya,Vecchiola&Selvi (Published by Mc Graw Hill Education Pvt. Ltd) –	2nd	2013
4	“Securing the Cloud “ By Vic (J.R.) Winkler 1st edition ,	1st	2011

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VIII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TDM 881** Course Title: **Disaster Management**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **VIII**
7. Category of Course: **DE**
8. Pre-requisite: **NIL**

9. **Course Outcome**:**	After completion of the course the students will be able to: CO1: Understanding foundations of hazards, disasters and associated natural/social phenomena of India CO2: Study the various natural disasters. CO3: Study the various manmade disasters. CO4: Understand the disaster management principles. CO5: Study the modern techniques used in disaster mitigation and management. CO6: Formulate Technological innovations in Disaster Risk Reduction

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.Details of the Course:

SL. NO.	Contents	Contact Hours
1	**Unit 1:** **Introduction, Definitions and Classification:** Concepts and definitions - Disaster, Hazard, Vulnerability, Resilience, Risks Natural disasters : Cloud bursts, earth quakes, Tsunami, snow, avalanches, landslides, forest fires,diversion of river routes (ex. Kosi river), Floods, Droughts Cyclones, volcanic hazards/ disasters(Mud volcanoes): causes and distribution, hazardous effects and environmental impacts of naturaldisasters, mitigation measures, natural disaster prune areas in India, major natural disasters in India with special reference to Uttarakhand.Man-induced disasters: water logging, subsidence, ground water depletion, soil erosion,, release of toxic gases and hazardous chemicals into environment , nuclear explosions	9

2	**Unit 2:** **Inter-relationship between Disasters and Development** Factors affecting vulnerabilities, differential impacts, impacts of development projects such asdams, embankments, changes in land use etc. climate change adaption, relevance of indigenous knowledge, appropriate technology and local resources, sustainable development and its role in disaster mitigation, roles and responsibilities of community, panchayat raj institutions/urban local bodies, state, centre and other stake holders in disaster mitigation.	**8**
3	**Unit 3:** **Disaster Management (Pre-disasterstage, Emergency stage and Post Disaster Stage)** 1. Pre-disaster stage (preparedness): Preparing hazard zonation maps, predictably/forecastingand warning, preparing disaster preparedness plans, land use zoning, preparedness through information, education and communication (IEC), disaster resistant house construction, population reduction in vulnerable areas, awareness2. Emergency Stage: Rescue training for search & operation at national & regional level,immediate relief, assessment surveys 3. Post Disaster stage: Rehabilitation and reconstruction of disaster affected areas; urban disaster mitigation: Political and administrative aspects, social aspects, economic aspects, environmental aspects.	**9**
4	**Unit 4:** **Disaster Management Laws and Policies in India** Environmental legislations related to disaster management in India: Disaster Management Act,2005; Environmental policies & programs in India- Institutions &nationalcentres for natural disaster mitigation: National Disaster Management Authority (NDMA):structure and functional responsibilities, National Disaster Response Force (NDRF): Rule andresponsibilities, National Institute Of Disaster Management (NlDM): Rule and responsibilities.	**8**
	Total	**34**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	M MSulphey," Disaster Management", PHI,	1st	2016

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VIII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 881** Course Title: **Advanced Computer Vision**
2. Contact Hours: **L: 3 T: 0 P: 0**
3. Examination Duration (Hrs): **Theory 3 Practical 0**
4. Relative Weight: **CIE 25 MSE 25 SEE 50**
5. Credits: **3**
6. Semester: **8th**
7. Category of Course: **DE**

8. Pre-requisite: TCS 301, Any Programming Language

9. **Course Outcome**:**	After completion of the course the students will be able to**:** **CO1:** Understand the principals the computer vision and image procesing used to describe features of images. **CO2:** Understand the mathematical foundations for digital manipulation of images **CO3:** Design, code and test computer applications using MATLAB/OpenCV. **CO4:** Analyze a wide range of problems and provide solutions related to the design of computer applications through suitable algorithms, structures, diagrams, and other appropriate methods. **CO5:** Plan and undertake a major individual computer applications. **CO6:** Write programs in MATLAB/OpenCV.for digital manipulation of images; image acquisition; preprocessing; segmentation.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** Image Processing Techniques: Image Enhancement: Histogram Processing, Smoothing filters, Sharpening filters; Image restoration, Image Compression– coding Redundancy, spatial and temporal redundancy, Compression models Segmentation: Segmentation concepts, point, line and Edge detection, Thresholding, region based segmentation.	9
2	**Unit 2:** Edge detection, Thresholding, Region growing, Fuzzy clustering, Watershed algorithm, Active contour models, Texture feature based segmentation, Graph based segmentation, Applications of image segmentation. Background Subtraction in Videos, Morphological processing,	9

3	**Unit 3:** Image content Analysis: Feature mapping using the scale-invariant feature transform (SIFT) algorithm, Image registration, Image classification, Object Localizatio**n,** Object Recognition, Object Detection, Object recognition, shape from shading, foreground-background separation.	11
4	**Unit 4:** Motion Estimation: Optical flow, general methodologies, pixel based motion estimation, Block matching algorithm, Mesh based motion Estimation, global Motion Estimation, Region based motion estimation, multi resolution motion estimation. Waveform based coding, Block based transform coding, predictive coding, Application of motion estimation in video coding.	9
5	**Unit 5:** Introduction to deep learning, deep learning techniques, CNN: Architectures, Convolution, Pooling Layers, Transfer Learning, Applications: Image classification using Convolutional Neural Networks (CNNs), Anomaly detection using Convolutional Neural Networks (CNNs), medical image-fusion using deep learning method, Image Captioning.	10
	Total	**48**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Digital Image Processing, by R. C. Gonzalez, R. E. Woods and S. L. Eddins , Publisher: Pearson.	4th Edition	**2017**
2.	Digital Image Processing using Matlab, by R. C. Gonzalez, R. E. Woods and S. L. Eddins , Publisher: Pearson.	2nd	**2017**
3.	Deep Learning for Computer Vision, by Rajalingappaa Shanmugamani, Publisher: O Reilly	1st	**2018**
	Reference Books		
1.	Deep Learning with Keras by Antonio Gulli, Sujit Pal, Publisher: O Reilly	1st	**2017**
2.	Programming Computer Vision with Python", Jan Salem, Publisher: O Reilly	1st	**2012**

