VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY

(Formerly Uttarakhand Technical University, Dehradun Established by Uttarakhand State Govt. wide Act no. 415 of 2005)
Suddhowala, PO-Chandanwadi, Premnagar, Dehradun, Uttarakhand (Website- www.uktech.ac.in)

SYLLABUS

For

B.TECH

(Computer Science and Engineering)

3RD Year

Effective From – Session 2024-25

SEMESTER-V													
S. NO.	Subject Codes	Category	Subject	Periods			Evaluation Scheme					Subject Total	Credit
							Sessional Exam			ESE			
				L	T	P	CT	TA	Total	TE	PE		
1	CST-010	DC	Design and Analysis of Algorithms	3	1	0	30	20	50	100		150	4
2	CST-011	DC	Database Management System	3	1	0	30	20	50	100		150	4
3	CST-012	DC	Compiler Design	3	1	0	30	20	50	100		150	4
4	CST-0XX	DE	Departmental Elective–1	3	0	0	30	20	50	100		150	3
5	CST-0XX	DE	Departmental Elective–2	3	0	0	30	20	50	100		150	3
6	CSP-010	DLC	Design and Analysis of Algorithms Lab	0	0	2		25	25		25	50	1
7	CSP-011	DLC	Database Management System Lab	0	0	2		25	25		25	50	1
8	CSP-012	DLC	Compiler Design Lab	0	0	2		25	25		25	50	1
9	CSP-013	DLC	Mini Project-II or Internship-II*	0	0	2			50			50	1
10	AHT-009/ AHT-010	MC	Constitution of India / Essence of Indian Traditional Knowledge	2	0	0	15	10	25	50			
11	GP-005	NC	General Proficiency						50				
			Total	17	3	8						950	22
12			Minor Course(Optional)**	3	1	0	30	20	50	100			4
	*The Mini Project-II or Internship-II (4-6weeks)will be conducted during summer break after IV semester and will be assessed during the V semester												
	MOOCs course												

Departmental Elective–1		
S. No.	**Subject Code**	**Subject Name**
1	CST-013	Graph Theory
2	CST-014	Computer Graphics
3	CST-015	Software Engineering
4	CST-016	Queuing Theory & Modelling

Departmental Elective- 2		
S. No.	**Subject Code**	**Subject Name**
1	CST-017	Fault Tolerant Computing
2	CST-018	Real-Time System
3	CST-019	Distributed System
4	CST-020	Fuzzy Logic

Abbreviations: L-No. of Lecture hours per week, **T**-No. of Tutorial hours per week, **P**-No. of Practical hours per week, **CT**-Class Test Marks, **TA**-Marks of teacher's assessment including student's class performance and attendance, **PS**-Practical Sessional Marks, **ESE**-End Semester Examination, **TE**- Theory Examination Marks, PE-Practical External Examination Marks

Minor Courses (Optional) **: Select any subject from Annexure – II from other departments

1 Hr Lecture	**1 Hr Tutorial**	**2 or 3 Hr Practical**
1 Credit	**1 Credit**	**1 Credit**

SEMESTER-VI													
S. NO.	Subject Codes	Category	Subject	Periods			Evaluation Scheme					Subject Total	Credit
							Sessional Exam			ESE			
				L	T	P	CT	TA	Total	TE	PE		
1	CST-021	DC	Computer Networks	3	1	0	30	20	50	100		150	4
2	CST-022	DC	Artificial Intelligence	3	1	0	30	20	50	100		150	4
3	CST-023	DC	Operating System	3	1	0	30	20	50	100		150	4
4	CST-0XX	DE	Departmental Elective-3	3	0	0	30	20	50	100		150	3
5	AHT-0XX	HSC	Open Elective-1	3	0	0	30	20	50	100		150	3
6	CSP-014	DLC	Computer Networks Lab	0	0	2		25	25		25	50	1
7	CSP-015	DLC	Artificial Intelligence Lab	0	0	2		25	25		25	50	1
8	CSP-016	DLC	Operating System Lab	0	0	2		25	25		25	50	1
9	AHT-009/AHT-010	MC	Constitution of India / Essence of Indian Traditional Knowledge	2	0	0	15	10	25	50			
10	AHT-014	NC	Happiness and Well-being	2	0	0	25	25	50				
11	GP-006	NC	General Proficiency						50				
			Total	17	3	6						900	21
12			Minor Course (Optional)	3	1	0	30	20	50	100			4
		DLC	Internship-III/Mini Project-III*	To be completed at the end of the sixth semester (during the Summer).									
	MOOCs course												

Departmental Elective-3		
S. No.	Subject Code	Subject Name
1	CST-024	Internet of Things
2	CST-025	Quantum Computing
3	CST-026	Augmented Reality
4	CST-027	Web Technology
5	CST-028	Reliable Computing

Open Elective-1		
S. No.	**Subject Code**	**Subject Name**
1	AHT-011	Total Quality Management
2	AHT-012	Managing E-Commerce and Digital Communication
3	AHT-013	Industrial safety and Hazard Management

Abbreviations: L-No. of Lecture hours per week, **T**-No. of Tutorial hours per week, **P**-No. of Practical hours per week, **CT**-Class Test Marks, **TA**-Marks of teacher's assessment including student's class performance and attendance, **PS**-Practical Sessional Marks, **ESE**-End Semester Examination, **TE**- Theory Examination Marks, PE-Practical External Examination Marks

Minor Courses (Optional) **: Select any subject from Annexure – II from other departments

1 Hr Lecture	**1 Hr Tutorial**	**2 or 3 Hr Practical**
1 Credit	**1 Credit**	**1 Credit**

DESIGN & ANALYSIS OF ALGORITHMS (CST-010)

L:T:P:: 3:1:0 **Credits-04**

COURSE OUTCOMES: The objectives of this course are to:

1. Understand and apply the algorithm analysis techniques.
2. Analyze the efficiency of alternative algorithmic solutions for the same problem.
3. Understand different algorithm design techniques.
4. Understand the limitations of Algorithmic power.

COURSE OUTCOMES: On successful completion of the course, the student will be able to:

1. Analyze worst-case running times of algorithms based on asymptotic analysis and justify the correctness of algorithms.
2. Describe the greedy paradigm and explain when an algorithmic design situation calls for it. For a given problem develop the greedy algorithms.
3. Describe the divide-and-conquer paradigm and explain when an algorithmic design situation calls for it. Synthesize divide-and-conquer algorithms. Derive and solve recurrence relation.
4. Describe the dynamic-programming paradigm and explain when an algorithmic design situation calls for it.
5. Analyze randomized algorithms and approximation algorithms.

Unit 1- Introduction: Characteristics of an algorithm, Analysis of algorithm**:** Asymptotic analysis of complexity bounds – best, average, and worst-case behavior, Sorting techniques and their performance analysis, Time a space trade-off.

Analysis of recursive algorithms through recurrence relations: Substitution method, Recursion tree method and master's theorem.

Unit 2- Fundamental Algorithmic Strategies: Brute-Force, Greedy, Dynamic Programming, Branch- and-Bound and Back tracking methodologies for the design of an algorithms, Illustrations of these techniques for Problem-Solving, Knapsack, Matrix Chain Multiplication, Activity selection and LCS Problem.

Unit 3- Graph and Tree Algorithms: Traversal algorithms: Depth First Search (DFS) and Breadth First Search (BFS), Shortest path algorithms, Minimum Spanning Tree, Topological sorting, Network Flow Algorithm, Binomial Heap and Fibonacci Heap.

Unit 4- Tractable and Intractable Problems: Computability of Algorithms, Computability classes – P, NP, NP-complete and NP-hard, Standard NP-complete problems and Reduction techniques.

Unit 5- Advanced Topics: Approximation algorithms and Randomized algorithms, Distributed Hash Table

TEXTBOOKS:

1. Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, Introduction to Algorithms, 4TH Edition, MITPress/McGraw-Hill.
2. Ellis Horowitz, Sartaj Sahni and SanguthevarRajasekaran, Computer Algorithms/ C++, Second Edition, Universities Press, 2007.

REFERENCE BOOKS:

1. Jon Kleinberg and ÉvaTardos,Algorithm Design, 1ST Edition, Pearson.
2. Michael T Goodrich and Roberto Tamassia,Algorithm Design: Foundations, Analysis, and Internet Examples, Second EditionWiley.
3. Anany Levitin, ―Introduction to the Design and Analysis of Algorithms, Third Edition, Pearson Education, 2012.

DATABASE MANAGEMENT SYSTEMS (CST-011)

L:T:P:: 3:1:0 **Credits-04**

COURSE OBJECTIVES: The objectives of this course are to:

1. Learn the fundamentals of data models and to represent a database system using ER diagrams.
2. Study SQL and relational database design.
3. Understanding the internal storage structures using different file and indexing techniques which will help in physical DB design.
4. Understand the fundamental concepts of transaction processing- concurrency control techniques and recovery procedures.
5. Have the knowledge about the Storage and Query Processing Techniques

COURSE OUTCOMES: On successful completion of the course, the student will be able to:

1. Write relational algebra expressions for that query and optimize the developed expressions.
2. Design the databases using E-R method and normalization.
3. Understand the concepts of function dependencies and various normal forms.
4. Understand the concept of transaction atomicity, consistency, isolation, and durability properties in context of real life examples.
5. Develop the understanding of query processing and advanced databases.

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Unit 1-Introduction: Data Abstraction, Data Independence, Data Definition Language(DDL),Data Manipulation Language(DML), 3 level Database System Architecture.

Database models: Entity-relationship model, network model, relational and object oriented data models, integrity constraints, data manipulation operations.

Unit 2-Relational Model: Structure of relational database, Relational Algebra: Fundamental operations, Additional Operations, Extended Relational-Algebra operations, Tuple Relational Calculus – Domain Relational Calculus. SQL: Basic structure, Set operations, Aggregate functions, Null Values, Nested subqueries, Views, Data Definition Language, Embedded SQL, Dynamic SQL, Domain Constraints, Referential Integrity and Triggers.

Unit 3-Relational database design: Functional Dependencies, First, Second, Third Normal Forms, Closure, Armstrong's Axioms, Canonical cover, Decomposition, Properties of Decomposition, Dependency Preservation, Boyce-Codd Normal Form, Fourth Normal Form, Fifth Normal Form.

Unit 4-Transaction processing: Transaction Concepts, ACID Properties, Two-Phase Commit, Save Points, Concurrency Control techniques: Locking Protocols, Two Phase Locking, timestamp-based protocol, Multi-version and optimistic Concurrency Control schemes, Database recovery.

Unit 5-Storage Structure, Query Processing and Advanced database: Storage structures: RAID. File Organization: Organization of Records, Indexing, Ordered Indices, B+ tree Index Files, B tree Index Files.

Query Processing: Overview, Measures of Query Cost, Query optimization.

Advanced Database: Object-oriented and object-relational databases, logical databases, web databases, distributed databases, data warehousing and data mining.

TEXTBOOKS:

1. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, ―Database System Concepts, Sixth Edition, Tata McGraw Hill, 2011.
2. RamezElmasri, Shamkant B. Navathe, ―Fundamentals of Database Systems, Sixth Edition, Pearson Education, 2011.

REFERENCE BOOK:

1. C.J.Date, A.Kannan, S.Swamynathan, ―An Introduction to Database Systems, Eighth Edition, Pearson Education, 2006.
2. Raghu Ramakrishnan, ―Database Management Systems, Fourth Edition, McGraw-Hill College Publications, 2015.
3. G.K.Gupta,"Database Management Systems, Tata McGraw Hill, 2011.

COMPILER DESIGN (CST-012)

L:T:P:: 3:1:0 **Credits-04**

OBJECTIVES: The objectives of this course are to:

1. Learn the various phases of compiler and various parsing techniques.
2. Understand intermediate code generation and run-time environment.
3. Learn to implement front-end of the compiler and code generator.

OUTCOMES: On successful completion of the course, the student will be able to:

1. Understand the different phases of compiler.
2. Design a lexical analyser for a sample language using LEX tool.
3. Apply different parsing algorithms to develop the parsers for a given grammar using YACC tool.
4. Understand syntax-directed translation and run-time environment.
5. Learn to implement code optimization techniques and a simple code generator.

UNIT - I

INTRODUCTION TO COMPILERS: Structure of a compiler – Lexical Analysis – Role of Lexical Analyzer – Input Buffering – Specification of Tokens – Recognition of Tokens – Lex – Finite Automata – Regular Expressions to Automata – Minimizing DFA.

