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BACHELOR OF TECHNOLOGY

COMPUTER SCIENCE & ENGINEERING

Course Components of Academic Programme
B.Tech (Computer Science and Engineering)

Minimum Duration	:	8 Semesters (4 Years)
Maximum Duration	:	12 Semesters (6 Year)
Total Number of Credits	:	195 Credits

Course Components		Credits
1.	**Compulsory Courses**	
I.	Basic Science Courses (BSC)	16
II.	Engineering Science Courses (ESC)	24
III.	Core Courses (CC)	85
2.	**Elective Courses**	
I.	Programme Elective Courses (PEC)	22
II.	Open Elective Courses (OEC)	9
3.	**Discipline-Centric Additional Courses**	
I.	Seminar(SM) /Project (PJ)/ Intern(IN)/ Comprehensive Viva-Voce (CM)	14
II.	Humanities and Social Science Including Management (HSMC)	14
4	**General Courses**	
I.	Healthy Living and Fitness (HF)	1
II.	Environmental Science (EV)	2
III.	General Proficiency (GP)	8

A. Requirement of Awards of Degree: - CGPA>= 4.5 Clearance of total no. of credits as 195 and any other condition as per regulation and ordinances.

B. Audit Courses (AC) upto 4 credits may be done by a student as Extra Course(s) over and above the requirement for award of this degree.

B.Tech (Computer Science and Engineering)
CURRICULUM STRUCTURE AND EVALUATION SCHEME W.E.F 2020-21

SEMESTER: I

COURSE MODULE Physics Group				TEACHING PERIODS			WEIGHTAGE : EVALUATION			
COURSE			Credits	L	T	P	CWA	MSE	ESE	Total
Code	Title	Component								
THU101	Professional Communication	HSMC	2	2	-	-	25	25	50	100
TPH101	Engineering Physics	BSC	3	3	-	-	25	25	50	100
TMA101	Engineering Mathematics-I	BSC	4	3	1	-	25	25	50	100
TEE101	Basic Electrical Engineering	ESC	3	3	-	-	25	25	50	100
TCS101	Fundamental of Computer & Introduction to Programming	ESC	3	3	-	-	25	25	50	100
THF101	Healthy Living & Fitness	HF	1	1	-	-	50	-	50	100
PPH151	Physics Lab	BSC	1	-	-	2	25	25	50	100
PEE151	Basic Electrical Engineering Lab.	ESC	1	-	-	2	25	25	50	100
PME151	Workshop and Manufacturing Practices	ESC	3	1	-	4	25	25	50	100
PCS151	Computer Lab-I	ESC	2	-	-	4	25	25	50	100
GP101	General Proficiency	GP	1	-	-	-	-	-	100	100
	Total		**24**	**16**	**1**	**12**	**275**	**225**	**600**	**1100**

COURSE MODULE Chemistry Group		TEACHING PERIODS			WEIGHTAGE : EVALUATION			
COURSE	Credits	L	T	P	CWA	MSE	ESE	Total

Code	Title	Component								
THU101	Professional Communication	HSMC	2	2	-	-	25	25	50	100
TCH101	Engineering Chemistry	BSC	3	3	-	-	25	25	50	100
TMA101	Engineering Mathematics-I	BSC	4	3	1	-	25	25	50	100
TEC101	Basic Electronics Engineering	ESC	3	3	-	-	25	25	50	100
TEV101	Environmental Science	EV	2	2	-	-	25	25	50	100
TCS101	Fundamental of Computer & Introduction to Programming	ESC	3	3	-	-	25	25	50	100
PCH151	Chemistry Lab	BSC	1	-	-	2	25	25	50	100
PME153	Engg. Graphics and Design Lab.	ESC	3	1	-	4	25	25	50	100
PCS151	Computer Lab - I	ESC	2	-	-	4	25	25	50	100
PEC151	Basic Electronics Engineering Lab.	ESC	1	-	-	2	25	25	50	100
GP101	General Proficiency	GP	1	-	-	-	-	-	100	100
	Total		**25**	**17**	**1**	**12**	**250**	**250**	**600**	**1100**

SEMESTER II

COURSE MODULE **Physics Group**				**TEACHING PERIODS**			**WEIGHTAGE : EVALUATION**			
COURSE			**Credits**	**L**	**T**	**P**	**CWA**	**MSE**	**ESE**	**Total**
Code	**Title**	**Component**								
THU201	Advanced Professional Communication	HSMC	2	2	-	-	25	25	50	100
TPH201	Engineering Physics	BSC	3	3	-	-	25	25	50	100
TMA201	Engineering Mathematics-II	BSC	4	3	1	-	25	25	50	100
TEE201	Basic Electrical Engineering	ESC	3	3	-	-	25	25	50	100

TCS201	Programming for Problem Solving	ESC	3	3	-	-	25	25	50	100
THF201	Healthy Living & Fitness	HF	1	1	-	-	50	-	50	100
PPH251	Physics Lab	BSC	1	-	-	2	25	25	50	100
PEE201	Basic Electrical Engineering Lab.	ESC	1	-	-	2	25	25	50	100
PME251	Workshop and Manufacturing Practices	ESC	3	1	-	4	25	25	50	100
PCS251	Computer Lab-II	ESC	2	-	-	4	25	25	50	100
GP201	General Proficiency	GP	1	-	-	-	-	-	100	100
	Total		**24**	**16**	**1**	**12**	**275**	**225**	**600**	**1100**

COURSE MODULE **Chemistry Group**				**TEACHING PERIODS**			**WEIGHTAGE : EVALUATION**			
COURSE			**Credits**	**L**	**T**	**P**	**CWA**	**MSE**	**ESE**	**Total**
Code	**Title**	**Component**								
THU201	Advanced Professional Communication	HSMC	2	2	-	-	25	25	50	100
TCH201	Engineering Chemistry	BSC	3	3	-	-	25	25	50	100
TMA201	Engineering Mathematics-II	BSC	4	3	1	-	25	25	50	100
TEC201	Basic Electronics Engineering	ESC	3	3	-	-	25	25	50	100
TEV201	Environmental Science	EV	2	2	-	-	25	25	50	100
TCS201	Programming for Problem Solving	ESC	3	3	-	-	25	25	50	100
PCH251	Chemistry Lab	BSC	1	-	-	2	25	25	50	100
PME253	Engg. Graphics and Design Lab.	ESC	3	1	-	4	25	25	50	100
PCS251	Computer Lab - II	ESC	2	-	-	4	25	25	50	100
PEC251	Basic Electronics	ESC	1	-	-	2	25	25	50	100

	Engineering Lab.									
GP201	General Proficiency	GP	1	-	-	-	-	-	100	100
	Total		**25**	**17**	**1**	**12**	**250**	**250**	**600**	**1100**

SEMESTER: III

COURSE MODULE				**TEACHING PERIODS**			**WEIGHTAGE : EVALUATION**			
COURSE			**Credits**	**L**	**T**	**P**	**CWA**	**MSE**	**ESE**	**Total**
Code	**Title**	**Component**								
TCS-301	Logic Design	CC	3	3	-	-	25	25	50	100
TCS-302	Data Structures with C	CC	3	3	-	-	25	25	50	100
TCS-307	Object Oriented Programming with C++	CC	3	3	-	-	25	25	50	100
	Program Elective-I	PEC	4	3	-	2	25	25	50	100
TMA-316	Discrete Structures and Combinatorics	CC	4	3	1	-	25	25	50	100
PCS-301	Logic Design Lab	CC	2	1	-	2	25	25	50	100
PCS-302	Data Structures Lab	CC	2	1	-	2	25	25	50	100
PCS-307	OOPS with C++ Lab	CC	2	1	-	2	25	25	50	100
XCS-301	Career Skills	HSMC	2	2	-	-	25	25	50	100
CSP-301	Mini Project	PJ	1	-	-	-	-	-	100	100
GP-301	General Proficiency	GP	1	-	-	-	-	-	100	100
	Total		**27**	**20**	**1**	**8**	**225**	**225**	**650**	**1100**

PROGRAM ELECTIVE-I AUDIT COURSE: TOC301 PROBABILITY AND STATISTICS

COURSE CODE	COURSE NAME
TCS-351	Fundamental of Cloud Computing and Bigdata
TCS-391	Fundamental of Cyber Security
TCS-331	Fundamental of IoT
TCS-320	Application Based Programming in Python (Through Swayam)

SEMESTER: IV

COURSE MODULE				TEACHING PERIODS			WEIGHTAGE:EVALUATION			
COURSE			Credits	L	T	P	C WA	MSE	ESE	Total
Code	Title	Component								
TCS-408	Java Programming Language	CC	3	3	-	-	25	25	50	100
TCS-402	Finite Automata and Formal Languages	CC	4	3	1	-	25	25	50	100
TCS-403	Microprocessors	CC	3	3	-	-	25	25	50	100
TCS-404	Computer Organization	CC	4	3	1	-	25	25	50	100
TCS-409	Design and Analysis of Algorithms	CC	3	3	-	-	25	25	50	100
	Program Elective-II	PEC	4	3	-	2	25	25	50	100
PCS-408	Java Programming Lab	CC	2	1	-	2	25	25	50	100
PCS-403	Microprocessors Lab	CC	2	1	-	2	25	25	50	100
PCS-409	DAA Lab	CC	2	1	-	2	25	25	50	100
XCS-401	Career Skills	HSMC	2	2	-	-	25	25	50	100
CSP-401	Mini Project	PJ	1	-	-	-	-	-	100	100
GP- 401	General Proficiency	GP	1	-	-	-	-	-	100	100
	Total		**31**	**23**	**2**	**8**	**250**	**250**	**700**	**1200**

PROGRAM ELECTIVE-II AUDIT COURSE: TOC 401: COMPETATIVE PROGRAMMING

COURSE CODE	COURSE NAME
TCS-451	Virtualization and Cloud Computing
TCS-471	Statistical Data Analysis with R
TCS-431	Microcontroller and Its Interfacing
TCS-491	Introduction to Cryptography
TCS-421	Fundamental of Statisticsand AI
TCS-433	Blockchain and its Applications (Through Swayam)

SEMESTER: V

COURSE MODULE				TEACHING PERIODS			WEIGHTAGE:EVALUATION			
COURSE			Credits	L	T	P	CWA	MSE	ESE	Total
Code	Title	Component								
TCS-501	System Software	CC	4	3	1	-	25	25	50	100
TCS-502	Operating Systems	CC	3	3	-	-	25	25	50	100
TCS-503	Data Base Management Systems	CC	3	3	-	-	25	25	50	100
TMA-502	Computer Based Numerical and Statistical techniques	CC	3	3	-	-	25	25	50	100
	Program Elective-III	PEC	4	3	-	2	25	25	50	100
PCS-506	Operating Systems Lab	CC	2	1	-	2	25	25	50	100
PCS-503	DBMS Lab	CC	2	1	-	2	25	25	50	100
PMA-502	CBNST Lab	CC	2	1	-	2	25	25	50	100
XCS-501	Career Skills	HSMC	2	2	-	-	25	25	50	100
CSP-501	Mini Project	PJ	1	-	-	-	-	-	100	100
GP-501	General Proficiency	GP	1	-	-	-	-	-	100	100
	Total		**27**	**20**	**1**	**8**	**225**	**225**	**650**	**1100**

PROGRAM ELECTIVE-III AUDIT COURSE: TOC 501: FOUNDATIONS OF DATA SCIENCE

COURSE CODE	COURSE NAME
TCS-552	Cloud Based Application Development and Management
TCS-571	Bigdata Visualization
TCS-531	Communication models and protocols
TCS-591	Computer system security
TCS-509	Machine learning
TCS-521	User Interface Design (Through Swayam)

SEMESTER: VI

COURSE MODULE				TEACHING PERIODS			WEIGHTAGE:EVALUATION			
COURSE			Credits	L	T	P	CWA	MSE	ESE	Total
Code	Title	Component								
TCS-601	Compiler Design	CC	3	3	-	-	25	25	50	100
TCS-611	Software Engineering	CC	3	3	-	-	25	25	50	100
TCS-604	Computer Networks-I	CC	3	3	-	-	25	25	50	100
TCS 693	Full Stack Web Development	CC	3	3	-	-	25	25	50	100
	Program Elective-IV	PEC	4	3	-	2	25	25	50	100
PCS-601	Compiler Design Lab	CC	2	1	-	2	25	25	50	100
PCS611	Software Engineering Lab	CC	2	1	-	2	25	25	50	100
PCS 693	Web Development Lab	CC	2	1	-	2	25	25	50	100
XCS-601	Career Skills	HSMC	2	2	-	-	25	25	50	100
CSP-601	Mini Project	PJ	1	-	-	-	-	-	100	100
GP-601	General Proficiency	GP	1	-	-	-	-	-	100	100
	Total		**26**	**20**	-	**8**	**225**	**225**	**650**	**1100**

PROGRAM ELECTIVE-IV AUDIT COURSE: TOC601: COMPETATIVE PROGRAMMING

COURSE CODE	COURSE NAME
TCS-691	Image processing and computer vision
TCS-651	Devops on cloud
TCS-671	Bigdata storage and processing
TCS-631	Network programming and wireless technologies (Through Swayam)
TCS-619	Network and system security

SEMESTER: VII

COURSE MODULE				TEACHING PERIODS			WEIGHTAGE:EVALUATION			
COURSE			Credits	L	T	P	CWA	MSE	ESE	Total
Code	Title	Component								
TCS-703	Computer Networks-II	CC	3	3	-	-	25	25	50	100
TCS-704	Advanced Computer Architecture	CC	3	3	-	-	25	25	50	100
	Open Elective-I	OEC	3	3	-	-	25	25	50	100
	Open Elective-II	OEC	3	3	-	-	25	25	50	100
	Program Elective-V	PEC	3	3	-	-	25	25	50	100
SCS-701	Seminar on Industrial Interaction	SM	1	-	-	-	-	-	100	100
CSP-701	Major Project- Phase 1	PJ	2	-	-	-	-	-	100	100
GP-701	General Proficiency	GP	1	-	-	-	-	-	100	100
	Total		**19**	**15**	**-**	**-**	**125**	**125**	**550**	**800**

PROGRAM ELECTIVE-V

Course Code	Course Name
TCS-750	Cloud orchestration and Load Balancing
TCS-771	Natural Language Processing using Bigdata
TCS731	Digital Forensics/Computer Forensics
TCS-761	Cloud Infrastructure Services
TIT-721	Business Intelligence
TCS-756	Human computer interaction
TCS-722	Data warehousing and data mining
TCS-723	Distributed Systems
TCS- 799	Software Verification, Validation and Testing
TCS-732	Web Mining (Through Swayam)

OPEN ELECTIVE-I

COURSE CODE	COURSE NAME
TOE-714	Artificial Intelligence
TOE-702	Sensor Networks
TOE-703	Intellectual Property Rights for Engineers
TOE-704	Entrepreneurship and Small Business Management

TOE-705	Human Resource Planning and Development
TOE-706	Digital Signal Processing

OPEN ELECTIVE-II

COURSE CODE	COURSE NAME
TOE-707	Cryptography and Network Security
TOE-708	Strategic Management
TOE-709	Customer Relationship Management
TOE-710	Corporate Communication
TOE-711	Digital Image Processing
TOE-712	Non-conventional resources and Energy systems

SEMESTER: VIII

	COURSE DETAILS			TEACHING PERIODS			WEIGHTAGE:EVALUATION			
COURSE			Credits	L	T	P	CWA	MSE	ESE	Total
Course	Title	Component								
	Open Elective-III	OEC	3	3	-	-	25	25	50	100
TDM-881	Disaster Management	HSMC	2	2	-	-	25	25	50	100
	Program Elective-VI	PEC	3	3	-	-	25	25	50	100
CSC-801	Comprehensive Viva-Voce	CM	2	-	-	-	-	-	100	100
SCS 801	Seminar	SM	1	-	-	-	-	-	100	100
CSP-801	Project Phase-II	PJ	4	-	-	-	-	-	100	100
GP-801	General Proficiency	GP	1	-	-	-	-	-	100	100
	Total		**16**	**8**	**-**	**-**	**75**	**75**	**550**	**700**

Program Elective - VI

Course Code	Course name
TCS821	Soft Computing
TCS822	Mobile Applications Development
TCS823	Multimedia Systems and Data Compression
TCS824	Computer Graphics (Through Swayam)
TCS825	Computational Geometry (Through Swayam)
TCS826	Unix Systems Programming

TCS851	Storage Networks
TCS852	Pattern Recognition
TCS855	Agile Software Engineering
TCS857	Game Theory
TCS810	Virtual Reality

Open Elective-III

Course Code	Course Name
TOE-811	Mobile Computing
TOE-802	Project Management
TOE-803	Corporate Leadership
TOE-804	Counseling Skills for Managers
TOE-805	Wind and Solar Energy Systems
TOE-806	Mobile Adhoc Networks
TOE-807	Embedded Systems
TOE-808	Speech Processing
TOE-809	Smart Grid Technology

Name of Department:- Computer Science and Engineering

1. Subject Code: **TCS 101** Course Title: FUNDAMENTALS OF COMPUTER AND INTRODUCTION TO PROGRAMMING
2. Contact Hours: L: 3 T: - P: -
3. Semester: I

4. Pre-requisite: Basic Knowledge of Mathematics

5. Course Outcomes: After completion of the course students will be able to

1. Learn the concepts of IT and understand the fundamentals of basic building blocks of computer science.
2. Understand basic data types and syntax of C programming. .
3. Propose solution to problem by using tools like algorithm and flowcharts.
4. Analyze and select best possible solution for decision-based problems using decision making skills.
5. Develop the aptitude to solve iterative problems using different types of looping statements.
6. Implement complex problem as a collection of sub problems by applying modularization in applications using functions.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
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 Algorithms and Flow Charts – Examples of Flow charts for loops and conditional statements	**8**
Unit - II	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 (AND, OR, NOT and XOR), Logical Operators, comma operator, precedence and associativity, Logical operators (AND, OR),	**10**
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**

Unit – IV	Arrays –Single and Multi-dimensional arrays, Initializing arrays, computing address of an element in array, row major and column major form of an array, character strings and arrays, segmentation fault, bound checking, Sorting Algorithms – Bubble sort, insertion sort, selection sort	**10**
Unit – V	**Functions** – Function prototype, function return type, signature of a function, function arguments, call by value, Function call stack and Activation Records, Recursion v/s Iteration, passing arrays (single and multi-dimensional) 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**
	Total	**43**

Text Books:

- Peter Prinz, Tony Crawford,"C in a Nutshell", 1stEdition, Oreilly Publishers, 2011.
- Peter Norton, "Introduction to computers", 6thEdition, TMH, 2009.