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VIII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 859** Course Title: **Services Oriented Cloud architecture**
2. Contact Hours: **L: 3** **T**: **0** **P**: **0**
3. Examination Duration (Hrs): **Theory** **3** **Practical** **0**
4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
5. Credits: **3**
6. Semester: **8**
7. Category of Course: **DE**
8. Pre-requisite: **: TCS 602**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Identify the concept of service-oriented cloud architecture. CO2: Demonstrate microservices architecture and services-oriented cloud architecture protocols with security aspects. CO3: Analyze the service-oriented cloud architecture for business technology and policy management. CO4: Apply digital age technologies in services-oriented cloud architecture-based cloud applications. CO5: Evaluate the performance of services-oriented cloud architecture governance framework and their legacy evolution. CO6: Design a serverless cloud-based web application and deploy as a Microservice on OpenShift and as static files on Cloud Object Storage.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

SL. NO.	Contents	Contact Hours
1	**Unit - I** Services oriented cloud architecture: Defining concepts, Principles, Patterns, Importance, components, working, limitations, Enterprise Service Bus (ESB) in service-oriented cloud architecture, Benefits of ESB, Interfaces and namespaces, SOLID principles, IoC containers, Case study of service oriented cloud architectures.	9
2	**Unit – II** Microservices architecture, Services oriented cloud architecture protocols, Security, Full stack cloud applications, Distributed applications and Web	9

	services. Technologies and frameworks for distributed and server side application development, Service-oriented cloud architecture communications, Case study of service oriented cloud architecture protocols and communications.	
3	**Unit – III** Services oriented cloud architecture for Business Technology, Cloud service accessibility, cloud service visibility, cloud service extensibility, Cloud service SLAs, cloud service deployment using contract-management techniques, Policy management techniques, Case study of service oriented cloud architecture for business policy management.	**9**
4	Unit – IV Services oriented cloud architecture in the Digital Age, Designing domain specific cloud services, Service-oriented distributed applications, Semantic web and web services, RESTful, AJAX, JSON, Web API, Web Socket application in cloud services, Open Standards Landscape around Architecture, Develop an application on Cloud leveraging cloud services like AI-powered APIs and NoSQL databases, Case study of service oriented cloud architecture in digital age applications.	**9**
5	**Unit – V** Services oriented cloud architecture governance framework, Legacy evolution, Services oriented cloud reference architecture, Windows communication foundation services (WCF), Hosting and consuming WCF services, evaluating performance of WCF services in cloud platform, Serverless computing, Create a serverless cloud based web application and deploy as a Microservice on OpenShift and as static files on Cloud Object Storage, Case study of service oriented cloud architecture for business governance.	**9**
	Total	**45**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	Barrie Sisisky, "Cloud Computing Bible" Published by Wiley Publishing, Inc.	2nd	2010
2	Berners Lee, Godel and Turing, "Thinking on the Web", Wiley inter science,.	1st	2008
3	Peter Mika, "Social Networks and the Semantic Web", Springer,.	1st	2007
	Reference Books		
1.	Thomas Erl ,"Cloud Computing: Concepts, Technology & Architecture" Published May	1st	2013
2	David S. Linthicum ,"Cloud Computing and SOA Convergence in your Enterprise, a step by step guide"	1st	**2009**

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VIII

Name of Department: - Computer Science and Engineering

1.	Subject Code:	**TCS 801**		Course Title:	**Mobile Computing**			
2.	Contact Hours:	**L:**	**3**	**T**:	**0**	**P**:	**0**	
3.	Examination Duration (Hrs):			**Theory**	**3**	**Practical**	**0**	
4.	Relative Weight:	**CIE**	**25**	**MSE**	**25**	**SEE**	**50**	
5.	Credits:		**3**					
6.	Semester:		**8**					
7.	Category of Course:		**DE**					

8. Pre-requisite: **Communication models and Protocols (TCS 53), Computer Networks (TCS 604), Network Programming and Wireless Technologies (TCS 631)**

9. **Course Outcome**:**	After completion of the course the students will be able to: CO1: Exemplify the concepts, techniques, protocols and architecture employed in wireless local area networks, cellular networks, and Adhoc Networks based on the standards CO2: Describe and analyze the network infrastructure requirements to support mobile devices and users. CO3: Design and implement mobile applications to realize location-aware computing CO4: Asses the important issues and concerns on security and Data management CO5: Development of various scenarios for mobile computing systems. CO6: Evaluate the concepts of mobile agents and mobile Adhoc algorithms with the help of NS2.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

SL. No.	Contents	Contact Hours
1	**Unit 1:** Introduction, issues in mobile computing, overview of wireless telephony: cellular concept, GSM: air-interface, channel structure, location management: HLR-VLR, hierarchical, handoffs, channel allocation in cellular systems, CDMA, GPRS	**9**

2	**Unit 2:** Wireless Networking, Wireless LAN Overview: MAC issues, IEEE 802.11, Blue Tooth, Wireless multiple access protocols, TCP over wireless, Wireless applications, data broadcasting, Mobile IP, WAP: Architecture, protocol stack, application environment, applications.	**8**
3	**Unit 3:** Data management issues, data replication for mobile computers, adaptive clustering for mobile wireless networks, File system, Disconnected operations	**9**
4	**Unit 4:** Mobile Agents computing, security and fault tolerance, transaction processing in mobile computing environment.	**8**
5	**Unit 5:** Ad Hoc networks, localization, MAC issues, Routing protocols, global state routing (GSR), Destination sequenced distance vector routing (DSDV), Dynamic source routing (DSR), Ad Hoc on demand distance vector routing (AODV), Temporary ordered routing algorithm (TORA), QoS in Ad Hoc Networks, applications	**9**
	Total	**45**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	J. Schiller,” Mobile Communications”, Addison Wesley.	2nd	2008
2	A. Mehrotra ,“GSM System Engineering”.		1997
3	M. V. D. Heijden, M. Taylor, “Understanding WAP”, Artech House		2000
	Reference Books		
1.	J. Schiller,” Mobile Communications”, Addison Wesley.	2nd	2008
2	A. Mehrotra ,“GSM System Engineering”.		1997
3	M. V. D. Heijden, M. Taylor, “Understanding WAP”, Artech House		2000