UNIT- II

SYNTAX ANALYSIS: Role of Parser – Grammars – Error Handling – Context-free grammars – Writing a grammar – Top Down Parsing - General Strategies, Recursive Descent Parser, Predictive Parser-LL(1) Parser-Shift Reduce Parser-LR Parser-LR (0)Item Construction of SLR Parsing Table - Introduction to LALR Parser - Error Handling and Recovery in Syntax Analyzer-YACC.

UNIT- III

SYNTAX-DIRECTED TRANSLATION: Syntax-Directed Definitions, Evaluation Orders for SDD's, Applications of Syntax-Directed Translation, Syntax-Directed Translation Schemes, Implementing L-Attributed SDD's.

INTERMEDIATE-CODE GENERATION: Variants of Syntax Trees, Three-Address Code, Types and Declarations, Type Checking, Control Flow, Switch-Statements, Intermediate Code for Procedures.

UNIT- IV

RUN-TIME ENVIRONMENTS: Stack Allocation of Space, Access to Nonlocal Data on the Stack, Heap Management, Introduction to Garbage Collection, Introduction to Trace-Based Collection.

CODE GENERATION: Issues in the Design of a Code Generator, The Target Language, addresses in the Target Code, Basic Blocks and Flow Graphs, Optimization of Basic Blocks, A Simple Code Generator, Peephole Optimization, Register Allocation and Assignment, Dynamic Programming Code-Generation.

UNIT- V

MACHINE-INDEPENDENT OPTIMIZATION: The Principal Sources of Optimization, Introduction to Data-Flow Analysis, Foundations of Data-Flow Analysis, Constant Propagation, Partial-Redundancy Elimination, Loops in Flow Graphs, peep-hole optimization.

TEXTBOOKS:

1. Compilers Principles, Techniques and Tools, Alfred V. Aho, Ravi Sethi, Jeffrey D. Ullman, PEA.
2. Introduction to Automata Theory Languages & Computation, 3rd Edition, Hopcroft, Ullman, PEA

REFERENCE BOOKS:

1. Theory of Computer Science, Automata Languages and Computation, 2nd Edition, Mishra, Chandra Shekaran, PHI.
2. Elements of Compiler Design, A.Meduna, Auerbach Publications, Taylor and Francis Group.

GRAPH THEORY (CST-013)

L:T:P:: 3:0:0: **Credits-03**

COURSE OBJECTIVES: The objectives of this course are to:

1. Understand the fundamentals of graph theory.
2. Study proof techniques related to various concepts in graphs.
3. Explore modern applications of graph theory.

COURSE OUTCOMES: On successful completion of the course, the student will be able to:

1. Understand the basic concept of walk, path and circuit in a graph.
2. Perform the basic operation of Euler graph and digraph
3. Discuss the various spanning trees algorithms.
4. Understand the concept of edge connectivity, vertex connectivity and separable graphs.
5. Derive the relations between the reduced incidence matrix, the fundamental cycle matrix, and the fundamental cut-set matrix of a graph G.

UNIT I: INTRODUCTION: Introduction to Graphs, Basic definition – Application of graphs – finite, infinite and bipartite graphs – Incidence and Degree – Isolated vertex, pendant vertex and Null graph. Paths and circuits – Isomorphism, sub graphs, walks, paths and circuits, connected graphs, disconnected graphs and components.

UNIT II: EULERIAN AND HAMILTONIAN GRAPHS : Euler graphs, Operations on graphs, Hamiltonian paths and circuits, Travelling salesman problem. Directed graphs – types of digraphs, Digraphs and binary relation, Directed paths and connectedness – Euler graphs.

UNIT III TREES AND GRAPH ALGORITHMS : Trees – properties, pendant vertex, Distance and centres in a tree - Rooted and binary trees, counting trees, spanning trees, Prim's algorithm and Kruskal's algorithm, Dijkstra's shortest path algorithm, Floyd-Warshall shortest path algorithm.

UNIT IV CONNECTIVITY AND PLANAR GRAPHS : Vertex Connectivity, Edge Connectivity, Cut set and Cut Vertices, Fundamental circuits, Planar graphs, Kuratowski's theorem (proof not required), Different representations of planar graphs, Euler's theorem, Geometric dual.

UNIT V: GRAPH REPRESENTATIONS AND VERTEX COLOURING : Matrix representation of graphs Adjacency matrix, Incidence Matrix, Circuit Matrix, Path Matrix. Coloring- Chromatic number, Chromatic polynomial, Matchings, Coverings, Four colour problem and Fivecolour problem.

TEXTBOOKS:

1. Narsingh Deo, "Graph Theory with Application to Engineering and Computer Science", Prentice-Hall of India Pvt.Ltd, 2003.
2. L.R.Foulds, "Graph Theory Applications", Springer ,2016.

REFERENCES:

1. Bondy, J. A. and Murty, U.S.R., "Graph Theory with Applications", North Holland Publication,2008.
2. West, D. B., ―Introduction to Graph Theory, Pearson Education, 2011.
3. John Clark, Derek Allan Holton, ―A First Look at Graph Theory, World Scientific Publishing Company, 1991.
4. Diestel, R, "Graph Theory", Springer,3rd Edition,2006. Kenneth H.Rosen, "Discrete Mathematics and Its Applications", Mc Graw Hill , 2007.

COMPUTER GRAPHICS (CST-014)

L:T:P:: 3:0:0 **Credits-03**

COURSE OBJECTIVES: The objectives of this course are to

1. Provide a comprehensive introduction to computer graphics leading to understanding contemporary terminology, progress, issues, and trends.
2. Understand computer graphics techniques (2-D/3-D), focusing on 3D modelling, image synthesis, and rendering.
3. Introduce geometric transformations, geometric algorithms, software systems (OpenGL), 3D object models (surface, volume and implicit), visible surface algorithms, image synthesis, shading and mapping, ray tracing, radiosity, global illumination, photon mapping, and anti-aliasing.
4. Explore the interdisciplinary nature of computer graphics which is emphasized in the wide variety of examples and applications.

COURSE OUTCOME: On successful completion of the course, the student will be able to:

1. Develop the understanding of the fundamentals of Graphics concepts, and standards.
2. Understand the algorithms that form the foundation of computer graphics.
3. Provide 3D representation for their applications.
4. Understand various transformation techniques and their application.
5. Interpret parallel and oblique projections and their applications.

Unit 1- Introduction to computer graphics & graphics systems: Overview of computer graphics, representing pictures, preparing, presenting & interacting with pictures for presentations, Visualization & image processing, RGB color model, direct coding, lookup table, storage tube graphics display, Raster scan display, 3D viewing devices, Plotters, printers, digitizers, Light pens etc., Active & Passive graphics devices, Computer graphics software.

Unit 2- Points & lines: Line drawing algorithms; DDA algorithm, Bresenhan's line algorithm, Circle generation algorithm; Ellipse generating algorithm; scan line polygon, fill algorithm, boundary fill algorithm, flood fill algorithm.

Unit 3- 2D transformation & viewing Basic transformations: Translation, rotation, scaling, Matrix representations & homogeneous coordinates, transformations between coordinate systems, reflection shear, Transformation of points, lines, parallel lines, intersecting lines. Viewing pipeline, Window to viewport co-ordinate transformation , clipping operations , point clipping , line clipping, clipping circles, polygons & ellipse.

Unit 4- 3D transformations: Translation, rotation, scaling & other transformations. Rotation about an arbitrary axis in space, reflection through an arbitrary plane, general parallel projection transformation, clipping, viewport

clipping, 3D viewing.

Unit 5- Curves representation: Surfaces, designs, Bezier curves, B-spline curves, end conditions for periodic B-spline curves, rational B-spline curves. Hidden surfaces Depth comparison, Z-buffer algorithm, Back face detection, BSP tree method, the Printer's algorithm, scan-line algorithm; Hidden line elimination, wire frame methods, fractal - geometry.

Color & shading models Light & color model, interpolative shading model and Texture

TEXTBOOKS:

1. Donald Hearn and Pauline Baker M, ―Computer Graphics, Prentice Hall, New Delhi, 2007.
2. Andleigh, P. K and Kiran Thakrar, ―Multimedia Systems and Design, PHI, 2003.

REFERENCES:

1. Judith Jeffcoate, ―Multimedia in practice: Technology and Applications, PHI, 1998.
2. Foley, Vandam, Feiner and Hughes, ―Computer Graphics: Principles and Practice, 2nd Edition, Pearson Education, 2003.
3. Jeffrey McConnell, ―Computer Graphics: Theory into Practice, Jones and Bartlett Publishers,2006.
4. Hill F S Jr., "Computer Graphics", Maxwell Macmillan , 1990.
5. Peter Shirley, Michael Ashikhmin, Michael Gleicher, Stephen R Marschner, Erik Reinhard, KelvinSung, and AK Peters, ―Fundamentals of Computer Graphics, CRC Press, 2010.
6. William M. Newman and Robert F.Sproull, ―Principles of Interactive Computer Graphics, Mc Graw Hill 1978.

SOFTWARE ENGINEERING (CST-015/CSO-052)

L:T:P:: 3:0:0 **Credits-03**

COURSE OBJECTIVES: The objectives of this course are to

1. Learn and understand the principles of Software Engineering.
2. Learn methods of capturing, specifying, visualizing, and analyzing software requirements.
3. Apply Design and Testing principles to S/W project development.
4. Understand project management through life cycle of the project.

COURSE OUTCOMES: On successful completion of the course, the student will be able to

1. Identify appropriate software design model based on requirement analysis.
2. Formulate Software Requirements Specification (SRS) reports for the real world application.
3. Translate a specification into a design and identify the components to build the architecture.
4. Plan a software engineering process to account for quality issues and non-functional requirements.
5. Estimate the work to be done, resources required and the schedule for a software project plan.

Unit 1- : **Introduction to Software Engineering**: Introduction, software applications, importance of software evolution of software, Software Components, Software Characteristics, Software Crisis & myths. Software Engineering paradigms: introduction, principles & Processes, Software Quality Attributes. Comparison between software engineering & computer science, & software engineering & Engineering. Some terminologies: product & process, deliverables and milestones, measures, metrics& indicators. Programs & software products. Software Development Life Cycle (SDLC) Models: Water Fall Model, Prototype Model, RAD model, Spiral Model, Evolutionary Development Models, Iterative Enhancement Models.

Unit 2- Software Requirement Analysis: Structured analysis, object-oriented analysis, software requirement specification, and validation.

Unit 3- Design and Implementation of Software: software design fundamentals, design methodology (structured design and object-oriented design), design verification, monitoring and control coding.

Unit 4- Testing: Testing fundamentals, white box and black box testing, software testing strategies: unit testing, integration testing, validation testing, system testing, debugging.

Unit 5- Software Reliability: Metric and specification, fault avoidance and tolerance, exception handling, defensive programming.Software Maintenance – maintenance characteristics, maintainability, maintenance tasks, maintenance side effects. CASE tools, software certification- requirement, types of certifications, third part certification. Software Re-Engineering, reverse software Engineering. Software Configuration Management

Activities, Change Control Process, Software Version Control, CASE: introduction, levels of case, architecture, case building blocks, objectives, case repository, characteristics of case tools, categories, Estimation of Various Parameters such as Cost, Efforts, Schedule/Duration, Constructive Cost Models (COCOMO), Resource Allocation Models, Software Risk Analysis and Management.

TEXTBOOKS:

1. Roger Pressman, ―Software Engineering: A Practitioner ‘s Approach, McGraw Hill, ISBN 007–337597–7.
2. Ian Sommerville, ―Software Engineering, Addison and Wesley, ISBN 0-13-703515-2.

REFERENCE BOOKS:

1. Carlo Ghezzi, ―Fundamentals of Software Engineering, Prentice Hall India, ISBN-10: 0133056996.
2. Rajib Mall, ―Fundamentals of Software Engineering, Prentice Hall India, ISBN-13: 9788120348981.
3. Pankaj Jalote, ―An Integrated Approach to Software Engineering, Springer, ISBN 13: 9788173192715.
4. S K Chang, ―Handbook of Software Engineering and Knowledge Engineering, World Scientific, Vol I, II, ISBN: 978-981-02-4973-1.
5. Tom Halt, ―Handbook of Software Engineering, ClanyeInternational ISBN- 10: 1632402939.

