தமிழ்நாடு மத்தியப் பல்கலைக்கழகம்

CENTRAL UNIVERSITY OF TAMIL NADU

तमिलनाडु केन्द्रीय विश्वविद्यालय

ESTABLISHED BY AN ACT OF PARLIAMENT IN 2009

DEPARTMENT OF COMPUTER SCIENCE

SCHOOL OF MATHEMATICS AND COMPUTER SCIENCES

M.Sc., COMPUTER SCIENCE PROGRAMME

CURRICULUM AND SYLLABUS

(2023-24 batch onwards)

1. Overview

Central University of Tamil Nadu (CUTN) is an institution of higher education established by an Act of Parliament in 2009. The University aims at the forming of an enlightened society founded on a relentless pursuit of excellence through innovation in teaching-learning process, interdisciplinary studies and research. With a host of diversified integrated postgraduate, postgraduate and doctoral programmes, the University has been keen to stay abreast of the ever expanding academic frontiers. Within a brief period CUTN has established itself as a frontrunner in the pursuit of excellence.

1.1 School of Mathematics and Computer Sciences

The School of Mathematics and Computer Sciences aims to be in the forefront of teaching, research, and extension activities. This School presently comprises the department of Mathematics, Computer Science and Statistics & Applied Mathematics.

1.2 Department of Computer Science

The department of computer science is one among the science departments that offer M.Sc. and Ph.D. in computer science. The department was started in the academic year 2016-17. The department is equipped with five faculty members with doctorates and they are actively involved in research besides teaching.

The curriculum is designed to meet the standards expected from the IT industry and also facilitates to aspire research. The department offers a choice based credit system. The students are evaluated through a continuous assessment system. The department is equipped with a smart class room and two computer labs with 50 systems that caters the needs of M.Sc. students

VISION

To develop the department as a global leader in knowledge dissemination and to perform cutting edge research in computer science in compliance with international standards

MISSION

M1	To produce students by inculcating them with state-of-the-art education to make them technically competent in solving real time problems
M2	To kindle students as efficient IT professionals, researchers and entrepreneurs
M3	To enrich the students as social, ethical and value-based graduates to make significant contribution to the society

PROGRAM SPECIFIC OBJECTIVES

After five years of successful completion of the program, the students will be able to

PSO1	Ability to apply good analytical, design and implementation skills to formulate and solve scientific and business applications by promoting themselves with equipped ideas
PSO2	Equip students with profound knowledge and understanding in the theoretical foundations of computer science
PSO3	To mould themselves into successful personnel in IT industry / higher education and grow like entrepreneurs

PSO to MISSION Mapping

	M1	M2	M3
PSO1	3	2	1
PSO2	2	3	1
PSO3	3	3	3

Graduate Attributes of M.Sc. Computer Science Programme

1. **Disciplinary Knowledge:** Content and pedagogical knowledge synchronised with the curriculum frameworks and policies
2. **Communication Skills:** Possess clarity in conveying the ideas
3. **Critical Thinking:** Capacity to apply analytical thought in the teaching and learning process
4. **Problem Solving:** Participate in the educational problem solving and applying the knowledge in the day-to-day professional endeavours.
5. **Cooperation:** Appreciate collaboration and cooperation among stakeholders of education.
6. **ICT Skills:** Selecting and integrating appropriate ICT skills for professional development.
7. **Ethics:** Doing what is right to society
8. **Self-Directed Learning:** Developing autonomy and self-regulation in teaching-learning and professional development.
9. **Reasoning:** Ability to interpret and draw the conclusion from qualitative/quantitative data with open-mindedness
10. **Creativity:** Ability to produce new ideas
11. **Societal and Environmental Concern:** Performing an act or solving a problem with respect to societal and environmental concern
12. **Lifelong Learning:** Understands the need for learning and practices it throughout life.

PROGRAM OBJECTIVES

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

PO1	**Core Knowledge:** Have ability to apply the knowledge of mathematics, probability and statistics and computer science in real-time applications
PO2	**Problem Analysis:** Possess clear understanding of the subject related concepts and contemporary issues and apply them to formulate, design, model, and analyze complex problems
PO3	**Design and Development of Product:** Acquire ability to design a component or a product that meet the specific needs with appropriate consideration for public health and safety, and the cultural, societal, and environmental considerations. Demonstrate knowledge and understanding of management skills related to project management
PO4	**Design and Conduct Experiments on Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
PO5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern IT tools including prediction and modelling to complex activities with an understanding of the limitations
PO6	**Individual and Teamwork:** Function effectively as an individual, and as a member or leader in diverse teams
PO7	**Life-long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

PO to PSO Mapping

	PSO1	PSO2	PSO3
PO1	3	3	2
PO2	3	3	3
PO3	3	3	3
PO4	3	3	2
PO5	3	1	2
PO6	1	2	3
PO7	3	3	3

2. Regulations

2.1 Name of the programme	**M.Sc. Computer Science**
2.2 Duration of the programme	Two Years (Four Semesters)
2.3 Specialisation	Computer Science
2.4 Total intake	26 (from the Academic Year 2022-2023)
2.5 Eligibility Criteria: Bachelor's degree in Computer Applications / Computer Sciences/Mathematics/ or any Bachelor's degree in Science stream with Mathematics as one of the subjects for at least four semesters. Candidates should have secured a minimum of 60% marks or 6.5 CGPA (on a 10-point scale) in the qualifying degree examination for General Category, 55% marks or 6.0 CGPA (on a 10 point scale) for EWS/OBC (Non-creamy layer) and 50% aggregate marks or 5.5 CGPA (on a 10-point scale) for SC/ST candidates.	
2.6 Medium of Instruction	English
2.7 Attendance	As per the University rules
2.8 Scheme of Examination: Each theory course shall have 40 marks towards continuous internal assessment and 60 marks towards end-semester examination. Lab courses shall have only continuous internal assessment of 100 marks, Internship and Dissertation shall have only continuous internal assessment of 100 marks.	
2.9 Miscellaneous: All other matters not referred specifically in these regulations shall be governed as per the ordinances of the university as revised from time to time.	

Amendments made in VI BOS meeting held on 07/05/2026 with immediate effect from batch 2024 – 26 onwards

2.10 Project / Dissertation for M.Sc. Computer Science

- Continuous Assessment shall be carried out by a committee consisting of the Project Coordinator (appointed by the HoD) and the Project Guide, with a minimum of two periodic reviews.
- If the Project Coordinator or HoD is also a Project Guide, the HoD shall nominate another faculty member to avoid conflict of roles.
- The End-Semester Evaluation will include a detailed project assessment and viva-voce, conducted by the Project Coordinator, Project Guide, and an External Examiner from academia or industry.

- **Approved Mark Distribution:**
  - Continuous Assessment – **40%**
  - End-Semester Evaluation – **60%**
    - External Examiner – **30%**
    - Project Guide – **30%**

Comprehensive Viva:

- The Comprehensive Viva will be conducted at the end of the final semester to assess the student's overall understanding of the programme across all core and elective courses.
- It shall be conducted by an Internal Examination Panel (Head of the Department or nominee + two senior faculty members) along with an **External Examiner from academia ONLY.**
- The evaluation will cover fundamental knowledge, concept integration, analytical ability, problem-solving, and communication skills.
- **Approved Mark Distribution:**
  - Internal Examination Panel – **50%**
  - External Examiner – **50%**

PROGRAM STRUCTURE

No	Course Code	Course Title	Course Type	Credit	Hours / Week	Marks	
						Int.	Ext.
SEMESTER – I							
1	CSC2011	Discrete Mathematics	CC	3	3	40	60
2	CSC2012	Data Structures and Algorithms	CC	4	4	40	60
3	CSC2013	Computer Organization and Architecture	CC	3	3	40	60
4	CSC2014	Database Management Systems	CC	4	4	40	60
5	CSC2015	Introduction to Programming using Python	CC	3	3	40	60
6	CSC2016	Data Structures and Algorithms Lab	CCP	2	4	100	
7	CSC2017	Database Management Systems Lab	CCP	2	4	100	
8	CSC2018	Python Programming Lab	CCP	2	4	100	
TOTAL				**23**	**29**		
SEMESTER – II							
1	CSC2021	Theory of Computation	CC	3	3	40	60
2	CSC2022	Artificial Intelligence	CC	3	3	40	60
3	CSC2023	Machine Learning	CC	3	3	40	60
4	CSC2024	Web Technology	CC	3	3	40	60
5	CSC2025	Artificial Intelligence and Machine Learning Lab	CCP	2	4	100	
6	CSC2026	Web Technology Lab	CCP	2	4	100	
7	CSCEC##	Elective – 1 / MOOCS	DSE	4	4	40	60
8		Open Elective	OE	3	3	40	60
9	CSCVA##	Value Added Course	VAC	--	2		
TOTAL				**23**	**29**		
		Internship / Field Visit / Training**	Internship	3	*		
* → **(Internship: 1 credit = 40 hours)**							

No	Course Code	Course Title	Course Type	Credit	Hours / Week	Marks	
						Inte-rnal	Exte-rnal
SEMESTER – III							
1	CSC2031	Cryptography and Network Security	CC	3	3	40	60
2	CSC2032	Operating Systems	CC	3	3	40	60
3	CSC2033	Computer Networks	CC	3	3	40	60
4	CSC2034	Software Engineering	CC	3	3	40	60
5	CSC2035	Object Oriented Programming using Java	CC	3	3	40	60
6	CSC2036	Operating Systems and Computer Networks Lab	CCP	2	4	100	
7	CSC2037	Java Programming Lab	CCP	2	4	100	
8	CSC2038	Soft Skills	SS	2	2	40	60
9	CSCEC##	Elective - 2 / MOOCS	DSE	4	4	40	60
TOTAL				**25**	**29**		
SEMESTER – IV							
1	CSC2041	Project / Dissertation	Project	12	*	100	
2	CSC2042	Comprehensive Viva-voce	CC	3	--	100	
3	CSC2043	Research Methodology	CC	3	3	40	60
4	CSC2044	Internship / Field Visit / Training**	Internship	3	**		
TOTAL				**21**	**3**		

*** → (Project: 1 credit = 40 hours)**

**** → (Internship: 1 credit = 40 hours) (Internship should be carried during the summer break i.e., between second and third semesters)**

**** If the student exit the course at the end of the first year, the student will be awarded PG Diploma in Computer Science after completing the Internship / Field Visit / Training. If the student completes all the four semesters, the student will be awarded M.Sc. Computer Science. In this case, the internship credits will be accounted in fourth semester.**

CC → Core Course	CCP → Core Course Practical	OE → Open Elective
DSE → Discipline Specific Elective	VAC → Value Added Course	SS → Soft Skill

TOTAL CREDITS = 92

M.Sc. Computer Science Credit Distribution based on Course type			
S. No.	Course Components	Credits	Percentage
1	Core Courses (CC)	50	54.35
2	Core Courses Practical (CCP)	14	15.22
3	Discipline Specific Elective (DSE)	08	8.69
4	Open Elective (OE)	03	3.26
5	Soft-Skill (SS)	02	2.17
6	Internship / Field Visit / Training	03	3.26
7	Project / Dissertation	12	13.05
	Total	92	100.00
8	Value Added Course	02	