Reference Books:

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

Name of Department:- Computer Science and Engineering

1. Subject Code: **TCS 201** Course Title: **Programming for Problem solving**
2. Contact Hours: L: 3 T: - P: -
3. Semester: II

4. Pre-requisite: Basic Knowledge of Mathematics and Computer Fundamentals

5. Course Outcomes: After completion of the course students will be able to

1. Learn and apply concepts of strings for providing solutions to homogenous collection of data types
2. Propose solution to problem by using tools like algorithm and flowcharts.
3. Apply the concept of pointers to optimize memory management by overcoming the limitations of arrays.
4. Process and analyze problems based on heterogeneous collection of data using structures.
5. Apply concepts of file handling to implement data storage and retrieval tasks.
6. Implement the basic real life problems using python

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	Strings – Declaration of strings, Initialization of strings using arrays and pointers, Standard library functions of <string.h>header file, Null-terminated strings, Char arrays and pointers, Pointers and Strings, comparing two strings, find substring in a string, tokenizing a string with strtok() function, pointer-based string-conversion function – atoi()	**6**
Unit - II	**Pointers** –Basic of pointers and addresses, Pointers and arrays, Pointer arithmetic, passing pointers to functions, call by reference, 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	**10**
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(),Difference between append and write mode, 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**
Unit – IV	**Introduction to Python-** History of Python, Need of Python Programming, Python features, Installation of Python in Windows and Linux, 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**
Unit-V	Control flow – if, if-elif-else, for, while, break, continue, pass, range(), nested loops,	**10**

	Data structures – List, Tuple, Dictionary File Handling – Reading text file, writing text file, copying one file to another	
	Total	**44**

Text Books:

- Peter Prinz, Tony Crawford,"C in a Nutshell", 1stEdition, Oreilly Publishers, 2011.
- YashwantKanetkar,"Let Us C",8th Edition,BPB Publication 2007

Reference Books:

- Steve Oualline, "Practical C programming", 3rdEdition, Orielly Publishers, 2011.
- Brian W Kernighan, Dennis M Ritcie,"The C Programming Language", 2ndEdition, Prentice Hall, 1988. R3. Herbert Schildt," C: The Complete Reference", 4thEdition.TMH, 2000.
- E.Balagurusamy,"Programming in ANSI C",6th Edition, McGraw Hill 2015

Name of Department:- Computer Science and Engineering

1. Subject Code: **TCS 301** Course Title: **Logic Design**
2. Contact Hours: L: 3 T: - P: -
3. Semester: III

4. Pre-requisite: Basics of Mathematics, Basic knowledge of computer programming and components of computer system

5. Course Outcomes: After completion of the course students will be able to

1. ExplaintheBinary, Octal, Hexadecimal number system and Gate level minimization using K-Map and Quine-McClusky Method.
2. Analyze and Designcombinational circuits.
3. Evaluate the machanism of Flip Flops (RS, JK, D and T).
4. Know the working of Asynchronous and Synchronous Counters.
5. Design and Evaluate Synchronous and Asynchronous Sequential circuits.
6. Apply and implement logic design for digital design problems of the society.

6. Details of Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	**Review of Number System:**positive and negative logic, Binary, Octal, Hexadecimal; Code conversion,Complements, Signed Binary Numbers, Arithmetic Operation, Binary Codes, Error Detection and Correction. **Boolean Algebra and Gate Level Minimization:** Basic Definition, Boolean Logic, postulates, Theorems and Properties. Digital Logic Gates, K-Map Method for Minimization upto 6-Variables, Quine-Mc Clusky Method for Minimization, NAND and NOR Gate Implementation.	**10**
Unit - II	**Combinational Logic Circuit:** Combinational circuits, Analysis Procedure, Design Procedure, Binary Adder & Subtractor, Decimal Adder, Binary Multiplier, Magnitude Comparator, Multiplexer, Demultiplexer, Decoder, Encoder, Parity Generator & Checker, Programmable Array Logic, Programmable Logic Array, Code Convertors (BCD, Gray and Seven Segment Code etc.).	**9**
Unit – III	**Sequential Logic Circuits:** Triggering, Latches, Flip Flops: RS, JK, D and T (Characteristics Table, Equation and Excitation Table), Difference between latch and Flip Flop, Flip Flop Conversion, Race Around Condition, JK Master Slave Flip Flop.	**9**
Unit – IV	**Register:** Types of Register, Serial In-Serial Out, Serial In-Parallel Out, Parallel In- Parallel Out, Parallel In- Serial Out, Universal Shift Register, Application of Shift Registers. **Counter:** Asynchronous Counter, Decoding Gates, Synchronous Counters, Changing the Counter Modulus, Decade Counter, Presettable Counter, Designing of Asynchronous and Synchronous Counters, Ring counter, Johnson counter.	**10**
Unit – V	**Design of Synchronous and Asynchronous Sequential Circuit:** Design of Synchronous Sequential circuit: Model Selection, State Transition Diagram, State Synthesis Table, Design Equations and Circuit Diagram, Implementation using Read Only Memory, State Reduction Table and ASM Chart, sequence detector. **Design of Asynchronous Sequential Circuit:** Analysis of Asynchronous Sequential Circuit, Problems with Asynchronous Sequential Circuit, Circuit Designing.	**8**

	Total	**46**

Text Book:

1. Donald P Leach, Albert Paul Malvino& Goutam Saha, "Digital Principle and Application," 7th Edition, Tata McGraw Hill, 2010
2. Mano M. Morris and Ciletti M.D., "Digital Design," Pearson Education 4th Edition.

Reference Books:

1. Charles H. Roth,"Fundamentals of Logic Design,Jr.," 5th Edition, Thomson, 2004
2. Ronald J. Tocci, Neal S. Widmer, Gregory L. Moss,"Digital Systems Principles and Applications," 10th Edition, Pearson Education, 2007

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 302 Course Title: **Data Structures with C**
2. Contact Hours: L: 3 T: - P: -
3. Semester: III

4. Pre-requisite: Good Knowledge of Programming in C (TCS 101, TCS 201)

5. Course Outcomes: After completion of the course students will be able to

1. Describe the concept of Data Structures and assess how the choice of data structures impacts the performance of programs
2. Compare and contrast merits and demerits of various data structures in terms of time and memory complexity.
3. Identify and propose appropriate data structure for providing the solution to the real world problems.
4. Implement operations like searching, insertion, deletion, traversing mechanism etc. on various data structures
5. Be familiar with advanced data structures such as balanced search trees, hash tables, AVL trees, priority queues, ADT etc.
6. To augment merits of particular data structures on other data structure to develop innovation in subject of study.

6. Details of Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	**Introduction:** Basic Terminology, Pointer and dynamic memory allocation, Elementary Data Organization, Data Structure operations, Algorithm 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.	**10**
Unit - II	**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**
Unit – III	**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**
Unit – IV	***Sorting****:* Insertion Sort, Bubble Sorting, Quick Sort, Two Way Merge Sort, Heap Sort, Sorting on Different Keys, Practical consideration for Internal Sorting.	**9**

	Binary Search Trees: Binary Search Tree (BST), Insertion and Deletion in BST, Complexity of Search Algorithm, Path Length, AVL Trees	
Unit – V	**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**

Text/ Reference Books:

1. Horowitz and Sahani, “Fundamentals of data Structures”, Galgotia Publication Pvt. Ltd., New Delhi.
2. R. Kruse etal, “Data Structures and Program Design in C”, Pearson Education Asia, Delhi-2002
3. A. M. Tenenbaum, “Data Structures using C & C++”, Prentice-Hall of India Pvt. Ltd., New Delhi.
4. K Loudon, “Mastering Algorithms with C”, Shroff Publisher & Distributors Pvt. Ltd.
5. Bruno R Preiss, “Data Structures and Algorithms with Object Oriented Design Pattern in C++”, Jhon Wiley & Sons, Inc.
6. Adam Drozdek, “Data Structures and Algorithms in C++”, Thomson Asia Pvt

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: - P: -
3. Semester: III

4. Pre-requisite: TCS 101, TCS 201

5. Course Outcomes: After completion of the course students will be able to

1. Demonstrate the C++ Program uses data types, operators, expressions, array, strings and functions.
2. Implement Constructors (Parameterized, Copy), this pointer, friend function, dynamic objects, arrays of objects,
3. Illustrate the Operator Overloading of +, -, pre-increment, post-increment, << and >>.
4. Implement the single, multiple, multilevel and hybrid inheritance in C++.
5. Illustrate function overloading, Overriding and virtual functions.
6. Carry out exception handling techniques and provide solutions to storage related problems using STL.

6. Details of Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	**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, user-defined types Function Components, argument passing .	**10**
Unit - II	**Classes & Objects:** Class Specification, Objects, Scope resolution operator, Access members, Defining member functions, Data hiding, Constructors , Parameterized constructors, Destructors, Static data members,Static member function , Friend functions, Passing objects as arguments, Returning objects, Arrays of objects, Dynamic objects, Pointers to objects, Copy constructors, This Pointer, initializer list. **Operator overloading** :Fundamentals of Operator Overloading, Overloading Binary Operators and unary operators using member function,Operator overloading using friend functions such as +, - , pre-increment, post-increment.	**9**
Unit – III	**Inheritance:** Necessity of inheritance,Types of inheritance with examples**,**Base Class and Derivedclass,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, Diamond problem	**9**
Unit – IV	**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**
Unit – V	I/O System Basics and STL: C++ stream classes, I/O manipulators, fstream and the File classes, basic file operations, function templates,	**9**

	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	
	Total	**46**

Text Books:

1. Herbert Schildt: "The Complete Reference C++", 4th Edition, Tata McGraw Hill, 2003.

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. Semester: III

4. Pre-requisite: TMA 101, TMA 201

5. Course Outcomes: After completion of the course students will be able to

1. Specify and manipulate basic mathematical objects such as sets, functions, and relations. Demonstrate partial order relations and Lattices.
2. Apply the discrete probability and number theory to solve the engineering problems.
3. Produce convincing arguments, conceive and/or analyze basic mathematical proofs and discriminate between valid and unreliable arguments.
4. Discriminate, identify and prove the properties of groups and subgroups
5. Apply the basic counting techniques to solve combinatorial problems
6. Demonstrate different traversal methods for trees and graphs. Model problems in Computer Science using graphs and trees.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	**Relations and Functions:** Review of Sets, 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	**11**
Unit – II	**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**
Unit – III	**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**
Unit – IV	**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**
Unit – V	**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**

Text Books:

1. Kenneth H. Rosen:" Discrete Mathematics and its Applications", 6th Edition, McGraw Hill, 2007.
2. Jayant Ganguly:" A Treatise on Discrete Mathematical Structures", Sanguine-Pearson, 2010.

Reference Books:

1. D.S. Malik and M.K. Sen: "Discrete Mathematical Structures: Theory and Applications", Thomson, 2004.
2. Thomas Koshy: "Discrete Mathematics with Applications", Elsevier, 2005, Reprint 2008.
3.Ralph P. Grimaldi: "Discrete and Combinatorial Mathematics", 5th Edition, Pearson Education, 2004.
4. S.B.Singh, Jaikishor and Ekata, "Discrete Mathematics", Khanna Publication, 2011.

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: 2
3. Semester: III

4. Course Outcomes: After completion of the course students will be able to

1. Discuss the evolution of cloud computing.
2. Recognize theservice and deployment models of cloud computing.
3. Identify the different types of cloud computing applications.
4. Analyze the cloud computing services, providers and standards.
5. Describe the significance of Bigdata.
6. Apply the cloud computingservices for Bigdata use cases.

5. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs.
Unit I	Introduction to Cloud Computing, History, Evolution, and Characteristics of Cloud Computing (NIST), Characteristic, Advantages and Disadvantages of Cloud Computing, Cloud computing vs. Cluster computing vs. Grid computing, Importance of Open Standards.	9
Unit II	Comparison with traditional computing architecture (client/server), Services provided at various levels, Working of Cloud Computing, Impact of Networks, Web Development and User Interface (UI)on Cloud computing, Cloud Service Models: Infrastructure as a Service(IaaS), Platform as a Service(PaaS), Software as a Service(SaaS), Cloud Deployment Models: Public cloud, Private cloud, Hybrid cloud, Community cloud.	10
Unit III	Infrastructure as a Service(IaaS): IaaS definition, Virtualization, Hypervisors, Machine Image, Virtual Machine(VM) Resource Virtualization Server Storage Network Virtual Machine(resource) provisioning and manageability, Data storage in cloud computing(storage as a service) Examples: Amazon EC2, EC2 Compute, Eucalyptus, Open Stack. Platform as a Service(PaaS): PaaS definition, Service Oriented Architecture (SOA) Cloud Platform and Management Computation Storage, Examples: Google App Engine Microsoft Azure Salesforce. Software as a Service(SaaS): SaaS definition, Web services, Web 2.0, Case Study on SaaS.	9
Unit IV	Introduction to Big Data, History, Characteristics and 5V's for Big Data, Advantages and Disadvantages of Big Data, Homogeneous and heterogeneous data, Data Quality, Data Mining Goals, Tools and Techniques used inBig Data, Learning Techniques applied in Big Data: Unsupervised Learning andChallenges for Big Data Analytics, Clustering, Associative Rule Mining,Challenges for big data analytics, Supervised Learning, Support VectorMachine.Use cases for Big Data application.	9
Unit V	Foundations of distributed systems, Integrating Big Data with Cloud computing, Prospects for the integration, Elasticity and Scalability, Data Storage in CloudLarge Scale Data Processing, AWS Lambda service. Service Management in Cloud Computing:Service Level Agreements(SLAs), Billing & Accounting. Economics of Cloud Computing: SWOT Analysis and Value Proposition, General Cloud Computing Risks, (Performance, Network Dependence, Reliability, Outages, and Safety Critical Processing Compliance and Information Security.	10
Total		47 Hrs.

Text Books:

- RajkumarBhuyya, Cloud Computing Priciples and Paradigms, Wiley, 2011
- Kannammal, Fundamentals of Cloud Computing, Cengage Learning, 2015
- Cloud Computing Bible, Barrie Sosinsky, Wiley-India, 2010

Reference Books:

- Jared Dean, Bigdata Data Mining and Machine Learning, Wiley, 2014
- Vince Reynolds, Bigdata for Biginners, Createspace Independent Publishing Platform, 2016

Name of Department:- Computer Science and Engineering

1. Subject Code: **TCS 391** Course Title: **Fundamentals of Cyber Security**
2. Contact Hours: L: 3 T: - P: 2
3. Semester: III

4. Pre-requisite: None

5. Course Outcomes: After completion of the course students will be able to

1. Summarize the concepts of cyber security, three pillars of cyber security.
2. Discriminate among the basic types of cyber threats and cybercrimes.
3. Categorize different types of vulnerabilities for threat management.
4. Analyze and select best possible security solutions in different security settings.
5. Demonstrate the use of Linux essentials for use in cyber security.
6. Apply concepts of Cyber Security for designing solutions in real world scenarios.

6. Details of Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	Basic Cyber Security Concepts: Introduction to Cyber Security, layers of security, Vulnerability, threat, Harmful acts, Internet Governance – Challenges and Constraints, CIA Triad, Assets and Threat, types and motives of attackers, active attacks, passive attacks, Softwareattacks, hardware attacks, Spectrum of attacks, Taxonomy of various attacks, IP spoofing, Methods of defense, Security Models, risk management, Cyber Threats-Cyber Warfare, Cyber Crime, Cyber terrorism, Cyber Espionage, etc.	**10**
Unit – II	Basic Data Privacy Concepts: Fundamental Concepts, Definitions, Statistics, Data Privacy. Attacks, Data linking and profiling, access control models, role-based access control,Discretionary and mandatory access control, privacy policies and their specifications, privacy policy languages, privacy in different domains-medical, financial, etc.	**9**
Unit – III	Cyber Security Vulnerabilities and Cyber Security Safeguards: Cyber Security Vulnerabilities – Overview, vulnerabilities in software, System administration, Complex Network Architectures, Open Access to Organizational Data, Weak Authentication, Poor Cyber Security Awareness. Cyber Security Safeguards – Overview, Access control, Audit, Authentication, Biometrics, Cryptography, Deception, Denial of Service Filters, Ethical Hacking, Firewalls, Intrusion Detection Systems, Response, Scanning, Security policy, Threat Management.	**9**
Unit – IV	Linux Basics and Scripting: 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 Basics of Bash or Shell Scripting, conditional statements, loops, Manipulating files	**9**
Unit – V	Cyber Forensics: Introduction to Cyber Forensics, Handling Preliminary	**8**

	Investigations,controlling an Investigation, conducting disk-based analysis, Investigating Information-hiding, Scrutinizing E-mail, Validating E-mail header information, Tracing Internet access, Tracing memory in real-time. Legal and Ethical Issues: Cybercrime and computer crime, Cyber Warfare, Cyber terrorism, Cyber Espionage, Intellectual property, copyright, patent, trade secret, Hacking and intrusion, Cyber laws, Roles of International Law, Privacy, identity theft, Computer Security Policy Categories:User Policies, IT Policies ,General Policies, National Cyber Security Policy.	
	Total	**45**

Text Book:

1. B. B. Gupta, D. P. Agrawal, Haoxiang Wang, Computer and Cyber Security: Principles, Algorithm, Applications, and Perspectives, CRC Press, ISBN 9780815371335, 2018.
2. William Stallings, "Cryptography and Network Security: Principles and Practice.", PrenticeHall.
3. Edward Amoroso, "Fundamentals of Computer Security Technology", Prentice-Hal

Reference Books:

1. Nina Godbole,SunitBelapure, "Cyber Security:Understanding Cyber Crimes, Cyber Forensics and Legal Perspectives," Wiley India,2011.

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 331 Course Title: **Fundamental of IoT**
2. Contact Hours: L: 3 T: - P: 2
3. Semester: III

4. Pre-requisite: Fundamentals of Computer System, TCS301

5. Course Outcomes: After completion of the course students will be able to

1. Explain the terms used in IoT and its architecture.
2. Describe the key technologies of IoT and IoT objects.
3. Use the RFID technologies in IoT applications.
4. Interpret the data transmission and security challenges.
5. Identify and manage the resources used in IoT.
6. Identify the security requirements of basic IoT applications.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	**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**
Unit - II	**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**
Unit – III	**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**
Unit – IV	**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**
Unit – V	**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	**10**

	Infrastructure, e-Health Body Area Networks, City Automation, Automotive Applications, Home Automation, Smart Cards.	
	Total	**48**

Text Books

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

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

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).