QUEUING THEORY AND MODELING (CST-016)

L:T:P:: 3:0:0

Credits-03

COURSE OBJECTIVES: The objectives of this course are to

1. Provide necessary basic concepts in probability and random processes for applications such as random signals, linear systems in communication engineering.
2. Understand the basic concepts of random processes which are widely used in IT fields.
3. Understand the concept of queueing models and application in engineering.
4. Provide the required mathematical support in real life problems and develop probabilistic models which can be used in several areas of science and engineering.

COURSE OUTCOMES: On successful completion of this course, the students shall be able to

1. Have a fundamental knowledge of the basic concepts of probability.
2. Have a well-founded knowledge of various probability distributions which can describe real-life phenomena.
3. Acquire skills in estimating expected values of variables and handling situations involving more than one random variable and functions of random variables.
4. Understand the stochastic processes and phenomena which evolve concerning time in a probabilistic manner.
5. Expose the basic characteristic features of Markov chains, queuing systems and queuing models.

Unit 1- Probability Models: Sample Space, Events and their algebra, graphical methods of representing events, Probability Axioms and their applications, Condition probability, Independence of Events, Bayes' Rule and Bernoulli Trials.

Unit 2- Random variables, and their event spaces: Probability mass function, Distribution functions, some discrete distributions (Bernoulli, Binomial, Geometric, Poisson, uniform, Probability Generating Function, Discrete random vectors, Continuous random variables: pdf some continuous distributions (Gamma, Normal), Exponential functions of random variables, joint1y distributed random variables.

Unit 3- Expectation: Expectation of functions of more than one random variable, Moments and transforms of some distributions (Uniform, Bernoulli, Binomial, Geometric, Poisson. Exponential, Gamma, Normal), Computation of mean time to failure.

Unit 4- Stochastic Processes: Classification of stochastic processes, the Bernoulli process, renewal process, renewal model of program behavior.

Unit 5- Markov Chains: Computation of n-step transition probabilities, State classification and limiting distributions, Irreducible finite chains with aperiodic states, M/G/l queuing system, Discrete parameter

BirthDeath processes, Analysis of program execution time. Continuous parameter Markov Chains, Birth-Death process with special cases, Non-Birth-Death Processes.

TEXTBOOKS:

1. Gross, D., Shortle, J.F, Thompson, J.M and Harris. C.M., ―Fundamentals of Queueing Theory", Wiley Student 4th Edition, 2014.
2. Ibe, O.C., ―Fundamentals of Applied Probability and Random Processes", Elsevier, 1st Indian Reprint, 2007.

REFERENCE BOOK:

1. Hwei Hsu, "Schaum‘s Outline of Theory and Problems of Probability, Random Variables and Random Processes", Tata McGraw Hill Edition, New Delhi, 2004.
2. Taha, H.A., "Operations Research", 9th Edition, Pearson India Education Services, Delhi, 2016.
3. Trivedi, K.S., "Probability and Statistics with Reliability, Queueing and Computer Science Applications", 2nd Edition, John Wiley and Sons, 2002.
4. Yates, R.D. and Goodman. D. J., "Probability and Stochastic Processes", 2nd Edition, Wiley India Pvt. Ltd., Bangalore, 2012.

FAULT-TOLERANT COMPUTING (CST-017)

L:T:P:: 3:0:0

Credits-03

COURSE OBJECTIVES: The objectives of this course are to

1. Understand fault-tolerant design principles.
2. Identify the requirement of fault-tolerant systems.
3. Understand fault-tolerant distributed systems and its requirement.
4. Design algorithms for fault-tolerant systems.

COURSE OUTCOMES: On successful completion of the course, the student will be able to

1. Understand research problems and challenges in fault tolerance computing.
2. Identify the state-of-the-art techniques and tools to address research problems and challenges.
3. Develop strong technical reviewing, writing, and presentation skills.
4. Design more reliable systems that can tolerate S/W faults.
5. Design more reliable systems that can tolerate H/W faults.

Unit 1- Basics of Fault Tolerance: Fault Classification, Types of Redundancy, Basic Measures of Fault Tolerance, Reliability concepts, Failures & faults, Reliability and Failure rate, Relation between reliability and mean time between failure, maintainability and availability, Fault Tolerant Design: Basic concepts-static, dynamic, hybrid, triple modular redundant system (TMR), Data redundancy, Time redundancy and software Redundancy concepts.

Unit 2- Hardware Fault Tolerance: canonical and Resilient Structures- Series and Parallel Systems, Non-Series/Parallel Systems, *M*-of-*N* Systems, Voters, Variations on *N*-Modular Redundancy, Duplex Systems, Other Reliability Evaluation Techniques-Poisson Processes, Markov Models, Fault-Tolerance Processor-Level Techniques, Watchdog Processor, Simultaneous Multithreading for Fault Tolerance, Byzantine Failures, Byzantine Agreement with Message Authentication.

Unit 3- Testability for Hardware: testability for combinational circuits: Basic concepts of Testability, Controllability and observability, The Reed Muller's expansion technique, use of control and syndrome testable designs. Design for testability by means of scan: Making circuits Testable, Testability Insertion, Full scan DFT technique- Full scan insertion, flip-flop Structures, Full scan design and Test, Scan Architectures full scan design, Shadow register DFT, Partial scan methods, multiple scan design, other scan designs.

Unit 4- Software Fault Tolerance: Acceptance Tests Single-Version Fault Tolerance- Wrappers, Software Rejuvenation, Data Diversity, Software Implemented Hardware Fault Tolerance (SIHFT), *N*-Version Programming- Consistent Comparison Problem, Version Independence, Recovery Block Approach- Basic Principles, Success Probability Calculation, Distributed Recovery Blocks, Preconditions, Postconditions, and Assertions, Exception-Handling- Requirements from Exception-Handlers, Basics of Exceptions and Exception-Handling, Language Support, Software Reliability Models- Jelinski–Moranda Model, Littlewood–Verrall Model, Musa–Okumoto Model, Model Selection and Parameter Estimation, Fault-Tolerant Remote Procedure

Calls-Primary-Backup Approach, The Circus Approach.

Unit 5- Checkpointing: Basics of checkpoint, Checkpoint Level, Optimal Checkpointing- An Analytical Model, Time Between Checkpoints-A First-Order Approximation, Optimal Checkpoint Placement, Reducing Overhead, Reducing Latency, Checkpointing in Distributed Systems-The Domino Effect and Livelock, A Coordinated Checkpointing Algorithm, Time-Based Synchronization, Diskless Checkpointing, Message Logging, Checkpointing in Shared-Memory Systems- Bus-Based Coherence Protocol, Directory-Based Protocol, Checkpointing in Real-Time Systems.

TEXTBOOKS:

1. Israel Koren And C. Mani Krishna, "Fault-Tolerant Systems, Morgan Kaufmann publisher
2. Parag K. Lala, "Fault Tolerant & Fault Testable Hardware Design", 1984, PHI

REFERENCE BOOKS:

1. Fault Tolerant Computer System Design, D. K. Pradhan, Prentice Hall, 1996.
2. Probability and Statistics with Reliability, Queuing and Computer Science Applications, Kishor S. Trivedi, John Wiley & Sons Inc., 2016.
3. ZainalabedinNavabi, "Digital System Test and Testable Design using HDL models and Architectures", Springer International Edition.
4. MironAbramovici, Melvin A. Breuer and Arthur D. Friedman, "Digital Systems Testing and Testable Design", Jaico Books

REAL-TIME SYSTEM (CST-018)

L:T:P:: 3:0:0 **Credits-03**

COURSE OBJECTIVES: The objectives of this course are to

1. Develop an understanding of various Real Time systems Application
2. Obtain a broad understanding of the technologies and applications for the emerging and exciting domain of real-time systems
3. Get in-depth hands-on experience in designing and developing a real operational system.

COURSE OUTCOMES: On successful completion of the course, the student will be able to

1. Grasp a fundamental understanding of goals, components, and evolution of real time systems.
2. Explain the concepts of real time scheduling.
3. Learn the scheduling policies of modern operating systems.
4. Understand the resource access control techniques in real time systems.
5. Understand the concept of real time communication.

Unit 1-Introduction: Definition, Typical Real Time Applications: Digital Control, High Level Controls, Signal Processing etc., Release Times, Deadlines, and Timing Constraints, Hard Real Time Systems and Soft Real Time Systems, Reference Models for Real Time Systems: Processors and Resources, Temporal Parameters of Real Time Workload, Periodic Task Model, Precedence Constraints and Data Dependency.

Unit 2-Real Time Scheduling: Common Approaches to Real Time Scheduling: Clock Driven Approach, Weighted Round Robin Approach, Priority Driven Approach, Dynamic Versus Static Systems, Optimality of Effective-Deadline-First (EDF) and Least-Slack-Time-First (LST) Algorithms, Offline Versus Online Scheduling, Scheduling Aperiodic and Sporadic jobs in Priority Driven and Clock Driven Systems.

Unit 3-Resources Access Control: Effect of Resource Contention and Resource Access Control (RAC), Non-preemptive Critical Sections, Basic Priority-Inheritance and Priority-Ceiling Protocols, Stack Based Priority-Ceiling Protocol, Use of Priority-Ceiling Protocol in Dynamic Priority Systems, PreemptionCeiling Protocol, Access Control in Multiple-Unit Resources, Controlling ConcurrentAccesses to Data Objects.

Unit 4-Multiprocessor System Environment: Multiprocessor and Distributed System Model, Multiprocessor Priority-Ceiling Protocol,Schedulability of Fixed-Priority End-to-End Periodic Tasks, Scheduling Algorithms for End-to-End Periodic Tasks, End-to-End Tasks in Heterogeneous Systems, Predictability andValidation of Dynamic Multiprocessor Systems, Scheduling of Tasks with Temporal Distance Constraints.

Unit 5-Real Time Communication: Model of Real Time Communication, Priority-Based Service and Weighted Round-Robin Service Disciplines for Switched Networks, Medium Access Control Protocols for

Broadcast Networks, Internet and Resource Reservation Protocols, Real Time Protocols,Communication in Multicomputer System, An Overview of Real Time Operating Systems.

TEXTBOOKS:

1. Real Time Systems – Jane W. S. Liu, Pearson Education Publication.
2. Real-Time Systems Design and Analysis, Phillip. A. Laplante, second edition, PHI, 2005.

REFERENCE BOOKS:

1. Real Time Systems – Mall Rajib, Pearson Education
2. Real-Time Systems: Scheduling, Analysis, and Verification – Albert M. K. Cheng, Wiley.

DISTRIBUTED SYSTEMS (CST-019)

L:T:P:: 3:0:0 **Credits-03**

COURSE OBJECTIVES: The objectives of this course are to

1. Understand the foundations of distributed systems.
2. Learn clock synchronisation issues and the need for global state in distributed systems.
3. Learn distributed mutual exclusion and deadlock detection algorithms.
4. Understand the significance of agreement, fault tolerance and recovery protocols in Distributed Systems.
5. Learn the characteristics of peer-to-peer and distributed shared memory systems.

COURSE OUTCOMES: On Successful completion of the course, the students will be able to

1. Acquire the theoretical and conceptual foundations of distributed computing.
2. Conceptualize the ideas of distributed operating systems and their issues.
3. Understand the issues involved in distributed resource environment.
4. Realize the importance of transaction and how to recovery the system from deadlocks.
5. Explore the principles of fault tolerance and its protocols.

Unit 1- Distributed Environment: Introduction, Limitations, Remote Procedure Call, Remote Object Invocation, Message-Oriented Communication, Unicasting, Multicasting and Broadcasting, Group Communication.

Unit 2-Distributed Operating Systems: Issues in Distributed Operating Systems, Threads in Distributed Systems, Clock Synchronization, Causal Ordering, Global States, Election Algorithms, Distributed Mutual Exclusion, Distributed Deadlock, Agreement Protocols

Unit 3- Distributed Resource Management: Distributed Shared Memory, Data-Centric Consistency Models, Client-Centric Consistency Models, Distributed File Systems, Sun NFS.

Unit 4- Distributed Transaction Processing: Transactions, Nested Transactions, Locks, Optimistic Concurrency Control, Timestamp Ordering, Comparison, Flat and Nested Distributed Transactions, Atomic Commit Protocols, Concurrency Control in Distributed Transactions, Distributed Deadlocks, Transaction Recovery, Overview of Replication and Distributed Multimedia Systems.