BRIDGE COURSES

COURSE CODE	COURSE TITLE	CREDITS
CSCBC01	Introduction to Computers	---
CSCBC02	Problem Solving Techniques	---

SKILL ENHANCEMENT COURSES

COURSE CODE	COURSE TITLE	CREDITS
CSCSE01	Functional Programming	4
CSCSE02	Advanced Java Programming	4

VALUE ADDED COURSES

COURSE CODE	COURSE TITLE	CREDITS
CSCVA01	Introduction to Data Analysis using Excel	2

DISCIPLINE SPECIFIC ELECTIVES

COURSE CODE	COURSE TITLE	CREDITS
CSCEC01	Computational Intelligence	4
CSCEC02	Big Data Analytics	4
CSCEC03	Digital Image Processing	4
CSCEC04	Data Warehousing and Data Mining	4
CSCEC05	Pattern Recognition	4
CSCEC06	Natural Language Processing	4
CSCEC07	Principles of Deep Learning	4
CSCEC08	Deep Learning in Computer Vision	4
CSCEC09	Artificial Emotional Intelligence	4
CSCEC10	Data Visualization	4
CSCEC11	Human Computer Interaction	4
CSCEC12	Software Testing	4
CSCEC13	Block Chain Technology	4
CSCEC14	Cloud Computing	4
CSCEC15	Web Services	4
CSCEC16	Ethical Hacking	4
CSCEC17	Internet of Things	4
CSCEC18	Internet of Things for Health Care	4
CSCEC19	Text Analytics	4
CSCEC20	Social Media Analytics	4
CSCEC21	Mobile App Development	4
CSCEC22	Dockers and Kubernetes	4
CSCEC23	Computational Social Science	4
CSCEC24	IOT Security and Trust	4
CSCEC25	Introduction to NoSQL Database	4
CSCEC26	Deep Learning for NLP	4
CSCEC27	Cyber Security	4
CSCEC28	Statistics for Data Science	4
CSCEC29	Computer Graphics	4
CSCEC30	Digital Watermarking and Steganography	4
CSCEC31	Parallel and Distributed Computing	4

COURSE CODE	COURSE TITLE	CREDITS
CSCEC32	Agile Process and Devops	4
CSCEC33	Software Project Management	4
CSCEC34	Design Patterns	4
CSCEC35	Wireless Sensor Networks	4
CSCEC36	Approximation Algorithms	4
CSCEC37	Parallel Algorithms	4

OPEN ELECTIVES

COURSE CODE	COURSE TITLE	CREDITS
CSCOE01	Fundamentals of Cyber Security (for integrated / UG students of other departments)	4
CSCOE02	LaTeX for Researchers	3
CSCOE03	Orientation on Research for PG Students	3
CSCOE04	Office Automation	3
CSCOE05	Fundamentals of Python Programming	3
CSCOE06	Object Oriented Programming using C++	3
CSCOE07	R Programming	3
CSCOE08	C Programming	3
CSCOE09	Foundations of Machine Learning (for integrated / UG / PG students of other departments)	3

SEMESTER – I

CSC2011	DISCRETE MATHEMATICS	3 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain the concepts of sets, relations, functions, and Boolean algebra with their applications	Understand
CO2	Apply propositional and predicate logic techniques to solve logical and mathematical problems	Apply
CO3	Solve counting and combinatorial problems using counting principles and mathematical induction	Apply
CO4	Analyze algebraic structures such as groups, rings, and fields and their applications	Analyze
CO5	Apply graph theoretic concepts and algorithms to solve computational problems	Apply

b. Syllabus

Unit – 1	SETS – RELATIONS – FUNCTIONS – BOOLEAN ALGEBRA	9 hrs
Set Operations – Representation and Properties of Relations – Equivalence Relations – Partially Ordering. Functions – one-one – onto bijective – composition of relations and functions – inverse functions. Boolean Algebra and Boolean Functions and its representations – Simplifications of Boolean Functions.		
Unit – 2	**MATHEMATICAL LOGIC**	**9 hrs**
Propositional and Predicate Logic – Propositional Equivalences – Normal Forms – Predicates and Quantifiers – Nested Quantifiers – Rules of Inference.		
Unit – 3	**COUNTING – MATHEMATICAL INDUCTION AND DISCRETE PROBABILITY**	**9 hrs**
Basics of Counting – Pigeonhole Principle – Permutations and Combinations – Inclusion-Exclusion Principle – Mathematical Induction – Probability – Bayes Theorem.		
Unit – 4	**GROUP THEORY**	**9 hrs**
Groups – Subgroups – Semi Groups – Product and Quotients of Algebraic Structures – Isomorphism – Homomorphism – Automorphism – Rings - Integral Domains – Fields – Applications of Group Theory – Polya's theory of counting – Introduction to Error-Correcting Codes. Discrete Geometry: Some basic definitions – Ham-Sandwich theorem.		

Unit – 5	GRAPH THEORY	9 hrs
Simple Graph – Multigraph – Weighted Graph – Paths and Circuits – Shortest Paths in Weighted Graphs – Eulerian Paths and Circuits – Hamiltonian Paths and Circuits – Planner graph – Graph Coloring –Bipartite Graphs.		

Text / Reference Books:

1. Rosen, K.H. and Kamala Krithivasan, Discrete Mathematics and its Applications, McGraw Hill, Eighth edition, 2021
2. Rosen, K.H, Discrete Mathematics and Its Applications with Combinatorics and Graph Theory,McGraw Hill Education, Seventh edition, 2017
3. Tremblay, J.P. and Manohar.R, Discrete Mathematical Structures with Applications to ComputerScience, McGraw Hill Education, First edition, 2017
4. Grimaldi, R.P. , Discrete and Combinatorial Mathematics: An Applied Introduction, Pearson, Fifthedition, 2013
5. Lipschutz, S. and Mark Lipson, Discrete Mathematics (Schaum's Outlines), McGraw Hill Education,Revised Third edition, 2017

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	-	1	-	-	1
CO2	3	3	1	2	-	-	1
CO3	3	3	2	2	-	-	1
CO4	3	3	2	2	1	-	1
CO5	3	3	3	2	1	1	1

CSC2012	DATA STRUCTURES AND ALGORITHMS	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain algorithm analysis techniques, asymptotic notations, and recurrence relations used in complexity analysis	Understand
CO2	Apply linear and non-linear data structures to solve computational problems efficiently	Apply
CO3	Analyze and implement searching, sorting, and divide-and-conquer algorithms	Analyze
CO4	Apply greedy and dynamic programming paradigms for solving optimization problems	Apply
CO5	Analyze advanced algorithmic paradigms and computational complexity classes for complex problem solving	Analyze

b. Syllabus

Unit – 1	INTRODUCTION TO ALGORITHMS AND ANALYSIS	10 hrs
Overview and importance of algorithms and data structures – Fundamentals of algorithm analysis – Space and time complexity of an algorithm – Asymptotic Notations – Order of growth – Algorithm Efficiency – Best case, Worst Case, Average Case – Recurrence Relations – Solving recurrence relations using substitution method, recurrence tree method and Master Method.		
Unit – 2	**LINEAR AND NON-LINEAR DATA STRUCTURES**	**12 hrs**
Linear Data Structures: Stacks – Queues – Lists – Applications. Non-linear Data Structures: Graphs – Trees – Binary Trees – Traversal Techniques – Binary Search Tree and its operations – AVL Trees.		
Unit – 3	**SEARCHING AND SORTING ALGORITHMS, DIVIDE AND CONQUER APPROACH**	**16 hrs**
Search Problem – Linear Search – Binary Search – Sorting Problem – Bubble Sort – Insertion Sort – HeapSort – Divide and Conquer Paradigm – Merge Sort – Quick Sort – Complexity analysis of searching and sorting algorithms.		
Unit – 4	**GREEDY METHOD AND DYNAMIC PROGRAMMING APPROACH**	**12 hrs**
Greedy Method: Activity Selection Problem – Graph Traversal Algorithms. Dynamic Programming Paradigm: Knapsack problem – Matrix Chain Multiplication – All Pair Shortest Path a – Single SourceShortest Path – Travelling Salesman Problem.		

Unit – 5	OTHER ALGORITHM PARADIGMS AND COMPUTATIONAL COMPLEXITY CLASSES	10 hrs

Backtracking: 8-Queens problem – Graph coloring. Brach and Bound: Least Cost 0/1 Knapsack problem.Tractable and Intractable problems – Decidable and Undecidable problems – P, NP and NP-Complete classes – Cook's Theorem (without proof) – NP-Hard problems.

Text / Reference Books:

1. Thomas H. Cormen, C.E. Leiserson, R L.Rivest and C. Stein, Introduction to Algorithms, MIT Press,Third edition, April, 2022
2. Sanjoy Dasgupta, C.Papadimitriou and U.Vazirani, Algorithms, McGraw-Hill Education, First edition,2006
3. Aho A.V., J.E. Hopcroft and J. D. Ullman, The Design and Analysis of Computer Algorithms, PearsonIndia, First edition, 2002
4. Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, Fundamentals of Data Structure in C, SiliconPress, Second edition, 2008

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	-	2	1	-	1
CO2	3	3	2	1	2	-	1
CO3	3	3	2	2	2	-	1
CO4	3	3	3	2	2	-	1
CO5	3	3	2	3	1	-	2

CSC2013	COMPUTER ORGANIZATION AND ARCHITECTURE	3 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain the functional organization and architecture of computer systems including instruction sets and addressing modes	Understand
CO2	Analyze processor organization, control units, pipelining concepts, and hazard handling mechanisms	Analyze
CO3	Apply memory organization and memory management concepts in computer systems	Apply
CO4	Explain I/O organization, bus architectures, and data transfer mechanisms in computer systems	Understand
CO5	Analyze parallel processing architectures, multicore processors, and GPU computing concepts	Analyze

b. Syllabus

Unit – 1	BASIC STRUCTURE OF COMPUTERS	9 hrs

Function and Structure of a Computer, Interconnection of Components, Performance of a Computer. Machine Instructions, Operands, Addressing Modes, Instruction Formats, Instruction Sets, Instruction Set Architectures - CISC and RISC Architectures.

Unit – 2	PROCESSING UNIT AND PIPELINING	9 hrs

Organization of a Processor - Registers, ALU and Control Unit, Arithmetic Units - Addition, Subtraction, Multiplication, Division, Floating-point Units - Data Path in a CPU, Instruction Cycle, Organization of a Control Unit - Operations of a Control Unit - Hardwired Control Unit - Micro Programmed Control Unit –Pipelining – Hazards - Overcoming Hazards.

Unit – 3	MEMORY SUBSYSTEM	9 hrs

Semiconductor Memories, Memory Cells - SRAM and DRAM Cells, Internal Organization of a Memory Chip, Organization of a Memory Unit, Error Correction Memories, Interleaved Memories, Cache MemoryUnit - Concept of Cache Memory, Mapping Methods, Organization of a Cache Memory Unit, Memory Management Unit - Concept of Virtual Memory, Address Translation, Hardware Support for Memory Management –HDMI: High Definition Multimedia Interface.