Reference Books

1. HakimaChaouchi, “The Internet of Things Connecting Objects to the Web” ISBN : 978-1- 84821-140-7, Willy Publications

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

3. Daniel Kellmereit, Daniel Obodovski, “The Silent Intelligence: The Internet of Things”,. Publisher: Lightning Source Inc; 1 edition (15 April 2014). ISBN-10: 0989973700, ISBN-13: 978- 0989973700.

4. Fang Zhaho, Leonidas Guibas, “Wireless Sensor Network: An information processing approach”, Elsevier, ISBN: 978-81-8147-642-5.

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 408 Course Title: **Java Programming Language**
2. Contact Hours: L: 3 T: - P: -
3. Semester: IV

4. Pre-requisite: TCS 101, TCS 201, TCS 302, TCS 307

5. Course Outcomes: After completion of the course students should be able to

1. Explain the Java programming features and develop programs to demonstrate the same.
2. Make use of object oriented concepts to develop applications
3. Classify exceptions and demonstrate applications for file handling and multithreading.
4. Analyze collection framework and develop applications using GUI.
5. Compare and utilize collection framework for programming applications
6. Design applications for event handling and accessing databases using Java features.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	**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,Wrapperclasses,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**
Unit - II	**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. **Interface:**Defining Interfaces, abstract methods declarations, implementing interfaces, extended interfaces, interface references.	**9**
Unit – III	**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**
Unit – IV	**Collection and Generic Framework:** Introduction to Collection and	**9**

	Generic Framework: Interfaces Iterator, List, Set, ArrayList, LinkedListHashSet 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	
Unit – V	**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**

Text books:

1. Patrick Naughton and Herbert Schildt, "Java 2 The Complete Reference", 9th edition, McGraw Hill Education, 2017.
2. Bruce Eckel, "Thinking in Java", 4thedition,Pearson Education India, 2008
3. E. Balaguruswamy, "Programming with Java a Primer", 4thedition, Tata McGraw Hill, 2009.

Reference Books:

1. Cay S Horstmann and Gary Cornell, "Core Java Volume –I and II", Standard edition, Sun Microsystems, 2001
2. Harvey Deitel and Paul Deitel, "Java How to Program" , 4thedition, PHI Learning, 2004

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. Semester: IV

4. Pre-requisite: TMA 101, TMA 201

5. Course Outcomes: After completion of the course students will be able to

1. Demonstrate the conversion of NFA into DFA, ϵ-NFA into DFA and Minimization of Finite Automata by using Myhill-Nerode Theorem
2. Formulate DFA, RE and FA with output.
3. Design CFG and check the language is not CFL.
4. Design PDA and convert n-PDA into d-PDA.
5. Design Turing machines for addition, substraction, multiplication etc.
6. Formulate finite machines, push down automata and Turing machines for automated functioning of devices.

6. 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, Distinguishing one string from other, Myhill-Nerode Theorem	**10**
Unit - II	Regular expression (RE), Definition, Operators of regular expression and their precedence, Algebraic laws for Regular expressions, Kleen's Theorem, Regular expression to FA, DFA to Regular expression, Arden Theorem, Non Regular Languages, Pumping Lemma for regular Languages. Application of Pumping Lemma, Closure properties of Regular Languages, Decision properties of Regular Languages, FA with output: Moore and Mealy machine, Equivalence of Moore and Mealy Machine, Applications and Limitation of FA.	**10**
Unit – III	Context free grammar (CFG) and Context Free Languages (CFL): Definition, Examples, Derivation, Derivation trees, Ambiguity in Grammar, Inherent ambiguity, Ambiguous to Unambiguous CFG, Useless symbols, Simplification of CFGs, Normal forms for CFGs: CNF and GNF, Closure proper ties of CFLs, Decision Properties of CFLs: Emptiness, Finiteness and Membership, Pumping lemma for CFLs.	**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,	**8**

	Introduction to Undecidability, Undecidable problems about TMs. Post correspondence problem (PCP), Modified PCP, Introduction to recursive function theory.	
	Total	**47**

Text Book:

- Hopcroft, Ullman, “Introduction to Automata Theory, Languages and Computation”, Pearson Education.
- KLP Mishra and N. Chandrasekaran, “Theory of Computer Science: Automata, Languages and Computation”, PHI Learning Private Limited, Delhi India.

Reference Books:

- Michael Sipser,” Introduction to Theory of Computation”, (2nd edition), Thomson, 2006
- Peter Linz, "An Introduction to Formal Language and Automata", Narosa Publishing house.
- Elaine Rich ,“Automata, Computability, Complexity-Theory and applications”

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 403 Course Title: **Microprocessors**

2. Contact Hours: L: 3 T: - P: -

3. Semester: IV

4. Pre-requisite: TEC 101, TEC 201, TCS 101, TCS 301

5. Course Outcomes: After completion of the course students will be able to

1. Identify of 8085 and 8086 microprocessors and memory segmentation
2. Analysis of Instruction set of 8085and 8086.
3. Implementation of different programs on 8085 and 8086 based microcomputer kit.
4. Design the Interfacing of 8255 and 8085/8086.
5. Design & develop Interfacing of microprocessor with Timing Devices1
6. Evaluate & Develop projects on embedded system using the foundation of microporcessor

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	Introduction to Microprocessors: Evolution of Microprocessors,Microcomputer , different type of buses, Example of an 8085 based System, Microprocessor Internal Architecture, Pin diagram and function of each pin, memory interfacing.	**9**
Unit - II	Programming with 8085: Instruction set, programming model of 8085, addressing modes, assembly language programming, Timing and control, peripheral I/O, memory mapped I/O, 8085 Interrupts, Stack and subroutines, Machine & Instruction cycle of 8085.	**10**
Unit – III	16 Bit Processor: 16-bit Microprocessors (8086): Architecture, pin diagram, Physical address, segmentation, memory organization, Bus cycle, Addressing modes, Instruction set ,Assembly Language Programming of 8086, comparison of 8086 & 8088	**8**
Unit – IV	Interfacing (Data Transfer) with Microprocessor: Data Transfer Schemes: Introduction, handshaking signals, Types of transmission, 8255 (PPI), Serial Data transfer (USART 8251), memory interfacing, 8257 (DMA), programmable interrupt Controller (8259).	**8**
Unit – V	Interfacing of Microprocessor with Timing Devices: Programmable Interval Timer/ Counter (8253/8254): Introduction, modes, Interfacing of 8253, applications, Need of ADC & DAC, resolution,Introduction to DAC & ADC, ADC & DAC Interfacing (0808, 0809).	**9**
	Total	**44**

Text Book:

1. Ramesh Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, 5th Edition, Penram International Publication (India) Pvt. Ltd.
2. Douglas V. Hall, “Microprocessors and Interfacing”, 2nd Edition, TMH, 2006.

Reference Book:

1. Kenneth L. Short, “Microprocessors and programmed Logic”, 2nd Ed, Pearson Education Inc.
2. A.K.Ray&K.M.Bhurchandi, “Advanced Microprocessors and peripherals” , Tata McGraw Hill, 2000.2nd edition

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 404 Course Title: **Computer Organization**
2. Contact Hours: L: 3 T: 1 P: 0
3. Semester: IV

4. Pre-requisite: Fundamentals of Computer System, TCS301

5. Course Outcomes: After completion of the course students will be able to

1. Understand the basic components of a computer and milestones in their historical development.
2. Discuss the operation of the arithmetic unit including the algorithms & implementation of fixed-point and floating-point addition, subtraction, multiplication & division.
3. Have a clear understanding of the elements of CPU working and Instruction Set Architecture
4. Identify the impact of the hierarchical memory system including cache memories and virtual on the overall computer system design
5. Evaluate the various aspects I/O operations and their impact on the overall performance and functioning of computers
6. Review the current trends in development of processor architectures with emphasis on instruction level parallelism, latency operations in pipeline design, fault tolerance etc.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	**Introduction:** The main components of a Computer, Historical Development: First through Fourth Generation Computers, Moore's Law, The Von Neumann and Non Von Neumann Model, The Evolution of the Intel x86 Architecture **Data Representation in Computer Systems:** Signed Integer Representation, Complement Systems: One's complement and Two's complement, Addition and Subtraction using signed numbers, Multiplication of Positive Numbers, Signed Operand Multiplication, Integer Division; Floating Point Representation, , The IEEE-754 Floating Point Standard,Floating Point Arithmetic, Floating Point Errors	**10**
Unit - II	**Machine Instructions and Programs:** Memory Location and Addresses, Memory Operations, Instructions and Instruction Sequencing, Addressing Modes, , Execution of a Complete Instruction, Single Bus Organization, Control Unit Operations: Instruction sequencing, Micro operations and Register Transfer. Hardwired Control, Micro-programmed Control: Basic concepts, Microinstructions and micro-program sequencing **Performance** – Processor Clock, Basic Performance Equation, Clock Rate, Performance Measurement Concept of Pipelining, Amdahl's Law	**12**
Unit – III	**Input/Output Organization:** Accessing I/O Devices, Interrupts – Interrupt Hardware, Enabling and Disabling Interrupts, Handling Multiple Devices, Controlling Device Requests, Exceptions, Direct Memory Access, Buses Interface Circuits, Standard I/O Interfaces – PCI Bus, SCSI Bus, USB	**9**
Unit – IV	**Memory System:** Basic Concepts, Types of Memory, Speed, Size, and Cost, The Memory Hierarchy, Locality of Reference, Cache Memories – Mapping Functions, Replacement Algorithms, Effective Access Time and Hit Ratio, Virtual Memory-Paging, Advantages and Disadvantages of Paging and Virtual Memory, Segmentation, Paging Combined with Segmentation,	**9**

	Real World Example of Memory Management-Pentium 4 Memory Management	
Unit – V	**Introduction to Alternative Architectures:** RISC Machines, Flynn's Taxonomy, Parallel and Multiprocessor Architectures: Instruction level pipelining,Superscalar and VLIW, Vector Processors, Interconnection Networks, Shared Memory Multiprocessors, Closely and Loosely coupled multiprocessors systems; Alternative Parallel Processing Approaches: Dataflow Computing, Neural Networks.	**8**
	Total	**48**

Text Books:

- William Stallings:" Computer Organization & Architecture", 8th Edition, PHI, 2010.
- Carl Hamacher, ZvonkoVranesic, SafwatZaky:" Computer Organization", 5th Edition, Tata McGraw Hill, 2002.

Reference Books:

- David A. Patterson, John L. Hennessy: "Computer Organization and Design – The Hardware / Software Interface ARM Edition", 4th Edition, Elsevier
- Linda Null, Julia Lobur: "Computer Organization and Architecture", Jones and Bartlett Publishers, 2003 Edition

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: - P: -
3. Semester: IV

4. Pre-requisite: TCS 101, TCS 201,TCS 302

5. Course Outcomes: After completion of the course students will be able to

1. Discuss various asymptotic notations to analyze time and space complexity of algorithms
2. Analyze the various paradigms for designing efficient algorithms using concepts of design and conquer, greedy and dynamic programming techniques
3. Provide solutions to complex problems using the concept of back tracking and branch and bound techniques.
4. Apply algorithm design techniques to predict the complexity of certain NP complete problems.
5. Implement Dijkstra's, Bellman-ford, Prims, Kruskal's algorithms to solve the real world problems like traveling salesman problem, job sequencing, packet routing etc
6. Apply pattern matching algorithms like Rabin Karp Algorithm, Brute-force techniques etc to find a particular pattern.

6.Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	**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 **Searching -** Linear search (sorted and unsorted), Iterative and recursive binary search, Exponential search, Tower of Hanoi and solving its recursion, Fibonacci and solving its recursion	**8**
Unit - II	**Sorting Algorithms Sorting -** Bubble sort, Insertion sort, selection sort, quick sort, randomized quick sort, merge sort, Heap & Heap sort , counting sort, External sorting, Radix sort , bucket sort. **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**
Unit – III	**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, Working on -ve edge & cycle, difference & similarity.	**12**

	All pair shortest paths - The Floyd Warshall algorithm	
Unit – IV	**Algorithm Design Techniques - Greedy and Dynamic Programming** **Greedy algorithms –O**ptimal substructure property,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, Longest increasing subsequence.	**10**
Unit – V	**Hashing, String Matching and NP-Completeness** **Hashing -** Introduction to Hashing, Hash function, Collision and collision handling, - Chaining, Open addressing (longest probing, quadratic probing, double hashing) **String Matching -** Naive string-matching algorithm, The Rabin-Karp algorithm, The Knuth-Morris-Pratt algorithm,Trie. **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**

Text Books:

1. Thomas H. Cormen, Charles E. Leiserson, Ronal L. Rivest, Clifford Stein:" Introduction to Algorithms", 2nd Edition, PHI, 2006.

Reference Books:

1. Donald E.Knuth:"The Art of Computer Programming: Volume 1: Fundamental Algorithms",3rd Edition
2. Ellis Horowitz, Sartaj Sahni, SanguthevarRajasekaran:" Fundamentals of Computer Algorithms", 2nd Edition, University press, 2007.
3. Anany Levitin: "Introduction to the Design & Analysis of Algorithms", 2nd Edition, Pearson Education, 2007.

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 451 Course Title: **Virtualization and Cloud Computing**

2.Contact Hours: L: 3 - 2

3. Semester: IV
4. Pre-requisite: TCS 101, TCS351
5. Course Outcomes: After completion of the course students will be able to
    1. Discuss the different paradigms of cloud computing.
    2. Contrast parallel and distributed computing.
    3. Identify the concept of virtualization technique.
    4. Apply virtualization technique in cloud computing platform.
    5. Describe the architectures of cloud computing.
    6. Demonstrate the Use case of the virtualization and cloud computing services.

6 Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	**Introduction to Cloud Computing** Why Cloud Computing (CC)? Different Perspectives on CC, Different Stakeholders in CC, Total cost of ownership (TCO) of on-premises IT, Cloud Computing Taxonomy, Characteristics of cloud computing, Characteristics of cloud computing as per NIST, Cloud DefinitionsCloud Computing at a Glance, The Vision of Cloud Computing, Cloud Computing Reference Model, Challenges Ahead, Historical Developments, Distributed Systems, Virtualization, Web 2.0, Service-Oriented Computing, Utility-Oriented Computing, Building Cloud Computing Environments, Application Development, Infrastructure and System Development, Computing Platforms and Technologies, Amazon Web Services (AWS), Google AppEngine, Microsoft Azure, Hadoop, Force.com and Salesforce.com	**9**
Unit - II	**Virtualization** Introduction, Characteristics of Virtualized Environments, Taxonomy of Virtualization Techniques, Execution Virtualization, Types of hardware virtualization: Full virtualization - partial virtualization - para virtualization Desktop virtualization: Software virtualization – Memory virtualization - Storage virtualization – Data Virtualization – Network virtualizationVirtualization and Cloud Computing, Pros and Cons of Virtualization, Technology Examples, Xen: Para virtualization, VMware: Full Virtualization, Microsoft Hyper-V.	**9**
Unit – III	**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	**8**
Unit – IV	**Parallel and Distributed Computing** Eras of Computing, Parallel vs. Distributed Computing, Elements of Parallel Computing, What is Parallel Processing?, Hardware Architectures for Parallel Processing, Approaches to Parallel Programming, Levels of Parallelism, Laws of Caution, Elements of Distributed Computing, General Concepts and Definitions, Components of a Distributed System, Architectural Styles for Distributed Computing, Models for Inter-Process Communication, Technologies for Distributed Computing, Remote Procedure Call, Distributed Object Frameworks, Service Oriented Computing	**8**
Unit – V	**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):	**9**

	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.	
	Total	**43**

Text Books:

- Mastering Cloud Computing by RajkumarBuyya etc., Published by McGraw Hill, 2013
- Virtual Machines by James E. Smith, Ravi Nair, Published by MK Publishers
- V K Pachghare, Cloud Computing, PHI, 2016

Reference Books:

- Barrie Sosinsky , Cloud Computing Bible, Wiley Publishing Inc.,2011

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: - P: 2
3. Semester: IV

4. Pre-requisite: TMA101, TCS 201, TCS351

5. Course Outcomes: After completion of the course students will be able to

1. Understand the concepts of statistics
2. Apply the probability distribution techniques in different applications.
3. Understand the needs of data preprocessing
4. Implement the manipulation and processing of data in R
5. Apply the concepts of functions in R
6. Understand the use of R in data Analytics

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	**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**
Unit - II	**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**
Unit – III	**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**
Unit – IV	**Objects and Data Types**: 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**
Unit – V	**Functions:**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	**9**
	Total	**46**

Text/ Reference Books:

1. Dr. Mark Gardener, “Beginning R: The Statistical Programming Language”, John willey& Sons, 2012
2. John M. Quick, “Statistical Analysis with R”, Pckt Publishing, 2010

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 431 Course Title: **Microcontroller and Its Interfacing**
2. Contact Hours: L: 3 T: - P: 2
3. Semester: IV

4. Pre-requisite: TCS331

5. Course Outcomes: After completion of the course students will be able to

    1. Understanding the concept of embedded system.
    2. Assembly language programming of 8051
    3. Study of Arduino.
    4. Interfacing of different IC with 8051.
    5. Design and develop systems based on 8051 micro-controller and its interfaces.
    6. Understand the working of interrupts

6. Detailed Syllabus

Sl. No.	Contents	Contact Hours
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	8051 Instruction Set: 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	9
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	**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	**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**

Text Books

1. Mazidi,"The 8051 Microcontrollers & Embedded Systems", Pearson Education, 2007
2. MykePredko ,"Programming and Customizing the 8051 Micro-controller",Tata McGraw-Hill edition, 2003
3. Brad Kendall,"Arduino Make use of:A complete beginner guide",2013

Reference Books

1. Kenneth Ayala, "The 8051 Microcontroller", West Publishing Company, 1993
2. Julien Bayle,"C-Programming for Arduino" , 2013

Name of Department:- Computer Science and Engineering

1. Subject Code: **TCS 491** Course Title: **Introduction to Cryptography**
2. Contact Hours: L: 3 T: - P: 2
3. Semester: IV

4. Pre-requisite: None

5. Course Outcomes: After completion of the course students will be able to

   1. Classify security vulnerabilities involved in data communication over Internet and make use of classical algorithms to address the vulnerabilities.
   2. Make use of symmetric block ciphers to secure data transmission and storage
   3. Analyze challenges involved in key distribution and select approache that can be adopted
   4. Evaluate different Public Key algorithms, their mathematical background and make use of the same for data communication and message authentication
   5. Categorize types of viruses, worms, intrusion and decide measures to counter the threats.
   6. Criticize the legal aspects related to Cybercrime, Intellectual Property, Privacy, Ethical Issues.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	Introduction: Computer Security Concepts: The OSI Security Architecture, 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**
Unit - II	Modern Cryptography : Symmetric Encryption and Message Confidentiality: Symmetric Encryption Principles,Fiestal structure. Symmetric Block Encryption Algorithms Simple DES, DES and Simple AES, Stream Ciphers and RC4, Random and Pseudorandom Numbers,	**9**
Unit – III	Symmetric key distribution using symmetric encryption: A Key Distribution Scenario, Session Key Lifetime, A Transparent Key Control Scheme, Decentralized Key Control, Controlling Key Usage Mathematical Background for cryptography: Prime and Relatively Prime Numbers, Euclid's algorithm for GCD, Extended Euclid's Algorithm for Multiplicative Inverse, Euler's Totient function.	**10**
Unit – IV	Public-Key Cryptography: Public-Key Encryption Structure, Applications for Public-Key Cryptosystems, Requirements for Public-Key Cryptography, The RSA Public-Key Encryption Algorithm, Digital Signature. Message Authentication: Approaches to Message Authentication, Authentication Using Conventional Encryption, Message Authentication without Message Encryption, MD5 Hash Algorithm.	**9**
Unit – V	Electronic mail security-pretty good privacy (PGP). 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,	**8**

	Intellectual Property, Privacy, Ethical Issues	
	Total	**44**

Text Books:

- William Stallings, Network Security Essentials – Applications and Standards, 4th edition, Pearson Education, 2011
- William Stallings , Cryptography and Network Security, 7th Edition , Pearson Education, 2017

Reference Books:

- Behrouz Forouzan , Cryptography and Network Security, 3rd Edition, McGraw Hill, 2015
- Atul Kahate, "Cryptography and Network Security", Third edition, McGraw Hill Education, 2017.