Unit 5- Fault Tolerance and Consensus: Introduction to Fault Tolerance, Distributed Commit Protocols, Byzantine Fault Tolerance, Impossibilities in Fault Tolerance.

TEXTBOOK(S):

1. A.S.Tanenbaum, M.Van Steen, "Distributed Systems", Pearson Education, 2007.
2. MukeshSinghal, NiranjanG.Shivaratri "Advanced Concepts in Operating Systems", McGrawHill Series in Computer Science, 2011.

REFERENCE BOOKS:

1. George Coulouris, Jean Dollimore, Tim Kindberg, "Distributed Systems Concepts and Design", 3rd Edition, Pearson Education Asia, 2002.
2. M.L.Liu, "Distributed Computing Principles and Applications", Pearson Addison Wesley, 2004.
3. Andrew S.Tenenbaum "Modern Operating system", 3rd Edition, Pearson Addison Wesley, 2008.

FUZZY LOGIC (CST-020)

L:T:P:: 3:0:0 **Credits-03**

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COURSE OBJECTIVES: The objectives of this course are to

1. Develop the fundamental concepts such as fuzzy sets, operations and fuzzy relations.
2. Lean about scalar variables' fuzzification and membership functions' defuzzification.
3. Learn three different inference methods to design fuzzy rule-based system.
4. Develop fuzzy decision making by introducing some concepts and also Bayesian decision methods.
5. Learn different fuzzy classification methods.

COURSE OUTCOMES: On successful completion of the course, the students will be able to

1. Understand the basic ideas of fuzzy sets, operations and properties of fuzzy sets, and fuzzy relations.
2. Understand the basic features of membership functions, fuzzification process and defuzzification process.
3. Design fuzzy rule-based system.
4. Know about combining fuzzy set theory with probability to handle random and non-random uncertainty, and the decision-making process.
5. Gain the knowledge about fuzzy C-Means clustering.

Unit – I: Classical Sets: Operations and properties of classical sets, Mapping of classical sets to the functions. Fuzzy sets - Membership functions, Fuzzy set operations, Properties of fuzzy sets.

Classical and Fuzzy Relations: Cartesian product, crisp relations-cardinality, operations, and properties of crisp relations. Fuzzy relations-cardinality, operations, properties of fuzzy relations, fuzzy Cartesian product and composition, Fuzzy tolerance and equivalence relations, value assignments and other format of the composition operation.

UNIT II: Fuzzification and Defuzzification : Features of the membership functions, various forms, fuzzification, defuzzification to crisp sets, l- cuts for fuzzy relations, Defuzzification to scalars. Fuzzy logic and approximate reasoning, other forms of the implication operation.

UNIT III : Fuzzy Systems : Natural language, Linguistic hedges, Fuzzy (Rule based) System, Aggregation of fuzzy rules, Graphical techniques of inference, Membership value assignments: Intuition, Inference, rank ordering, Fuzzy Associative memories.

UNIT IV: Fuzzy Decision Making: Fuzzy synthetic evaluation, Fuzzy ordering, Preference and consensus, Multi
objective decision making, Fuzzy Bayesian, Decision method, Decision making under Fuzzy states and fuzzy actions.

UNIT V: Fuzzy Classification: Classification by equivalence relations-crisp relations, Fuzzy relations, Cluster analysis, Cluster validity, C-Means clustering, Hard C-Means clustering, Fuzzy C-Means algorithm, Classification metric, Hardening the Fuzzy C-Partition.

TEXTBOOK(s):

1. Timothy J.Ross - Fuzzy logic with engineering applications, 3rd edition, Wiley,2010.
2. George J.KlirBo Yuan - Fuzzy sets and Fuzzy logic theory and Applications, PHI, New Delhi,1995.

REFERENCE BOOK(s):

1. S.Rajasekaran, G.A.Vijayalakshmi - Neural Networks and Fuzzy logic and Genetic Algorithms, Synthesis and Applications, PHI, New Delhi,2003.

DESIGN & ANALYSIS OF ALGORITHMS LAB (CSP-010)

L:T:P:: 0:0:2 **Credits-01**

COURSE OBJECTIVES: The objectives of this course are to

1. Build a solid foundation in algorithms and their applications.
2. Implement various divide and conquer techniques examples, Greedy techniques examples, and Dynamic Programming techniques examples.
3. Provide a practical exposure of various algorithms.
4. Understand the importance of algorithm and its complexities.

COURSE OUTCOMES: Upon successful completion of the course, the students will be able to

1. Solve recurrence equations by considering time and space complexity.
2. Analyse the complexities of various problems in different domains.
3. Solve the problems that comprises of shortest route issue.
4. Solve the problems that address the issue of dynamic programming
5. Synthesize efficient algorithms in common engineering design situations.

LIST OF EXCERCISES

1. Programming that uses recurrence relations to analyse recursive algorithms.
2. Computing best, average, and worst-case time complexity of various sorting techniques.
3. Performance analysis of different internal and external sorting algorithms with different type of data set.
4. Use of divide and conquer technique to solve some problem that uses two different algorithms for solving small problem.
5. Implementation of different basic computing algorithms like Hash tables, including collision-avoidance strategies, Search trees (AVL and B-trees).
6. Consider the problem of eight queens on an (8x8) chessboard. Two queens are said to attack each other if they are on the same row, column, or diagonal. Write a program that implements backtracking algorithm to solve the problem i.e. place eight non-attacking queens on the board.
7. Write a program to find the strongly connected components in a digraph.
8. Write a program to implement file compression (and un-compression) using Huffman's algorithm.
9. Write a program to implement dynamic programming algorithm to solve the all pairs shortest path problem.
10. Write a program to solve 0/1 knapsack problem using the following:
    a) Greedy algorithm.
    b) Dynamic programming algorithm.
    c) Backtracking algorithm.
    d) Branch and bound algorithm.

11. Write a program that uses dynamic programming algorithm to solve the optimal binary search tree problem.

12. Write a program for solving traveling salespersons problem using the following:

a) Dynamic programming algorithm.

b) The back tracking algorithm.

c) Branch and bound.

DATABASE MANAGEMENT SYSTEM LAB (CSP-011)

L:T:P:: 0:0:2 **Credits-01**

COURSE OBJECTIVES: The objectives of this course are to

1. Understand data definitions and data manipulation commands.
2. Learn the use of nested and join queries.
3. Understand functions, procedures and procedural extensions of data bases.
4. Familiar with the use of a front-end tool and understand design and implementation of typical database applications

COURSE OUTCOMES: On successful completion of the course, the students will be able to

1. Understand, appreciate, and effectively explain the concepts of database Technologies.
2. Declare and enforce integrity constraints on a database using RDBMS.
3. Devise a complex query using SQL DML/DDL commands.
4. Create views and use in-built functions to query a database.
5. Write PL/SQL programs including stored procedures, stored functions and triggers.

LIST OF EXPERIMENTS

1. Build the following database schemas and perform the manipulation operations on these schemas using SQL DDL,DML,TCL and DCL commands.

   (I) Database Schema for a customer-sale scenario

   Customer(Custid : integer, cust_name: string)

   Item(item_id: integer, item_name: string, price: integer)

   Sale(bill_no: integer, bill_data: date, cust_id: integer, item_id: integer, qty_sold: integer)

   For the above schema, perform the following:-

   a) Create the tables with the appropriate integrity constraint
   b) Insert around 10 records in each of the tables
   c) List all the bills for the current date with the customer namesand item numbers
   d) List the total Bill details with the quantity sold price of theitem and the final amount
   e) List the details of the customer who have bought a productwhich has a price>200
   f) Give a count of how many products have been bought byeach customer
   g) Give a list of products bought by a customer having cust_idas 5
   h) List the item details which are sold as of today
   i) Create a view which lists out the bill_no, bill_date, cust_id, item_id, price, qty_sold, amount
   j) Create a view which lists the date wise daily sales for the last one week
   k) Identify the normalization of this schema. Justify your answer.
   l) If the schema is not normalized, then normalize the schema.

   (II) Database Schema for a Employee-pay scenario

Employee(emp_id : integer, emp_name: string)

Department (dept_id: integer, dept_name:string)

Paydetails(emp_id : integer, dept_id: integer, basic: integer,deductions: integer, additions: integer, DOJ: date)

payroll(emp_id : integer, pay_date: date)

For the above schema, perform the following:—

a) Create the tables with the appropriate integrity constraints
b) Insert around 10 records in each of the tables
c) List the employee details department wise
d) List all the employee names who joined after particular date
e) List the details of employees whose basic salary is between 10,000 and 20,000
f) Give a count of how many employees are working in each department
g) Give a name of the employees whose netsalary>10,000
h) List the details for an employee_id=5
i) Create a view which lists out the emp_name, department, basic, deductions,netsalary
j) Create a view which lists the emp_name and his netsalary
k) Identify the normalization of this schema. Justify your answer
l) If the schema is not normalized then normalize the schema.

2. Construct a PL/SQL program to find largest number from the given three numbers.
3. Build a PL/SQL program to generate all prime numbers below 100.
4. Construct a PL/SQL program to demonstrate %type and %row type attributes.
5. Develop a PL/SQL procedure to find reverse of a given number.
6. Create a PL/SQL procedure to update the salaries of all employees by 10% in their basic pay.
7. Execute a PL/SQL procedure to demonstrate IN, OUT and INOUT parameters.
8. Design a PL/SQL trigger before/after update on employee table for each row/statement.
9. Create a PL/SQL trigger before/after delete on employee table for each row/statement.
10. Build a PL/SQL trigger before/after insert on employee table for each row/statement.
11. Design and build the following applications using SQL and front end tool and generate report

- Student information system for your college.
- Hospital Management System.
- A video library management system.
- Inventory management system for a hardware / sanitary item shop.
- Banking System.
- Railway Reservation System
- Car Insurance Company

COMPILER DESIGN LAB (CSP-012)

L:T:P:: 0:0:2 **Credits-01**

COURSE OBJECTIVES: The objectives of this course are to

1. Understand the various phases in the design of a compiler.
2. Understand the design of top-down and bottom-up parsers.
3. Understand syntax directed translation schemes.
4. Introduce lex and yacc tools.

COURSE OUTCOMES: On successful completion of the course, the students will be able to

1. Understand the basic concepts; ability to apply automata theory and knowledge on formal languages.
2. Understand the basic concepts and application of Compiler Design
3. Apply their basic knowledge Data Structure to design Symbol Table, Lexical Analyser, Intermediate Code Generation, Parser (Top Down and Bottom-Up Design) and will able to understand strength of Grammar and Programming Language.
4. Understand various code optimization techniques and error recovery mechanisms.
5. Understand and Implement a Parser.

LIST OF PRACTICALS:

1. Design a lexical analyzer for given language and the lexical analyzer should ignore redundant spaces, tabs and new lines. It should also ignore comments. Although the syntax specification states that identifiers can be arbitrarily long, you may restrict the length to some reasonable value. Simulate the same in C language
2. Write a C program to identify whether a given line is a comment or not
3. Write a C program to test whether a given identifier is valid or not.
4. Write a C program to simulate lexical analyzer for validating operators.
5. To Study about Lexical Analyzer Generator(LEX) and Flex(Fast Lexical Analyzer)
6. Implement following programs using Lex:

   a) Create a Lexer to take input from text file and count no of characters, no. of lines & no. of words.

   b) Write a Lex program to count number of vowels and consonants in a given input string.
7. Implement following programs using Lex.

   a) Write a Lex program to print out all numbers from the given file.

   b) Write a Lex program to printout all HTML tags in file.

   c) Write a Lex program which adds line numbers to the given file and display the same onto the standard output.
8. Write a Lex program to count the number of comment lines in a given C program. Also eliminate them and copy that program into separate file.
9. Write a C program for implementing the functionalities of predictive parser for the mini language.

10. Write a C program for constructing of LL (1) parsing.
11. Write a C program for constructing recursive descent parsing
12. Write a C program to implement LALR parsing.
13. Write a C program to implement operator precedence parsing.
14. To Study about Yet Another Compiler-Compiler(YACC).
15. Create Yacc and Lex specification files to recognizes arithmetic expressions involving +, -, * and / .
16. Create Yacc and Lex specification files are used to generate a calculator which accepts,integer and float type arguments.