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VIII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 822** Course Title: **Mobile Applications Development**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **VIII**
7. Category of Course: **DE**
8. Pre-requisite: **TCS 693**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Understand and apply the key technological principles and methods for delivering and maintaining mobile applications, CO2: Evaluate and contrast requirements for mobile platforms to establish appropriate strategies for development and deployment, CO3: Develop and apply current standard-compliant scripting/programming techniques for the successful deployment of mobile applications targeting a variety of platforms, CO4: Carry out appropriate formative and summative evaluation and testingutilising a range of mobile platforms, CO5: Interpret a scenario, plan, design and develop a prototype hybrid and native mobile application, CO6: investigate the leading edge developments in mobile application development and use these to inform the design process.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

SL. NO.	Contents	Contact Hours
1	**Unit 1:** **Getting started with Mobility**	**9**

	Mobility landscape, Mobile platforms, Mobile apps development, Overview of Android platform, setting up the mobile app development environment along with an emulator, a case study on Mobile app development	
2	**Unit 2:** **Building blocks of mobile apps** App user interface designing – mobile UI resources (Layout, UI elements, Draw-able, Menu), Activity- states and life cycle, interaction amongst activities. App functionality beyond user interface - Threads, Async task, Services – states and life cycle, Notifications, Broadcast receivers, Telephony and SMS APIs Native data handling – on-device file I/O, shared preferences, mobile databases such as SQLite, and enterprise data access (via Internet/Intranet)	**8**
3	**Unit 3:** **Sprucing up mobile apps** Graphics and animation – custom views, canvas, animation APIs, multimedia – audio/video playback and record, location awareness, and native hardware access (sensors such as accelerometer and gyroscope)	**9**
4	**Unit 4:** **Testing mobile apps** Debugging mobile apps, White box testing, Black box testing, and test automation of mobile apps, JUnit for Android, Robotium, MonkeyTalk	**9**
5	**Unit 5:** **Taking apps to Market** Versioning, signing and packaging mobile apps, distributing apps on mobile market place	**8**
	Total	**43**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	Jeff McWherter, Scott Gowell, “Professional Mobile Application Development”,Wrox Publication.	1st	2012
2	“Mobile Application Development “Black Book, Dreamtech Press	2nd	2014

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VIII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 821** Course Title: **Soft Computing**
2. Contact Hours: **L:** **3** **T**: **0** **P**: **0**
3. Examination Duration (Hrs): **Theory** **3** **Practical** **0**
4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
5. Credits: **3**
6. Semester: **8**
7. Category of Course: **DE**
8. Pre-requisite: **Good knowledge of Artificial Intelligence**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Summarize about soft computing techniques and their applications CO2: Analyze various neural network architectures CO3: Designperceptrons and counter propagation networks. CO4: Classify the fuzzy systems CO5: Analyze the genetic algorithms and their applications. CO6: Compose the fuzzy rules.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

S.NO.	**Contents**	**Contact Hours**
1	**Unit 1:** Fundamentals of ANN: The Biological Neural Network, Artificial Neural Networks -Building Blocks of ANN and ANN terminologies: architecture, setting of weights,activation functions - McCulloch-pitts Neuron Model, Hebbian Learning rule, Perceptionlearning rule, Delta learning rule.	**9**
2	**Unit 2:** Models of ANN: Single layer perception, Architecture, Algorithm, application procedure- Feedback Networks: Hopfield Net and BAM - Feed Forward Networks: BackPropogation Network (BPN) and Radial Basis Function Network (RBFN) – SelfOrganizing Feature Maps: SOM and LVQ	**8**
3	**Unit 3:** Fuzzy Sets, properties and operations - Fuzzy relations, cardinality, operations andproperties of fuzzy relations, fuzzy composition.	**9**

4	**Unit 4:** Fuzzy variables - Types of membership functions - fuzzy rules: Takagi and Mamdani –fuzzy inference systems: fuzzification, inference, rulebase, defuzzification.	**9**
5	**Unit 5:** Genetic Algorithm (GA): Biological terminology – elements of GA: encoding, types ofselection, types of crossover, mutation, reinsertion – a simple genetic algorithm –Theoretical foundation: schema, fundamental theorem of GA, building block hypothesis.	**9**
	Total	**44**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	S. N. Sivanandam, S. Sumathi, S.N. Deepa, "Introduction to Neural Networks using MATLAB 6.0 ", Tata McGraw-Hill, New Delhi, 2006	1st	2017
2	S. N. Sivanandam, S.N. Deepa, "Principles of Soft Computing", Wiley-India, 2008.	1st	2008
3	D.E. Goldberg, "Genetic algorithms, optimization and machine learning"	1st	2008

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VIII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 823** Course Title: **Multimedia Systems and Data Compression**
2. Contact Hours: **L:** 3 **T**: 0 **P**: 0
3. Examination Duration (Hrs): **Theory** 3 **Practical** 0
4. Relative Weight: **CIE** 25 **MSE** 25 **SEE** 50
5. Credits: 3
6. Semester: 8
7. Category of Course: **DE**
8. Pre-requisite: **TCS 308**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Demonstrate the basic concept of multimedia information representation. Delve into the requirement of multimedia communication in today's digital world. CO2: Compare circuit mode and packet mode.Explain QoS and its applications. CO3: Summarize the various multimedia information representations CO4: Compute Arithmetic, Huffman, Lempel –Ziv and Lempel–Ziv Welsh coding. Summarize Joint Photographic Expert Group (JPEG). CO5: Differentiate between the audio compression techniques: PCM, DPCM, ADPCM, LPC, CELPC and MPEG. Differentiate MPEG1, MPEG2 and MPEG4. CO6: Construct Haptic Interfaces and Virtual reality Systems

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

SL. No.	Contents	Contact Hours
1	**Unit. I** Introduction to Multimedia Presentation and Production, Multisensory Perception, Digital Representation of Data: Why it is required, Analog to Digital Conversion and Digital to Analog Conversion, Nyquist's Theorem, Relation between Sampling Rate and Bit Depth, Quantization Error, Fourier Representation, Pulse Modulation Describing Multimedia Presentations: SMIL Text: Typeface, Fonts; Tracking, Kerning, Spacing; Optical Character Recognition; Unicode Standard; Text to Voice	**10**