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: 1 P: 2
3. Semester: IV

4. Pre-requisite: TMA101, TMA201

5. Course Outcomes: After completion of the course students will be able to

1. Demonstrate knowledge of statistical and exploratory data analysis data analysis techniques utilized in decision making.
2. Apply principles of Data Science to the analysis of business problems.
3. To use Machine Learning Algorithms to solve real-world problems.
4. To provide data science solution to business problems and visualization.
5. To learn the basic concepts and techniques of AI and machine learning
6. To explore the various mechanism of Knowledge and Reasoning used for building expert system.

6.Detailed Syllabus

Sl. No.	Contents	Contact Hours
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	**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	**An Introduction to Data Science** Definition, working, benefits and uses of Data Science, Data science vs BI, The data science process, Role of a Data Scientist.	9

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
5	**Statistical Applications** Basic Statistical operations, Linear Regression Analysis, Logistic and Exponential Regression, Time Series Analysis, Probability Distribution, ANOVA, Correlation and Covariance.	8
	Total	**45**

Text/ Reference Books:

1. Tom M. Mitchell. "Machine Learning" McGraw-Hill, 1997.
2. “Statistical programming in R”, Oxford University Press 2017

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 501 Course Title: **System Software**
2. Contact Hours: L: 3 T: 1 P: 0
3. Semester: V

4. Pre-requisite: TCS 301, TCS 403, TCS 307

5. Course Outcomes: After completion of the course students will be able to

1. Define system software and differentiate system software with other softwares.
2. Assess the working of Assembler, Loader/Linker and Microprocessor.
3. Understand the concept of passes in translators.
4. Determine the purpose of linking, and types of linking.
5. Develop the system software according to machine limitations.
6. Compare and Contrast the various text editors.

6.Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	**Machine Architecture:** Introduction, System Software and its relation to Machine Architecture, Simplified Instructional Computer (SIC), Architecture of SIC Machine , SIC Programming Examples	**9**
Unit - II	**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**
Unit – III	**Loaders and Linkers:** Basic Loader Functions - Design of an Absolute Loader, A Simple Bootstrap Loader, Machine-Dependent Loader Features – Relocation, 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	**10**
Unit – IV	**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**
Unit – V	**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,	**10**

	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.	
	Total	**46**

Text/ Reference Books:

1. Leland.L.Beck: " System Software: an introduction to systems programming", 3rd Edition, Addison-Wesley, 1997.
2. John.R.Levine," Tony Mason and Doug Brown: Lex and Yacc", O'Reilly, SPD, 1998.

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 502 Course Title: **Operating Systems**
2. Contact Hours: L: 3 T: - P: -
3. Semester: V

4. Pre-requisite: TCS 301, TCS 403, TCS 404

5. Course Outcomes: After completion of the course students will be able to

1. Understand the concept and design issues associated with an operating system
2. Identify the problems related to process management and synchronization and apply learned methods to solve basic problems
3. Explain the basics of memory management andthe use of virtual memory in modern operating systems.
4. Understand the concept deadlock avoidance, prevention and detections techniques.
5. Implementation of process management, memory management and file management using system calls.
6. Analyze the data structures and algorithms used for developing an operating systems

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	**Introduction to Operating Systems, UNIX:** What operating systems do; Operating System structure; Operating System Services; Type of Operating system, User - Operating System interface; System calls; Types of system calls; System programs; Operating System structure.	8
Unit - II	**Process Management:** Process concept; Process scheduling; Operations on processes; Multi-Threaded Programming: Overview; 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
Unit – III	**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
Unit – IV	**File System, Implementation of File System:** File System:File concept; Access methods; Directory structure; File system mounting; File sharing; Protection. Implementing File System: File system structure; Directory implementation; Allocation methods; Free space management. **Secondary Storage Structures, Protection :** Mass storage structures; Disk structure; Disk scheduling; Disk management; Swap space management. Protection: Goals of protection, Principles of protection, Access matrix.	8

Unit – V	**Unix Command:** Command structure, Internal and external commands, filter,vi editor. **Shell Programming:** Shell scripts, Running script in the current shell, Pattern Matching, Redirection, String handling, Conditional Parameter Substitution, Shell functions. **Case Study: The Linux Operating System:** Linux history; Design principles; Kernel modules; Process management; Scheduling; Memory management; File systems, Input and output; Inter-process communication.	8
	Total	**44**

Text Books:

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne:" Operating System Principles", 7th edition, Wiley India, 2006.
2. William Stallings: "Operating Systems: Internals and Design Principles", 6th edition, Pearson, 2009
3. SumitabhaDas,"Unix concepts and applications"

Reference Books:

1. Andrew S Tanenbaum: "Operating Systems: Design and Implementation", 3rd edition, Prentice Hall, 2006
2. Stuart E. "Madnick, John Donovan: Operating Systems", Tata McGraw Hill, 2008

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 503 Course Title: **Data Base Management Systems**
2. Contact Hours: L: 3 T: - P: -
3. Semester: V

4. Pre-requisite: TCS 302, TCS 404

5. Course Outcomes: After completion of the course students will be able to

1. Identify the different issues involved in the design and implementation of a database system.
2. Identify the physical and logical database designs, database modeling, relational, hierarchical, and network models
3. Recognize and use data manipulation language to query, update, and manage a database.
4. Develop an understanding of essential DBMS concepts such as: database security, integrity, concurrency,
5. Design and build a simple database system and demonstrate competence with the fundamental tasks involved with modeling, designing, and implementing a DBMS.
6. Design & develop a database application to appraise a business situation.

6.Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	**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**
Unit - II	**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, 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.	**9**
Unit – III	**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 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; Single Row Function ,group function, sub 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;Database stored procedures.	**11**

Unit – IV	**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; Lossy & Lossless decomposition, Algorithms for Relational Database Schema Design; Multivalued Dependencies and Fourth Normal Form; Join Dependencies and Fifth Normal Form.	**9**
Unit – V	**Transaction Management:** The ACID Properties; Transactions and Schedules; Concurrent Execution of Transactions; Lock- Based Concurrency Control, Transaction support in SQL; Introduction to crash recovery; 2PL, Serializability and Recoverability; Lock 9Management; Log Files; Checkpointing; Deadlock handling, Recovering from a System Crash; Media Recovery	**9**
	Total	**47**

Text Books:

1. Elmasri and Navathe: "Fundamentals of Database Systems", 5th Edition, Pearson Education, 2007.
2. Karth, silbertz,Silberschatz, "Database Concepts", McGraw Hill.
3. Raghu Ramakrishnan and Johannes Gehrke: " Database Management Systems", McGraw-Hill.

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: - P: -
3. Semester: V

4. Pre-requisite: TMA 101, TMA 201, TCS 101, TCS 201

5. Course Outcomes: After completion of the course students will be able to

1. Develop the notion of errors, finding of errors, roots and apply them in problem solving in concern subject.
2. Use effectively interpolation techniques and use them for numerical differentiation and integration.
3. Interpret asymptotic notation, its significance, and be able to use it to analyse asymptotic performance for basic algorithmic examples.
4. Examine statistical control techniques and be able to relate these to practical examples.
5. Elaborate the basics of regression, curve fitting and be able to apply the methods from these subjects in problem solving.
6. Explain the concepts of numerical solutions of ordinary differential equations.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	**Introduction:** Numbers and their accuracy, Computer Arithmetic, Mathematical preliminaries, Errors and their Computation, General error formula, Error in series approximations. **Solution of Algebraic and Transcendental Equation:** Bisection Method, Iteration method, Method of false position, Newton-Raphson method, Rate of convergence of Iterative methods. **Solution of system of linear equations:** Gauss Elimination method, Gauss Jordan method and Gauss Seidel method.	**10**
Unit – II	**Interpolation:** Finite Differences, Difference tables, Polynomial Interpolation: Newton's forward and backward formula, Central difference formulae: Gauss forward and backward formula, Stirling's, Bessel's, Everett's formula. Interpolation with unequal intervals: Lagrange's interpolation, Newton divided difference formula.	**10**
Unit – III	**Numerical Differentiation and Integration:** Introduction, Numerical differentiation Numerical Integration: Trapezoidal rule, Simpson's 1/3 and 3/8 rule, Weddle's rule	**9**
Unit – IV	**Numerical Solution of differential Equations:** Taylor's Method, Picard's Method, Euler's and modified Euler's method, Runge-Kutta Method, Milne's Predictor Corrector Method	**9**
Unit – V	**Statistical Computation:** Frequency charts, Curve fitting by method of least squares, fitting of straight lines, polynomials, exponential curves etc, Data fitting with Cubic splines, Regression Analysis, Linear, Non linear Regression and Multiple regression	**10**
	Total	**48**

Text Books:

- Rajaraman V, "Computer Oriented Numerical Methods", Pearson Education, 2000.
- Grewal B S, "Numerical methods in Engineering and Science", Khanna Publishers, Delhi, 2005.

Reference Books:

- Goyal, M, “Computer Based Numerical and Statistical Techniques”, Laxmi Publication (P) Ltd., New Delhi, 2005.
- Jain, Iyengar and Jain, “Numerical Methods for Scientific and Engineering Computations”, New Age Int, 2003.
- T Veerarajan, T Ramachandran, “Theory and Problems in Numerical Methods, TM, 2004.
- Francis Scheld, “Numerical Analysis”, TMH, 2010.
- Sastry, S. S, “Introductory Methods of Numerical Analysis”, Pearson Education, 2009.

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: - P: 2
3. Semester: V

4. Pre-requisite: TCS 451

5. Course Outcomes: After completion of the course students will be able to

1. Identify thecloud computing platforms.
2. Analyze various cloud service provider's applications.
3. Develop and deploy cloud-based applications in various cloud service provider's environments.
4. Identifyadvanced cloud computing application's concepts.
5. Describe cloud-based application deployment and management concepts.
6. Explore usecases of various cloud platforms, offered services and security aspects.

6.Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	**Cloud Computing Fundamentals**: Cloud computing and its model (NIST), Client –Server Computing Model, Cluster and Grid Computing, Data Intensive Computing, Public, Private andHybrid Cloud, Cloud Services Providers. Case study of Cloud Services Providers.	**9**
Unit - II	**Cloud Platforms in Industry** Amazon Web Services: Compute Services, Storage Services, Communication Services. Google AppEngine: 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, Salesforce, Heroku. Case study on available Cloud Platforms in Industry.	**9**
Unit – III	**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. Case study on Advanced Cloud Computing services.	**10**

Unit – IV	**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.	**8**
Unit – V	**Cloud Based Secured Applications: A Case study** Current trends in cloud computingi.e.IoT, Big Data, Machine Learning. Cloud Infrastructure Security, Network level security, Host level security, Application level security, Access management andcontrol. Case Study on Open Source and Commercial Clouds applications: Amazon EC2,Amazon S3,Amazon Redshift, GitHub Repository, and Microsoft Azure.	**9**
	Total	**45**

Text Books

- Mastering Cloud Computing by RajkumarBuyya, Vecchiola&Selvi (Published by McGraw Hill Education Pvt. Ltd), 2013.
- Cloud Management & Security by Imad.M.Abbadi (WILEY Publication 2014).

Reference Books

- Cloud Computing – A Hands-On Approach by ArshdeepBahga, Vijay Madisetti (2014).

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 571 Course Title: **Big Data Visualization**

2. Contact Hours: L: 3 T: - P: 2

3. Semester: V

4. Pre-requisite: TCS 471

5. Course Outcomes: After completion of course student will be able to

1.Clean up, format and analyze data to prepare for interactives

2. Design visualizations that represent the relationships contained in complex data sets and adapt them to highlight the ideas we want to communicate

3.Use principles of human perception and cognition in visualization design

4. Identify the statistical analysis needed to validate the trends present in data visualizations.

5.Critically evaluate visualizations and suggest improvements and refinements

6. 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

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	**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 **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**
Unit - II	**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**
Unit – III	**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	**9**

	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	
Unit – IV	**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**
Unit – V	**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**

Text Book:

1. Andy Kirk ,“Data Visualization: a successful design process”, Packt Publishing, 2012

Reference Books:

1. Tamara Munzer, “Visualization Analysis and Design”, CRC Press

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 531 Course Title: **Communication Models and Protocols**
2. Contact Hours: L: 3 T: - P: 2
3. Semester: V

4. Pre-requisite: TCS431

5. Course Outcomes: After completion of the course students will be able to

1. Understand the common network communication primitives as part of programming tasks in various languages.
2. Discuss the various Protocols used in Communication
3. Analyze more complex protocol engineering and network management tasks
4. Understand terminology, concepts, and technologies required for telecommunication in local area networks (LANs) and on the global Internet
5. Describe and analyze the Data Encoding and Transmission techniques.
6. Use of network management tools

6.Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	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**
Unit - II	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	**9**
Unit – III	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**
Unit – IV	Data Link Control: Introduction and services, Error detection and correction, Multiple access protocols, LANs, Addressing & ARP,	**8**

	Ethernet, Switches, VLANs, PPP, Link virtualization, MPLS, Data center networking, Web request processing.	
Unit – V	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**

Text Books

1.Douglas E. Comer," Internetworking with TCP/IP Volume One - 6th Edition" Publisher is Pearson, © 2014

2. Protocol specifications (RFCs) and other readings will also be assigned

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 591 Course Title: **Computer System Security**
2. Contact Hours: L: 3 T: - P: 2
3. Semester: V

4. Pre-requisite: TCS491

5. Course Outcomes: After completion of the course students will be able to
   1. Explain the basics of System Security
   2. Discuss the software security
   3. Assess the Web Security
   4. Use the various models of Smartphone Security
   5. Identify the security loopholes in smartphone
   6. Identify the security breaches in hardware

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	**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), Privilege, access control, and Operating System Security, Exploitation techniques, and Fuzzing	**8**
Unit - II	**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, Sandboxing native code, web security model, securing web applications	**10**
Unit – III	**Web Security** Same origin Policy, Cross site scripting attack, Cross site request forgery attack, Sql Injection attack, Click Jacking attack, Content Security Policies (CSP) in web, Web Tracking, Session Management and User Authentication, Session Integrity, Https, SSL/TLS, Threat Modeling, Attack Surfaces, and other comprehensive approaches to network design for security.	**10**
Unit – IV	**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**
Unit – V	**Hardware and system security** Meltdown Attack, spectre attack, 80x86 protection mode(access control in hardware), Authentication and password, Access control concept, ACL: 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	**10**
	Total	**47**

Text Book: Charles P. Pfleeger,**"**Security in Computing", Fourth Edition By

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 509 Course Title: **Machine Learning**
2. Contact Hours: L: 3 T: - P: 2
3. Semester: V

4. Pre-requisite: TCS201, TCS421

5. Course Outcomes: After completion of the course students will be able to

1. Haveagoodunderstandingofthefundamentalissuesandchallengesofmachine learning: data, model selection, model complexity,etc.
2. Distinguishthestrengthsandweaknessesofmanypopularmachine learningapproaches.
3. Analyze the underlying relationships within and across Machine Learning algorithms and the paradigms of supervised and un-supervisedlearning.
4. Utilize the structure and design concepts of neural networks applications to solve real lifeproblems
5. Plan and execute successful machine learning and big data projects, including selecting an adequate process for the specific task and avoiding the machine learningpitfalls.
6. Evaluate the issues raised by current research in the field of machinelearning

6.Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	**Review of Statistical Concepts:** Mean, Median, Mode, Outliers, Range, Average Deviation, Absolute Deviation, Squared Deviation, Standard Deviation, Total Sum of Squares. **Review of Linear Algebra:** Vectors and Matrices, Addition and Multiplication of Scalars, Matrix Multiplication Properties, Inverse and Transpose. **Introduction to Machine Learning:** What is Machine Learning, Introduction to ML's three approaches: Supervised, Unsupervised and Reinforcement Learning.	**10**
Unit - II	**Validation Techniques:** Hold out, K-Fold Cross Validation, Leave one out, Bootstrapping. **Supervised Learning Algorithms:** Linear Regression, Logistic Regression, Decision Trees, Random Forest, Support Vector Machine,K-Nearest Neighbours, CN2 Algorithm, Naive Bayes, Artificial Neural Networks.	**10**
Unit – III	**Ensemble Learning:** Bagging, Random Forest, AdaBoost, Bucket of Models, Stacking **Clustering:** K-means, Silhoutte Scores, Hierarchical Clustering, Fuzzy c-means, DBScan **Association Rule Learning:** Support, Confidence, Lift, Conviction, Apriori Algorithm, Eclat Algorithm.	**8**

Unit – IV	**Dimensionality Reduction:** Low Variance Filter, High Correlation Filter, Backward Feature Elimination, Forward Feature Selection,Principle Component Analysis, Projection Methods.	**14**
Unit – V	**The Rise of Deep Learning:** Mask R-CNN, Yolo, AlexNet, VGG, MobileNet, Deeplab, Fully Convolutional Networks, Image captioning (CNN+LSTM), Word2vec, Doc2Vec, Autoencoder. **Deep Learning Tools:** TensorFlow, PyTorch, Keras	**7**
	Total	**49**

Text and Reference Books

1. "Machine Learning For Dummies", John Paul Mueller and Luca Massaron
2. "A Course in Machine Learning", Hal Daumé III.
3. "Programming Collective Intelligence: Building Smart Web 2.0 Applications", Toby Segaran
4. "Building Machine Learning Systems with Python", WilliRichert and Luis Pedro Coelho
5. "Learning scikit-learn: Machine Learning in Python", Raúl Garreta and Guillermo Moncecchi
6. "Machine Learning in Action", Peter Harrington

Name of Department: - Computer Science and Engineering

1. Subject Code: TCS 601 Course Title: **Compiler Design**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VI
4. Pre-requisite: TCS-402
5. Course Outcomes: After completion of the course students will be ableto

1. Appraise the principles of compiler design like lexical, syntactical, semantic analysis, code generation and optimization.
2. Compare and contrast various parsing techniques such as SLR, CLR, LALR, etc.
3. Use annotated tree to design the semantic rules for different aspects of programming language.
4. Implement lexical analyzer and parser by using modern tools like Flex and Bison.
5. Examine patterns, tokens & regular expressions for solving a problem in the field of data mining.
6. Design a compiler for a concise programming language.