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INTERNSHIP-II / MINI PROJECT-II (CSP-013)

L:T:P:: 0:0:2 **Credits-01**

ABOUT INTERNSHIP/MINI PROJECT

It is an organized method or activity of enhancing and improving engineering students' skill sets and knowledge, which boosts their performance and consequently helps them meet their career objectives. Industrial Training is essential in developing the practical and professional skills required for an Engineer and an aid to prospective employment.

OBJECTIVES OF INTERNSHIP/MINI PROJECT:

1. The main objective of the internship/mini projectis to expose the students to the actual working environment and enhance their knowledge and skill from what they have learned in college.
2. Another purpose of this program is to enhance the good qualities of integrity, responsibility, and self-confidence. Students must follow all ethical values and good working practices.
3. It is also to help the students with the safety practices and regulations inside the industry and to instils the spirit of teamwork and good relationship between students and employees.

COURSE OUTCOMES: At the end of internship/mini project, the students will be able to

1. Understand organizational issues and their impact on the organization and employees.
2. Identify industrial problems and suggest possible solutions.
3. Relate, apply and adapt relevant knowledge, concepts and theories within an industrial organization, practice and ethics.
4. Apply technical knowledge in an industry to solve real world problems.
5. Demonstrate effective group communication, presentation, self-management, and report writing skills**.**

CONSTITUTION OF INDIA (AHT-009)

L:T:P:: 2:0:0 **Credits-0**

COURSE OBJECTIVES: The objectives of this course are to

1. To acquaint the students with legacies of constitutional development in India and help to understand the most diversified legal document of India and philosophy behind it.
2. To make students aware of the theoretical and functional aspects of the Indian Parliamentary System.
3. To channelize students' thinking towards basic understanding of the legal concepts and its implications for engineers.

COURSE OUTCOMES

On successful completion of the course, the students will be able to

1. Understand the basic knowledge and salient features of Indian Constitution.
2. Identify and explore the basic features and modalities about Indian constitution.
3. Discusses the essence of Union and its territories, Citizenship, Fundamental Rights, DPSP and Fundamental Duties.
4. Differentiate and relate the functioning of Indian parliamentary system at the center and state level.
5. Differentiate different aspects of Indian Legal System and its related bodies.

Unit-1 Constitutional Framework

Meaning of Terms and Phrases frequently used in political system like constitution, constitutionalism, Rule of Law, Federal system, Government and so on. Historical Background of Indian Constitution, Making of Indian Constitution, Salient features of Indian Constitution, Preamble of Indian Constitution.

Unit-2 Different Parts, Articles, and their significance

Part I to IVA (Union and its territories w.r.t. Indian States, Citizenship, Fundamental Rights conferred to citizens and foreigners, Directive Principles of State Policy– Its importance and implementation and Fundamental Duties and its legal status), Article 1 to 51A and their significance.

Unit-3 System of Government

Parliamentary Form of Government in India – The constitution powers and status of the President of India, Federal structure and distribution of legislative and financial powers between the Union and the States, Emergency Provisions: National Emergency, President Rule, Financial Emergency and Amendment of the Constitutional Powers and Procedure and the significance of basic structure in Indian Judicial system

Unit-4 Working of Central, State & Local Self Government as per constitution

Framework for central government (President, Vice president, Prime Minister, Central

council of ministers, Parliament, Supreme court and so on), Framework for state government (Governor, Chief Minister, state legislature, High court and so on) and Framework for local self government (Panchayatiraj, Municipalities) and Union Territories.

Unit-5 Constitutional, Non-Constitutional and other bodies

Discussion on Various constitutional bodies like Election Commission, UPSC, SPSC, Finance commission, NCSC, NCST, NCBC, CAG and AGI. Discussion on Various non-constitutional bodies like NITI Aayog, NHRC, CIC, CVC, CBI, Lokpal and Lokayukta. Discussion on Various other constitutional bodies like Co- operative societies, Official Language, Tribunals etc.

Text/Reference books-

1. M. Laxmikanth, "Indian Polity", McGraw- Hill, 6th edition, 2020
2. D.D. Basu, "Introduction to the Indian Constitution", LexisNexis, 21st edition, 2020
3. S.C. Kashyap, " Constitution of India", Vitasta publishing Pvt. Ltd., 2019

ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE (AHT-010)

L:T:P:: 2:0:0 **Credits-0**

COURSE OBJECTIVES: The objectives of this course are to

1. To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system.
2. To make the students understand the traditional knowledge and analyses it and apply it to their day to day life.
3. To make the students know the need and importance of protecting traditional knowledge.
4. To make the students understand the concepts of Intellectual property to protect the traditional knowledge.
5. This course is also concentrating on various acts in protecting the environment and Knowledge management impact on various sectors in the economy development of the country.

COURSE OUTCOMES:

On successful completion of the course, the students will be able to

1. Understand the concept of Traditional knowledge and its importance.
2. Know the need and importance of protecting traditional knowledge.
3. Know the various enactments related to the protection of traditional knowledge.
4. Understand the concepts of Intellectual property to protect the traditional knowledge.
5. Know the contribution of scientists of different areas.

Unit – 1 Introduction to Traditional and Culture Knowledge

Define culture, traditional, civilization and heritage knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK). Indigenous traditional knowledge Vs western traditional knowledge vis-à-vis formal knowledge.

Unit-2 Protection of Traditional Knowledge

Protection of traditional knowledge: The need for protecting traditional knowledge Significance of traditional knowledge Protection, value of traditional knowledge in global economy, Role of Government to harness traditional knowledge.

Unit – 3 Traditional Knowledge and Intellectual Property

Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, Global legal forums for increasing protection of Indian Traditional Knowledge.

Unit – 4 Traditional Knowledge in Different Sectors

Traditional knowledge in engineering, biotechnology and agriculture, traditional medicine system, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of traditional knowledge.

Unit – 5 Education System in India

Education in ancient, medieval and modern India, aims of education, subjects, languages, Science and Scientists of Ancient India, Scientists of Medieval India, Scientists of Modern India. The role Gurukulas in Education System, Value based Education.

Text/Reference Books:

1. Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002.
2. "Knowledge Traditions and Practices of India" Kapil Kapoor1, Michel Danino2.
3. Traditional Knowledge System in India, by Amit Jha, 2009.
4. Satya Prakash, “Founders of Sciences in Ancient India”, Vijay Kumar Publisher, 1989
5. Traditional Knowledge System and Technology in India by Basanta Kumar Mohanta and Vipin Kumar Singh Pratibha Prakashan 2012.

COMPUTER NETWORKS (CST-021/CSO-051)

L:T:P:: 3:1:0 **Credits-04**

COURSE OBJECTIVES: The objectives of this course are to

1. Understand the protocol layering and physical level communication.
2. Analyze the performance of a network .and understand the various components required to build different networks.
3. Learn the functions of network layer and the various routing protocols.
4. Familiarize the functions and protocols of the Transport layer.

COURSE OUTCOMES: On completion of the course, the students will be able to

1. Explain the functions of the different layer of the OSI Protocol.
2. Draw the functional block diagram of local area networks (LANs, wide-area networks (WANs) and Wireless LANs (WLANs).
3. Address the issues related to network layer and various routing protocols.
4. Configure DNS, TELNET, EMAIL, File Transfer Protocol (FTP), WWW, HTTP, SNMP.
5. Configure Bluetooth, Firewalls using open source available software and tools.

Unit 1- Data communication Components: Representation of data and its flow Networks, Various Connection Topology, Protocols and Standards, OSI model, Transmission Media, LAN: Wired LAN, Wireless LANs, Connecting LAN and Virtual LAN, Techniques for Bandwidth utilization: Multiplexing - Frequency division, Time division and Wave division, Concepts on spread spectrum.

Unit 2- Data Link Layer and Medium Access Sub Layer: Error Detection and Error Correction - Fundamentals, Block coding, Hamming Distance, CRC; Flow Control and Error control protocols - Stop and Wait, Go back – N ARQ, Selective Repeat ARQ, Sliding Window, Piggybacking, Random Access, Multiple access protocols- Pure ALOHA, Slotted ALOHA, CSMA/CD, CDMA/CA, high level data link control(HDLC), Point To Point protocol (PPP).

Unit 3- Network Layer: Repeater, Hub, Switches, Bridges, Gateways, Switching, Logical addressing – IPV4, IPV6, Address mapping – ARP, RARP, BOOTP and DHCP–Delivery, Forwarding and Unicast Routing protocols.

Unit 4- Transport Layer: Process to Process Communication, User Datagram Protocol (UDP), Transmission Control Protocol (TCP), SCTP Congestion Control; Quality of Service, QoS improving techniques: Leaky Bucket and Token Bucket algorithm.

Unit 5- Application Layer: Domain Name Space (DNS), DDNS, TELNET, EMAIL, File Transfer Protocol

(FTP), WWW, HTTP, SNMP, Bluetooth, Firewalls, Basic concepts of Cryptography , Digital Signature.

TEXTBOOK:

1. Behrouz A. Forouzan, Data Communications and Networking, Fifth Edition TMH, 2013.

REFERENCE BOOKS:

1. Larry L. Peterson, Bruce S. Davie, Computer Networks: A Systems Approach, Fifth Edition, Morgan Kaufmann Publishers Inc., 2012.
2. William Stallings, Data and Computer Communications, Tenth Edition, Pearson Education, 2013.
3. Nader F. Mir, Computer and Communication Networks, Second Edition, Prentice Hall, 2014.
4. Ying-Dar Lin, Ren-Hung Hwang and Fred Baker, Computer Networks: An Open Source Approach, McGraw Hill Publisher, 2011.
5. James F. Kurose, Keith W. Ross, Computer Networking, A Top-Down Approach Featuring the Internet, Sixth Edition, Pearson Education, 2013

ARTIFICIAL INTELLIGENCE (CST-022)

L:T:P:: 3:1:0 **Credits-04**

COURSE OBJECTIVES: The objectives of this course are to

1. Understand the various characteristics of Intelligent agents.
2. Learn the different search strategies in AI.
3. Learn to represent knowledge in solving AI problems.
4. Understand the different ways of designing software agents and know about the various applications of AI.

COURSE OUTCOMES: On successful completion of the course, the students will be able to

1. Build intelligent agents for search and games
2. Solve AI problems through programming with Python.
3. Learn optimization and inference algorithms for model learning.
4. Design and develop programs for an agent to learn and act in a structured environment.
5. Possess the ability to apply AI techniques to solve problems of Game Playing, Expert Systems and machine learning.

Unit 1- Introduction: What is AI, Foundations of AI, History of AI, The State of the Art, AI Techniques, Problem Solving: Problem solving agents, uniformed search strategies, Informed search strategies, Constraint Satisfaction Problems.

Unit 2- Knowledge Representation: Approaches and issues in knowledge representation, Knowledge Based Agents, Propositional Logic, Predicate Logic- Unification and Resolution, Weak slot –Filler Structure, Strong slot- Filler structure.

Unit 3- Probabilistic Reasoning: Probability, conditional probability, Bayes Rule, Bayesian Networks-representation, construction and inference, Brief introduction of Neural Networks, Fuzzy Logic and Genetic Algorithms

Unit 4- Planning and Learning: Planning with state space search, conditional planning, continuous planning, Multi-Agent planning. Forms of learning, Inductive Learning, Statistical learning method and Reinforcement learning.

Unit 5- Advanced Topics: Expert Systems- Representation- Expert System shells- Knowledge Acquisition with examples**.**

Game Playing-Minimax Search Procedure, Alpha-Beta Pruning, Imperfect, Real-Time Decisions.

Swarm Intelligent Systems- Ant Colony System, Development, Application and Working of Ant Colony System.

TEXTBOOKS:

1. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach, Prearson Education, 4thEdition, 2022.
2. Michael Negnevitsky, Artificial Intelligence, 3rd edition, Pearson Education.
3. I. Bratko, ―Prolog: Programming for Artificial Intelligence, Fourth edition, Addison-Wesley Educational Publishers Inc., 2011.

REFERENCE BOOKS:

1. George F Luger, Artificial Intelligence, 6th edition, Pearson Education.
2. M. Tim Jones, ―Artificial Intelligence: A Systems Approach(Computer Science), Jones and Bartlett Publishers, Inc.; First Edition, 2008.
3. Nils J. Nilsson, ―The Quest for Artificial Intelligence, Cambridge University Press, 2009.
4. William F. Clocksin and Christopher S. Mellish, Programming in Prolog: Using the ISO Standard, Fifth Edition, Springer, 2003.
5. Gerhard Weiss, ―Multi Agent Systems, Second Edition, MIT Press, 2013.
6. David L. Poole and Alan K. Mackworth, ―Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press, 2010.