2	**Unit. II** Data Compression: Approaches to compression, Basic Techniques: Run-Length Encoding ; Statistical Methods: Information Theory Concepts, Variable-Size codes, Shanon-Fano coding, Huffman coding, Adaptive Huffman Coding, Arithmetic Coding; Dictionary Methods: LZ77(Sliding Window), LZ78, LZW; Various LZ Applications, Deflate: zip and Gzip, LZMA and 7-zip.	**9**
3	**Unit. III** Image types, how we see color, Vector and Bitmap, Color Models: RGB, CMYK, Lab, HSL, HSB/HSV, YUV, conversion between different color models; Basic steps of image processing, Scanner, Digital Camera, Gamma Correction, General Study of the following image formats: BMP,TIF,PNG,GIF,SVG Image Compression: Approaches, Image Transforms, The Discrete Cosine Transform, Detailed study of JPEG,JPEG-LS, Progressive image compression, JBIG	**9**
4	**Unit – IV** Acoustics and the Nature of Sound Waves, Fundamental Characteristics of Sound, Musical Note, Pitch, Beat, Rhythm, Melody, Harmony and Tempo; Elements of Audio Systems, General study of Microphone, Amplifier, Loudspeaker, Mixer; Digital Audio, Synthesizers, MIDI, MIDI Connections, MIDI messages, Staff Notation, Sound Card, Audio Codecs: AIFF, WAV, Apple Lossless, Dolby TrueHD, DTS-HD Master Audio, FLAC, WMA, Audio Playing Software, Audio Recording using Dolby, Dolby Digital and Dolby Digital Surround EX, Voice Recognition Video: Analog Video, Transmission of Video Signals, Chroma Sub sampling, Composite and Components Video, NTSC, PAL and SECAM, Digital Video, High Definition TV, Video Recording Formats; Video Compression, MPEG, MPEG-4; General Study of the following formats and codecs: avi, flv, m4v	**9**
5	**Unit – V** Multimedia Messaging Service(MMS): MMS standard, MMS Architecture, An Engineering perspective on How a MMS is created, sent and retrieved Introduction to Virtual Reality: Components of a VR System, Haptic Interfaces, Virtual Reality Programming, Impact of Virtual Reality, Case study of Second Life	**8**
	Total	**45**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Ranjan Parekh, “Principles of Multimedia”, McGraw Hill,	2nd	2006
	Reference Books		
1.	David Salomon, “Data Compression: The Complete Reference”, Fourth Edition, Springer Books	1^{st}	2003

2.	GrigoreBurdea, Philippe Coiffet, “Virtual reality technology, Volume 1”, Wiley,	2^{nd}	2003

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VIII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 826** Course Title: **Unix Systems Programming**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **8**
7. Category of Course: **DE**
8. Pre-requisite: **TCS-302, TCS-502 DSA, Operating Systems**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Experiment with various system calls CO2: Compare between ANSI C AND C++ AND POSIX standards CO3: Mapping the relationship between UNIX Kernel support for files CO4: Use Kernel support for process creation and termination and memory allocation CO5: Analyze Process Accounting process UID ,Terminal logins, network logins CO6: Analyze process control,Deamon characteristics, coding rules and error logging

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

SL. No.	Contents	Contact Hours
1	**Unit 1:** Introduction to System Programming, File I/O, Difference between Buffered and Unbuffered I/O, I/O system calls: open(), close(), read(), write(), Effect of I/O buffering in stdio and the kernel; synchronized I/O, Seeking to a file offset: lseek(), File control: fcntl(), Locking, Open file status flags, Open files and file descriptors, Duplicating file descriptors with dup, dup2 and fcntl. A brief recap of Buffered I/O, Forays into Advanced I/O	**9**
2	**Unit 2:** Processes: Process ID and Parent process ID, Memory layout, Running and Terminating a process, Waiting for Terminated child processes (fork, the exec family, wait, waitpid), copy on write, Advanced Process Management: Process Priorities, nice(), Setting the scheduling policy	**10**

3	**Unit 3:** Processes and Inter-Process Communication: Introduction, pipes, FIFOs, XSI IPC: Message Queues, Semaphores, Shared Memory	**9**
4	**Unit 4:** Signals: Signal types and default actions, Basic Signal management, signal function, unreliable signals, SIGCLD, Sending signals, Signal sets, Blocking signals (the signal mask), Interruption and restarting of system calls, Designing signal handlers	**8**
5	**Unit 5:** Network Programming: Sockets, Operation, Socket types, Client/Server Models, Connection Based Services, Handling Out of Band Data, Connectionless Services, Design issues of Concurrent and iterative servers, Socket options	**9**
	Total	**45**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Richard Stevens and Stephen Rago," Advanced Programming in the Unix Environment", Addison-Wesley	3rd	2013
2	Michael Kerrisk," The Linux Programming Interface", No Starch Press	2nd	2010
	Reference Books		
1.	Richard Stevens and Stephen Rago," Advanced Programming in the Unix Environment", Addison-Wesley	3rd	2013
2	Michael Kerrisk," The Linux Programming Interface", No Starch Press	2nd	2010

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VIII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 851** Course Title: **Storage Networks**
2. Contact Hours: **L: 3** **T**: **0** **P**: **0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **8**
7. Category of Course: **DE**
8. Pre-requisite: **Computer Network(TCS-703), TCS-604**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Understand the different aspects of storage management CO2: Describe the various applications of RAID CO3: Compare and contrast the I/O Techniques CO4: Categorize virtualization on various levels of storage network CO5: Estimate the various requirements of storage management systems CO6: Design a complete data center and enhance employability in this field

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

SL. No.	**Contents**	**Contact Hours**
1	**Unit 1:** Introduction to Storage Technology Introduction to storage network, Five pillars of IT, parameters related with storage, data proliferation, problem caused by data proliferation, Hierarchical storage management, Information life cycle management (ILM), Role of ILM, Information value vs. time mapping, Evolution of storage, Storage infrastructure component, basic	**10**

	storage management skills and activities, Introduction to Datacenters, Technical & Physical components for building datacenters	
2	**Unit 2:** Technologies for Storage network Server centric IT architecture & its limitations, Storage centric IT architecture & advantages, replacing a server with storage networks, Disk subsystems, Architecture of disk subsystem, Hard disks and Internal I/O channel, JBOD, RAID& RAID levels, RAID parity, comparison of RAID levels, Hot sparing, Hot swapping, Caching : acceleration of hard disk access, Intelligent Disk subsystem architecture Tape drives: Introduction to tape drives, Tape media, caring for Tape& Tape heads, Tape drive performance, Linear tape technology, Helical scan tape technology	**9**
3	**Unit 3:** I/O techniques I/O path from CPU to storage systems, SCSI technology – basics & protocol, SCSI and storage networks, Limitations of SCSI Fibre channel: Fibre channel, characteristic of fibre channel, serial data transfer vs. parallel data transfer, Fibre channel protocol stack, Links, ports & topologies, Data transport in fibre channel, Addressing in fibre channel, Designing of FC-SAN, components, Interoperability of FCSAN, FC products IP Storage: IP storage standards (iSCSI, iFCP, FCIP, iSNS), IPSAN products, Security in IP SAN, introduction to InfiniBand, Architecture of InfiniBand NAS – Evolution, elements & connectivity, NAS architecture	**10**
4	**Unit 4:** Storage Virtualization Introduction to storage virtualization, products, definition, core concepts, virtualization on various levels of storage network, advantages and disadvantages, Symmetric and asymmetric virtualization, performance of San virtualization, Scaling storage with virtualization	**9**
5	**Unit 5:** Management of storage Networks Management of storage network, SNMP protocol, requirements of management systems, Management interfaces, Standardized and proprietary mechanism, In-band& Out-band management, Backup and Recovery	**8**
	Total	**46**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	"Storage Networks: The Complete Reference", R. Spalding, McGraw-Hill	1st	2017