Unit – 4	INPUT/OUTPUT SUBSYSTEM	9 hrs
Access of I/O Devices, I/O Ports, I/O Control Mechanisms - Program Controlled I/O, Interrupt ControlledI/O and DMA Controlled I/O - I/O Interfaces - Serial Port - Parallel Port - PCI Bus - SCSI Bus - USB Bus - I/O Peripherals - Input Devices - Output Devices - Secondary Storage Devices.		
Unit – 5	**PARALLELISM, MULTI-CORE PROCESSORS AND GRAPHICS PROCESSING UNIT (GPUS)**	**9 hrs**
Instruction-Level Parallelism (ILP) - Dynamic Scheduling, Introduction to Multi-Core Processors - Homogeneous Multicore Processor - Heterogeneous Multicore Processor - Current Trends in Multicore Processing - Pros and Cons of Multicore Processing, Graphics Processing Unit (Gpus) - GPU and CPU - GPUVs. Graphics Card - Integrated Graphics Processing Unit - Discrete Graphics Processing Unit - GPUs For Gaming - GPUs for Video Editing and Content Creation - GPUs in the Data Center.		

Text / Reference Books:

1. William Stallings, Computer Organization and Architecture – Designing for Performance, PearsonEducation, Eleventh edition, 2019
2. David Patterson & John Hennessy, Computer Organization and Design: The Hardware/SoftwareInterface, Morgan-Kaufmann, Fifth Edition, 2014
3. Linda Null and Julia Lobur, Essentials of Computer Organization and Architecture, Jones & BartlettLearning, Fifth edition, 2017
4. Joseph D. Dumas, Computer Architecture: Fundamentals and Principles of Computer Design, CRCPress, Second edition, 2016
5. John P. Hayes, Computer Architecture and Organization, Tata Mc Graw Hill, Third edition, 1998
6. Carl Hamacher, Zvonko Vranesic, Safwat Zaky and Naraig Manjikian, Computer Organization andEmbedded Systems, Tata Mc Graw Hill, Sixth edition, 2012

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	-	1	-	1
CO2	3	2	2	2	1	-	1
CO3	3	3	2	2	2	-	1
CO4	3	2	1	1	2	-	1
CO5	3	3	2	2	2	-	2

CSC2014	DATABASE MANAGEMENT SYSTEMS	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain database concepts, relational models, ER modelling, and normalization techniques for database design	Understand
CO2	Apply relational query languages and SQL for database querying and query optimization	Apply
CO3	Analyze transaction management, concurrency control, recovery mechanisms, and database security concepts	Analyze
CO4	Apply file organization, indexing, and hashing techniques for efficient data storage and retrieval	Apply
CO5	Analyze advanced database systems including distributed, NoSQL, object-oriented, and web databases	Analyze

b. Syllabus

Unit – 1	BASIC CONCEPTS & RELATIONAL DATABASE DESIGN	12 hrs
File System versus DBMS – Advantages -Views – Data models – Database languages – Architecture – ER Model – Entities, Attributes and Entity Sets, Relationships and Relationship Sets – Features of ER Model – Conceptual design with ER – Extended E-R. Relational Model - Codd's rule – Integrity Constraints over Relations – Relational database design – Anomalies - Functional dependencies – Normalization – NormalForms – Decomposition – Denormalization.		
Unit – 2	**RELATIONAL MODEL , LANGUAGES & QUERY OPTIMIZATION**	**12 hrs**
Relational Query Languages – Relational Algebra – Tuple and Domain Relational Calculus – SQL – Query processing and optimization – Transformation of relational expressions – Evaluation Plans.		
Unit – 3	**TRANSACTION CONCURRENCY CONTROL AND SECURITY**	**12 hrs**
Transaction – Properties – Concurrent execution – Serializability – Concurrency control – Protocols – Recovery System – Database Security.		
Unit – 4	**FILE ORGANIZATION**	**12 hrs**
File organization – Organization of records in files – Indexing – B tree and B+ tree index files – Static hashing – Dynamic hashing.		

Unit – 5	ADVANCED CONCEPTS	12 hrs
Parallel and distributed databases – Object-based databases - Mobile databases - XML and Web databases – Intelligent databases – Mongo DB – NOSQL – PostgreSQL.		

Text / Reference Books:

1. Silberchatz A., F. Korth, and S. Sudarshan, Database System Concepts, McGraw Hill, Seventh edition,2021
2. R. Elmasri and S. B. Navathe, Fundamentals of Database Systems, Pearson, Seventh edition, 2016
3. Coronel, Carlos, and Steven Morris. t., Database systems: design, implementation, & management,Cengage Learning, Thirteenth edition, 2016
4. Ramakrishnan, R., Gehrke, J., & Gehrke, J., Database management systems, McGraw Hill, Thirdedition, 2006

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	1	1	-	1
CO2	3	2	3	2	2	-	1
CO3	3	2	2	2	2	-	1
CO4	3	2	2	2	3	-	1
CO5	3	3	2	2	3	-	2

CSC2015	INTRODUCTION TO PROGRAMMING USING PYTHON	3 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain the fundamental concepts, syntax, and programming constructs of Python	Understand
CO2	Develop Python programs using variables, operators, control structures, and functions	Apply
CO3	Apply Python data structures such as lists, tuples, dictionaries, and sets in problem solving	Apply
CO4	Develop Python programs using exception handling, object-oriented concepts, and file operations	Apply
CO5	Apply Python visualization libraries for data plotting and graphical representation	Apply

b. Syllabus

Unit – 1	INTRODUCTION TO PYTHON	9 hrs
Introduction to a programming language – History of Python- Python environment setup – Python 2 vs. Python 3 - Comments and documentation in Python- Keywords and Identifiers -Programming Errors - Writing and Running python programs.		
Unit – 2	**VARIABLES AND CONDITIONALS IN PYTHON**	**9 hrs**
Variables – Constants- Strings - Assignment statements – Expressions-Operators – Type Conversions - Control Flow statements and Loops- Functions.		
Unit – 3	**DATA STRUCTURES IN PYTHON**	**9 hrs**
List Basics- List Indexing and Slicing-Appending-Sorting and Ranging-Tuples-Creation-Deletion-Converting tuple to list- Assignment- Dictionaries-Adding-Modifying and Retrieving Values-Traversing all keys in the dictionary-Operations and methods-Sets- manipulating and accessing sets.		
Unit – 4	**EXCEPTION HANDLING AND FILE I/O**	**9 hrs**
Exception handling - Catching and Handling Exceptions-Object Orientated Concepts (Basics) – Creating python class and Objects - Object properties and methods- Inheritance- Operator overloading - Polymorphism- File handling - Opening, Reading, Writing and Deleting files.		

Unit – 5	GRAPH PLOTTING	9 hrs
Introduction to plotting python libraries -Plots and Graphs- Applied Visualizations – Seaborn – Matplotlib		

Text / Reference Books:

1. Eric Matthes, Python Crash Course, No Starch Press, Second edition, 2019
2. Martin C. Brown, Python: The Complete Reference, McGraw Hill Education, Fourth edition, 2018
3. Ryan Marvin Mark Ng'Ang'A Amos Omondi, Python Fundamentals, Packet Publishing, Second edition, 2018
4. Zed Shaw, Learn Python 3 the Hard Way: A Very Simple Introduction to the Terrifyingly Beautiful World of Computers and Code, Addison-Wesley Professional, First edition, 2017

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	-	1	-	1
CO2	3	3	2	1	2	-	1
CO3	3	3	2	1	2	-	1
CO4	3	3	3	2	2	-	1
CO5	3	2	2	2	3	-	2

CSC2016	DATA STRUCTURES AND ALGORITHMS LAB	2 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Implement linear and non-linear data structures	Apply
CO2	Implement search and sorting algorithms	Apply
CO3	Implement problems related to various algorithm paradigms	Apply
CO4	Determine the run-time complexity of algorithms	Analyze
CO5	Identify proper data structures and algorithm strategies to solve problems	Evaluate

b. Syllabus

Programs should include but not limited to:

Implementation of

i. Stacks and Queues
ii. Lists
iii. Linear Search and Binary Search
iv. Sorting Algorithms
v. Graph Traversal Algorithms
vi. Tree Traversal Algorithms
vii. Shortest Path Algorithms
viii. Knapsack Problem
ix. Travelling Salesman Problem
x. N-Queens's Problem

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	-	2	1	-	1
CO2	3	3	2	1	2	-	1
CO3	3	3	2	2	2	-	1
CO4	3	3	3	2	2	-	1
CO5	3	3	2	3	1	-	2

CSC2017	DATABASE MANAGEMENT SYSTEMS LAB	2 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Transform an information model into a relational database schema	Apply
CO2	Use an SQL interface of a multi-user relational DBMS package to create, secure, populate, maintain, and query a database	Apply
CO3	Use a desktop database package to create, populate, maintain, and query a database	Apply
CO4	Formulate query, using SQL, solutions to a broad range of query and data update problems	Analyse
CO5	Demonstrate a rudimentary understanding of programmatic interfaces to a database and be able to use the basic functions of one such interface	Apply

b. Syllabus

Programs should include but not be limited to:
Exercises on

i. DDL commands
ii. DML commands- Basic Queries
iii. Aggregate Commands
iv. Nested Queries
v. Joins
vi. Views
vii. Index
viii. Functions
ix. Procedures
x. Triggers

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	1	1	-	1
CO2	3	2	3	2	2	-	1
CO3	3	2	2	2	2	-	1
CO4	3	2	2	2	3	-	1
CO5	3	3	2	2	3	-	2

CSC2018	PYTHON PROGRAMMING LAB	2 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Understand the fundamental concepts of python and its main components	Understand
CO2	Develop (Read and Write) python programs using variables, assignments, and conditionalstatements using functions	Create
CO3	Illustrate and implement different data structures	Analyze
CO4	Demonstrate Object-oriented concepts and file handling	Analyze
CO5	Analyse and plot data using python visualization libraries	Analyze

b. Syllabus

Programs should include but not limited to:

I. Test and Debug simple Python programs
II. Different data types in python (variables constants and strings)
III. Programs on different operators
IV. Control statements and Loops
V. Working on Functions
VI. Data structures in python (List, Tuple, Dictionary and Set)
VII. Objects and Classes manipulation using python
VIII. Open, Read and write data from/to files in Python
IX. Different plots using Matplotlib
X. Visualization of data using seaborn

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	-	1	-	1
CO2	3	3	2	1	2	-	1
CO3	3	3	2	1	2	-	1
CO4	3	3	3	2	2	-	1
CO5	3	2	2	2	3	-	2

SEMESTER – II

CSC2021	THEORY OF COMPUTATION	3 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain finite automata, regular languages, and regular expressions used in formal language modelling	Understand
CO2	Apply context free grammars and normal forms for language representation and parsing	Apply
CO3	Analyze pushdown automata and context free languages using formal computational methods	Analyze
CO4	Analyze Turing machines, computability, and decidability concepts in computational theory	Analyze
CO5	Explain undecidability, tractability, and computational complexity classes such as P and NP	Understand

b. Syllabus

Unit – 1	FINITE AUTOMATA	9 hrs

Introduction- Basic Mathematical Notation and Techniques- Finite Automata (FA) – Deterministic Finite Automata (DFA) – Non-Deterministic Finite Automata (NFA) – Finite Automaton with €- Moves – RegularLanguages – Regular Expression - Proving Languages not to be Regular – Closure Properties of Regular Languages – Equivalence of NFA and DFA – Equivalence of NDFA's with and Without €-Moves – Minimization of DFA – Pumping Lemma for Regular Language - Its Use as an Adversarial Game.