OPERATING SYSTEMS (CST-023)

L: T:P :: 3:1:0 **Credits-04**

COURSE OBJECTIVES: The objectives of this course are to

1. Learn and understand the Concepts of the operating systems.
2. Learn and understand operating system services.
3. The core structure, functions and design principles of operating system.
4. Interposes communications and basic concepts of virtualization.

COURSE OUTCOMES: On completion of this course, the students will be able to

1. Create processes and threads.
2. Develop process scheduling algorithms for a given CPU utilization specification, Throughput, Turnaround Time, Waiting Time, and Response Time.
3. Develop the techniques for optimally allocating memory to processes by increasing memory utilization and improving access time.
4. Design and implement a file management system.
5. Develop the I/O management functions in OS.

Unit 1- Introduction: Concept of Operating Systems, Generations of Operating systems, Types of Operating Systems, OS Services, System Calls, Structure of an OS -Layered, Microkernel Operating Systems, Concept of Virtual Machine.

Processes: Definition, Process Relationship, Different states of a Process, Process State transitions, Process Control Block (PCB), Context switching

Thread: Definition, Various states, Benefits of threads, Types of threads, Concept of multi threads

Unit 2- Process Scheduling: Foundation and Scheduling objectives, Types of Schedulers, Scheduling criteria: CPU utilization, Throughput, Turnaround Time, Waiting Time, Response Time; Scheduling algorithms: Pre-emptive and Non-preemptive, FCFS, SJF, RR; Multiprocessor scheduling: Real-Time scheduling: RM and EDF.

Inter-process Communication: Critical Section, Race Conditions, Mutual Exclusion, Hardware Solution, Strict Alternation, Peterson's Solution, The Producer-Consumer Problem, Semaphores, Monitors, Message Passing, Classical IPC Problems: Reader's & Writer Problem, Dinning Philosopher Problem etc.

Unit 3- Deadlocks: Definition, Necessary and sufficient conditions for Deadlock, Deadlock Prevention, Deadlock Avoidance: Banker's algorithm, Deadlock detection and Recovery.

Memory Management: Basic concept, Logical and Physical address map, Memory allocation: Contiguous Memory allocation–Fixed and variable partition– Internal and External fragmentation and Compaction; Paging: Principle of operation – Page allocation –Hardware support for paging,Protection and sharing, Disadvantages of paging.

Unit 4- Virtual Memory: Basics of Virtual Memory – Hardware and control structures – Locality of reference, Page fault, Working Set, Dirty page/Dirty bit – Demand paging, Page Replacement algorithms: Optimal, First in First Out (FIFO), Second Chance (SC), Not recently used (NRU) and Least Recently used(LRU).

Unit 5- File Management: Concept of File, Access methods, File types, File operation, Directory structure, File System structure, Allocation methods (Contiguous, linked, indexed).

Disk Management: Disk structure, Disk scheduling - FCFS, SSTF, SCAN, C-SCAN, Disk reliability.

TEXTBOOKS:

1. AviSilberschatz, Peter Galvin, Greg Gagne , Operating System Concepts Essentials, 9th Edition by, Wiley Asia Student Edition.
2. William Stallings , Operating Systems: Internals and Design Principles, 9th Edition (2022), Prentice Hall of India.

Reference Books:

1. RamazElmasri, A. Gil Carrick, David Levine, ―Operating Systems – A Spiral Approach, Tata McGraw Hill Edition, 2010.
2. Achyut S.Godbole, Atul Kahate, ―Operating Systems, McGraw Hill Education, 2016.
3. Andrew S. Tanenbaum, ―Modern Operating Systems, Second Edition, Pearson Education, 2004.

INTERNET OF THINGS (IOT) (CST-024)

L:T:P:: 3:0:0 **Credits-03**

COURSE OBJECTIVES: The objectives of this course are to

1. Understand Smart Objects, IoT Architectures and learn about various IOT-related protocols.
2. Build simple IoT Systems using Arduino and Raspberry Pi.
3. Understand data analytics and cloud in the context of IoT.
4. Develop IoT infrastructure for popular applications

COURSE OUTCOMES: On completion of this course, the students will be able to

1. Understand the application areas of IOT
2. Explore interconnection and integration of the physical world
3. Design & develop IOT Devices
4. Realize the revolution of Internet in Mobile Devices, Cloud &Sensor Networks
5. Understand the building blocks of Internet of Things and their characteristics.

Unit 1-INTRODUCTION TO IOT: Internet of Things - Physical Design- Logical Design- IOT Enabling Technologies - IOT Levels & Deployment Templates - Domain Specific IOTs - IOT and M2M - IoT System Management with NETCONF-YANG- IoT Platforms Design Methodology

Unit 2-IOT ARCHITECTURE: M2M high-level ETSI architecture - IETF architecture for IoT - OGC architecture - IoT reference model - Domain model - information model - functional model - communication model - IoT reference architecture

Unit 3-IOT PROTOCOLS: Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Unified Data Standards – Protocols – IEEE 802.15.4 – BACNet Protocol – Modbus– Zigbee Architecture – Network layer – 6LowPAN - CoAP - Security

Unit 4-BUILDING IOT WITH RASPBERRY PI & ARDUINO: Building IOT with RASPERRY PI- IoT Systems - Logical Design using Python – IoT Physical Devices & Endpoints - IoT Device -Building blocks - Raspberry Pi -Board - Linux on Raspberry Pi - Raspberry Pi Interfaces -Programming Raspberry Pi with Python - Other IoT Platforms - Arduino.

Unit 5-CASE STUDIES AND REAL-WORLD APPLICATIONS: Real world design constraints - Applications - Asset management, Industrial automation, smart grid, Commercial building automation, Smart cities - participatory sensing - Data Analytics for IoT – Software & Management Tools for IoT, Cloud Storage Models & Communication APIs - Cloud for IoT - Amazon Web Services for IoT

TEXTBOOK:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, ―IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017

REFERENCE BOOKS:

1. ArshdeepBahga, Vijay Madisetti, ―Internet of Things – A hands-on approach, Universities Press, 2015.
2. Olivier Hersent, David Boswarthick, Omar Elloumi , ―The Internet of Things – Key applications and Protocols, Wiley, 2012.
3. Jan Ho¨ ller, VlasiosTsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.
4. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), ―Architecting the Internet of Things, Springer, 2011.
5. Michael Margolis, Arduino Cookbook, Recipes to Begin, Expand, and Enhance Your Projects, 2nd Edition, O'Reilly Media, 2011.

QUANTUM COMPUTING (CST-025)

L:T:P:: 3:0:0 **Credits-03**

COURSE OBJECTIVES: The objectives of this course are to

1. Impart knowledge about the quantum-mechanical phenomena such as superposition and entanglement to perform computation.
2. Introduce the fundamental concepts, Quantum Computing.
3. Enable the students to understand the quantum computing and quantum information in depth.

COURSE OUTCOMES: On successful completion of the course, the students will be able to

1. Explain the working of Quantum Computing program.
2. Understand its architecture and programing model.
3. Develop quantum logic gate circuits.
4. Develop quantum algorithm.
5. Program quantum algorithm on major toolkits.

Unit 1- Introduction to Quantum Computing: Motivation for studying Quantum Computing, Major players in the industry (IBM, Microsoft, Rigetti, D-Wave etc.) Origin of Quantum Computing, Overview of major concepts in Quantum Computing, Qubits and multi-qubits states, Bloch Sphere representation, Quantum Superposition, Quantum Entanglement.

Unit 2-Math Foundation for Quantum Computing: Matrix Algebra: basis vectors and orthogonality, inner product and Hilbert spaces, matrices, and tensors, unitary operators and projectors, Dirac notation, Eigen values and Eigen vectors.

Unit 3-Building Blocks for Quantum Program: Architecture of a Quantum Computing platform, Details of q-bit system of information representation: Block Sphere, Multi-qubits States, Quantum superposition of qubits (valid and invalid superposition), Quantum Entanglement ,Universal quantum gates, Quantum Fourier Transform.

Unit 4-Quantum Algorithms: Basic techniques exploited by quantum algorithms. The quantum search algorithm, Quantum Walks, Major Algorithms, Shor's Algorithm, Grover's Algorithm Deutsch's Algorithm,Deutsch -Jozsa Algorithm

Unit 5-Toolkits: OSS Toolkits for implementing Quantum program, IBM quantum experience, Microsoft Q, RigettiPyQuil (QPU/QVM)

TEXTBOOKS:

1. Eric R. Johnston, Nic Harrigan, Mercedes and Gimeno-Segovia "Programming Quantum Computers: Essential Algorithms And Code Samples, SHROFF/ O'Reilly.
2. Dr. Christine Corbett Moran, Mastering Quantum Computing with IBM QX: Explore the world of quantum computing using the Quantum Composer and Qiskit, Kindle Edition Packt
3. V.K Sahni, Quantum Computing (with CD), TATA McGrawHill.

REFERENCE BOOKS:

1. Chris Bernhardt, Quantum Computing for Everyone (The MIT Press).
2. Michael A. Nielsen and Issac L. Chuang, "Quantum Computation and Information", Cambridge (2002).
3. Riley Tipton Perry, "Quantum Computing from the Ground Up", World Scientific Publishing Ltd (2012).
4. Scott Aaronson, "Quantum Computing since Democritus", Cambridge (2013).
5. P. Kok, B. Lovett, "Introduction to Optical Quantum Information Processing", Cambridge

AUGEMENTED REALITY (AR) (CST-026)

L:T:P:: 3:0:0 **Credits-03**

COURSE OBJECTIVES: The objectives of this course are to

1. Gain the knowledge of historical and modern overviews and perspectives on virtual reality.
2. Learn the fundamentals of sensation, perception, and perceptual training.
3. Have the scientific, technical, and engineering aspects of augmented and virtual reality systems.
4. Learn the technology of augmented reality and implement it to have practical knowledge.

COURSE OUTCOME: On successful completion of the course, the students will be able to

1. Understand geometric modelling and Virtual environment.
2. Study about Virtual Hardware and Software
3. Present geometric model for VR systems
4. Identify which type hardware and software is suitable to design their own VR systems
5. Develop Virtual Reality applications.

Unit 1-Introduction to Virtual Reality: Virtual Reality and Virtual Environment: Introduction, Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement, benefits of virtual reality, Historical development of VR, Scientific Landmark,3D Computer Graphics: Introduction, The Virtual world space, positioning the virtual observer, the perspective projection, human vision, stereo perspective projection, 3D clipping, Colour theory, Simple 3D modelling, Illumination models, Reflection models, Shading algorithms, Radiosity, Hidden Surface Removal, Realism-Stereographic image.

Unit 2-Geometric Modelling: Geometric Modelling: Introduction, From 2D to 3D, 3D space curves, 3D boundary representation Geometrical Transformations: Introduction, Frames of reference, Modelling transformations, Instances, Picking, Flying, Scaling the VE, Collision detection Generic VR system: Introduction, Virtual environment, Computer environment, VR technology, Model of interaction, VR Systems.

Unit 3-Virtual Environment: Animating the Virtual Environment: Introduction, The dynamics of numbers, Linear and Non-linear interpolation, the animation of objects, linear and non-linear translation. Physical Simulation: Introduction, Objects falling in a gravitational field, Rotating wheels, Elastic collisions, projectiles, simple pendulum, springs, Flight dynamics of an aircraft.

Unit 4-VR Hardware and Software: Human factors: Introduction, the eye, the ear, the somatic senses.
VR Hardware: Introduction, sensor hardware, Head-coupled displays, Acoustic hardware, Integrated VR systems. VR Software: Introduction, Modelling virtual world, Physical simulation, VR toolkits, Introduction to VRML

Unit 5-VR Applications: Introduction, Engineering, Entertainment, Science, Training. The Future: Virtual environment, modes of interaction.