2	"Storage Networking Fundamentals: An Introduction to Storage Devices, Subsystems,	3rd	2004
3	Applications, Management, and Filing Systems", Marc Farley, Cisco Press.	1st	2005
	Reference Books		
1.	"Storage Networks: The Complete Reference", R. Spalding, McGraw-Hill	1st	2017
2	"Storage Networking Fundamentals: An Introduction to Storage Devices, Subsystems,	3rd	2004
3	Applications, Management, and Filing Systems", Marc Farley, Cisco Press.	2nd	**2004**

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VIII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 852** Course Title: **Pattern Recognition**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **8**
7. Category of Course: DE
8. Pre-requisite: Knowledge of Probability theory, mathematics, and algorithms

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Explain and compare a variety of pattern classification, structural pattern recognition, and pattern classifier combination techniques. CO2. Summarize, analyze, and relate research in the pattern recognition area verbally and in writing. CO3. Apply performance evaluation methods for pattern recognition, and critique comparisons of techniques made in the research literature. CO4. Apply pattern recognition techniques to real-world problems such as document analysis and recognition. CO5. Implement simple pattern classifiers, classifier combinations, and structural pattern recognizers. CO6. Describe the various clustering methods

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	**Contents**	**Contact Hours**
1	**Unit 1**: Introduction: Machine perception, pattern recognition example, pattern recognition systems, the design cycle, learning and adaptation Bayesian Decision Theory : Introduction, continuous features – two categories classifications, minimum error-rate classification- zero–one loss function, classifiers, discriminant functions, and decision surfaces	9
2	**Unit 2:** Normal density: Univariate and multivariate density, discriminant functions for the normal densitydifferent cases, Bayes decision theory – discrete features, compound Bayesian decision theory and context Maximum likelihood and Bayesian parameter estimation : Introduction, maximum likelihood	9

	estimation, Bayesian estimation, Bayesian parameter estimation–Gaussian	
3	Un-supervised learning and clustering: Introduction, mixture densities and identifiability, maximum likelihood estimates, application to normal mixtures, K-means clustering. Date description and clustering – similarity measures, criteria function for clustering Component analysis: Principal component analysis, non-linear component analysis; Low dimensional representations and multi-dimensional scaling	8
4	Discrete Hidden Markov Models : Introduction, Discrete–time Markov process, extensions to hidden Markov models, three basic problems for HMMs	8
5	Continuous hidden Markov models : Observation densities, training and testing with continuous HMMs, types of HMMs	8
	Total	**48**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	Richard O. Duda, Peter E. Hart, David G. Stroke. “Pattern Recognition”, Wiley (Indian adaptation)	2nd	2021
2	M. Narasimha Murty, V. Susheela Devi, “Pattern Recognition”, Universities Press	1st	2016
	Reference Books		
1.	Christopher M. Bishop, “Pattern Recognition and Machine Learning”, Springer	1st	2016

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VIII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 855** Course Title: **Agile Software Engineering**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **8**
7. Category of Course: **DE**
8. Pre-requisite: **Software Engineering(TCS-611)**

9. **Course Outcome**:**	After completion of the course the students will be able to: CO1: Describe two or more agile software development methodologies. CO2: Identify the benefits and pitfalls of transitioning to agile. CO3: Compare agile software development to traditional software development models. CO4: Apply agile practices such as test-driven development, standup meetings, and pair programming to their software engineering practices. CO5: Apply the agile testing CO6: Describe the agile in current market scenario.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

SL. NO.	Contents	Contact Hours
1	**Unit 1:** **Fundamentals of Agile:** The Genesis of Agile, Introduction and background, Agile Manifesto and Principles, Overview of Agile Methodologies – Scrum methodology, Extreme Programming, Feature Driven development, Design and development practices in an Agile projects, Test Driven Development, Continuous Integration, Refactoring, Pair Programming, Simple Design, User Stories, Agile Testing, Agile Tools	**10**
2	**Unit 2:** **Agile Project Management:** Agile Scrum Methodology, Project phases, Agile Estimation, Planning game, Product backlog, Sprint backlog, Iteration planning, User story definition, Characteristics and content of user stories, Acceptance tests and Verifying	**10**

	stories, Agile project velocity, Burn down chart, Sprint planning and retrospective, Daily scrum, Scrum roles – Product Owner, Scrum Master, Scrum Developer, Scrum case study, Tools for Agile project management	
3	**Unit 3:** **Agile Software Design and Programming:** Agile Design Principles with UML examples, Single Responsibility Principle, Open Closed Principle, Liskov Substitution Principle, Interface Segregation Principles, Dependency Inversion Principle, Need and significance of Refactoring, Refactoring Techniques, Continuous Integration, Automated build tools, Version control, Test-Driven Development (TDD), xUnit framework and tools for TDD	**9**
4	**Unit 4:** **Agile Testing:** The Agile lifecycle and its impact on testing, Testing user stories - acceptance tests and scenarios, Planning and managing Agile testing, Exploratory testing, Risk based testing, Regression tests, Test Automation, Tools to support the Agile tester	**9**
5	**Unit 5:** **Agile in Market:** Market scenario and adoption of Agile, Roles in an Agile project, Agile applicability, Agile in Distributed teams, Business benefits, Challenges in Agile, Risks and Mitigation, Agile projects on Cloud, Balancing Agility with Discipline, Agile rapid development technologies	**8**
	Total	**46**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Ken Schawber, Mike Beedle, “Agile Software Development with Scrum”, Pearson		2008