6. DetailedSyllabus

UNIT	CONTENTS	CONTACT Hrs
Unit – I	**Introduction:** Compiler Introduction; Analysis of source program; Phases and Passes of Compiler; Symbol table & its implementation; Cousins of a Compiler; Compiler Construction Tools; Bootstrapping: Regular Grammar and Regular Expressions. **Lexical analysis:** Role of a Lexical Analyzer; Input Buffering; Specifications of Tokens; Recognition of Tokens; LEX Tool and its Implementation	9
Unit - II	**Syntax Analysis:** Introduction toCFG; Writing a Grammar; Ambiguous Grammars; Role of a Parser; Basic Parsing Techniques; Top-down Parsing; Bottom-up Parsing; Operator-Precedence Parsing; Parser Generators (YACC)	10
Unit – III	**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-Allocation Strategies, Parameter Passing: Stack/Heap Allocation. Error Handling	10
Unit – IV	**Intermediate Code Generation (ICG):** Intermediate Code; ICG using Postfix Notation, Syntax Tree, Directed Acyclic Graph (DAG); Three Address Code; Quadruples & Triples; Back Patching; Intermediate Languages; Declarations; Assignment Statements; Boolean Expressions; Case Statements;; Procedure Calls; Array References: **Code Optimization:** Introduction toCode Optimization; Principal Sources of Optimization; Machine Dependent & Independent Code Optimization; Peephole optimization; Global and Local Optimization of Basic Blocks.	12
Unit – V	**Code Generation:** Code Generation Issues; The Target Machine; Basic Blocks And Flow Graphs; Next-Use Information; A Simple Code Generator; Register Allocation & Assignment; DAG Representation of Basic Blocks; Generating CodeFrom DAG. **Compiler Development**: Planning a Compiler; Compiler Development Approaches; Compiler development environment; Testing &Maintenance.	9
	Total	50

Text Books:

1. AlfredVAho,RaviSethi,JeffreyDUllman:"Compilers-Principles,TechniquesandTools", Pearson Education,2007.

Reference Books:

1. Charles N. Fischer, Richard J. leBlanc, Jr.:" Crafting a Compiler with C", Pearson Education, 1991.
2. Andrew W Apple: "Modern Compiler Implementation in C", Cambridge University Press, 1997.
3. Kenneth C Louden: "Compiler Construction Principles & Practice", Thomson Education, 1997.

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 611 Course Title: **Software Engineering**
2. Contact Hours: L: 3 T: - P: 0
3. Semester: VI

4. Pre-requisite: Basics of Programming

5. Course Outcomes: After completion of the course students will be able to

1. Discuss Software Development Life Cycle and importance of engineering the software.
2. Development of efficient software requirement specification for desired product.
3. Compare various software development methodologies and conclude on their applicability in developing specific type of product.
4. Construct an efficient design specification document for attainment of user desired product.
5. Develop applications using the concepts of various phases of software development life cycle.
6. Study various software testing techniques and identify their relevance to developing a quality software.

7. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	Introduction:What is Software Engineering and its history, Software Crisis, Evolution of a Programming System Product, Characteristics of Software, Type of requirements- User requirement and System requirement ,functional& non-functional requirements, 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**
Unit - II	**Requirements:** Importance of Requirement Analysis, User Needs, Software Features and Software Requirements, Requirement Engineering Process(RE Process), Functional and Non-functional requirements; Requirement Elicitation Techniques, The software requirements document and SRS standards, Case Study of SRS for a Real Time System Tools for Requirements Gathering: Decision Table, Decision Tree; Structured Analysis: DFD, Data Dictionary, E R Diagrams.	**9**
Unit – III	**Software Design:** Goals of Good Software Design, Design Strategies and Methodologies, Data Oriented Software Design, Structured Design: Structure Chart, Coupling, Cohesion,, Modular Structure, Packaging; Object Oriented Design, Top-Down and Bottom-Up Approach, Design architecture. Software Measurement and Metrics: Various Size Oriented Measures: Halestead's Software Science, Function Point (FP) Based Measures,	**8**

	Cyclomatic Complexity Measures: Control Flow Graphs. **Development:** Selecting a Language, Coding Guidelines, Writing Code, Code Documentation	
Unit – IV	**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), Design test cases & Test suite preparation, Alpha and Beta Testing of Products. Static Testing Strategies: Formal Technical Reviews (Peer Reviews), Walk Through, Code Inspection, Automated Testing	**10**
Unit – V	**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), Software Risk Analysis and Management. Software Quality Assurance: SQA Plans, ISO 9000 models, SEI-CMM Model	**8**
	Total	**45**

Text Books:

1. R. S. Pressman," Software Engineering: A Practitioners Approach", McGraw Hill.
2. P.K.J. Mohapatra," Software Engineering (A Lifecycle Approach)", New Age International Publishers

Reference Books:

7. Ian Sommerville," Software Engineering", Addison Wesley.
8. Pankaj Jalote:" An Integrated Approach to Software Engineering", Narosa Publishing House.
9. Carlo Ghezzi, M. Jarayeri, D. Manodrioli," Fundamentals of Software Engineering", PHI Publication.
10. Rajib Mall," Fundamentals of Software Engineering", PHI Publication.
11. Pfleeger, "Software Engineering", Macmillan Publication.

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 604 Course Title: **Computer Network-I**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VI

4. Pre-requisite: TCS 505

5. Course Outcomes: After completion of the course students will be able to

1. Characterize and appreciate computer networks from the view point of components and from the view point of services
2. Display good understanding of the flow of a protocol in general and a network protocol in particular
3. Model a problem or situation in terms of layering concept and map it to the TCI/IP stack
4. 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.
5. Design a Reliable Data Transfer Protocol and incrementally develop solutions for the requirements of Transport Layer
6. Describe the essential principles of Network Layers and use IP addressing to create subnets for any specific requirements

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	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, Queing, 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**
Unit – II	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 Non-persistent 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	**12**
Unit – III	Transport Layer: Introduction and Services, The Transport layer in internet, Difference between Connection Oriented and Connectionless services	**6**

	UDP: Segment structure, checksum in UDP	
Unit – IV	Transport Layer2:The principles behind connection oriented data transfer, designing a connection oriented protocol, 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**
Unit – V	Network Layer I: 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, A brief discussion on IP security (Note: Network Layer will continue with Routing Algorithms in Computer Networks II in the next semester)	**10**
	Total	**45**

Text Books:

1. Computer Networking: "A Top Down Approach (5th edition)", Ross and Kurose, Pearson/Addison-Wesley

Reference Books:

1. Andrew Tanenbaum and David Wetherhall, "Computer Networks(5th edition)", Prentice Hall
2. Peterson and Davie, "Computer Networks: A System Approach (4th edition)", Elsevier
3. Forouzan, "Data Communication and Networking (4th edition)", McGraw Hill
4. William Stallings: "Data and Computer Communication", 8th Edition, Pearson Education, 2007
5. Nader F. Mir:" Computer and Communication Networks", Pearson Education, 2007.

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 693 Course Title: **Full Stack Web Development**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VI

4. Pre-requisite: TCS 408, TCS 503

5. Course Outcomes: After completion of the course students will be able to

1. Describe the concepts of WWW including browser and HTTP protocol.
2. List the various HTML tags and use them to develop the user-friendly web pages.
3. Define the CSS with its types and use them to provide the styles to the web pages at various levels.
4. Develop the modern web pages using the HTML and CSS features with different layouts as per need of applications.
5. Use the JavaScript to develop the dynamic web pages.
6. Use server-side scripting with PHP to generate the web pages dynamically using the database connectivity.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
1	HTML Basics of HTML, formatting and fonts, commenting code, hyperlink, lists, tables, images, forms, XHTML, Meta tags, Character entities, frames and frame sets, Browser architecture and Web site structure. Overview and features of HTML5.0, data list.	8
2	CSS Need for CSS, introduction to CSS, basic syntax and structure, using CSS, type of CSS(inline CSS, internal CSS, external CSS), CSS Box model , material design, SCSS, background images, colors and properties, manipulating texts, using fonts, borders and boxes, margins, padding lists, positioning using CSS, Introduction to Bootstrap.	8
3	JavaScript and jQuery 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, DHTML: Combining HTML, CSS and JavaScript, Events and buttons. Introduction to jQuery. Introduction to XML, uses of XML, simple XML, XML key components, DTD and Schemas,	10

UNIT	CONTENTS	Contact Hrs
4	PHP 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 table names, creating a table, inserting data, altering tables, queries, deleting database, deleting data and tables. XAMPP Server Configuration, introduction tolaravel.	11
5.	Web Application Deployment Concept of WWW, Internet and WWW, HTTP Protocol: Request and Response paradigm, Web browser and Web servers, Features of Web 2.0. Concepts of effective web design, Web design issues including Browser, Bandwidth and Cache, Display resolution, Look and Feel of the Website, Page Layout and linking, User centric design, Sitemap, Planning and publishing website, Designing effective navigation, Introduction to CMS. Ajax, AngularJS, JSON.	8
	Total	45

Text/ Reference Books:

1. Ralph Moseley and M. T. Savaliya ,"Developing Web Applications", , Wiley-India
2. "Web Technologies", Black Book, dreamtech Press
3. "HTML 5", Black Book, dreamtech Press
4. Joel Sklar ,"Web Design", Cengage Learning
5. "Developing Web Applications in PHP and AJAX", Harwani, McGrawHill
6. P.J. Deitel&H.M. ,"Internet and World Wide Web How to program", Deitel, Pearson

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: - P: 2
3. Semester: VI

4. Pre-requisite: TCS 301, Any Programming Language

5. Course Outcomes: After completion of the course students will be able to

1. Identify the principals the Image Processing terminology used to describe features of images.
2. Identify the mathematical foundations for digital manipulation of images
3. Design, code and test digital image processing applications using MATLAB/OpenCV.
4. Analyze a wide range of problems and provide solutions related to the design of image processing systems through suitable algorithms, structures, diagrams, and other appropriate methods.
5. Analyze the image segmentation, object recognition & image classification methods.
6. Develop methods for computer vision & image processing Application

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	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:BasicOpeartions, Image / Video handling, Flow Control, Vectorization. INTRODUCTION TO PYTHON:BasicOpeartions**,** Lists, Tuples, Strings, Dictionaries, Flow Control, Numpy, Image/Video handling, OpenCV, PIL, Orange.	**10**
Unit - II	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, Stereo Vision, Motion Analysis, Local and Image Features, Visual Saliency.	**12**
Unit – III	**MID-LEVEL VISION:** Hough Transform, Otsu Thresholding, k-means, GraphCut, GrabCut, Normalized Cut, Watersheds, Skeleton Extraction, Object Proposals, Co-segmentation, Background Subtraction in Videos, Motion History Image	**9**
Unit – IV	HIGH-LEVEL VISION: Image Classification, Object Localization, Object Recognition, Object Detection, CNN, AlexNet, VGG, YOLO, Image Captioning, generative adversarial networks	**9**

Unit – V	APPLICATIONS OF IMAGE PROCESSING AND COMPUTER VISION: Video Surveillance Systems, Automatic activity recognition system, Medical image reconstruction , Medical Image Denoising, Multimodality medical image fusion , Face Recognition and Detection ,Automatic car tracking system.	**8**
	Total	**48**

Text/ Reference Books:

1. "Digital Image Processing using Matlab", R. C. Gonzalez, R. E. Woods and S. L. Eddins
2. "Programming Computer Vision with Python", Jan Salem
3. "Mastering OpenCV with Practical Computer Vision Projects", D. L. Baggio, S. Emami, D. M. Escrivá, K Levgen, N. Mahmood, J. Saragih,R.Shilkrot.
4. "Learning OpenCV 3 Computer Vision with Python", Joe Minichino and JosphHowse
5. "Deep Learning with Keras", Antonio Gulli
6. "Hands-On Machine Learning with Scikit-Learn and TensorFlow ", AurélienGéron
7. "Deep Learning for Computer Vision", RajalingappaaShanmugamani

Name of Department: - Computer Science and Engineering

1. Subject Code: TCS 651 Course Title: **DevOps on Cloud**
2. Contact Hours: 3 - 2
3. Semester: **VI**

4. Prerequisite: Students should have a strong technology background, an understating of cloud infrastructure and skill with a scripting language to master this course.

5. Course Outcomes: On completion of this course, the student should be able to

1. Define and understand ideas of DevOps.
2. Describe and demonstrate how DevOps relate to working in the cloud.
3. Describe and demonstrate how DevOps relate to Agile and ITIL.
4. Use a public/private cloud environment as a framework to examine the ideas of DevOps.
5. Examine some use cases, possible architectures, automation, continuous delivery, and the public/private cloud toolsets for DevOps.
6. Implement the software engg practices

6. Details of the Course: -

UNIT	CONTENTS	Contact Hrs
Unit – I	An introduction to Software Engineering, SDLC, Agile Framework, An introduction to DevOps, Gain insights of the DevOps environment, DevOps Vs Agile, DevOps Ecosystem.	**9**
Unit - II	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**
Unit – III	Continuous Testing, learn and Install Selenium, create test cases in Selenium, Integrate Selenium with Jenkins, Continuous Deployment, Install and configure puppet, understand master-slave architecture of puppet.	**10**
Unit – IV	Introduction to Docker, understanding images and containers, Docker Ecosystem, Introduction to Docker Networking, configuration management, configuration management with Ansible, Differentiate Ansible and Puppet.	**8**
Unit – V	Containerization using Kubernetes, Integrate Docker and Kubernetes, Auto-scaling, Continuous monitoring with Nagios, operate continuous monitoring tools, Implement Nagios commands.	**8**
	Total	**44**

Books:

1. Gene Kim and George Spafford ,"The Visible Ops Handbook by Kevin Behr", IT Process Institute.
2. Michael Hüttermann ,"DevOps for Developers".
3. by Eliyahu M. Goldratt, Jeff Cox ,DavidWhitford (Other Contributor) ,"The Goal: A Process of Ongoing Improvement",

4. Material provided by the instructor

References:

5. “Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation “, Jez Humble and David Farley
6. “The Phoenix Project”, Gene Kim, Kevin Behr, George Spafford

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 671 Course Title: **Bigdata Storage and Processing**
2. Contact Hours: L: 3 T: - P: 2
3. Semester: VI

4. Pre-requisite: TCS 404, TCS 408

5. Course Outcomes: After completion of the course students will be able to

1. Understand the various paradigms of Big Data
2. Use Hadoop distributed file system
3. Create the Hadoop Cluster
4. Explain NoSQL databases
5. Create the Map Reduce based programs
6. Understand the I/O system of Hadoop

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	Big Data Overview: Understanding Big Data, Capturing Big data, Benefitting from big data, management of big data, Organizing big data, Analyzing big data, Technological challenges from big data.	**8**
Unit - II	Hadoop Distributed File System (HDFS), HDFS design, HDFS concepts: Data node, name node, Command line interface, File system, Data flow, limitations	**9**
Unit – III	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**
Unit – IV	Setting up a Hadoop cluster: Basic system requirements, installation and cluster formation, Modes of installation: standalone, pseudo-distributed and distributed, purpose of different mode of installations and applications	**8**
Unit – V	NoSQL Databases:- RDBMS Vs NoSQL, Types of No SQL Databases, Architecture of NoSQL Databases, CAP Theorem, HBase Architecture, Reading and writing data	**9**
	Total	**43**

Text Books:

1. Tom White, "Hadoop: A definitive guide, 3/e", O' Reilly Press, 2012.

Reference Books:

2. Fei Hu, "Big Data: Storage, Sharing and Security", CRC Press, Taylor and Francis, 2016.

Name of Department: - Computer Science and Engineering

1. Subject Code: TCS 619 Course Title: **Network and System Security**
2. Contact Hours: 3 - 2
3. Semester: VI
4. Prerequisite: TCS591
5. Course Outcomes: After completion of the course students will be able to

    1. Explainthe basics of computer security
    2. Elaborate the cryptographic techniques.
    3. Discuss the transport layer security
    4. Find the pros and cons of various key distribution methods
    5. Analyze the wireless Network security
    6. Find the level of system security

6. Details of the Course: -

UNIT	CONTENTS	Contact Hrs
Unit – I	I**ntroduction** Computer Security Concepts, The OSI Security Architecture, Security Attacks, Security Services, Security Mechanisms, Models for network security, standards.	**9**
Unit - II	**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**
Unit – III	**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**
Unit – IV	**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	**8**

	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	
Unit – V	**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**

Text/ Reference Books:

1. W. Stallings," Network Security Essentials". Prentice Hall, 2003.
2. Ch. P. Pfleeger, S. L. Pfleeger „*Security in Computing", 4th Edition* Prentice Hall, 2006

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 703 Course Title: **Computer Networks-II**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VII