Unit – 2	CONTEXT FREE GRAMMARS (CFG) AND LANGUAGES	9 hrs

Notion of Grammars and Languages Generated by Grammars – Parse Trees – Derivations and Languages – Ambiguity – Relationship between Derivation and Derivation Trees – Simplification of CFG – Eliminationof Useless Symbols – Unit Productions – Null Productions – Greibach Normal Form (GNF) – Chomsky Normal Form (CNF) – Problems related to CNF And GNF – Applications To Compliers.

Unit – 3	PUSHDOWN AUTOMATA (PDA)	9 hrs

Definition of the Pushdown Automata – Languages of a Pushdown Automata – Moves - Instantaneous Descriptions – Deterministic and Nondeterministic Pushdown Automata – Equivalence of Pushdown Automata and CFL – Pumping Lemma for CFL – Closure Properties of CFL – Problems Based on PumpingLemma.

Unit – 4	TURING MACHINES	9 hrs

Definitions of Turing Machines – Models – Universal Turing Machine – Deterministic and Nondeterministic Turing Machines – Computable Languages and Functions – Techniques for Turing Machine Construction – Multi Head and Multi Tape Turing Machines – The Halting Problem – Partial Solvability - Problems about Turing Machines.

Unit – 5	UNDECIDABALITY AND INTRACTABILITY	9 hrs

A Language that is not Recursively Enumerable (RE) – An Undecidable Problem that is RE – Undecidable Problems about Turing Machine - Post's Correspondence Problem – Measuring and Classifying Complexity: Tractable and Intractable Problems – Tractable and Possibly Intractable Problems – P and NP.

Text / Reference Books:

1. Hopcroft J.E., Motwani R. and Ullman J.D, Introduction to Automata Theory, Languages and Computations, Pearson Education, Third edition, 2008
2. Dexter C. Kozen, Automata and Computability, Springer, Eighth edition, 2007
3. Micheal Sipser, Introduction of the Theory of Computation, Cengage, Third edition, 2014
4. Kamala Krithivasan and Rama R., Introduction to Formal Languages, Automata Theory and Computation, Pearson Education, First edition, 2009
5. J. Martin, Introduction to Languages and the Theory of Computation, McGraw-Hill Higher Education,Third edition, 2002

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	1	1	-	-	1
CO2	3	3	2	2	-	-	1
CO3	3	3	2	2	1	-	1
CO4	3	3	2	3	1	-	2
CO5	3	3	1	2	-	-	2

CSC2022	ARTIFICIAL INTELLIGENCE	3 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain the foundations of Artificial Intelligence and intelligent agent architectures	Understand
CO2	Apply uninformed and heuristic search techniques to solve AI-based problems	Apply
CO3	Analyze adversarial and optimization-based search techniques in complex environments	Analyze
CO4	Apply knowledge representation and planning techniques for intelligent decision making	Apply
CO5	Analyze AI applications in expert systems, NLP, information retrieval, and semantic web technologies	Analyze

b. Syllabus

Unit – 1	INTRODUCTION AND INTELLIGENT AGENTS	9 hrs

Introduction to Artificial Intelligence (AI) – Foundations of AI – History of AI – State-of-the-art – Risks andBenefits of AI. Intelligent Agents: Agents and Environments – Concept of Rationality – Nature of Environments – Structure of Agents.

Unit – 2	SEARCH PROBLEMS	9 hrs

Problem-solving Agents – Example Problems – Search Algorithms – Best-First Search – Search data structures – Uninformed Search Strategies – Breadth-First Search – Uniform Cost Search – Depth-First Search – Bi-directional Search – Heuristic Search Strategies – Greedy Best-First Search – A* Search – Bi- directional Heuristic Search – Heuristic Functions

Unit – 3	SEARCH IN COMPLEX ENVIRONMENTS AND ADVERSARIAL SEARCH	9 hrs

Local Search and Optimization Problems – Hill Climbing Search – Simulated Annealing – Evolutionary Algorithms – Local Search in Continuous Spaces – AND-OR Search Trees – Search in Partially ObservableEnvironments – Online Search Agents. Adversarial Search: Introduction to Game theory – Two-player Zero sum games – Optimal Decisions in Games – Heuristic Alpha-Beta Tree Search – Monte Carlo Tree Search.

Unit – 4	KNOWLEDGE REPRESENTATION & PLANNING	9 hrs

Knowledge Representation and Reasoning: ontologies – Foundations of Knowledge Representation and Reasoning about Objects – Relations – Events – Actions – Time and Space - Predicate Logic - Situation Calculus – Reasoning about Knowledge, Sample Applications. The blocks world, Components of Planning Systems, Goal Stack Planning, Nonlinear Planning, Hierarchical Planning. Multi Agent Panning, Case based planning.

Unit – 5	APPLICATIONS	9 hrs

Application Areas: Expert system, decision support systems, Speech and vision, Natural language processing, Information retrieval, Semantic web

Text / Reference Books:

1. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, Pearson India Education Pvt. Ltd., Fourth Edition, January 2022
2. Elaine Rich, Kevin Knight and Shivashankar B Nair, Artificial Intelligence, Tata McGraw Hill., Third Edition, 2017
3. Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, Pearson Education, Second Edition, 1998

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	-	1	-	1
CO2	2	3	2	2	2	-	1
CO3	3	3	2	2	2	-	1
CO4	3	3	3	2	2	1	1
CO5	3	3	2	2	3	1	2

CSC2023	MACHINE LEARNING	3 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain machine learning concepts, data preprocessing techniques, model preparation, and evaluation methods	Understand
CO2	Apply feature engineering and probabilistic concepts for machine learning model development	Apply
CO3	Analyze and implement supervised learning algorithms for regression and classification problems	Analyze
CO4	Apply unsupervised learning techniques for clustering, dimensionality reduction, and pattern discovery	Apply
CO5	Analyze ensemble learning techniques and apply machine learning models on real-world datasets and case studies	Analyze

b. Syllabus

Unit – 1	INTRODUCTION – MODEL PREPARATION – EVALUATION	8 hrs

Introduction to Machine Learning: Human Learning and its Types; Machine Learning and its types; Well-Posed Learning Problem; Applications of Machine Learning; Issues in Machine Learning.

Preparing To Model: Basic Data Types; Exploring Numerical Data; Exploring Categorical Data; Exploring Relationship Between Variables; Data Issues and Remediation; Data Pre-Processing.

Modelling And Evaluation: Selecting A Model; Training Model – Holdout, *K*-Fold Cross-Validation, Bootstrap Sampling; Model Representation and Interpretability – Under-Fitting, Over-Fitting, Bias-Variance Tradeoff – Model Performance Evaluation – Classification, Regression, Clustering – Performance Improvement.

Unit – 2	FEATURE ENGINEERING – REVIEW OF PROBABILITY – CONCEPT LEARNING	10 hrs

Feature Engineering: Feature Construction – Feature Extraction – Feature Selection. Brief Review ofProbability: Basic Concept Of Probability – Random Variables – Discrete Distributions – Binomial, Poisson – Bernoulli - Continuous Distribution – Uniform, Normal, Laplace; Central Theorem; Monte CarloApproximation. Concept Learning: Find – S algorithm – Version Space and Candidate Elimination algorithm – Inductive Bias.

Unit – 3	SUPERVISED LEARNING	15 hrs
Supervised Learning – Regression: Simple Linear Regression; Other Regression Techniques. Supervised Learning – Classification: Basics of Supervised Learning – Classification; Logistic Regression – k-Nearest neighbor – Decision Tree Learning. Neural Networks: Introduction – Perceptron – Multi Layer Perceptron- Back Propagation Algorithm. Linear Discriminant Analysis – Support Vector Machine. Bayesian Concept Learning: Bayes Theorem – Prior and Posterior Probability, Likelihood; Bayesian Belief Network.		
Unit – 4	**UNSUPERVISED LEARNING**	**6 hrs**
Unsupervised Learning: Basics of Unsupervised Learning – Clustering Techniques; Association Rules. Mixture Models – EM algorithm – PCA.		
Unit – 5	**ENSEMBLE LEARNING – PUBLIC DATASETS AND CASE STUDIES**	**6 hrs**
Concept of Ensemble Learning – Bagging and Boosting and its impact on bias and variance – Random Forest – Adaboost Classifier – Gradient Boosting Machines – XG Boost. Exploring UCI Machine Learning Repository – Kaggle Data Sets – Analyzing Data Sets – Case Studies		

Text / Reference Books:

1. Saikat Dutt, Subramanian Chandramouli, Amit Kumar Das, Machine Learning, Pearson EducationIndia, January 2018
2. Tom Mitchell, Machine Learning, McGraw Hill Education, First Edition, 2017
3. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, First edition, 2010.
4. Ethem Alpaydin,"Introduction to Machine Learningll, MIT Press, Prentice Hall of India, Third Edition2015.

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	2	-	1
CO2	3	3	2	2	2	-	1
CO3	3	3	3	2	3	-	1
CO4	3	3	2	2	3	-	1
CO5	3	3	3	3	3	1	2

CSC2024	WEB TECHNOLOGY	3 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain Internet principles, web concepts, client-server architecture, and Internet protocols	Understand
CO2	Apply networking and Internet technologies including sockets, protocol handlers, and remote method invocation	Apply
CO3	Develop web pages using HTML, XML, DOM, CSS, and advanced styling techniques	Apply
CO4	Develop interactive client-side web applications using JavaScript, JQuery, Ajax, and scripting technologies	Apply
CO5	Develop server-side web applications with database connectivity using modern web technologies and frameworks	Create

b. Syllabus

Unit – 1	WEB ESSENTIALS	9 hrs
Internet Principles – basic web concepts – Client/ server model – Retrieving data from Internet – Internet Protocols and applications		
Unit – 2	**INTERNET TECHNOLOGIES**	**9 hrs**
Streaming – Networking Principles – Sockets for Clients – Sockets for Servers – Protocol Handlers – Content Handlers – Multicast sockets – Remote method Invocation.		
Unit – 3	**MARKUP LANGUAGES AND STYLE SHEETS**	**9 hrs**
HTML Elements – HTML Lists – HTML Tables – HTML Forms – Links and addressing – HTML Frames and Images – DHTML – Document Object model (DOM) – XML Schemas – CSS – Text Properties – Advanced CSS.		
Unit – 4	**CLIENT SIDE TECHNOLOGY**	**9 hrs**
Scripts – Javascript – VB Script – JQuery and Ajax		
Unit – 5	**SERVER SIDE TECHNOLOGY AND DATABASE**	**9 hrs**
Server Scripts – Servlets – Sessions – Cookies – PHP– Node.js – Java Server Pages (JSP) – Active Server pages (ASP) – Simple Applications – On-line databases – Monitoring user events – Plug-ins – Database connectivity – Case Studies on connecting Mongo DB with Java		