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VIII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 857** Course Title: **Game Theory**
2. Contact Hours: **L:** **3** **T**: **0** **P**: **0**
3. Examination Duration (Hrs): **Theory** **3** **Practical** **0**
4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
5. Credits: **3**
6. Semester: **8**
7. Category of Course: **DE**
8. Pre-requisite: **Excellent knowledge of programming and mathematics**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Identify strategic situations and represent them as games CO2: Find dominant strategy equilibrium, pure and mixed strategy Nash equilibrium, CO3: Solve simple games using various techniques CO4: Analyze economic situations using game theoretic techniques CO5: Recommend and prescribe which strategies to implement CO6: Find the needs of extensive games.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

SL. No.	Contents	Contact Hours
1	**Unit 1:** **Introduction, Strategic Games:** What is game theory? The theory of rational choice; Interacting decision makers. Strategic games; Examples: The prisoner's dilemma, Bach or Stravinsky, Matching pennies; Nash equilibrium; Examples of Nash equilibrium; Best-response functions; Dominated actions; Equilibrium in a single population: symmetric games and symmetric equilibria.	**11**

	Mixed Strategy Equilibrium: Introduction; Strategic games in which players may randomize; Mixed strategy Nash equilibrium; Dominated actions; Pure equilibria when randomization is allowed, Illustration: Expert Diagnosis; Equilibrium in a single population, Illustration: Reporting a crime; The formation of players' beliefs; Extensions; Representing preferences by expected payoffs	
2	**Unit 2:** **Extensive Games:** Extensive games with perfect information; Strategies and outcomes; Nash equilibrium; Subgame perfect equilibrium; Finding subgame perfect equilibria of finite horizon games: Backward induction. Illustrations: The ultimatum game, Stackelberg's model of duopoly, Buying votes. **Extensive games: Extensions and Discussions:** Extensions: Allowing for simultaneous moves, Illustrations: Entry in to a monopolized industry, Electoral competition with strategic voters, Committee decision making, Exit from a declining industry; Allowing for exogenous uncertainty, Discussion: subgame perfect equilibrium and backward induction	**10**
3	**Unit 3:** **Bayesian Games, Extensive Games with Imperfect Information:** Motivational examples; General definitions; Two examples concerning information; Illustrations: Cournot's duopoly game with imperfect information, Providing a public good, Auctions; Auctions with an arbitrary distribution of valuations. Extensive games with imperfect information; Strategies; Nash equilibrium; Beliefs and sequential equilibrium; Signaling games; Illustration: Strategic information transmission. **Strictly Competitive Games, Evolutionary Equilibrium:** Strictly competitive games and maximization; Maximization and Nash equilibrium; Strictly competitive games; Maximization and Nash equilibrium in strictly competitive games. Evolutionary Equilibrium: Monomorphic pure strategy equilibrium; Mixed strategies and polymorphic equilibrium; Asymmetric contests; Variations on themes: Sibling behavior, Nesting behavior of wasps, The evolution of sex ratio	**10**
4	**Unit 4:** **Iterated Games:** Repeated games: The main idea; Preferences; Repeated games; Finitely and infinitely repeated Prisoner's dilemma; Strategies in an infinitely repeated Prisoner's dilemma; Some Nash equilibria of an infinitely repeated Prisoner's dilemma, Nash equilibrium payoffs of an infinitely repeated Prisoner's dilemma	**8**
5	**Unit 5:** **Coalitional Games and Bargaining:** Coalitional games. The Core. Illustrations: Ownership and distribution of wealth, Exchanging homogeneous items, Exchanging heterogeneous items, Voting, Matching. Bargaining as an	**8**

	extensive game; Illustration of trade in a market; Nash's axiomatic model of bargaining	
	Total	**47**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Martin Osborne: "An Introduction to Game Theory", Oxford University Press, Indian Edition,.	2nd	2004
	Reference Books		
1.	Roger B. Myerson: "Game Theory: Analysis of Conflict", Harvard University Press,	1st	1997

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VIII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS- 841** Course Title: **Quantum Computing**
2. Contact Hours: **L:** **3** **T**: **0** **P**: **0**
3. Examination Duration (Hrs): **Theory** **3** **Practical** **0**
4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
5. Credits: **3**
6. Semester: **8th**
7. Category of Course: **DE**
8. Pre-requisite: Probability and Linear Algebra

9. **Course Outcome**:**	After completion of the course the students will be able to**:** **CO1:** Understand the principles of quantum computation. **CO2:** Learn the circuit and gates involved in quantum computing. **CO3:** Understand the algorithms used in quantum computing. **CO4:** Study the information theory aspects of quantum computing. **CO5:** Use and build Quantum algorithms for solving various problems.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** **Introduction:** Overview of classical computing and its limitations; Introduction to quantum mechanics and quantum information theory; Quantum bits; Bloch sphere representation of a qubit; multiple qubits; Dirac notation; Hilbert space; Probabilities and measurements; Density operators and correlation; Quantum Parallelism; Entanglement and Superposition.	10
2	**Unit 2:** **Quantum Gates and Circuits:** Quantum circuit representation; Quantum Logic Gates; Unitary Transformation; Hadamard Gate; Controlled Quantum Gates; Universal Quantum Gates; Special 2-Qubit Gates (CSIGN; SWAPα; iSWAP; Berkeley B); Quantum measurements and observables	8
3	**Unit 3:** **Quantum Algorithms:** Relationship between classical and quantum algorithms; Classical computation on quantum computers; Relationship between quantum and classical complexity classes; Deutsch's algorithm, Deutsch's-Jozsa algorithm; Shor factorization algorithm; Grover search algorithm; Quantum Approximate optimization algorithm (QAOA).	10

4	**Unit 4:** **Quantum Information Theory:** Entropy and information; Shannon entropy; Basic properties of entropy; Von Neumann entropy; Physical realisation; Harmonic oscillator quantum computer; Quantum teleportation and superdense coding; Quantum noise and quantum operations; Marcov process; Data compression; Quantum error corrections; 3 Qubit phase flip code; Fault tolerant quantum computation; Quantum cryptography.	12
5	**Unit 5:** **Qiskit Programming:** Introduction and IBM Quantum Perspective; Qiskit software; Quantum gates and operations in Qiskit, Quantum measurement and simulation in qiskit; Quantum teleportation with qiskit; Implementation of Grover algorithm qiskit.	8
	Total	**48**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	Nielsen, M., & Chuang, I. In Quantum Computation and Quantum Information. Cambridge University Press	10th	2010
2.	John Gribbin (2014), Computing with Quantum Cats: From Colossus to Qubits, Prometheus Books.	1st	2014
3.	"Quantum Computing: A Gentle Introduction" by Eleanor G. Rieffel and Wolfgang H. Polak. The MIT Press	1st	2011
4.	Quantum information Theory, Mark M. Wilde, Cambridge University Press.	1st	2013
	Reference Books		
1.	Quantum error correction, D. A. Lidar & T. A. Brun, Cambridge University Press.	1st	2013
2.	Quantum Computing: From Linear Algebra to Physical Realizations" by Mikio Nakahara and Tetsuo Ohmi.	1st	2008