4. Pre-requisite: TCS 604

5. Course Outcomes: After completion of the course students will be able to

1. Analyze Global and Centralized Routing protocols and utilize tools (such as NS2) to examine routing protocols of LS and DV types
2. Evaluate and select the appropriate technology to meet Data Link Layer requirements
3. Specify the devices, components and technologies to build a cost-effective LAN
4. Appreciate issues for supporting real time and multimedia traffic over public network
5. Describe the key benefited of SDN, in particular those benefits brought about by the separation of data and control planes.
6. Implement client server applications with TCP/UDP Socket Programming

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	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**
Unit - II	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, Checksumming, 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**
Unit – III	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**
Unit – IV	Generalized forwarding and SDN Match , Action, Open flow, SDN Control Plane , SDN controller and SDN control Application , Open flow protocol, Data and control plane Interaction , SDN : PAST and FUTURE.	**9**
Unit – V	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**

Text Book:

1. "Computer Networking A Top Down Approach, Kurose and Ross", 5th edition, Pearson

Reference Book:

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

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 704 Course Title: **Advanced Computer Architecture**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VII

4. Pre-requisite: TCS 404

5. Course Outcomes: After completion of the course students will be able to

1. Analyze the classes of computers, and new trends and developments in computer architecture.
2. Evaluate advanced performance enhancement techniques such as pipelines ,dynamic scheduling branch predictions, caches.
3. Compare and contrast the modern computer architectures such as RISC, Scalar, and multi CPU systems.
4. Critically evaluate the performance of different CPU architecture.
5. Improve the performance of applications running on different CPU architectures.
6. Develop applications for high performance computing systems.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	Fundamentals: Computer Architecture and Technology Trends, Moore's Law, Classes of Parallelism and Parallel Architectures, Instruction Set Architecture: The Myopic View of Computer Architecture, Trends in Technology, Trends in Cost, Processor Speed, Cost, Power, Power Consumption, Fabrication Yield Performance Metrics and Evaluation: Measuring Performance, Benchmark Standards, Iron Law of Performance, Amdahl's Law, Lhadma's Law	**10**
Unit - II	Memory Hierarchy Design: Basics of Memory Hierarchy, Coherence and locality properties, Cache memory organizations, Cache Performance, Cache optimization techniques, Virtual Memory, Techniques for Fast Address Translation	**9**
Unit – III	Pipelining: What is pipelining, Basics of a RISC ISA, The classic five-stage pipeline for a RISC processor, Performance issues in pipelining, Pipeline Hazards	**10**
Unit – IV	Branches and Prediction: Branch Prediction, Direction Predictor, Hierarchical Predictors, If Conversion, Conditional Move Instruction Level Parallelism: Introduction, RAW and WAW, dependencies, Duplicating Register Values, ILP	**8**
Unit – V	Multiprocessor architecture: taxonomy of parallel architectures. Centralized shared-memory, Distributed shared-memory architecture, Message passing vs Shared Memory	**9**
	Total	**46**

Text/ Reference Books

1. John L. Hennessy, David A. Patterson, **"Computer Architecture:** A Quantitative Approach" 5th edition, Morgan Kaufmann
2. **"**by Kai Hwang **,"Advanced Computer Architecture"**, McGraw Hill Publishing

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: - P: -
3. Semester: VII

4. Pre-requisite: TCS 651

5. Course Outcomes: After completion of the course students will be able to

1. Understand the concepts in cloud automation, orchestration and load balancing.
2. Identify the need for and techniques behind automation, orchestration and load balancing.
3. Identify the need forkey scheduling considerations in the cloud.
4. Describe cloud management techniques.
5. Evaluate different cloud load balancing for cloud software deployment.
6. Evaluate fault tolerant techniques for cloud software deployment.

6. Detailed Syllabus

Sl. No.	Contents	Contact Hours
Unit I	Introduction to automation, orchestration and load balanincg. Identify the need for and techniques behind automation and orchestration of resources, as well as key scheduling considerations in the cloud.	8
Unit II	Recall and describe cloud management techniques such as middleware, resource provisioning, metering, and orchestration.	6
Unit III	Describe and evaluate different cloud software deployment considerations such as scaling strategies, load balancing, fault tolerance, accounting for tail latencies and optimizing for cost. Case study of any one or two of the following: IBM Cloud Orchestrator, Ingram Micro Cloud Orchestrator, Microsoft Azure Automation, Microsoft Cycle Computing, Morpheus, OpenStack Heat orchestration engine, Saltstack, Zymr etc.	8
Unit IV	Heat orchestration service, Heat orchestration Template(HoT) Explain the main execution flow, scheduling and fault tolerance concepts in the MapReduce programming model. 4.5.3. Recall and contrast different cloud programming models (MapReduce, Spark, GraphLab, Spark Streaming and Samza).	10

	5	
Unit V	Students will work in teams to design and implement a complete web-service that 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. In this team project, student teams are expected to use different tools and services to achieve build a performing web-service that meets the requirements. The students' 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).	12
	Total	44

Text/Reference Book:

1. Barrie Sisisky, "Cloud Computing Bible",Published by Wiley Publishing, Inc.
2. Felipe Gutierrez ,"Spring Cloud Data Flow: Native Cloud Orchestration Services for Microservice"
3. Adnan Ahmed Siddiqui, "OpenStack Orchestration", Packt Publishing Ltd
4. "Practical Load Balancing: Ride the Performance Tiger (Expert's Voice in Networking)", Apress

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 771 Course Title: **Natural Language Processing Using Big Data**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VII

4. Pre-requisite: TCS 507, TCS 601

5. Course Outcomes: After completion of the course students will be able to

1. Demonstrate key concepts from NLP are used to describe and analyze language
2. Examine linguistic properties of English Language
3. Implement POS Tagging and Named Entity Recognition using Python
4. Construct NLP solutions by choosing between traditional and deep learning techniques
5. Apply classifiers and modelling techniques for Text Classification
6. Build a conversational dialog system using the principles of NLP

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	Introduction to Natural Language Understanding: Overview, Differences between Programming Languages and Natural Languages, Modern Applications of NLP, Basic Steps of NLP: Tokenization, Stemming, Lemmatization, POS Tags, Named Entity Recognition, Chunking Why NLP is hard- Ambiguity in Language Regular Expressions Introduction to NLP libraries: SpaCy and NLTK	**8**
Unit - II	Data Sourcing for NLP, Web Scrapping using Python Bag of Words Model, Implementation of Bag of Words model in Python using NLTK Linguistic Analysis, Language Properties, Syntactic and Semantic Analysis Tool, Morphenes in Linguistics, Difference between Inflectional and Derivational Morphene	**9**
Unit – III	POS Tagging and Named Entity Recognition in SpaCy, Parts-of-Speech Tagging Baseline, Named Entity Recognition Baseline, Analyzing Sentence Structure, Converting text to features and labels, Naive Bayes Classifier, Leveraging Confusion Matrix How to identify the who, what, and where of your texts using pre-trained model Modeling and Semantic Analysis in NLP, Latent Semantic Analysis, Semantics and Word Vectors with SpaCy	**9**
Unit – IV	Text classification, Examples of Text Classification, Linear Classifiers, Deep Learning Techniques, Language Modelling, Prediction a sequence of text,	**8**

	Higher Abstraction for Texts, traditional models of distributional semantics. Machine Translation, Vectorization techniques and processing using python	
Unit – V	Case Study: Building a NLP based chatbot/dialog system, Main building blocks, Intents, Entities, Dialog, Building a chatbot from scratch, Deep Learning Frameworks	**11**
	Total	**45**

Text/ Reference Books:

1. D. Jurafsky, J. H. Martin, Speech and Language Processing, Pearson Education
2. Nitin Indurkhya and Fred J Damerau, "Handbook of natural language processing," Chapman and Hall/CRC
3. Ian Goodfellow, YoshuaBengio, and Aaron Courville, Deep Learning, http://www.deeplearningbook.org. MIT Press

Name of Department: - Computer Science and Engineering

1. Subject Code: TCS 731 Course Title: **Digital Forensics /Computer Forensics**
2. Contact Hours: 3 - -
3. Semester: **VII**
4. Prerequisite:
5. Course Outcomes: After completion of the course students will be able to

1. Understand the importance of a systematic procedure for investigation of data found on digital storage media that might provide evidence of wrong-doing.
2. Identify and document potential security breaches of computer data that suggest violations of legal, ethical, moral, policy and/or societal standards
3. 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
4. Work with computer forensics tools used in data analysis, such as searching, absolute disk sector viewing and editing, recovery of files, password cracking, etc.
5. Present the results of forensics analysis as an expert.
6. Discuss the Cyber Laws and Cyber Crimes.

6. Details of the Course: -

UNIT	CONTENTS	Contact Hrs
Unit - I	**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**
Unit - II	**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	**9**

	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	
Unit – III	**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**
Unit – IV	**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**
Unit – V	**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**

TEXT BOOKS:

1. Bill Nelson, Amelia Phillips, Frank Enfinger, Christopher Steuart, ―"Computer Forensics and Investigations", Cengage Learning, India Edition, 2016
2. MarjieT.Britz, "Computer Forensics and Cyber Crime": An Introduction", 3rd Edition, Prentice Hall

REFERENCES:

1. Kenneth C.Brancik ―"Insider Computer Fraud Auerbach ", Publications Taylor &; Francis Group
2. "CEH official Certfied Ethical Hacking Review Guide", Wiley India Edition, 2015

Name of Department: - Computer Science and Engineering

1. Subject Code: TCS 761 Course Title: **Cloud Infrastructure Services**
2. Contact Hours: 3 - -
3. Semester: **VII**
4. Prerequisite: TCS604, TCS651
5. Course Outcomes: After completion of the course students will be able to

1. Understand basics of cloud infrastructure
2 Understanding the insight of cloud infrastructure
3. Understanding different components of service oriented architecture
4. Getting insight of the cloud storage
5. Demonstration of the cloud infrastructure services
6. Use the cloud infrastructure services

6. Detailed Syllabus:

UNIT	CONTENTS	Contact Hrs
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**
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**
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**
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).	**8**

Unit – V	**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.	**9**
	Total	**45**

Text/Reference Books:

1. Barrie Sisisky ,"Cloud Computing Bible", Published by Wiley Publishing, Inc.
2. Berners Lee, Godel and Turing, "Thinking on the Web" - Wiley inter science, 2008.
3. Peter Mika, "Social Networks and the Semantic Web", Springer, 2007.
4. Thomas ,"Cloud Computing: Concepts, Technology & Architecture",Erl Published May 2013
5. David S. Linthicum ,"Cloud Computing and SOA Convergence in your Enterprise, a step by step guide"

Name of Department:- Computer Science and Engineering

1. Subject Code: TIT 721 Course Title: **Business Intelligence**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VII

4. Pre-requisite: TCS671

5. Course Outcomes: After completion of the course students will be able to

1. Understand the frameworks of Business Intelligence
2. Categorize the structured, semi structured and unstructured data
3. Create the schemas for data warehouse
4. Perform the multi dimensional data modeling
5. Use of different visualization techniques
6. Use of Business Intelligence for ERP

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	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	**10**
Unit - II	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**
Unit – III	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,	**9**

	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	
Unit – IV	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 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	**8**
Unit – V	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**

Reference Book:

R.N. Prasad and Seema Acharya ,"Fundamentals of Business Analytics", Wiley India

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 756 Course Title: **Human Computer Interaction**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VII

4. Pre-requisite: Fundamentals of Computer architecture

5. Course Outcomes: After completion of the course students will be able to

1. Explain the capabilities of both humans and computers from the viewpoint of human information processing.
2. Describe typical human–computer interaction (HCI) models, styles, and various historic HCI paradigms.
3. Apply an interactive design process and universal design principles to designing HCI systems.
4. Describe and use HCI design principles, standards and guidelines.
5. Analyze and identify user models, user support, socio-organizational issues, and stakeholder requirements of HCI systems.
6. Discuss tasks and dialogs of relevant HCI systems based on task analysis and dialog design.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	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**
Unit - II	Design process – Human interaction with computers, importance of human characteristics human consideration, Human interaction speeds, understanding business junctions	**8**
Unit – III	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**
Unit – IV	Windows – New and Navigation schemes selection of window, selection of devices based and screen based controls. Components – text and messages, Icons and increases – Multimedia,	**8**

	colors, uses problems, choosing colors	
Unit – V	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**

.**Text Books :**

1. “The essential guide to user interface design”, Wilbert O Galitz, Wiley DreamaTech.

2. “Designing the user interface”. 3rd Edition Ben Shneidermann , Pearson Education Asia.

Reference Book:

1. “Human – Computer Interaction”. ALAN DIX, JANET FINCAY, GRE GORYD, ABOWD, RUSSELL BEALG, PEARSON.

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: - P: -
3. Semester: VII

4. Pre-requisite: Excellent knowledge of Database Management Systems

5. Course Outcomes: After completion of the course students will be able to

1. Describe the fundamental concepts, benefits and problem areas associated with datawarehousing
2. Understand the various architectures and main components of a data warehouse.
3. Find the issues that arise when implementing a data warehouse.
4. Understand the techniques applied in data mining.
5. Compare and contrast OLAP and data mining as techniques for extracting knowledge from a data warehouse.
6. Find the association rules.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	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**
Unit - II	Concept Description:- Definition, Data Generalization, Analytical Characterization, Analysis of attribute relevance, Mining Class comparisions, 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**
Unit – III	What is Classification & Prediction, Issues regarding Classification and prediction, Decision tree, Bayesian Classification, Classification by Back propagation, Multilayer feed-forward Neural Network, Back propagation Algorithm, Classification methods K-nearest neighbor classifiers, Genetic Algorithm. Cluster Analysis: Data types in cluster analysis, Categories of clustering methods, Partitioning methods. Hierarchical Clustering- CURE and Chameleon, Density Based Methods-DBSCAN, OPTICS, Grid Based Methods- STING, CLIQUE, Model Based Method –Statistical Approach,	**9**

	Neural Network approach, Outlier Analysis	
Unit – IV	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**
Unit – V	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**
	Total	**43**

Books:

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

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 723 Course Title: **Distributed Systems**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VII

4. Pre-requisite: TCS 604

5. Course Outcomes: After completion of the course students will be able to

1. Characterize Distributed Systems and understand the Theoretical Foundations for Distributed Systems
2. Evaluate various distributed mutual exclusion algorithms
3. Demonstrate knowledge of deploying different distributed deadlock algorithms in various models of distributed systems.
4. Determine the appropriate use of different Agreement protocols
5. Identify the state of a distributed system to apply the appropriate context of commit protocols
6. Utilize real life DFS (NFS4 and GFS) to examine work of distributed file systems

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	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**
Unit - II	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**
Unit – III	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**
Unit – IV	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 Self Stabilization: Definition, Randomized Self Stabilization, Probabilistic Self stabilization, Issues in design of self-stabilization algorithms, Dijkstra's self-	**9**

	stabilizing token ring	
Unit – V	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**

Text/ Reference Books:

1. Singhal & Shivaratri, "Advanced Concept in Operating Systems", McGraw Hill
2. Coulouris, Dollimore, Kindberg, "Distributed System: Concepts and Design", Pearson Ed.
3. Gerald Tel, "Distributed Algorithms", Cambridge University Press
Laxmi Publicationa (P) Ltd., New Delhi.

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 799 Course Title: **Software Verification and Validation and Testing**
2. Contact Hours: L: 3 T: P: -
3. Semester: VI

4. Pre-requisite: TIT 501

5. Course Outcomes: After completion of the course students will be able to

1. Demonstrate the application of verification and validation tasks and their outcomes during the software life cycle.
2. Apply various verification and validation techniques based on various characteristics of the system/software (safety, security, risk, etc).
3. Differentiate between the overall role of verification and validation and the specific role of software/system testing.
4. Compare and Contrast the theoretical and practical limitations to software verification and validation analysis.
5. Apply appropriate planning and scoping to a verification and validation effort based on the needs of the software system being developed.
6. Develop a software verification and validation plan that reflects an understanding of verification and validation objectives, and appropriate problem/risk identification and tracking.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	**Introduction:** What is software testing and why it is so hard?, Error, Fault, Failure, Incident, TestCases, Limitations of Testing, Goals of software Testing, Principles of software testing ,Bugs –States of Bug, Bug life cycles or defect life cycle, Types of Bug, Software Testing Life Cycle (STLC),V-Testing Model, Verification activities ,Validation activities ,Test case design, Test suite.	**11**
Unit – II	**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**
Unit – III	**Reducing the number of test cases:** Prioritization guidelines, Priority category, Scheme, Risk Analysis, Regression Testing, Smoke testing , Sanity Testing.	**12**
Unit – IV	**Testing Activities:** Unit Testing, Levels of Testing, Integration Testing, System testing, Debugging, Debugging process, Debugging techniques.	**10**
Unit – V	**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**

Text Books:

1. William Perry, “Effective Methods for Software Testing”, John Wiley & Sons, New York, 1995.
2. CemKaner, Jack Falk, Nguyen Quoc, “Testing Computer Software”, Second Edition, Van Nostrand Reinhold, New York, 1993.
3. Boris Beizer, “Software Testing Techniques”, Second Volume, Second Edition, Van Nostrand Reinhold, New York, 1990.
4. Louise Tamres, “Software Testing”, Pearson Education Asia, 2002

Reference Books:

1. Roger S. Pressman, “Software Engineering – A Practitioner’s Approach”, Fifth Edition, McGraw-Hill International Edition, New Delhi, 2001.
2. Boris Beizer, “Black-Box Testing – Techniques for Functional Testing of Software and Systems”, John Wiley & Sons Inc., New York, 1995.
3. K.K. Aggarwal & Yogesh Singh, “Software Engineering”, New Age International Publishers, New Delhi, 2003.
4. Marc Roper, “Software Testing”, McGraw-Hill Book Co., London, 1994.
5. Gordon Schulmeyer, “Zero Defect Software”, McGraw-Hill, New York, 1990.
6. Watts Humphrey, “Managing the Software Process”, Addison Wesley Pub. Co. Inc., Massachusetts, 1989.
7. Boris Beizer, “Software System Testing and Quality Assurance”, Van Nostrand Reinhold, New York, 1984.
8. Glenford Myers, “The Art of Software Testing”, John Wiley & Sons Inc., New York, 1979.

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 732 Course Title: Web Mining
2. Contact Hours: L: 3 T: - P: -
3. Semester: VII

4. Pre-requisite: Basic knowledge of algebra, discrete math and statistics

5. Course Outcomes: After completion of the course students will be able to

1. Introduce students to the basic concepts and techniques of Information Retrieval, Web Search, Data Mining, and Machine Learning for extracting knowledge from the web.
2. Develop skills of using recent data mining software for solving practical problems of Web Mining.
3. Gain experience of doing independent study and research.
4. After successful completion of this course student will be able extract knowledge from the raw data available on the Web.