Text / Reference Books:

1. Jeffery J. Jackson . Web Technologies: A Computer Science Perspective, Pearson India, January 2015
2. N.P. Gopalan, T. J. Akilandeswari, Web Technology: A Developer's Perspective, Phi Learning Private Limited, Second edition, October 2014
3. Jeffrey C. Jackson, WEB TECHNOLOGIES A Computer Science Perspective, Pearson Edition, Secondedition, 2007
4. Paul Deital, Internet & World Wide Web: How to Program, Pearson Edition, Fourth edition, 2007
5. Uttam K. Roy, Web Technologies, Oxford, First Edition, 2010

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	-	1	-	1
CO2	3	3	2	1	2	-	1
CO3	3	3	3	1	2	-	1
CO4	3	3	3	2	3	-	1
CO5	3	3	3	2	3	1	2

CSC2025	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING LAB	2 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Design and develop solutions for informed and uninformed search problems in AI	Apply
CO2	Explore advance packages to solve AI problems	Analyze
CO3	Implement classical supervised learning classification algorithms	Apply
CO4	Implement various clustering algorithms and analyze clusters formed	Apply
CO5	Implement various ensemble classifiers and analyze the results	Analyze

b. Syllabus

Programs should include but not limited to:

i. 8-puzzle problem
ii. Magic Square
iii. 4-Queen Problem
iv. River crossing problem
v. TIC-TAC-TOE
vi. Water Jug Problem
vii. Simple CHATBOT
viii. Expert system
ix. Simple Sudoku
x. Data Analysis and Data Visualization
xi. Linear Regression and Multiple Regression
xii. Logistic Regression
xiii. Decision Trees
xiv. k-Nearest Neighbor
xv. Random Forest
xvi. Adaboost and XG Boost

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	-	1	-	1
CO2	3	3	2	1	2	-	1
CO3	3	3	3	1	2	-	1
CO4	3	3	3	2	3	-	1
CO5	3	3	3	2	3	1	2

CSC2026	WEB TECHNOLOGY LAB	2 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Understand the principles of www and concepts of web clients and web servers	Understand
CO2	Interpret the key responsibilities and functionalities of different internet technologies	Analyse
CO3	Demonstrate Markup languages and illustrate the working of it	Apply
CO4	Analyze the different client side scripting/programming languages	Analyse
CO5	Explain and demonstrate server side , presentation and database technologies	Skill

b. Syllabus

Programs should include but not be limited to:
Implementations of

i. Demonstration of client server programming
ii. Static and Dynamic web pages creation using HTML
iii. Inline, Internal and external style sheet using CSS
iv. Creation and manipulation of XML schema
v. Scripts – Simple programs
vi. Front end development using JavaScript, VBScript
vii. Programs based on sessions and cookies
viii. Web applications (Backend) using PHP, Servlets
ix. Exercises based on database connectivity
x. Web application for event tracking and monitoring

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	2	2	2	2
CO2	3	3	3	2	2	2	2
CO3	3	3	3	2	2	2	2
CO4	3	3	3	2	2	2	2
CO5	3	3	3	2	2	2	2

SEMESTER – III

CSC2031	CRYPTOGRAPHY AND NETWORK SECURITY	3 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain fundamental concepts of cryptography, security attacks, security services, and algebraic foundations used in cryptographic systems	Understand
CO2	Analyze symmetric key cryptographic algorithms and block cipher techniques for secure communication	Analyze
CO3	Apply asymmetric cryptographic algorithms and key exchange mechanisms for secure data transmission	Apply
CO4	Analyze cryptographic hash functions, message authentication techniques, and digital signature mechanisms for data integrity	Analyze
CO5	Apply network security protocols and electronic commerce security mechanisms for secure networked systems	Apply

b. Syllabus

Unit – 1	FOUNDATIONS OF CRYPTOGRAPHY AND SECURITY	9 hrs
Computer Security Concepts – Security Attacks – Security Services – Security Mechanisms – Network Security Model – Modular Arithmetic – Divisibility and Division Algorithm – Euclidean Algorithm – Algebraic Structures – Galois Field GF(2n) – Symmetric Cryptography – Modern Symmetric Key Ciphers.		
Unit – 2	**ADVANCED BLOCK CIPHER ALGORITHMS**	**9 hrs**
Data Encryption Standard (DES) – Strength of DES – DES Analysis – Double DES – Triple DES – AdvancedEncryption Standard (AES) – AES Analysis – Block cipher operations.		
Unit – 3	**ASYMMETRIC KEY CRYPTOGRAPHY**	**9 hrs**
Concept of Prime Numbers – Fermat's Theorem – Euler's Theorem – Testing for primality – Exponentiation and Discrete Logarithms – Principles of Public Key Cryptosystems – RSA algorithm – DiffieHellman Key Exchange – ElGamal Cryptosystem – Elliptic Curve Cryptography – Pseudo random numbergeneration.		
Unit – 4	**DATA INTEGRITY**	**9 hrs**
Cryptographic Hash Functions – Secure Hash Algorithm (SHA) – SHA-256 algorithm – Message Authentication Codes – Digital Signatures.		

Unit – 5	NETWORK SECURITY	9 hrs
Key Management and Distribution – Secure Sockets Layer – Transport Level Security – Network Security – Email security – IP Security – Electronic Commerce Security: Electronic Payment Systems, SecureElectronic Transaction, E-cash, Smart Card Based Systems.		

Text / Reference Books:

1. William Stallings, Cryptography and Network Security - Principles and Practice, Pearson, Seventhedition, 2017
2. William Stallings, Network Security Essentials Applications and Standards, Pearson Education, Sixthedition, 2018
3. B. Forouzan, Cryptography And Network Security, McGraw Hill Education, Third edition, 2015
4. Atul Kahate, Cryptography And Network Security, McGraw-Hill; Fourth edition, Fourth edition, 2019

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	1	-	1
CO2	3	3	2	2	2	-	1
CO3	3	3	3	2	3	-	1
CO4	3	3	2	3	2	-	1
CO5	3	3	3	2	3	1	2

CSC2032	OPERATING SYSTEMS	3 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain the structure, functions, and services of operating systems and process management concepts	Understand
CO2	Analyze process scheduling, inter-process communication, multithreading, and synchronization mechanisms	Analyze
CO3	Apply CPU scheduling and deadlock handling algorithms for efficient resource management	Apply
CO4	Analyze memory management and secondary storage management techniques in operating systems	Analyze
CO5	Apply file system management concepts and evaluate operating system case studies including Linux, Windows, and mobile operating systems	Apply

b. Syllabus

Unit – 1	OVERVIEW OF OPERATING SYSTEMS	9 hrs

Introduction to Operating Systems – Computer System Organization, Architecture – Operating System Structure, Operations – Process, Memory, Storage Management – Protection and Security – DistributedSystems – Computing Environments – Open-Source Operating Systems – OS Services – User Operating- System Interface – System Calls – Types – System Programs – OS Structure – OS Generation – System Boot – Process Concept – Scheduling – Operations on Processes – Cooperating Processes – Inter-ProcessCommunication – Examples – Multithreading Models – Thread Libraries – Threading Issues – OS Examples.

Unit – 2	PROCESS MANAGEMENT	9 hrs

Process Concept – Process Scheduling – Operations on Processes – Inter-Process Communication (IPC) – IPC Examples – Client-Server Communication – Threads – Multi-Core Models – Multi-Threading Models – Threading Issues – Process Synchronization – Critical Section Problem – Peterson's Solution –Synchronization Hardware – Mutex Locks – Semaphores – Monitors.

Unit – 3	CPU SCHEDULING AND DEADLOCKS	9 hrs

Basic Concepts – Scheduling Criteria – Scheduling Algorithms – Thread Scheduling – Multi-Processor Scheduling – Real-Time CPU Scheduling. Deadlocks: System Model – Deadlock Characterization – Methods for Handling Deadlocks – Deadlock Prevention – Deadlock Avoidance – Deadlock Detection – Recovery From Deadlock.

Unit – 4	MEMORY MANAGEMENT	9 hrs

Main Memory Concept – Swapping – Contiguous Memory Allocation – Segmentation – Paging – ExampleArchitectures – Virtual Memory Concept – Demand Paging – Page Replacement - Frame Allocation – Thrashing – Memory Mapped Files – Kernel Memory Allocation. Secondary Storage: Disk Structure – Disk Scheduling – Disk Management – RAID Structure.

Unit – 5	I/O SYSTEMS AND CASE STUDIES	9 hrs

File Concept – Access Methods – Directory Structure – File-System Mounting – Protection – Directory Implementation – Allocation Methods – Free-Space Management – Protection File Systems. Case Studies: Linux – Windows – Mobile Operating Systems

Text / Reference Books:

1. Abraham Silberschatz, Peter B. Galvin, Greg Gagne, Operating System Concepts, John Wiley & SonsInc, Tenth edition, 2021
2. Andrew S. Tanenbaum, Modern Operating Systems, Addison Wesley, Fourth edition, 2016
3. Charles Crowley, Operating Systems: A Design-Oriented Approach, Tata McGraw Hill Education, ,1996
4. D M Dhamdhere, Operating Systems: A Concept-based Approach, Tata McGraw-Hill Education,Second edition, 2007
5. William Stallings, Operating Systems: Internals and Design Principles, PHI , Seventh edition, 2011

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	1	-	1
CO2	3	3	2	2	2	-	1
CO3	3	3	3	2	2	-	1
CO4	3	3	2	3	2	-	1
CO5	3	2	2	2	3	1	2

CSC2033	COMPUTER NETWORKS	3 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain communication models, protocol architectures, transmission media, and physical layer concepts	Understand
CO2	Analyze data link layer protocols, error control techniques, and wired/wireless LAN technologies	Analyze
CO3	Apply network layer protocols, routing algorithms, addressing mechanisms, and congestion control techniques	Apply
CO4	Analyze transport layer protocols, flow control, congestion control, and quality of service mechanisms	Analyze
CO5	Apply application layer protocols and Internet applications for network communication systems	Apply

b. Syllabus

Unit – 1	FUNDAMENTAL CONCEPTS AND PHYSICAL LAYER	9 hrs
Basic Definitions - Basic Communication Models – Network Types – Protocol Layers and Service Models – OSI Model – TCP/IP Protocol Suite. Physical Layer: Data and Signals – Digital Transmission – BandwidthUtilization – Transmission Media – Switching – Packet Switching – Circuit Switched Networks.		
Unit – 2	**DATA LINK LAYER**	**9 hrs**
Error Detection and Correction – Data Link Control – Multiple Access – Wired LANs – Wireless LAN – IEEE 802.11 – Bluetooth – Connecting Devices.		
Unit – 3	**NETWORK LAYER**	**9 hrs**
Circuit Switching – Packet Switching – Virtual Circuit Switching – IP – ARP – DHCP – ICMP – Routing – RIP – OSPF – Subnetting – CIDR – Interdomain Routing – BGP – IPV6 Basic Features – Multicast –CongestionAvoidance in Network Layer.		
Unit – 4	**TRANSPORT LAYER**	**9 hrs**
Transport Layer Services – Port Numbers – Protocols – User Datagram Protocol (UDP) – Transmission Control Protocol (TCP) – Details - Flow Control – Congestion Control – Queuing Discipline - Introduction to Quality of services (QOS).		