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VIII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 842** Course Title: **Recent trends in AI**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **ESE 50**
5. Credits: **3**
6. Semester: **8**
7. Category of Course: **DE**
8. Pre-requisite: **TCS 542**

9. **Course Outcome**:**	After completion of the course the students will be able to: CO1: learn about the current trends in AI in chatbots and virtual assistants CO2: understand the research progress being made in AI-driven cyber-security and ITOps CO3: learn current applications of AI in healthcare CO4: learn about the applications of AI in in IoT and quantum computing CO5: understand and create an AI application from recent trends

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	AI-powered Chatbots & Virtual Assistants: AI-driven chatbots such as ChatGPT, virtual assistants, question answering systems, Hyper-automation: automation tools, such as AI, ML, RPA, and NLP, to streamline intricate workflows, utilizing the newest advances in AI app trends to provide effective and cost-efficient solutions	10
2	AI-driven cybersecurity: safety against cyber threats and overall cybersecurity defense, utilizing the technology of artificial intelligence and machine learning technology	9

3	Artificial intelligence for IT operations: machine learning and other AI techniques to automate and optimize IT operations and management. AI in healthcare: leveraging artificial intelligence and machine learning to create efficient delivery, maximize patient outcomes, and minimize expenses	9
4	Integration of AI and IoT: leverage machine learning algorithms to interpret the tremendous data generated from IoT-enabled devices AI and quantum computing are increasingly converging as AI technologies progress, with quantum computing playing an essential role in refining the precision and practicality of AI algorithms.	8
5	Apply the knowledge gained from the recent trends in AI to develop and demonstrate an application that demonstrates their learning.	6
	Total	**42**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
	There is no textbook, recent research papers and material available online will be discussed		
	Reference Books		

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VIII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 862** Course Title: **FATE in AI**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs): **Theory 3** **Practical 0**
4. Relative Weight: **CIE 25** **MSE 25** **SEE 50**
5. Credits: **3**
6. Semester: **8**
7. Category of Course: **DE**
8. Pre-requisite: **TCS 562**

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Apply Fairness in designing AI algorithms. CO2: Understand and Examine Accountability in AI CO3: Understand and Examine pitfalls of various contemporary AI applications. CO4: Analyze the ethics for designing future AI systems. CO5: Evaluate fairness and transparency of AI systems. CO6: Examine Real World Cases from policy perspectives

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** Data: Protection rational & genesis, data protection in India (judicial developments on right to privacy, legislative developments); Territorial and Personal Scope; Personal data; Sensitive personal data; Processing of data; Processing of sensitive data; Rights: Introduction, right to object to processing, right to be forget; Case studies.	8
2	**Unit 2:** Fairness: Introduction, sources of unfairness, definitions; Metrics for fairness, fair data; pre-processing methods; In-processing methods; post-processing methods; Model auditing for fairness; ML models and privacy; ML models and security; Fair product design & development; Laws for ML; Compliance tools: Anonymization, Privacy by design.	10
3	**Unit 3:**	8

	Accountability & Ethics: Introduction, Guidelines in AI ethics; AI in practice; Advances in AI ethics;	
4	**Unit 4:** Transparency (Explainability): Importance of explainability in AI systems, Case studies; Accuracy-interpretability tradeoff in machine learning; Different types of interpretability approaches: Rule-based, Prototype-based, Feature importance-based, post-hoc explanations.	10
5	**Unit 5:** FATE incorporation in AI designing systems, Issues, Effectiveness, Responsible AI, Algorithm Inclusivity and Accessibility, Real World use case examination.	12
	Total	**48**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	Aileen Nielsen, Practical Fairness: Achieving Fair and Secure Data Models, O'Reilly Media, Inc	1st	2021
2.	Solon Barocas, Moritz Hardt, Arvind Narayanan, Fairness And Machine Learning Limitations and Opportunities	1st	2019

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VIII

Name of Department: - Computer Science and Engineering

1.	Subject Code:	**TCS 893**		Course Title:	**Privacy and Security in Online social media**		
2.	Contact Hours:	**L:** 3		**T:** 0		**P:** 0	
3.	Examination Duration (Hrs):		**Theory** 3		**Practical** 0		
4.	Relative Weight:	**CIE** 25		**MSE** 25		**SEE** 50	
5.	Credits:	3					
6.	Semester:	8th					
7.	Category of Course:	**DE**					
8.	Pre-requisite:	TCS 693 Full Stack Web Development					

9. **Course Outcome**:**	After completion of the course the students will be able to**:** CO1: Understand the security and privacy concerns in Online social media. CO2: Develop Secure Web Applications CO3: Understand the Architecture of Web and working with social media APIs. CO4: Perform social media analysis and visualization using various tools and techniques. CO5: Know the various cases and data protection laws. CO6: Analyze the security parameters in social media.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10.**Details of the Course:**

SL. NO.	Contents	Contact Hours
1	**Unit - I** **Understanding Working of Web and Related Technologies** Working with Linux and Python, Understanding Basics of FrontEnd and Backend Technologies (HTML, CSS, JavaScript, Node JS), Understanding the HTTP Methods, Client Server Architecture, Working of DNS, Introduction to Online Social Media (OSM) - Pros and Cons, Introduction to Social Media APIs - Twitter, Facebook	12
2	**Unit – II** **Understanding Privacy and Security Concerns in Web** Misinformation on Social Media - Past Examples, Privacy and Social Media, Policing and Social Media, E-Crime and Social Media	10