6. Details of Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	**Introduction:** The Web Challenges (How to turn the web data into web knowledge):Web Search Engines, Topic Directories, Semantic Web, **Web Mining:** Web content mining - discovery of Web document content patterns (text mining). Web structure mining - discovery of hypertext/linking structure patterns use hyperlinks to enhance text classification, page ranking, modeling and measuring the Web. Web usage mining - discovery of web users activity patterns, mining web server logs, mining client machine access logs.	**10**
Unit – II	**Information Retrieval and Web Search:**Crawling the Web, Indexing and keyword search, Document representation, Relevance Ranking, Vector space model, Euclidian distance, cosine similarity, Relevance feedback Advanced text search, Using the HTML structure in keyword search Evaluating search quality, Similarity search	**10**
Unit – III	**Clustering approaches for Web Mining:**web content mining using- Learning by Example and Clustering • Hierarchical Agglomerative Clustering •K-Means Clustering • Probability-Based Clustering • Collaborative Filtering	**9**
Unit – IV	**Evaluating Clustering:** Evaluation techniques and criteria. Approaches to Evaluating Clustering • Similarity-Based Criterion Functions • Probabilistic Criterion Functions • Probabilistic Criterion Functions • MDL-Based Model and Feature Evaluation • Classes to Clusters Evaluation	**9**

	• Precision, Recall and F-measure • Entropy	
Unit – V	**Classification approaches for Web Mining:** Nearest Neighbor Feature Selection Naïve Bayes Numeric Approaches Relational Learning	**10**
	Total	**48**

Text Book:

1. Zdravko Markov and Daniel T. Larose. Data Mining the Web: Uncovering Patterns in Web Content, Structure, and Usage, Wiley, 2007, ISBN: 978-0-471-66655-4.
2. Ian H. Witten and Eibe Frank. Data Mining: Practical Machine Learning Tools and Techniques (Second Edition), Morgan Kaufmann, 2005, ISBN: 0-12-088407-0.

Reference :

1. Prabhakar Raghavan, Christopher D. Manning, Hinrich Schütze: "Introduction to information retrieval", Cambridge.
2. Stefan Buttcher, Charles L. A. Clarke, Gordon V. Cormack: "Information Retrieval: Implementing and Evaluating Search Engines", MIT Press.

Name of Department:- Computer Science and Engineering

1. Subject Code: TOE-714 Course Title: **Artificial Intelligence**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VII

4. Pre-requisite: Basics of mathematics and database are required

5. Course Outcomes: After completion of the course students will be able to

1. Identify the basics of the theory and practice of Artificial Intelligence.
2. Learn the basics of Artificial Intelligence programming.
3. Identify various searching techniques use to solve the AI problems.
4. Apply knowledge representation techniques and problem solving strategies to common AI applications.
5. Build self-learning and research skills to tackle a topic of interest on his/her own or as part of a team.
6. Apply the knowledge of AI and agents in developing multidisciplinary real world projects

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	**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**
Unit – II	**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**
Unit – III	**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**
Unit – IV	**Expert System** Existing Systems (DENDRAL, MYCIN, DART,XOON expert, shells), domain exploration, Meta Knowledge, Expertise Transfer, Self ExplainingSystem, Architecture of Expert system	**9**
Unit – V	**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**

Text/ Reference Books:

1. Charnick “Introduction to Artificial Intelligence.” Addision Wesley.
2. Rich & Knight, “Artificial Intelligence”.TMH
3. Winston, “LISP”, Addison Wesley.
4. Marcellous, “Expert Systems Programming”, PHI.

Name of Department: - Computer Science and Engineering

1. Subject Code: TOE 702 Course Title: **Sensor Networks**
2. Contact Hours: 3 - -
3. Semester: VII
4. Prerequisite: TCS631
5. Course Outcomes: After completion of the course students will be able to

1. Understand the wireless sensor networks basics and characteristics.
2. Analyze various medium access control protocols.
2. Describe routing and data gathering protocols.
3. Understand embedded operating systems.
5. Describe WSN applications.
6. Use various WSN protocols for different applications in real-time.

6. Details of the Course: -

UNIT	CONTENTS	Contact Hrs
Unit – I	**Introduction to Wireless Sensor Networks:**Introduction: Motivations, Applications, Performance metrics, History and Design factors, Traditional layered stack, Cross-layer designs, Sensor Network Architecture. **Characteristics of WSN:** Characteristic requirements for WSN - Challenges for WSNs – WSN vs Adhoc Networks - Sensor node architecture – Commercially available sensor nodes –Imote, IRIS, Mica Mote, EYES nodes, BTnodes, TelosB, Sunspot -Physical layer and transceiver design considerations in WSNs, Energy usage profile, Choice of modulation scheme, Dynamic modulation scaling, Antenna considerations.	**9**
Unit – II	**Medium Access Control Protocols:**Fundamentals of MAC protocols - Low duty cycle protocols and wakeup concepts – Contentionbased protocols - Schedule-based protocols - SMAC - BMAC - Traffic-adaptive medium access protocol (TRAMA) - The IEEE 802.15.4 MAC protocol.	**9**
Unit – III	**Routing and Data Gathering Protocols:**Routing Challenges and Design Issues in Wireless Sensor Networks, Flooding and gossiping – Data centric Routing – SPIN – Directed Diffusion – Energy aware routing - Gradient-based routing - Rumor Routing – COUGAR – ACQUIRE – Hierarchical Routing - LEACH, PEGASIS – Location Based Routing – GF, GAF, GEAR, GPSR – Real Time routing Protocols – TEEN, APTEEN, SPEED, RAP - Data aggregation -	**10**

	data aggregation operations - Aggregate Queries in Sensor Networks - Aggregation Techniques – TAG, Tiny DB	
Unit – IV	**Embedded Operating Systems:**Operating Systems for Wireless Sensor Networks – Introduction - Operating System Design Issues - Examples of Operating Systems – TinyOS – Mate – MagnetOS – MANTIS - OSPM - EYES OS – SenOS – EMERALDS – PicOS – Introduction to Tiny OS – NesC – Interfaces and Modules-Configurations and Wiring - Generic Components -Programming in Tiny OS using NesC, Emulator TOSSIM	**8**
Unit – V	**Applications of WSN:** Current Trends in WSN, Future scope of WSN in Various Field like IOT, Machine Learning. WSN Applications - Home Control - Building Automation - Industrial Automation - Medical Applications - Reconfigurable Sensor Networks - Highway Monitoring - Military Applications - Civil and Environmental Engineering Applications - Wildfire Instrumentation - Habitat Monitoring - Nanoscopic Sensor Applications – Case Study: IEEE 802.15.4 LR-WPANs Standard - Target detection and tracking - Contour/edge detection - Field sampling	**9**
	Total	**45**

TEXT BOOKS

1.Kazem Sohraby, Daniel Minoli and TaiebZnati, " Wireless Sensor Networks Technology, Protocols, and Applications", John Wiley & Sons, 2007.
2.Holger Karl and Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley & Sons, Ltd, 2005.

REFERENCE BOOKS

1.K. Akkaya and M. Younis, "A survey of routing protocols in wireless sensor networks", Elsevier Ad Hoc Network Journal, Vol. 3, no. 3, pp. 325--349
2.Philip Levis, " TinyOS Programming"
3.Anna Ha´c, "Wireless Sensor Network Designs", John Wiley & Sons Ltd,

Name of Department:- Computer Science and Engineering

1. Subject Code: TOE 707 Course Title: **Cryptography and Network Security**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VII

4. Pre-requisite: TCS 604 Computer Networks - I

5. Course Outcomes: After completion of the course students will be able to

1. Classify security vulnerabilities involved in data communication over Internet and make use of classical algorithms to address the vulnerabilities.
2. Make use of modern block ciphers to secure data transmission and storage
3. Analyze challenges involved in key distribution and select approache that can be adopted
4. Analyze strengths of public key algorithms and explore applications in exchange, authentication and hashing of messages.
5. Appreciate application of algorithms for ensuring access control, authentication, secured transmission of data at different layers.
6. Appraise risks related to wireless, web, cloud security and measures to be adopted to secure organizational network.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	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**
Unit – II	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**
Unit – III	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**
Unit – IV	Authentication Applications: Kerberos and X.509 directory authentication service, electronic mail security-S /MIME	**9**

	IP Security: Architecture, Authentication header, Encapsulating security payloads, combining security associations, key management.	
Unit – V	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**

Text Books:

1. William Stallings, "Cryptography and Network Security: Principals and Practice", 7th Edition, Pearson, 2017
2. William Stallings, "Network Security Essentials – Applications and Standards", 4th edition, Pearson Education, 2011

Reference Books

1. Behrouz A Forouzan, Debdeep Mukhopadhyay, "Cryptography and Network Security"Mc-GrawHill, 3rd Edition, 2015
2. Johannes A. Buchmann, "Introduction to Cryptography", Springer-Verlag, 2012

Name of Department:- Computer Science and Engineering

1. Subject Code: TDM 881 Course Title: **Disaster Management**
2. Contact Hours: L: 2 T: - P: -
3. Semester: VIII

4. Pre-requisite: None

5. Course Outcomes: After completion of the course students will be able to

1- Study and investigate the various types of Hazards and disasters and create awareness in the community to effectively prevent and react to such incidents.
2- Investigate and analyze hazards, disasters and measure their interrelationships with the developing humanitarian activities for solving future disaster problems.
3- To study, analyze and build skills to respond to disasters and hazards with community participation for controlling climate change.
4- To develop skills by training disaster forces and communities for successful Disaster Risk Reduction.
5- Understand the Disaster Management Laws and Policies and effectively apply for prevention and building the Disaster management system.
6- Building robust reaction and response systems by Technological innovations and skill building.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	**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**
Unit – II	**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**

Unit – III	**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, awareness 2. 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**
Unit – IV	**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 &nationalcenters 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 (NIDM): Rule and responsibilities.	**8**
	Total	**34**

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Text Books:

- M MSulphey," Disaster Management", PHI, 2016

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 821 Course Title: **Soft Computing**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VIII

4. Pre-requisite: Good Knowledge of Artificial intelligence

5. Course Outcomes: After completion of the course students will be able to

1. Summarize about soft computing techniques and their applications
2. Analyze various neural network architectures
3. Design perceptions and counter propagation networks.
4. Classify the fuzzy systems
5. Analyze the genetic algorithms and their applications.
6. Compose the fuzzy rules.

7. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	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, Perception learning rule, Delta learning rule.	**9**
Unit – II	Models of ANN: Single layer perception, Architecture, Algorithm, application procedure- Feedback Networks: Hopfield Net and BAM - Feed Forward Networks: Back Propogation Network (BPN) and Radial Basis Function Network (RBFN) –Self Organizing Feature Maps: SOM and LVQ	**8**
Unit – III	Fuzzy Sets, properties and operations - Fuzzy relations, cardinality, operations andproperties of fuzzy relations, fuzzy composition.	**9**
Unit – IV	Fuzzy variables - Types of membership functions - fuzzy rules: Takagi and Mamdani –fuzzy inference systems: fuzzi fication, inference, rule base, defuzzi fication.	**9**
Unit – V	Genetic Algorithm (GA): Biological terminology – elements of GA: encoding, types of selection, types of crossover, mutation, reinsertion – a simple genetic algorithm –Theoretical foundation: schema, fundamental theorem of GA, building block hypothesis.	**9**
	Total	**44**

TEXT BOOKS :

- S. N. Sivanandam, S. Sumathi, S.N. Deepa, “Introduction to Neural Networks using MATLAB 6.0 “, Tata McGraw-Hill, New Delhi, 2006
- S. N. Sivanandam, S.N. Deepa, “Principles of Soft Computing”, Wiley-India, 2008.
- D.E. Goldberg, “Genetic algorithms, optimization and machine learning”, Addison Wesley 2000.

REFERENCE BOOKS :

1. Satish Kumar," Neural Networks – A Classroom approach", Tata McGraw-Hill, New Delhi, 2007.
2. Martin T. Hagan, Howard B. Demuth, Mark Beale, "Neural Network Design", Thomson Learning, India, 2002.
3. B. Kosko," Neural Network and fuzzy systems", PHI, 1996.
4. Klir& Yuan, "Fuzzy sets and fuzzy logic – theory and applications", PHI, 1996.
5. Melanie Mitchell, "An introduction to genetic algorithm", PHI, India, 1996.

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 822 Course Title: **Mobile Applications Development**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VIII

4. Pre-requisite: Excellent Knowledge of JAVA programming and Database Management System

5. Course Outcomes: After completion of the course students will be able to

1. Identify and apply the key technological principles and methods for delivering and maintaining mobile applications,
2. Evaluate and contrast requirements for mobile platforms to establish appropriate strategies for development and deployment,
3. Develop and apply current standard-compliant scripting/programming techniques for the successful deployment of mobile applications targeting a variety of platforms,
4. Carry out appropriate formative and summative evaluation and testingutilising a range of mobile platforms,
5. Interpret a scenario, plan, design and develop a prototype hybrid and native mobile application,
6. Investigate the leading edge developments in mobile application development and use these to inform the design process.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	**Getting started with Mobility** 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	**9**
Unit - II	**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**
Unit – III	**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**

Unit – IV	**Testing mobile apps** Debugging mobile apps, White box testing, Black box testing, and test automation of mobile apps, JUnit for Android, Robotium, MonkeyTalk	**9**
Unit – V	**Taking apps to Market** Versioning, signing and packaging mobile apps, distributing apps on mobile market place	**8**
	Total	**43**

Text/ Reference Books:

1. Jeff McWherter, Scott Gowell, “Professional Mobile Application Development”,Wrox Publication.
2. “Mobile Application Development “Black Book, Dreamtech Press

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: - P: -
3. Semester: VIII

4. Pre-requisite: Excellent knowledge of Computer Network and Communication

5. Course Outcomes: After completion of the course students will be able to

1. Demonstrate the basic concept of multimedia information representation. Delve into the requirement of multimedia communication in today's digital world.
2. Compare circuit mode and packet mode.Explain QoS and its applications.
3. Summarize the various multimedia information representations.
4. Compute Arithmetic, Huffman, Lempel –Ziv and Lempel–Ziv Welsh coding. Summarize Joint Photographic Expert Group (JPEG).
5. Differentiate between the audio compression techniques: PCM, DPCM, ADPCM, LPC, CELPC and MPEG. Differentiate MPEG1, MPEG2 and MPEG4.
6. Construct Haptic Interfaces and Virtual reality Systems

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
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**
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**
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**

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**
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**

Text/ Reference Books:

1. Ranjan Parekh, “Principles of Multimedia”, McGraw Hill, 2006
2. David Salomon, “Data Compression: The Complete Reference”, Fourth Edition, Springer Books
3. GrigoreBurdea, Philippe Coiffet, “Virtual reality technology, Volume 1”, Wiley, 2003

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 824 Course Title: **Computer Graphics**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VIII

4. Pre-requisite: Excellent knowledge of mathematics

5. Course Outcomes: After completion of the course students will be able to

1. Understand the structure of modern computer graphics systems
2. Understand the basic principles of implementing computer graphics primitives
3. Familiarity with key algorithms for modeling and rendering graphical data
4. Develop, design and problem solving skills with application to computer graphics
5. Gain experience in constructing interactive computer graphics programs using OpenGL
6. Assess the two dimensional viewing

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	Introduction: What is Computer Graphics and what are the applications, Graphics Systems: Video Display Devices, Raster Scan and Random Scan Displays, Flat Panel Displays, Three-Dimensional Viewing Devices; Video Controller, Input Devices, Graphics on the Internet, Graphics Software, Coordinate Representations Introduction to OpenGL, Basic OpenGL syntax, Related Libraries, Header Files, Display-Window Management using GLUT, A complete OpenGL program	**11**
Unit - II	Geometric Transformations: Two Dimensional Translation, Rotation and Scaling, Matrix Representations and Homogeneous Coordinates, Inverse Transformations, Composite Transformations, Reflection, Shear, Raster Methods for Geometric Transformations, Geometric Transformations in three-dimensional space, Affine Transformations, OpenGL Geometric-transformation programming examples Two Dimensional Viewing: Viewing Pipeline, The Clipping Window, Normalization and Viewport Transformations, Clipping Algorithms: Cohen-Sutherland Line Clipping, Liang-Barsky Line Clipping; Line clipping against non rectangular clip windows; Polygon Clipping: Sutherland-Hodgman, Weiler-Atherton; Curve Clipping, Text Clipping	**10**
Unit – III	Three Dimensional viewing, Transformations from world to viewing coordinates, 3-D clipping Three-Dimensional Object Representations: Polyhedra, Curved and Quadric surfaces, Blobby Objects, Spline Representations, Bezier Spline curves,	**9**

	Bezier Surfaces, B-Spline curves, B-Spline Surfaces, Octrees, Introduction to fractals	
Unit – IV	Visible Surface Detection Methods: Classification, Back-Face Detection, Depth-Buffer method, A-buffer method, Scan-Line method, Curved Surfaces Illumination Models and Surface Rendering Methods: Basic Illumination models- Ambient light, Diffuse Reflection, Specular Reflection and the Phong model; Polygon Rendering Methods: Gouraud Surface Rendering, Phong Surface Rendering; Ray Tracing, Texture Mapping	**10**
	Total	**40**

Text Book:

1. Computer Graphics with OpenGL by Donald Hearn and M. Pauline Baker, Third Edition, 2004, Pearson

Reference Books:

1. J.D. Foley, A. Dam, S.K. Feiner, Graphics Principle and Practice , Addison Wesley
2. Rogers, " Procedural Elements of Computer Graphics", McGraw Hill
3. Steven Harrington, "Computer Graphics: A Programming Approach" , TMH
4. Edward Angel, Interactive Computer Graphics – A Top Down Approach with OpenGL

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 825 Course Title: **Computational Geometry**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VIII

4. Pre-requisite: Excellent knowledge of Graph Theory

5. Course Outcomes: After completion of the course students will be able to

1. Analyze randomized algorithms for small domain problems.
2. Use line-point duality to develop efficient algorithms.
3. Apply geometric techniques to real-world problems in graphics.
4. Solve linear programs geometrically
5. Understand the use of randomization in computational geometry
6. Describe the voronoi diagrams and its applications

6.Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	Convex hulls: construction in 2d and 3d, lower bounds; Triangulations: polygon triangulations, representations, point-set triangulations, planar graphs	**10**
Unit - II	Voronoi diagrams: construction and applications, variants; Delayney triangulations: divide-and-conquer, flip and incremental algorithms, duality of Voronoi diagrams, min-max angle properties	**9**
Unit – III	Geometric searching: point-location, fractional cascading, linear programming with prune and search, finger trees, concatenable queues, segment trees, interval trees; Visibility: algorithms for weak and strong visibility, visibility with reflections, art-gallery problems	**10**
Unit – IV	Arrangements of lines: arrangements of hyper planes, zone theorems, many-faces complexity and algorithms; Combinatorial geometry: Ham-sandwich cuts	**9**
Unit – V	Sweep techniques: plane sweep for segment intersections, Fortune's sweep for Voronoi diagrams, topological sweep for line arrangements; Randomization in computational geometry: algorithms, techniques for counting; Robust geometric computing; Applications of computational geometry	**8**
	Total	**46**

Text/ Reference Books

1. Franco P. Preparata and Michael Ian Shamos; “Computational Geometry: An Introduction “,SpringerVerlag ,1985.
2. Mark de Berg, Marc van Kreveld, Mark Overmars, and OtfriedSchwarzkopf ,“Computational Geometry, Algorithms and Applications”,; Springer-Verlag, 1997. from Springer.