Unit – 5	APPLICATION LAYER AND INTERNET APPLICATIONS	9 hrs

Network Architecture – Layers - HTTP – DNS – E-Mail (SMTP, MIME, POP3, IMAP, Web Mail) – FTP –Telnet – SNMP.

Text / Reference Books:

1. J William Stallings, Data and Computer Communications, Pearson, Eighth Edition, 2011
2. Behrouz A. Forouzan, Computer Networks - A top-down approach, Tata McGraw-Hill, Fourth Edition,2016
3. James F. Kurose, Keith W. Ross, Computer Networking, A Top-Down Approach Featuring the Internet,Pearson, Sixth Edition, 2012
4. Larry L. Peterson, Bruce S. Davie, Computer Networks: A Systems Approach, Morgan Kaufman, FifthEdition, 2015
5. Ying-Dar Lin, Ren-Hung Hwang and Fred Baker, Computer Networks: An Open Source, McGraw Hill,First Edition, 2011

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	1	-	1
CO2	3	3	2	2	2	-	1
CO3	3	3	3	2	3	-	1
CO4	3	3	2	3	2	-	1
CO5	3	2	2	2	3	1	2

CSC2034	SOFTWARE ENGINEERING	3 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Understand the Fundamentals of Software Process Models	Understand
CO2	Acquire knowledge on Principles of Requirement Engineering	Remember
CO3	Learn design concepts with architectural design, component-level design and userinterface design	Understand
CO4	Apply software testing strategies on real world problems, testing conventionalapplications and testing object-oriented applications	Apply
CO5	Familiarize with software configuration management, estimation of software projects,project scheduling and risk management maintenance	Analyse

b. Syllabus

Unit – 1	FUNDAMENTALS OF SOFTWARE ENGINEERING AND SOFTWARE PROCESS	9 hrs

The Nature of Software - Software Engineering - The Software Process - Software Engineering Practice - Software Process - Generic Process Model - A Generic Process Model - Process Assessment and Improvement - Prescriptive Process Models - Specialized Process Models - The Unified Process - Personaland Team Process Models - Agile Development - Extreme Programming (XP) - Other Agile Process Models.

Unit – 2	PRINCIPLES OF REQUIREMENT ENGINEERING	9 hrs

Principles that Guide Practice - Understanding Requirements - Requirements Modelling: Scenarios, Information, and Analysis Classes - Creating a Behavioral Model - Patterns for Requirements Modelling.

Unit – 3	DESIGN CONCEPTS AND DIFFERENT DESIGNS	9 hrs

Design Process - Design Concepts - Design Model - Software Architecture - Architectural Styles - Architectural Design - Architectural Design - Architectural Mapping Using Data Flow - Component - Designing Class-Based Components - Conducting Component-Level Design - User Interface Analysis andDesign - Interface Analysis - Interface Design Steps.

Unit – 4	SOFTWARE TESTING AND TESTING OF CONVENTIONAL AND OBJECT-ORIENTED APPLICATIONS	9 hrs

A Strategic Approach to Software Testing - Test Strategies for Conventional Software -Test Strategies forObject-Oriented Software - Validation and System testing - Basis Path Testing - Control Structure Testing - Black-Box Testing - Model-Based Testing - Object-Oriented Testing Strategies - Object-Oriented Testing Methods - Testing Methods Applicable at the Class Level.

Unit – 5	SOFTWARE CONFIGURATION MANAGEMENT, ESTIMATION OF PROJECT SCHEDULING AND RISK MANAGEMENT	9 hrs

Software Configuration Management - SCM Repository - SCM Process- Estimation - Resources - Software Project Estimation - Decomposition Techniques - Empirical Estimation Models - Project Scheduling - Defining a Task Set for the Software Project - Scheduling - Software Risks - Risk Identification – Risk Projection - Risk Mitigation, Monitoring, and Management.

Text / Reference Books:

1. Roger S.Pressman, Bruce R. Maxim, Software Engineering: A Practitioner's Approach, McGraw HillInternational edition, Eighth edition, 2022
2. Ian Sommerville, Software Engineering, Pearson Education, Tenth edition, 2015
3. Stephan Schach, Object Oriented and classical Software Engineering, Tata McGraw Hill, Eighth edition, 2016

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	1	1	1	1
CO2	3	3	2	2	1	-	1
CO3	3	3	3	2	2	1	1
CO4	3	3	2	3	2	-	1
CO5	3	3	3	2	2	1	2

CSC2035	OBJECT ORIENTED PROGRAMMING USING JAVA	3 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain object-oriented programming concepts and Java programming fundamentals	Understand
CO2	Develop Java programs using classes, objects, constructors, methods, and access control mechanisms	Apply
CO3	Apply inheritance, interfaces, packages, and exception handling techniques in Java applications	Apply
CO4	Develop multithreaded applications and utilize Java collection frameworks effectively	Apply
CO5	Develop Java applications using I/O handling, JDBC, and networking concepts	Create

b. Syllabus

Unit – 1	OVERVIEW OF OOP AND INTRODUCTION TO JAVA	9 hrs

Structured Programming and its limitation – Object-Oriented Paradigm: Basic concepts of Object-Oriented Programming (OOP) – Structured Programming vs OOP – Benefits of OOP – Object Modeling – Association – Aggregation and Generalization. Introduction to Java – Evolution of Java – Features of Java – Java Environment – JVM – Data types – variables – operators – Decision statements – Control Structures – Loops – Arrays in Java – Strings in Java – String Buffer Class – Wrapper Classes.

Unit – 2	OBJECTS AND CLASSES	9 hrs

Introducing Classes - Class Fundamentals - Declaring Objects - Object Reference Variables - Introducing Methods - Constructors - this Keyword - Garbage Collection - A Closer Look at Methods and Classes - Overloading Methods - Objects as Parameters - Returning Objects - Access control - static - final - nestedand inner class - Command line arguments.

Unit – 3	INHERITANCE, PACKAGES, INTERFACES AND EXCEPTION HANDLING	9 hrs

Inheritance in Java – Constructors in Inheritance – super – Multilevel Inheritance – Overriding – DynamicMethod Dispatch – final Keyword – Interfaces – Packages – JAR files – Exception Handling.

Unit – 4	MULTI THREADING AND JAVA COLLECTIONS	9 hrs

Threads – Multithreading in Java – Thread Priorities – Creating Multiple Threads – Inter Thread Communication – Synchronization – Suspending, Resuming and Stopping Threads – Collections Overview– Collection Interfaces – Collection Classes – Accessing collection via Iterator.

Unit – 5	JAVA I/O, JDBC AND JAVA NETWORKING	9 hrs

I/O Basics - Reading Console Input - Java I/O Classes and Interfaces - Serialization. Networking Classes and Interfaces – Inet Address - TCP/IP Client Sockets - URL - URL Connection - JDBC Driver, Database Connection Steps, Driver Manager Class, Statement Interface, ResultSet Interface.

Text / Reference Books:

1. Herbert Schildt, Java: The Complete Reference, McGraw-Hill, 12th edition, January 2022
2. Javin Paul, Grokking the Java Interview: Prepare for Java interviews by learning essential Core Javaconcepts and APIs, , Kindle Edition, 2020
3. Kishori Sharan, Adam L. Davis, Beginning Java 17 Fundamentals, Springer Nature, 2022

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	-	1	-	1
CO2	3	3	3	1	2	-	1
CO3	3	3	3	2	2	-	1
CO4	3	3	2	2	3	1	1
CO5	3	3	3	2	3	1	2

CSC2036	OPERATING SYSTEMS AND NETWORKS LAB	2 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Implement CPU scheduling algorithms	Apply
CO2	Implement client server communication mechanisms	Apply
CO3	Implement the HTTP and FTP using TCP	Apply
CO4	Develop chat applications	Create
CO5	Implement error detection and correction algorithms	Apply

b. Syllabus

Programs should include but not limited to:

i. Implementation of Scheduling algorithms – FCFS, SJF, RR etc
ii. Message Passing
iii. Shared Memory
iv. Implementation of HTTP using TCP
v. Exercise on implementation of FTP using TCP
vi. Exercise on implementation of Chat Application using UDP
vii. Implementation of Stop and Wait, GBN and SR
viii. Implementation of Error detection and Error correction

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	1	-	1
CO2	3	3	2	2	2	-	1
CO3	3	3	3	2	3	-	1
CO4	3	3	2	3	2	-	1
CO5	3	2	2	2	3	1	2

CSC2037	JAVA PROGRAMMING LAB	2 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Understanding Object-Oriented programming concepts using Java	Understand
CO2	Identification of classes, objects, members of a class and the relationships among them neededfor a finding the solution to specific problem	Apply
CO3	Illustration to achieve reusability using inheritance, interfaces, and packages and describes fasterapplication development can be achieved with exception handling mechanisms	Apply
CO4	Understanding concept of multithreading for robust faster and efficient application developmentand applications of collection interfaces in Java	Analyse
CO5	Learning of various I/O operations, connecting Java with databases using JDBC andimplementation of networking with Java	Apply

b. Syllabus

Programs should include but not limited to:
Programming Assignment on

i. Basic Problems
ii. Arrays
iii. Panagrams
iv. Duplicate Elements
v. Class – Objects – Constructors
vi. Access Specifiers
vii. Static and Non-static variables
viii. Packages and Interfaces
ix. Exception Handling
x. Multithreading
xi. JDBC and Networking

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	-	1	-	1
CO2	3	3	3	1	2	-	1
CO3	3	3	3	2	2	-	1
CO4	3	3	2	2	3	1	1
CO5	3	3	3	2	3	1	2

CSC2038	SOFT SKILLS	2 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Apply verbal reasoning, reading comprehension, and effective communication skills in professional contexts	Apply
CO2	Analyze logical reasoning problems using analytical and critical thinking techniques	Analyze
CO3	Solve quantitative aptitude problems involving arithmetic and algebraic concepts	Apply
CO4	Apply problem-solving and basic algorithmic skills to programming-related scenarios	Apply
CO5	Develop professional skills including resume preparation, interview handling, and data analysis techniques	Create

b. Syllabus

Unit – 1	VERBAL ABILITY	4 hrs
Verbal Reasoning – Sentence correction – Sentence completion – Reading Comprehension – Writing Skills – Effective Communication.		
Unit – 2	**LOGICAL REASONING**	**10 hrs**
Thinking Skills – Coding & Decoding – Series – Analogy – Odd man out – Visual Reasoning – Sudoku puzzles – Attention to details – Clocks – Calendars – Blood Relations.		
Unit – 3	**QUANTITATIVE APTITUDE**	**8 hrs**
Speed Maths – Algebra and Functions – Time and Work – Time, Speed and Distance – Profit and Loss - Ratios and Proportions		
Unit – 4	**PROBLEM SOLVING AND ALGORITHMIC SKILLS**	**4 hrs**
Logical methods to solve problem statements in programming – Basic algorithms		
Unit – 5	**DATA ANALYSIS AND PLACEMENT ESSENTIALS**	**4 hrs**
Data Interpretation – Data Sufficiency - Preparing effective resume – Impression management – Skype Interviews – Stress Interviews – Panel Interviews -		