TEXTBOOKS:

1. Coiffet, P., Burdea, G. C., (2003), "Virtual Reality Technology," Wiley-IEEE Press, ISBN: 9780471360896
2. Schmalstieg, D., Höllerer, T., (2016), "Augmented Reality: Principles & Practice," Pearson, ISBN: 9789332578494
3. Norman, K., Kirakowski, J., (2018), " Wiley Handbook of Human Computer Interaction," Wiley-Blackwell, ISBN: 9781118976135
4. LaViola Jr., J. J., Kruijff, E., McMahan, R. P., Bowman, D. A., Poupyrev, I., (2017), "3D User Interfaces: Theory and Practice," Pearson, ISBN: 9780134034324
5. Fowler, A., (2019), "Beginning iOS AR Game Development: Developing Augmented Reality Apps with Unity and C#," Apress, ISBN: 9781484246672
6. Hassanien, A. E., Gupta, D., Khanna, A., Slowik, A., (2022), "Virtual and Augmented Reality for Automobile Industry: Innovation Vision and Applications," Springer, ISBN: 9783030941017

REFERENCE BOOKS:

1. Craig, A. B., (2013), "Understanding Augmented Reality, Concepts and Applications," Morgan Kaufmann, ISBN: 9780240824086
2. Craig, A. B., Sherman, W. R., Will, J. D., (2009), "Developing Virtual Reality Applications, Foundations of Effective Design," Morgan Kaufmann, ISBN: 9780123749437
3. John Vince, J., (2002), "Virtual Reality Systems, " Pearson, ISBN: 9788131708446
4. Anand, R., "Augmented and Virtual Reality," Khanna Publishing House
5. Kim, G. J., (2005), "Designing Virtual Systems: The Structured Approach", ISBN: 9781852339586
6. Bimber, O., Raskar, R., (2005), "Spatial Augmented Reality: Merging Real and Virtual Worlds," CRC Press, ISBN: 9781568812304
7. O'Connell, K., (2019), "Designing for Mixed Reality: Blending Data, AR, and the Physical World," O'Reilly, ISBN: 9789352138371
8. SanniSiltanen, S., (2012), "Theory and applications of marker-based augmented reality," Julkaisija – Utgivare Publisher, ISBN: 9789513874490

WEB TECHNOLOGY (CST-027)

L:T:P:: 3:0:0

Credits-03

COURSE OBJECTIVES: The objectives of this course are to

1. Understand about client-server communication and protocols used during communication.
2. Design interactive web pages using Scripting languages.
3. Learn server-side programming using servlets and JSP.
4. Develop web pages using XML/XSLT.

COURSE OUTCOMES: On successful completion of this course, the student will be able to:

1. Design simple web pages using mark-up languages like HTML and XHTML.
2. Create dynamic web pages using DHTML and java script that is easy to navigate and use.
3. Program server-side web pages that have to process request from client side web pages.
4. Represent web data using XML and develop web pages using JSP.
5. Understand various web services and how these web services interact.

UNIT-I Introduction to HTML: HTML Common tags- List, Tables, images, forms, Frames; Cascading Style sheets;
Introduction to JavaScript: Scripts, Objects in Java Script, Dynamic HTML with Java Script
XML: Document type definition, XML Schemas, Document Object model, Presenting XML, Using XML Processors: DOM and SAX

UNIT-II Java Beans: Introduction to Java Beans, Advantages of Java Beans, BDK Introspection, Using Bound properties, Bean Info Interface, Constrained properties Persistence, Customizes, Java Beans API, Introduction to EJB's

UNIT-III Web Servers and Servlets: Tomcat web server, Introduction to Servelets: Lifecycle of a Serverlet, JSDK, The Servelet API, Thejavax.servelet Package, Reading Servelet parameters, Reading Initialization parameters. The javax.servelet HTTP package, Handling Http Request & Responses, Using Cookies-Session Tracking, Security Issues.

UNIT-IV Introduction to JSP: The Problem with Servelet. The Anatomy of a JSP Page, JSP Processing. JSP Application Design with MVC Setting Up and JSP Environment: Installing the Java Software Development Kit, Tomcat Server & Testing Tomcat

UNIT-V JSP Application Development: Generating Dynamic Content, Using Scripting Elements Implicit JSP Objects, Conditional Processing – Displaying Values Using an Expression to Set an Attribute, Declaring

Variables and Methods Error Handling and Debugging Sharing Data Between JSP pages, Requests, and Users Passing Control and Date between Pages – Sharing Session and Application Data – Memory Usage Considerations.

TEXT BOOK:

1. Jeffrey C. Jackson, "Web Technologies--A Computer Science Perspective", Pearson Education, 2006.

REFERENCE BOOK:

1. Robert. W. Sebesta, "Programming the World Wide Web", 8thEdition(2022), Pearson Education, 2007.
2. Deitel, Deitel, Goldberg, "Internet & World Wide Web How To Program", Third Edition, Pearson Education, 2006.
3. Marty Hall and Larry Brown, Core Web Programming Second Edition, ‖ ‖ Volume I and II, Pearson Education, 2001.
4. Bates, ―Developing Web Applications‖, Wiley, 2006

RELIABLE COMPUTING (CST-028)

L:T:P:: 3:0:0 **Credits-03**

COURSE OBJECTIVES: The objectives of this course are to

1. Understand the fault tolerant design principles
2. Identify the requirement of fault tolerant systems
3. Understand fault tolerant distributed systems and its requirement
4. Design algorithms for fault tolerant systems

COURSE OUTCOMES: O successful completion of this course, the students will be able to

1. Understand the risk of computer failures and their comparison with other equipment failures.
2. Analyze hardware and software fault-tolerant or non-fault-tolerant on the basis of dependability requirements.
3. Know the different advantages and limits of fault avoidance and fault tolerance techniques.
4. Understand the principles behind reliability
5. Gain knowledge in sources of faults and their prevention and forecasting.
6. Learn the programming tools in designing reliable systems

Unit 1-Reliability& fault: Definition, System reliability, Parameter values, Reliability models for hardware redundancy, Testing: Various testing methods, Definition, Fault types, Detection, Redundancy, Data diversity, Reversal checks, Byzantine failures, Integrated failure handling.

Unit 2- Hardware Fault Tolerance:-Definition, Fault types, Detection, Redundancy, Data diversity, Reversal checks, Byzantine failures, Integrated failure handling, canonical and Resilient Structures- Series and Parallel Systems, Non-Series/Parallel Systems, *M*-of-*N* Systems, Voters, Variations on *N*-Modular Redundancy, Duplex Systems, Other Reliability Evaluation Techniques-Poisson Processes, Markov Models, Fault-Tolerance Processor-Level Techniques, Watchdog Processor, Simultaneous Multithreading for Fault Tolerance, Byzantine Failures, Byzantine Agreement with Message Authentication.

Unit 3-Testability for Hardware: testability for combinational circuits: Basic concepts of Testability, Controllability and observability, The Reed Muller's expansion technique, use of control and syndrome testable designs. Design for testability by means of scan: Making circuits Testable, Testability Insertion, Full scan DFT technique- Full scan insertion, flip-flop Structures, Full scan design and Test, Scan Architecturesfull scan design, Shadow register DFT, Partial scan methods, multiple scan design, other scan designs.

Unit 4- Software Fault Tolerance: Acceptance Tests Single-Version Fault Tolerance- Wrappers, Software Rejuvenation, Data Diversity, Software Implemented Hardware Fault Tolerance (SIHFT), *N*-Version Programming- Consistent Comparison Problem, Version Independence, Recovery Block Approach- Basic Principles, Success Probability Calculation, Distributed Recovery Blocks, Preconditions, Postconditions, and

Assertions, Exception-Handling- Requirements from Exception-Handlers, Basics of Exceptions and Exception-Handling

Unit 5-Programming Languages and Tools: Desired Language Characteristics, Data typing, control structures, Hierarchical decomposition, Packages, Exception handling, Over loading and Generics, Multi-tasking, Task scheduling, Timing specification., Flex, Euclid, Environments, Run time support.

Text Book:

1. Fault Tolerant Systems, I. Koren, Morgan Kauffman , 2007
2. Fault Tolerant Computer System Design,D. K. Pradhan, Prentice Hall, 1996.

Reference Book:

1. Probability and Statistics with Reliability, Queuing and Computer Science Applications, Kishor S. Trivedi, John Wiley & Sons Inc., 2016.

TOTAL QUALITY MANAGEMENT (AHT-011)

L:T:P:: 3:0:0 **Credits-03**

Course Objectives:

The course should enable the students:

1. To understand the concept of Quality in Manufacturing and Service units.
2. To understand the Implication of Quality in Business.
3. To understand the Organization Structure in TQM.
4. To understand how to implement Quality Programs in an Organization.
5. To have exposure to challenges in Quality Improvement Programs.

Course Outcomes:

Upon successful completion of the course, the student will be able to:

1. Identify the significance of quality in an organization.
2.Describe how to manage quality improvement teams.
3. Describe how to organize management and quality policies in TQM.
4. Apply the tools of quality improvement programs in an organization.
5. Assess the benefits of implementing TQM Program in an organization.

Unit	Course Content	Lectures
I	**Introduction:** Evolution of Quality, Historical Perspectives, Relationship among Quality, Vision, Mission and Objectives of an Organization, Role of Quality in a Corporate Structure of an Organization, Attributes of Product and Service Quality, Quality Characteristics: Quality of Design, Quality of Performance and Quality of Conformance, Zero Defect and Continuous Improvement.	07
II	**Conceptualization of TQM:** Introduction to Total Quality Management (TQM), Barriers to TQM, Benefits of TQM implementation, Basic Approaches of TQM, TQM Models, Quality Information System and Planning. Importance of TQM in manufacturing and Service Industry.	07
III	**Organization Structure in TQM:** Role of Top Management, Quality Council, Quality Circles, Organization Structure for Quality Circles, Quality Policies, Role of Middle and Lower Management, Problem Solving Techniques.	07
IV	**Tools and Systems for Quality Management:** Basic Tools: Cause & Effect Diagram, Flow Diagrams, Trend Charts, Histogram, Scatter Diagram, Control Chart, Advanced Tools: Affinity Diagram, Inter Relationship Diagram, Tree Diagram, Matrix Diagram, Process Decision Program Chart (PDPC) and Matrix Data Analysis, Fault Tree Analysis, Quality Function Deployment (QFD) Definition and Phases in QFD. Taguchi Approach To Quality System Design, Six - sigma Definition & Implementation Steps, Just In Time Production System, Quality Production through JIT and Kanban, Failure Mode and Effect Analysis (FMEA): Scope, Mode, Illustrative Example and Applications.	10
V	**Quality Assurance:** Causes of Quality Failure, Quality Assurance: Need and Various Elements in Quality Assurance Programme, Quality Control- on Line and off Line, Statistical Concepts in Quality, Chance and Assignable Causes, Bench Making in Quality Management. Implementation and Need of ISO 9000: ISO 9000 - 2000 Quality System: Elements, Registration, Documentation, Implemental Steps, Quality Audit, Product and Process Audit Scope, Steps and Benefits.	09

Books and References

1. Total Quality Management by Dale H Bersterfilled, PHI Publication.
2. Total Quality Management by N.V.R Naidu, G. Rajendra, New Age international Publication.
3. Total Quality Management by L. Sugandhi and Samuel Anand, PHI Publication.
4. Total Quality Management by R.S Naagarazan, New Age International Publication.

MANAGING E-COMMERCE AND DIGITAL COMMUNICATION (AHT-012)

L:T:P:: 3:0:0 **Credits-03**

COURSE OBJECTIVES:

The course should enable the students:

1. To understand of concepts and techniques of internet marketing.
2. To study behavior and experience of online customer.
3. To study the various techniques of digital promotion.
4. To find out the opportunities for marketers on digital platform.
5. To understand the role of several e commerce models in customer value creation.

COURSE OUTCOMES

Upon successful completion of the course, the student will be able to:

1. Understand strategies used in digital marketing.
2. Apply interactive marketing communications to gratify online buyer.
3. Apply digital promotion techniques for marketing of product and services.
4. Evaluate the role of web analytics in social media marketing.
5. Apply and design various e commerce models for e-business.