	Social Media Attacks-Phishing, Reconnaissance, Fake Profiles, Social Engineering, Fake News, Profile Compromise Website Security and Threats - Cross-Site Scripting (XSS), SQL injection, Cross-Site Request Forgery (CSRF), Denial of Service (DoS), Clickjacking	
3	**Unit – III** **Online Social Media and Security** How to keep your account secure (Facebook, Google, Twitter, LinkedIn, Instagram) - Two factor Authentication, Creating Strong Passwords Use Social Media for Awareness, Understand the pattern of Fake News on Social Media, Understanding Dark Web and its Role in Security, Anonymous Web Browsing, Proxy Servers	**10**
4	Unit – IV Learning Social Media Analysis on Publicly Available Twitter Data - Creating Twitter Developer Account, Download Twitter Data using API, Social Media Analysis using NLTK, Geo-Location Analysis, Gephi Network Visualization	**10**
5	**Unit – V** Case Studies - Facebook and Cambridge Analytica and The Misuse private data of 50 million Facebook users Data Protection Law - Need of Data Protection Laws, The General Data Protection Regulation (EU), Information Technology Act, 2000 (India)	**8**
	Total	**50**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	Social Media Security: Leveraging Social Networking While Mitigating Risk 1st Edition by Michael Cross	1st	**2017**
	Reference Books		

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VIII

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 894** Course Title: **E-Privacy: Privacy and Trust in Electronic Society**
2. Contact Hours: **L:** **3** **T:** **0** **P:** **0**
3. Examination Duration (Hrs): **Theory** **3** **Practical** **0**
4. Relative Weight: **CIE** **25** **MSE** **25** **SEE** **50**
5. Credits: **3**
6. Semester: **8th**
7. Category of Course: **DE**
8. Pre-requisite: TCS 332 Fundamentals of Information Security and Block Chain

9. **Course Outcome****:	After completion of the course the students will be able to: CO1: Explain e-privacy and trust. CO2: Know the working of e-privacy mechanisms. CO3: Analyze the various mechanisms of e-privacy. CO4: Use e-privacy and trust to maintain the privacy of an information system. CO5: Apply e-privacy in various applications. CO6: Develop strategies of e-privacy.

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

SL. NO.	Contents	Contact Hours
1	**Unit - I** **Overview** e-privacy, information security, CIA triad, vulnerability, threats, attacks, trust, computation of trust, privacy- an issue of global concern, technology and rising concern over privacy, a new theory of privacy	12
2	**Unit – II** **Privacy theories and reconstructing**	8

	Methods of conceptualizing, conceptions of privacy, feasibility of privacy conceptualizing, privacy- method, generality, variability and focus	
3	**Unit – III** **Value of privacy** Virtues and vices of privacy, theories of valuation of privacy, social value of privacy, privacy's pluralistic value	**8**
4	Unit – IV **Taxonomy of privacy** Information collection, information processing, information dissemination, invasion.	**8**
5	**Unit – V** **Privacy benefits and future** Nature of privacy problems, privacy and society, privacy and cultural difference, benefits of a pluralistic conception of privacy, future of privacy	**10**
	Total	**46**

11**. Suggested Books:**

SL. No.	**Name of Authors/Books/Publishers**	**Edition**	**Year of Publication / Reprint**
	Textbooks		
1.	Daniel J. Solove, "Understanding Privacy", Harvard university press..	1st	**2008**
2	Peter Carey, Eduardo Ustaran, "E-privacy and Online Data Protection", Tottel publishing.	1st	**2002**
3	Michael E. Whitman and Herbert J. Mattord, Principles of Information Security, (2e), Thomson Learning, 2007	2nd	2007
	Reference Books		
2	Ronald Leenes, Rosamunde van Brakel, Serge Gutwirth, Paul de Hert, "Data Protection and Privacy: The Age of Intelligent Machines", Hart Publishing, 2017	1st	**2017**
3			

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VIII

Name of Department: - Computer Science and Engineering

1.	Subject Code:	**TCS 895**		Course Title:	**Crypto assets and crypto economy.**		
2.	Contact Hours:	**L:** 3	**T:** 0	**P:** 0			
3.	Examination Duration (Hrs):	**Theory** 3		**Practical** 0			
4.	Relative Weight:	**CIE** 25	**MSE** 25	**SEE** 50			
5.	Credits:	3					
6.	Semester:	8th					
7.	Category of Course:	DE					

8. Pre-requisite: TCS 332 Fundamentals of Information Security and Block Chain

9. **Course Outcome**:**	After completion of the course the students will be able to**:** **CO1:** Explain fundamentals of crypto assets and crypto. **CO2:** Know the working mechanism of crypto assets. **CO3:** Analyze the different mechanism of crypto assets and crypto economy. **CO4:** Use blockchain mechanism to maintain crypto assets. **CO5:** Apply crypto assets in crypto economy applications. **CO6:** Develop policies of crypto economy. .

*** Describe the specific knowledge, skills or competencies the students are expected to acquire or demonstrate.*

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** Overview of distributed ledger technology: Details of blockchain, distributed ledger technology, its working mechanism and usability, security of crypto assets	6
2	**Unit 2:** **Overview of crypto assets:** Different types of crypto assets and their use, cryptocurrencies and non- currency assets-tokens and utility tokens, characteristics of cryptocurrencies- borderless, censorship-free, greater financial control, greater security, lower costs, greater accessibility **Working mechanism of crypto assets:** Mechanism of bitcoin (BTC), Litecoin (LTC), Ethereum (ETH), ripple (XRP), zcash (ZEC), bitcoin cash, Ethereum classic, stellar lumen (XLM)	8

3	**Unit 3:** **Overview of crypto economy:** Introduction to crypto economy, past, present, and future of crypto economy, the institutional economics of blockchain, the universal turing institution, the micro foundations of ledgers.	10
4	**Unit 4:** **Advanced topics of crypto economy:** Money, dequity, and the barter economy of the future, supply chains and identity, the V-form organization, and the future of the firm.	10
5	**Unit 5:** **Ethics and issues**: Ethics and issues in crypto economy, capitalism, policy in blockchain era, capitalism after Satoshi.	4
	Total	**46**

11**. Suggested Books:**

SL. No.	Name of Authors/Books/Publishers	Edition	Year of Publication / Reprint
	Textbooks		
1.	Chris Berg, Sinclair Davidson, and Jason Potts, Understanding the Blockchain Economy- An Introduction to Institutional Crypto economics, Edward Elgar Publishing, (1e) 2019.	1st	**2019**
2.	Imran Bashir,” Mastering Blockchain”: Distributed Ledger Technology, decentralization, and smart contracts explained”, 2nd edition, Packt publishing	2nd	
	Reference Books		
1.	George Icahn, “the complete guide to understand the blockchain technology”, 2020	1st	**2020**

12.	**Mode of Evaluation**	Test / Quiz / Assignment / Mid Term Exam / End Term Exam