Text / Reference Books:

1. FACE, Aptipedia Aptitude Encyclopedia, 2nd Edition, 2017, Wiley Publications, Delhi.
2. ETHNUS, Aptimithra, 2013, 1stEdition, McGraw-Hill Education Pvt.Ltd.
3. SMART, PlaceMentor, 2018, 1st Edition, Oxford University Press.
4. R S Aggarwal, Quantitative Aptitude For Competitive Examinations, 2017, 3rd Edition

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	2	1	-	-	2	2
CO2	2	3	1	1	-	1	1
CO3	2	2	1	1	-	-	1
CO4	2	3	2	1	1	-	1
CO5	1	2	2	1	1	3	3

SEMESTER – IV

CSC2041	PROJECT / DISSERTATION	12 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Identify, formulate, and analyze a research or real-world problem in Computer Science	Analyse
CO2	Design and develop a computational solution using appropriate methodologies and modern tools	Create
CO3	Conduct experiments, analyze results, and interpret findings to derive valid conclusions	Evaluate
CO4	Prepare technical reports and effectively present project outcomes through presentations and viva-voce	Apply
CO5	Demonstrate independent learning, ethical practices, project management, and professional responsibility during project execution	Apply

b. Description

The project done will be evaluated by the faculty members in the project review meetings. Two midterm reviews and one final review will be conducted where the student has to present the work done in the project followed by viva-voce. The complete work carried out has to be represented in the form of a project report. The report should also contain the plagiarism check report (max 10%) certified by the project guide.

The report should strictly follow the specifications of the report. Four copies should be submitted by the student. One copy will be returned to the student after evaluation.

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	1	1	2
CO2	3	3	3	2	3	2	2
CO3	3	3	2	3	2	1	2
CO4	2	2	2	2	1	3	2
CO5	2	2	3	2	2	3	3

CSC2042	COMPREHENSIVE VIVA-VOCE	3 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Demonstrate comprehensive understanding of core Computer Science concepts studied during the programme	Understand
CO2	Analyze and solve technical problems by integrating knowledge from multiple domains of Computer Science	Analyze
CO3	Apply theoretical knowledge and practical skills acquired through laboratory courses, internship, and project work	Apply
CO4	Evaluate recent technological developments and emerging trends in Computer Science and related applications	Evaluate
CO5	Communicate technical concepts, project outcomes, and problem-solving approaches effectively during viva-voce examinations	Apply

b. Description

The comprehensive viva-voce should be based on the theoretical knowledge, skills and the practices which the students have undergone during the entire programme duration. It is based on all the courses studied, covering the latest technical developments and technologies learned during the internship and in the project.

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	1	-	1
CO2	3	3	2	2	1	-	1
CO3	3	3	3	2	2	1	1
CO4	2	3	2	3	2	-	2
CO5	2	2	3	1	1	3	2

CSC2043	RESEARCH METHODOLOGY	3 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain research concepts, research types, and characteristics of scientific investigation	Understand
CO2	Analyze research problems, perform literature review, and formulate appropriate research designs	Analyze
CO3	Apply data collection methods, sampling techniques, hypothesis testing, and statistical analysis methods in research	Apply
CO4	Apply quantitative methods including probability distributions, correlation, regression, and time series analysis for research studies	Apply
CO5	Demonstrate ethical research practices and prepare technical research reports following academic standards	Apply

b. Syllabus

Unit – 1	INTRODUCTION TO RESEARCH	9 hrs

Introduction to research; Definitions and characteristics of research; Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, Main components of any research work.

Unit – 2	PROBLEM FORMULATION AND DESIGN	9 hrs

Defining and formulating the research problem: Selecting the problem - Necessity of defining the problem, Literature review: Importance of literature review in defining a problem, Primary and secondary sources –reviews, treatise, and monographs-patents – web as source – searching in the web - Critical literature review – Identifying gap areas from literature review. Essentials of Research Design, Need for Research Design, Classifications of Research Design: causations and Experimental Design, Errors in Research Design, Types of Research Errors.

Unit – 3	DATA COLLECTION	9 hrs

Observation and Collection of data, Methods of data collection, Different types of variables, Sampling Methods- Data Processing and Analysis strategies - Data Analysis with Statistical Packages, Hypothesis-testing, Generalization and Interpretation

Unit – 4	QUANTITATIVE METHODS	9 hrs
Probability Distributions, Fundamentals of Statistical Analysis and Inference, Multivariate methods, Concepts of Correlation and Regression, Fundamentals of Time Series Analysis and Spectral Analysis		
Unit – 5	**ETHICS AND REPORT WRITING**	**9 hrs**
Ethical issues - Copy right - Intellectual property rights and patent law - Reproduction of published material - Plagiarism - Citation and acknowledgement - Reproducibility and accountability. Structure and Components of Research Report, Types of Report, Layout of Research Report, Mechanism of writing a research report.		

Text / Reference Books:

1. Ranjit Kumar," Research Methodology: A Step-by-Step Guide for Beginners", SAGE Publications Ltd; Fourth edition, 2014.
2. C.R. Kothari, " Research Methodology: Methods and Techniques", NEW AGE; Second Edition, 2014.
3. Peter Pruzan, "Research Methodology: The Aims, Practices and Ethics of Science", Springer; First Edition, 2016
4. Andries P. Engelbrecht "Computational Intelligence: An Introduction", Wiley-Blackwell; 2nd Edition, 2007.
5. Anthony J. Hayter "Probability and Statistics for Engineers and Scientists", CENGAGE Learning Custom Publishing; 4th edition, 2011.
6. Bernard C. Beins and Maureen A. McCarthy "Research Methods and Statistics" Pearson, 2011
7. Colin Neville "The Complete Guide to Referencing and Avoiding Plagiarism", Open University Press, 2007.
8. Dinesh Kumar, Research Methods for Successful PhD, River Publishers Series in Innovation and Change in Education- Cross Cultural Perspective, 2017 (ISBN: 9788793609181).
9. Marc van Dongen, LaTeX and Friends, Springer, Feb. 29, 2012 (ISBN 978-3-642-23815-4).

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	2	1	1	-	-	2
CO2	3	3	2	2	1	-	2
CO3	3	3	2	3	2	-	2
CO4	3	3	2	3	2	-	2
CO5	2	2	1	2	1	1	3

BRIDGE COURSES

The bridge courses are designed for students who have completed their UG degree in science stream having four mathematics papers studied. These courses support the students to learn and understand the fundamentals of computers and develop the logic skills.

CSCBC01	INTRODUCTION TO COMPUTERS	10 hrs

Topics covered in this course should include but not limited to:

i. Parts of a computer
ii. Hardware – Software -
iii. System Configuration
iv. Office Tools
v. Internet Concepts

CSCBC02	PROBLEM SOLVING TECHNIQUES	10 hrs

Topics covered in this course should include but not limited to:

i. Summation of a set of numbers
ii. Reversing the digits of an integer
iii. Character to Number conversion
iv. Smallest Divisor of an integer
v. Linear Pattern Search
vi. Computing nth Fibonacci number

DISCIPLINE SPECIFIC ELECTIVES

CSCEC01	COMPUTATIONAL INTELLIGENCE	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain the concepts, paradigms, and applications of soft computing techniques	Understand
CO2	Apply artificial neural network models and learning algorithms for intelligent system development	Apply
CO3	Analyze fuzzy sets, fuzzy relations, and membership functions for handling uncertainty and imprecision	Analyze
CO4	Apply fuzzy logic and fuzzy rule-based systems for classification and pattern recognition problems	Apply
CO5	Analyze rough set theory and knowledge reduction techniques for intelligent decision-making systems	Analyze

b. Syllabus

Unit – 1	INTRODUCTION TO SOFT COMPUTING	6 hrs
Introduction to Soft Computing – Evolutionary Computing – Hard computing vs Soft computing – RecentTrends in Soft Computing.		
Unit – 2	**ARTIFICIAL NEURAL NETWORKS**	**18 hrs**
History – Mathematical model of neuron – ANN architectures – Learning rules and paradigms – Perceptron – Back propagation Network – BPA Learning – Associative Memory: Auto Correlation and Hetero correlation – Self Organizing Map.		
Unit – 3	**FUZZY SETS AND RELATIONS**	**12 hrs**
Uncertainty and Imprecision - Chance vs ambiguity - Classical Sets and Fuzzy Sets - Classical Relations andFuzzy Relations - Membership functions - Properties of Membership functions - Fuzzification and Defuzzification.		
Unit – 4	**FUZZY LOGIC**	**12 hrs**
Classical Logic and Fuzzy logic – Fuzzy Rule based systems – Fuzzy Classification – Fuzzy Pattern Recognition.		
Unit – 5	**ROUGH SETS**	**12 hrs**
Introduction to Rough Sets - Information Tables and Attributes – Set Approximation - Knowledge representation and reduction systems – Comparison with other systems – Case studies.		

Text / Reference Books:

1. S. Haykins, Neural Networks and Learning Machines 3e: Pearson Education India, Third edition, April 2016
2. T.J.Ross, Fuzzy Logic with Engineering Applications, Wiley-Blackwell, Fourth edition, November 2016
3. S. Rajasekaran and G.A.V. Pai, Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis andApplications, Second edition, PHI Learning, July 2017
4. J.M. Zurada,, Introduction to Artificial Neural systems, Jaico Publishing House, 2009
5. C.M. Bishop, Pattern Recognition and Machine Learning, Springer First edition, August 2016

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	2	2	2	2
CO2	3	2	2	2	2	2	2
CO3	3	2	2	2	2	2	2
CO4	3	2	2	2	2	2	2
CO5	3	2	2	2	2	2	2

CSCEC02	BIG DATA ANALYTICS	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain big data concepts, analytics processes, storage mechanisms, and big data processing frameworks	Understand
CO2	Apply Hadoop and MapReduce programming techniques for distributed data processing	Apply
CO3	Develop big data applications using Apache Spark, Spark SQL, Spark Streaming, and MLlib	Apply
CO4	Apply NoSQL database concepts and MongoDB operations for handling large-scale unstructured data	Apply
CO5	Analyze Cassandra databases and data visualization tools for big data analysis and presentation	Analyze

b. Syllabus

Unit – 1	INTRODUCTION TO BIG DATA ANALYTICS	12 hrs
Big Data Technology Foundations – Challenges of Conventional Systems - Five Vs - Data analysis – Natureof Data – Big data analytic processes - Ingesting data into the system - Persisting the data in storage - Computing and Analyzing data - Visualizing the results – Processing and Analyzing Big Data batch processing - Stream Processing – overview on big data tools applied in different stages of Big data.		
Unit – 2	**MAP REDUCE**	**12 hrs**
Introduction – Distributed file system – Map Reduce – Stages in Map Reduce - MapReduce Architecture - Algorithms using map reduce, Matrix-Vector Multiplication by Map Reduce – Hadoop - Understanding the Map Reduce architecture - Writing Hadoop MapReduce Programs - Loading data into HDFS -Executing the Map phase - Shuffling and sorting - Reducing phase execution.		
Unit – 3	**SPARK**	**12 hrs**
Introduction to data analysis with spark - Programming with RDDs – working with key value pairs –loading and saving your data – Spark SQL – Spark Streaming – Apache spark MLIB – Machine Learning with MLib – Development of real time applications using SPARK.		
Unit – 4	**NOSQL**	**12 hrs**
NoSQL: Types of Databases – Advantages - No SQL databases: Mongo DB: Introduction – Features – Data types – Mongo DB Query language – CRUD operations – Arrays – Functions: Count – Sort – Limit – Skip –Aggregate – Map Reduce. Cursors – Indexes – Mongo Import – Mongo Export.		
Unit – 5	**CASSANDRA AND DATA VISUALIZATION**	**12 hrs**

Cassandra: Introduction – Features – Data types – CQLSH – Key spaces – CRUD operations – Collections – Counter – TTL – Alter commands – Import and Export – Querying System tables. Big Data Visualization - Basics - Trends in Data Visualization - Interactive Graphics - Visualization Designers – Use of Data Visualization - Visualization Process Into Practice - Visualization Software - TABLEAU DESKTOP - Elastic Stack, Apache Solr and Banana.