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 826 Course Title: **Unix Systems Programming**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VIII

4. Pre-requisite: Excellent Knowledge of Operating Systems and C- programming

5. Course Outcomes: After completion of the course students will be able to

1. Experiment with various system calls
2. Compare between ANSI C AND C++ AND POSIX standards
3. Mapping the relationship between UNIX Kernel support for files
4. Use Kernel support for process creation and termination and memory allocation
5. Analyze Process Accounting process UID ,Terminal logins, network logins
6. Analyze process control,Deamon characteristics, coding rules and error logging

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	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**
Unit - II	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**
Unit – III	Processes and Inter-Process Communication: Introduction, pipes, FIFOs, XSI IPC: Message Queues, Semaphores, Shared Memory	**9**
Unit – IV	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**
Unit – V	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**

Text/ Reference Books:

1. Richard Stevens and Stephen Rago," Advanced Programming in the Unix Environment", Addison-Wesley
2. Michael Kerrisk," The Linux Programming Interface", No Starch Press

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 851 Course Title: **Storage Networks**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VIII

4. Pre-requisite: Knowledge of Database and Networking is required

5. Course Outcomes: After completion of the course students will be able to

1. Understand the different aspects of storage management
2. Describe the various applications of RAID
3. Compare and contrast the I/O Techniques
4. Categorize virtualization on various levels of storage network
5. Estimate the various requirements of storage management systems
6. Design a complete data center and enhance employability in this field

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	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 storage management skills and activities, Introduction to Datacenters, Technical & Physical components for building datacenters	**10**
Unit - II	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**
Unit – III	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,	**10**

	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	
Unit – IV	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**
Unit – V	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**

Text/ Reference Books:

1. "Storage Networks: The Complete Reference", R. Spalding, McGraw-Hill
2. "Storage Networking Fundamentals: An Introduction to Storage Devices, Subsystems, Applications, Management, and Filing Systems", Marc Farley, Cisco Press.
3. "Designing Storage Area Networks: A Practical Reference for Implementing Fibre Channel and IP SANs, Second Edition", Tom Clark Addison Wesley

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 852 Course Title: **Pattern Recognition**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VIII

4. Pre-requisite: Knowledge of Probability theory, mathematics and algorithms is required

5. Course Outcomes: After completion of the course students will be able to

1. Explain and compare a variety of pattern classification, structural pattern recognition, and pattern classifier combination techniques.
2. Summarize, analyze, and relate research in the pattern recognition area verbally and in writing.
3. Apply performance evaluation methods for pattern recognition, and critique comparisons of techniques made in the research literature.
4. Apply pattern recognition techniques to real-world problems such as document analysis and recognition.
5. Implement simple pattern classifiers, classifier combinations, and structural pattern recognizers.
6. Describe the various clustering methods

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	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	**10**
Unit - II	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 estimation, Bayesian estimation, Bayesian parameter estimation–Gaussian	**9**
Unit – III	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 analyses : Principal component analysis, non-linear component analysis; Low dimensional representations and multi dimensional scaling	**10**
Unit – IV	Discrete Hidden MorkovModels : Introduction, Discrete–time markov process, extensions to hidden Markov models, three basic problems for HMMs.	**9**
Unit – V	Continuous hidden Markov models : Observation densities, training and	**8**

	testing with continuous HMMs, types of HMMs	
	Total	**46**

Text/ ReferenceBooks :

1.Richard O. Duda, Peter E. Hart, David G. Stroke. Wiley,“Pattern classifications”, student edition, Second Edition.
2.LawerenceRabiner,“Fundamentals of speech Recognition”, Biing – Hwang Juang Pearson education.

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 855 Course Title: **Agile Software Engineering**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VIII

4. Pre-requisite: TCS 602

5. Course Outcomes: After completion of the course students will be able to

1. Describe two or more agile software development methodologies.
2. Identify the benefits and pitfalls of transitioning to agile.
3. Compare agile software development to traditional software development models.
4. Apply agile practices such as test-driven development, standup meetings, and pair programming to their software engineering practices.
5. Apply the agile testing
6. Describe the agile in current market scenario.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	**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**
Unit - II	**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 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	**10**
Unit – III	**Agile Software Design and Programming:** Agile Design Principles with UML examples, Single Responsibility Principle,	**9**

	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	
Unit – IV	**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**
Unit – V	**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**

Text Book:

1. Ken Schawber, Mike Beedle, “Agile Software Development with Scrum”, Pearson, 2008

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS857 Course Title: **Game Theory**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VIII

4. Pre-requisite: Excellent knowledge of programming and mathematics

5. Course Outcomes: After completion of the course students will be able to

1. Identify strategic situations and represent them as games
2. Find dominant strategy equilibrium, pure and mixed strategy Nash equilibrium,
3. Solve simple games using various techniques
4. Analyze economic situations using game theoretic techniques
5. Recommend and prescribe which strategies to implement
6. Find the needs of extensive games.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	**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. **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	**11**
Unit - II	**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**
Unit – III	**Bayesian Games, Extensive Games with Imperfect Information:** Motivational examples; General definitions; Two examples concerning	**10**

	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	
Unit – IV	**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**
Unit – V	**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 extensive game; Illustration of trade in a market; Nash's axiomatic model of bargaining	**8**
	Total	**47**

Text Books:

1. Martin Osborne: "An Introduction to Game Theory", Oxford University Press, Indian Edition, 2004.

Reference Books:

1. Roger B. Myerson: "Game Theory: Analysis of Conflict", Harvard University Press, 1997.

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 810 Course Title: **Virtual Reality**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VIII

4. Pre-requisite:

5. Course Outcomes: After completion of the course students will be able to

1. Demonstrate an understanding of techniques, processes, technologies and equipment used in virtual reality
2. Identify appropriate design methodologies for immersive technology development, especially from a physiological perspective
3. Exploit the characteristics of human visual perception in Virtual Reality techniques
4. Provide rendering to VR specific problems
5. Effectively categorize the benefits/shortcomings of available VR technology platforms.
6. Discuss the use of geometry in virtual reality

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	**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**
Unit - II	**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**
Unit – III	**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**
Unit – IV	**Visual Rendering**: Shading models, rasterization, Pixel shading, VR specific problems, Distortion shading, Post-rendering image wrap	**9**
Unit – V	**Audio**: Physics and physiology, Auditory perception, Auditory Localization, Rendering, Spatialization and display, Combining other	**8**

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

Text Books:

1. Grigore C. Burdea , Philippe Coiffet, “Virtual Reality Technology”, Wiley-IEEE press
2. Marschner, Shirley "Fundamentals of Computer Graphics", 4th Edition, CRC Press 2016
3. LaValle "Virtual Reality", Cambridge University Press, 2016
4. “Virtual Reality”, Steve Lavalle (online open book)

Reference Books:

1. K. S. Hale and K. M. Stanney, “Handbook on Virtual Environments”, 2nd edition, CRC Press, 2015

2. George Mather,” Foundations of Sensation and Perception:” Psychology Press

Name of Department:- Computer Science and Engineering

1. Subject Code: TOE 811 Course Title: **Mobile Computing**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VIII

4. Pre-requisite: TIT 704, TCS 703

5. Course Outcomes: After completion of the course students will be able to

1. Explain the concepts, techniques, protocols and architecture employed in wireless local area networks, cellular networks, and Adhoc Networks
2. Describe and analyze the network infrastructure requirements to support mobile devices and users.
3. Interpret data management issues and distributed file system.
4. Asses the important issues and pertaining to clustering in wireless networks.
5. Value assessment of mobile agent in mobile computing environment.
6. Investigate Adhoc Routing Protocol.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	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**
Unit - II	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**
Unit – III	Data management issues, data replication for mobile computers, adaptive clustering for mobile wireless networks, CODA File system, Disconnected operations	**9**
Unit – IV	Mobile Agents computing, security and fault tolerance, transaction processing in mobile computing environment.	**8**
Unit – V	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), Optimized link state routing protocol (OLSR), QoS in Ad Hoc Networks, applications	**9**
	Total	**43**

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Text/ Reference Books:

1. D.P. Agarwal, Qing Amazing"Introduction to wireless and Mobile systems" , Cengage learning India
2. J. Schiller," Mobile Communications", Addison Wesley.
3. Raj Pandya "Mobile and personal communication systems and services" IEEE press.
4. Kukumgarg , "Mobile computing – Theory and practice ", pearson.

AUDIT COURSE: TOC301 PROBABILITY AND STATISTICS

Probability Theory

Probability I: Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions,mathematical expectation, moments, moment generating function, characteristic function.

Discrete distributions: uniform, binomial, Poisson, geometric, negative binomial, continuous distributions: uniform, normal, exponential.

Joint and conditional discrete distributions. Univariate densities and distributions, standard univariate densities (Normal, Exponential, Gamma, Beta, Chi-square, Cauchy). Expectation and moments of continuous random variables.

Probability II: Transformation of variables (assuming Jacobian formula). Distributions of sum, maxima, minima, order statistics, range etc. Multivariate normal (properties, linear combinations) and other standard multivariate distributions (discrete and continuous) with examples. Standard sampling distributions like $t, \chi^2, and\ F$. Conditional distributions, Conditional Expectation. Characteristic functions: properties, illustrations, inversion formula, continuity theorem (without proof).

Probability-III: Independence, Kolmogorov Zero-one Law, Kolmogorov Three-series theorem, Strong law of large Numbers. Levy Cramer Continuity theorem, CLT for i. i. d. components, Infinite Products of probability measures, Kolmogorovs Consistency theorem, Radon-Nikodym Theorem, Conditional expectations. Discrete parameter martingales with applications.

Reference Books :

1. C B Gupta, S R Singh and Mukesh Kumar entitled “Engineering Mathematics for Semesters III and IV”, McGraw-*Hill Education* (2016)
2. Mukesh Kumar, A.P. Singh, Anand Chauhan and A Kumar entitled Probability and Statistics, Scientific International Publisher(2018)
3. K. L. Chung: Elementary Probability Theory.
4. P. G. Hoel, S.C. Port and C.J. Stone: Introduction to Probability Theory
5. J. Nevue, Mathematical foundations of the calculus of probability, Holden-Day (1965.
6. P. Billingsley, Probability and measure, John Wiley (1995).

7. Y. S. Chow and H. Teicher, Probability theory. Independence, interchangeability, martingales, Springer Texts in Statistics. Springer-Verlag (1997).

Syllabus 2

Statistics

Statistics-I:
Introduction to Statistics with examples of its use; Descriptive statistics; Graphical representation of data: Histogram, Stem-leaf diagram, Box-plot; Exploratory Basic distributions, properties; Model fitting and model checking: Basics of estimation, method of moments,Bi-variate data, covariance, correlation, regression, and least squares method.

Statistics- II:
Inferential statistics, Hypothesis testing, Sampling distributions based on normal populations: $t, chi-square \; and \; F \; tests$. Sufficiency, Exponential family, Bayesian methods, Moment methods, Maximum likelihood estimation, Criteria for estimators, UMVUE, Large sample theory: Consistency; asymptotic normality, Confidence intervals, Elements of hypothesis testing; Neyman-Pearson Theory, UMP tests, Likelihood ratio and relatedtests, large sample tests.

Statistics- III:
Multivariate normal distribution, Transformations and quadratic forms; Review of matrix algebra involving projection matrices and matrix decompositions; Linear models; Regression and Analysis of variance (one -way and two-way classifications); General linear model, Matrix formulation, Estimation in linear model, Gauss-Markov theorem, Estimation of error variance.

Reference Books:

1. Lambert H. Koopmans: An introduction to contemporary statistics
2. David S Moore and William I Notz: Statistics Concepts and Controversies
3. George Casella and Roger L Berger: Statistical Inference
4. Peter J Bickel and Kjell A Doksum: Mathematical Statistics
5. Erich L Lehmann and George Casella: Theory of Point Estimation
6. Erich L Lehmann and Joseph P Romano: Testing Statistical Hypotheses
7. Sanford Weisberg: Applied Linear Regression
8. C R Rao: Linear Statistical Inference and Its Applications
9. George A F Seber and Alan J Lee: Linear Regression Analysis

Syllabus 3

Linear Algebra

Linear Algebra-1:

Vector spaces, linear transformations, characteristic roots and characteristic vectors, systems of linear equations, inner product spaces, diagonalization of symmetric and Hermitian matrices, quadratic forms.

Review of linear transformations and matrices. Eigenvectors, characteristic polynomial, orthogonal matrices and rotations. Inner product spaces, Hermitian, unitary and normal transformations, spectral theorems, bilinear and quadratic forms. Multilinear forms, wedge and alternating forms.

Review of basic concepts from rings and ideals required for module theory (if necessary). Modules over commutative rings: examples. Basic concepts: submodules, quotients modules, homomorphisms, isomorphism theorems, generators, annihilators, torsion, direct product and sum, direct summand, free modules, finitely generated modules, exact and split exact sequences.

Properties of K[X] over a field K. Structure theorem for finitely generated modules over a PID; applications to Abelian groups, rational and Jordan canonical forms. Time permitting, snake‘s lemma, complexes and homology sequences may be introduced.

Commutative rings with unity: examples, ring homomorphisms, ideals, quotients, isomorphism theorems with applications to non-trivial examples. Prime and maximal ideals, Zorn‘s Lemma and existence of maximal ideals. Product of rings, ideals in a finite product, Chinese Remainder Theorem. Prime and maximal ideals in a quotient ring and a finite product. Field of fractions of an integral domain. Irreducible and prime elements; PID, and UFD.

Linear Algebra-2:

Topics from: Majorization and doubly stochastic matrices. Matrix Decomposition Theorems (Polar, QR, LR, SVD etc.) and their applications. Perturbation Theory. Nonnegative matrices and their applications. Wavelets and the Fast Fourier Transform. Basic ideas of matrix computations.

Reference Books:

1. Mukesh Kumar, A.P. Singh, Anand Chauhan and A Kumar“Linear Algebra” Scientific International Publisher (2020).

2. D.S. Dummit and R.M. Foote, Abstract Algebra, John Wiley (Asian reprint 2003).

3.S. Lang, Algebra, GTM (211), Springer (Indian reprint 2002).

4.K. Hoffman and R. Kunze, Linear Algebra, Prentice-Hall of India (1998).
5.N.S. Gopalakrishnan, University Algebra, Wiley Eastern (1986).
6.R. Bhatia, Matrix Analysis, GTM (169), Springer-Verlag (1997).

AUDIT COURSE: TOC 401: COMPETATIVE PROGRAMMING

Unit	Detail	Number of hours
1	Arrays:-Two numbers in array having sum equals target, One string Is subsequence of another, Square of sorted array, Predict the winner, smallest non-constructible change, Three sum, minimum absolute difference, move elements to one end of array, monotonic array,Match calendar, spiral traversal of matrix, Tapping Rain Water	11 hours
2	Linked List:-Remove Linked List from Duplicate, Design Linked List, remove nth node from end of LL, add two numbers given as linked list, Cycle in LL - 1, Reverse Linked List O(n) Space, Merge Two Sorted LL, Palindrome LL, Swap nodes in pair	9 hours
3	Searching & sorting:- Bubble Sort, insertion sort, selection sort, heap, heap sort, quick sort, merge Sort, Radix Sort, Counting Sort, count inversions, Sort three numbers in place, Binary search, maximum product of three numbers, Search in sorted matrix, search in rotated array, First and last occurence in sorted array, kth largest element in an array, find fixed point in an array, Sort K-Sorted Array	11 hours
4	Stack:- Min stack O(1) Time, Valid parentheses, ocean view building, Sort a given stack, Next Greater Element 1, Next Greater Element 2, shorten path, Largest Rectangle in histogram	8 hours
5	String:- Valid Palindrome, Caesar Cipher, String Compression, Anagram, First unique character in a string, Longest Palindromic Substring, Group anagrams, Validate IP address, Reverse Words in String, minimum window substring, longest substring without repeating characters, word pattern	10 hours

CP - 2

Unit	Detail	Number of hours
1	Arrays:-longest peak in array, Product of array except self, duplicate in an array, Merge intervals, Four sum, Shortest unsorted continuos subarray, minimum rewards, Zig zag traversal matrix, Match calendar 2, Match Calendar 3,	9 hours
2	Linked List:-Cycle in LL - 2, Reverse Linked List O(1) Space, Merge in between LL, Merge K sorted LL, Reverse nodes in K group, Rotate LL in place, LRU Cache, partition LL, Reorder LL,	9 hours
3	Recursion and Trees:- Closest value in BST, Validate BST, Inorder Traversal, Postorder Traversal, Preorder Traversal, Construct BST from preorder, Convert sorted array to height balanced BST, Find kth smallest element in a bst, Inorder Successor, Inorder Predecessor in BST, Path Sum, Maximum Depth of BT, Diameter of Binary Tree, Invert BT, Lowest common ancestor	10 hours
4	Graph and Greedy:- DFS, BFS, Clone Graph, number of islands, island parameter, Contain Virus, Cheapest Flight with k stops, redundant connection, Redundant connection 2, Bipartite Graph, Detect Arbitrage, count squares, course schedule 1, course schedule 2,	13 hours
5	DP and Backtracking:-LCS, LIS, Max non adjacent subset sum, coin change 1, Coin change 2, unique path in matrix, unique path 2, jump game, palindrome partition min cut, Taget sum,	