Unit	Course Content	Lectures
I	**Introduction to digital marketing:** Digital marketing meaning scope and importance, Internet versus traditional marketing. Use of business to consumer and business to internet marketing, internet marketing strategy, Incorporating self-service technologies (SSTs).	08
II	**Online buyer behaviour and models:** marketing mix in online context. Managing online customer experience, planning website design, understanding site user requirement, site design and structure, integrated marketing communications (IIMC), measurement of interactive marketing communication, e-WOM.	08
III	**Digital promotion techniques:** email marketing, strategy to craft email marketing campaign, permission marketing, viral marketing, blogs, search engines marketing (SEM), Search engine optimization, content marketing.	08
IV	**Social media marketing:** designing content for social media marketing, mobile marketing advertising on mobile devices, mobile apps, tracking mobile marketing performance, and introduction to web analytics-meaning types, key metrics and tools.	08
V	**Introduction to e-Commerce and Retailing in Online Space:** advantages of e-Commerce Platforms, Differentiate Show-rooming and Web-rooming, e-tailing, e-Commerce Business Process, Business Models, Interpret e-Commerce Shopping Cart Software & Other Factors of e-Commerce based business, role of aggregators in e-Commerce business.	08

Books and References

1. Kotler, P. and Keller, K.L. (2017) Marketing Management. 15 ° ed . India: Pearson Education .
2. Chaffey, D. and Ellis - Chadwick, F. (2012) . Digital Marketing Strategy. Implementation and Practice. 1st ed. Education
3. Digital Marketing: Cases from India by Rajendra Nargundkar and Romi Sainy, Notion Press, Inc.

4. Understanding Digital Marketing: Marketing Strategies for Engaging the Digital Generation by Damian Rya Publisher.
5. Marketing 4.0: Moving from Traditional to Digital by Philip Kotler, Publisher Wiley.

INDUSTRIAL SAFETY AND HAZARD MANAGEMENT (AHT-013)

L:T:P: 3:0:0 **Credits-03**

COURSE OBJECTIVES:

The course should enable the students:

1. To impart knowledge about various aspects of industrial safety and occupational health.
2. To impart knowledge about Occupational Health and Toxicology.
3. To enable the students to identity hazard and assess risk.
4. To understand Acts and Rules of industrial safety and hazard management.
5. To teach about various safety acts and rules along with safety education and training.

COURSE OUTCOMES

Upon successful completion of the course, the student will be able to:

1. Identify the key aspects of industrial safety and mitigating them.
2. Describe various types of solution to problems arising in safety operations and hygiene.
3.Apply principles of OSHA in controlling industrial disasters and losses.
4. Identify various Acts and Rules of industrial safety and hazard management.
5. Assess the overall performance of safety protocols of chemical industries and hazard management.

Unit	Course Content	Lectures
I	**Concepts and Techniques:** History of safety movement -Evolution of modern safety concept - Incident Recall Technique (IRT), disaster control, safety analysis, safety survey,safety inspection, safety sampling. Safety Audits - components of safety audit, types of audit,audit methodology, non - conformity reporting (NCR), audit checklist- identification of unsafe acts of workers and unsafe conditions in the industry.	08
II	**Occupational Health and Toxicology:** Concept and spectrum of health, functional units and activities of occupational health services, occupational related diseases and levels of prevention of diseases. Toxicology- local, systemic and chronic effects, temporary and cumulative effects, carcinogens entry into human systems.	08
III	**Hazard Identification and Risk Assessment:** The process of risk management, hazard identification, evaluation (risk assessment, risk matrix), risk control implementation, action and recommendation.	08
IV	**Acts and Rules**: Indian boiler Act 1923, static and mobile pressure vessel rules (SMPV). motor vehicle rules, mines act 1952, workman compensation act, rules - electricity act and rules - hazardous wastes (management and handing) rules, 1989, with amendments in 2000 the building and other construction workers act 1996, Petroleum rules, Explosives Act 1963 Pesticides Act. Factories Act 1948 Air Act 1981 and Water Act 1974.	08
V	**Safety Education and Training:** importance of training - identification of training needs training methods - programmes, seminars, conferences, competitions - method of promoting sale practice motivation communication - role of government agencies and private consulting agencies in safety training creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign - domestic Safety and Training.	08

Books and References

1. Industrial Accident Prevention by H.W Heinrich, McGraw - Hi 1980.

2. Safety Management in industry by NV. Krishnan, Jaico Publishing House, Bombay, 1997.
3. Loss Prevention in Process Industries by FP Lees, Butterworth London, 1990.
4. Safety at Work by J.R. Ridey Butterwort London 1983.

COMPUTER NETWORKS LAB (CSP-014)

L:T:P:: 0:0:2

Credits-01

COURSE OBJECTIVES: The objectives of this course are to

1. Equip the students with a general overview of the concepts and fundamentals of computer networks.
2. Familiarize the students with the standard models for the layered approach to communication between machines in a network and the protocols of the various layers.

COURSE OUTCOMES: On Completion of this course, the students will be able to

1. Learn about hardware component like RJ-45 connector, CAT-6 Cable etc.
2. Implement the various services of data link layer.
3. Configuration of router, hub, switch etc
4. Configuration of server in programming mode they will learn about socket programming, client server programming for deeply understanding TCP/ IP model and various protocols.
5. Configure their own Network management systems in simulation area, they will work on Cisco networking, NS-2 or NS-3 tools for more clear understanding about computer network.

LIST OF PRACTICALS

1. Installation and configuration of NS2 and Qual Net
2. Creating a network: nodes, links and queues, Creating connections, traffic and computing routers Insertion of errors and analysis of trace file.
3. Study of basic network command and network configuration commands.
4. Simple project on NS2 – wired, wireless and combination of wired and wireless
5. Implementation of new protocols in NS2
6. Simulation study of pure ALOHA protocol;
7. Simulation study of slotted ALOHA protocol;
8. Simulation study of Token Bus LAN protocol;
9. Simulation study of Token Ring LAN protocol;
10. Simulation study of WAN protocol like Frame Relay, X. 25
11. Study of 802. 11 wireless LAN protocols.
12. Implement the Distance Vector Routing protocol for finding the shortest path.
13. Write a program to connect server with client and passes information from one system to another and vice versa that by creating / establishing connection.

ARTIFICIAL INTELLIGENCE LAB (CSP-015)

L:T:P:: 0:0:2 **Credits-01**

COURSE OBJECTIVES: The objectives of this course are to

1. Understand the various characteristics of Intelligent agents and implement the different search strategies in AI.
2. Learn to represent knowledge in solving AI problems
3. Design the different ways of designing software agents.
4. Identify the various applications of AI.

COURSE OUTCOMES: On successful completion of the course, the students will be able to

1. Implement the Artificial Intelligence techniques for building well engineered and efficient intelligent systems.
2. Describe the nature of AI problem and provide the solution as a particular type.
3. Learn optimization and inference algorithms for model learning.
4. Solve game challenging problems
5. Design and develop programs for an agent to learn and act in a structured environment.

LIST OF PRACTICALS

1. Write a python program to implement simple Chatbot ?
2. Implementation of following algorithms:
   a. A* and Uniform cost search algorithms.
   b. Implement AO* Search algorithm.
   c. Write a python program to implement Breadth First Search Traversal.
   d. Implementation of TSP using heuristic approach.
3. Implementation of Hill-climbing to solve 8- Puzzle Problem.
4. Write a python program to implement Water Jug Problem?
5. Write a program to implement Hangman game using python.
6. Write a program to implement Tic-Tac-Toe game using python.
7. Write a Program for Expert System by Using Forward Chaining.
8. Write a python program to remove stop words for a given passage from a text file using NLTK?
9. Write a python program to implement stemming for a given sentence using NLTK?
10. Write a python program to implement Lemmatization using NLTK.
11. Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
12. Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.

OPERATING SYSTEMS LAB (CSP-016)

L:T:P:: 0:0:2 **Credits-01**

COURSE OBJECTIVES: The objectives of this course are to

1. Learn Unix commands and shell programming.
2. Implement various CPU Scheduling Algorithms and Process Creation and Inter Process Communication.
3. Implement Deadlock Avoidance and Deadlock Detection Algorithms.
4. Implement Page Replacement Algorithms, File Organization and File Allocation Strategies.

COURSE OUTCOMES: On successful completion of the course, the students will be able to

1. Understand the system calls and I/O system calls in UNIX
2. Evaluate the process scheduling algorithms FCFS, SJF, Priority and Round robin
3. Simulate the process of communication through various techniques
4. Simulate memory management schemes
5. Simulate File Allocation Techniques

LIST OF EXPERIMENTS

1. Write programs using the following system calls of UNIX operating system: fork, exec, getpid, exit, wait, stat, opendir, readdir
2. Write programs using the I/O system calls of UNIX operating system (open, read, write, etc)
3. Write C programs to simulate UNIX commands like ls, grep, etc.
4. Given the list of processes, their CPU burst times and arrival times, display/print the Gantt chart for FCFS and SJF. For each of the scheduling policies, compute and print the average waiting time and average turnaround time (2 sessions)
5. Given the list of processes, their CPU burst times and arrival times, display/print the Gantt chart for Priority and Round robin. For each scheduling policy, compute and print the average waiting and turnaround times (2 Sessions).
6. Developing Applications using Inter Process communication (using shared memory and pipes)
7. Simulate the Producer-Consumer problem using semaphores (using UNIX system calls).
8. Simulate First fit, best fit and Worst fit memory management algorithms.
9. Simulate Page Replacement Algorithms (FIFO, LRU and Optimal)
10. Simulate the Paging memory management scheme

HAPPINESS AND WELL-BEING (AHT-014)

L:T:P: 2:0:0 **Credits-0**

COURSE OBJECTIVES: The objectives of this course are:

1. To obtain a basic understanding of Positive emotions, strengths and virtues; the concepts and determinants of happiness and well-being.
2. To bring an experience marked by predominance of positive emotions and informing them about emerging paradigm of Positive Psychology
3. Build relevant competencies for experiencing and sharing happiness as lived experience and its implication.
4. To become aware of contextual and cultural influences on health and happiness.

COURSE OUTCOMES: On successful completion of the course, the students will be able to

1. Provide an insight to see the importance of positive emotions, Strength and Virtues in everyday life and society.
2. Use the strength and virtues in improving human behavior and mental health.
3. Understand the biological, social, psychological and spiritual determinants of Happiness and well-being.
4. Light on research findings related to effects of happiness and well-being on mental illness and stress.
5. Give an insight of the Indian philosophy of happiness and life satisfaction in context of Karma, Moksha and destiny and role of socio-demographic and cultural factors in Happiness and well-being.
6. Establish work life balance in an individual's life.

UNIT I: Introduction to Positive Psychology

Importance of positive emotions in everyday life and society, Positive Emotions and well being: Hope & Optimism, Love. The Positive Psychology of Emotional Intelligence, Influence of Positive Emotions Strength and Virtues; implications for human behavior and mental health.

UNIT II: Happiness

Determinants of Happiness and well-being – biological, social, psychological and spiritual, Types of happiness- Eudaimonic and Hedonic, Traits associated with Happiness, Setting Goals for Life and Happiness, Research findings on effects of happiness and well-being on mental illness and stress.

UNIT III: Resilience and Well Being

Meaning, Nature and Approaches Theories of Resilience, Positive Response to loss, Post Traumatic Growth, Models of PTG as Outcome, Models of PTG as a Coping Strategy Benefit Finding, Mindfulness and Positive Thinking, Building Resilience and Wellbeing.

UNIT IV: Happiness and Well-being in the Indian context

Indian philosophy of happiness and life satisfaction. – Karma, Moksha and destiny. theory of happiness and wellbeing in Taittiriya Upanishad, Role of socio-demographic and cultural factors in Happiness and well-being. Health and Happiness in contemporary India – rural and urban differences and similarities.

UNIT V: Positive work life

Employee engagement- what causes individuals to join an organization and why they stay or leave, person-centered approach to engagement Understand the concept of work as meaning, Impact of employee well-being on the organization and impact of feelings about work on the individual's well-being. Bringing Positive Psychology to Organizational Psychology

SUGGESTED READINGS:

1. Dandekar, R. N. (1963). On dharma. In De Bary (ed.) Sources of Indian Tradition. Delhi, India: Motilal Banarasidass Publishers.
2. Dandekar R. N. (1981). Exercises in Indology. Delhi, India: Ajanta Publishers.
3. Snyder, C.R., &Lopez,S.J.(2007). Positive psychology: The scientific and practical explorations of human strengths. Thousand Oaks, CA: Sage. Snyder, C. R., & Lopez, S. (Eds.). (2002). Handbook of positive psychology. New York: Oxford University Press.
4. Seligman, M. (2011). Flourish: A Visionary New Understanding of Happiness and Well-being, Atria Books.
5. Peterson, C. A. (2006). A Primer in Positive Psychology, Oxford University Press.
6. Nettle, D.S. (2006). Happiness: The Science Behind Your Smile, Oxford University Press.
7. Lyubomirsky, S. (2013). The Myths of Happiness: What Should Make You Happy, but Doesn't, What Shouldn't Make You Happy, but Does, Penguin