Text / Reference Books:

1. Raj Kamal, Preeti Saxena, Big Data Analytics, Introduction to Hadoop, Spark, and Machine-Learning,McGraw-Hill India, 2019
2. Subhashini Chellappan, Seema Acharya, Big Data and Analytics, Wiley, 2ed, 2019,
3. Big Data Fundamentals by Thomas Erl, PEARSON INDIA, 2016
4. Jure Leskovec, Anand Rajaraman, Jeffrey D. Ullman, “Mining of Massive Datasets”, CambridgeUniversity Press, 2014.
5. Boris lublinsky, Kevin t. Smith, Alexey Yakubovich, “Professional Hadoop Solutions”, Wiley, 2015.
6. Chris Eaton, Dirk deroos et al. , “Understanding Big data ”, McGraw Hill, 2012.
7. Tom White, “HADOOP: The definitive Guide” , O Reilly 2012.
8. Spark - The Definitive Guide, Bill Chambers and Matei Zaharia, 2018, O'Reilly Media, Inc,USA,
9. Holden Karau, Andy Konwinski, Patrick Wendell & Matei Zaharia, Learning Spark Lightning Fast Data Analysis, O’Reilly, 2015
10. Josh Wills, Sandy Ryza, Sean Owen, and Uri Laserson, Advanced Analytics with Spark:
11. Patterns for Learning from Data at Scale 2nd Edition, O'Reilly, 2016
12. Sosulski kristen, Data visualization made simple insights into becoming visual, 2019, Routledge
13. Kieran Healy , Data Visualization: A Practical Introduction Paperback, 2018

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	2	2	2	2
CO2	3	2	2	2	2	2	2
CO3	3	2	2	2	2	2	2
CO4	3	2	2	2	2	2	2
CO5	3	2	2	2	2	2	2

CSCEC03	DIGITAL IMAGE PROCESSING	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain the fundamental concepts of digital image processing, image acquisition, spatial filtering, and histogram processing	Understand
CO2	Analyze image transform techniques in spatial and frequency domains for image representation and processing	Analyze
CO3	Apply image enhancement and restoration techniques in spatial and frequency domains for improving image quality	Apply
CO4	Apply morphological processing and segmentation techniques for object extraction and image analysis	Apply
CO5	Analyze feature extraction and object detection techniques for image representation and pattern analysis	Analyze

b. Syllabus

Unit – 1	BASICS OF DIGITAL IMAGE PROCESSING	12 hrs
Introduction – Fundamental Steps in DIP – Elements of Visual Perception – Image Sensing and Acquisition – Image Sampling and Quantization – Pixel Relationships – Intensity Transformations – Histogram Processing – Convolution – Spatial Filtering – Smoothing and Sharpening in Spatial Domain		
Unit – 2	**IMAGE TRANSFORMS**	**12 hrs**
Unitary Transforms – Two Dimensional Discrete Fourier Transform – Fast Fourier Transform - TwoDimensional Discrete Cosine Transformation – KL Transform – Hadamard Transform – Haar Transform		
Unit – 3	**IMAGE ENHANCEMENT IN FREQUENCY DOMAIN AND IMAGE RESTORATION**	**12 hrs**
Concept of Frequency Domain – Filtering in Frequency Domain – Smoothing and Sharpening in FrequencyDomain – Image Degradation and Restoration Process – Noise Models – Restoration in the presence of Noise only using Spatial Filtering – Periodic Noise Reduction using Frequency Domain Filtering – Linear Position Invariant Degradation - Inverse Filtering		
Unit – 4	**MORPHOLOGICAL PROCESSING AND IMAGE SEGMENTATION**	**12 hrs**
Preliminaries – Erosion and Dilation – Opening and Closing – Basic Morphological Algorithms – Segmentation Fundamentals – Point-Line Detection – Edge Detection – Thresholding – Region Based Segmentation		

Unit – 5	FEATURE EXTRACTION AND OBJECT DETECTION	12 hrs
Basic Representations – Boundary Descriptors – Regional Descriptors – SIFT – Local Binary Pattern – LocalDirectional Pattern – Dimensionality Reduced Local Directional Pattern		

Text / Reference Books:

1. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, Pearson, Fourth edition, July 2018.
2. Anil K. Jain, Fundamentals of Digital Image Processing, Pearson, 2002.
3. Kenneth R. Castleman, Digital Image Processing, Pearson Education India, First edition,2007.
4. William K. Pratt, Digital Image Processing, John Wiley & Sons, Fourth edition, 2007
5. Milan Sonka et al, Image Processing, Analysis, and Machine Vision with MindTap, Cengage India Private Limited; Fourth edition, 2017

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	2	2	2	2
CO2	3	3	3	2	2	2	2
CO3	3	3	3	2	2	2	2
CO4	3	3	3	2	2	2	2
CO5	3	3	3	2	2	2	2

CSCEC04	DATA WAREHOUSING AND DATA MINING	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain data warehousing concepts, OLAP operations, and multidimensional data analysis techniques	Understand
CO2	Apply data preprocessing and association rule mining techniques for knowledge discovery from data	Apply
CO3	Analyze classification and prediction techniques for data mining applications	Analyze
CO4	Apply clustering and outlier analysis techniques for pattern discovery in large datasets	Apply
CO5	Analyze mining techniques for spatial, multimedia, text, and web data applications	Analyze

b. Syllabus

Unit – 1	DATA WAREHOUSING AND BUSINESS ANALYSIS	12 hrs

Data warehousing Components –Building a Data warehouse –Data Warehouse Architecture – DBMS Schemas for Decision Support – Data Extraction, Cleanup, and Transformation Tools –Metadata – reporting – Query tools and Applications – Online Analytical Processing (OLAP) – OLAP and Multidimensional Data Analysis.

Unit – 2	DATA MINING & ASSOCIATION RULE MINING	12 hrs

Data Preprocessing – Data Cleaning – Data Integration and Transformation – Data Reduction – Data Discretization and Concept Hierarchy Generation- Architecture Of A Typical Data Mining Systems- Classification Of Data Mining Systems- Efficient and Scalable Frequent Item set Mining Methods – MiningVarious Kinds of Association Rules – Association Mining to Correlation Analysis – Constraint-Based Association Mining.

Unit – 3	CLASSIFICATION AND PREDICTION	12 hrs

Issues Regarding Classification and Prediction – Classification by Decision Tree Introduction – Bayesian Classification – Rule Based Classification – Classification by Back propagation – Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods – Prediction – Accuracy and Error Measures – Evaluating the Accuracy of a Classifier or Predictor – Ensemble Methods – Model Selection.

Unit – 4	CLUSTER ANALYSIS	12 hrs
Types of Data in Cluster Analysis – A Categorization of Major Clustering Methods – Partitioning Methods – Hierarchical methods – Density-Based Methods – Grid-Based Methods – Model-Based ClusteringMethods – Clustering High-Dimensional Data – Constraint-Based Cluster Analysis – Outlier Analysis.		
Unit – 5	**MINING OBJECT, SPATIAL, MULTIMEDIA, TEXT AND WEB DATA**	**12 hrs**
Multidimensional Analysis and Descriptive Mining of Complex Data Objects – Spatial Data Mining – Multimedia Data Mining – Text Mining – Mining the World Wide Web.		

Text / Reference Books:

1. Jiawei Han, Micheline Kamber and Jian Pei, Data Mining Concepts and Techniques, Elsevier, Thirdedition, 2011.
2. Alex Berson and Stephen J. Smith, Data Warehousing, Data Mining & OLAP, Tata McGraw – HillEdition, Tenth Reprint 2007.
3. K.P. Soman, Shyam Diwakar and V. Ajay, Insight into Data mining Theory and Practice, Easter Economy Edition, Prentice Hall of India, 2006.
4. G. K. Gupta, Introduction to Data Mining with Case Studies, Easter Economy Edition, Prentice Hall ofIndia, 2006.
5. Pang-Ning Tan, Michael Steinbach and Vipin Kumar, Introduction to Data Mining, Pearson Education,2007.

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	2	2	3	1	1
CO2	2	3	3	3	3	2	2
CO3	2	2	2	2	3	2	2
CO4	2	2	1	2	3	2	2
CO5	3	2	2	3	3	1	2

CSCEC05	PATTERN RECOGNITION	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain Bayesian decision theory and probabilistic approaches used in pattern recognition system	Understand
CO2	Analyze maximum likelihood estimation, Bayesian estimation, EM algorithms, and probabilistic graphical models	Analyze
CO3	Apply linear and non-linear classification techniques for pattern classification problems	Apply
CO4	Analyze structural pattern recognition techniques using grammars, parsing, and graph-based representations	Analyze
CO5	Apply feature selection and feature generation techniques for efficient pattern recognition and dimensionality reduction	Apply

b. Syllabus

Unit – 1	INTRODUCTION TO PATTERN RECOGNITION AND BAYESIAN DECISION THEORY	12 hrs

Machine Perception – Sub-problems of Pattern Classification – Learning and Adaptation – BayesianDecision Theory – Continuous Features – Minimum Error Rate Classification – Classifiers – Discriminants – Decision Surfaces – Normal Density – Discriminant Functions for Normal Density – Bayesian DecisionTheory for Discrete Features

Unit – 2	MAXIMUM LIKELIHOOD AND BAYESIAN ESTIMATION	12 hrs

Maximum Likelihood Estimation – Bayesian Estimation – Bayesian Parameter Estimation: General Theory and Gaussian Case – Problems on Dimensionality – Expectation-Maximization – Bayesian Belief Networks – Hidden Markov Models

Unit – 3	LINEAR AND NON-LINEAR CLASSIFIERS	12 hrs

Linear Discriminant Functions and Decision Hyperplanes – Perceptron – Least Squares Methods – MeanSquare Estimation – XOR Problem – SVM for XOR Problem – Polynomial Classifiers – Radial Basis FunctionNetworks

Unit – 4	STRUCTURAL PATTERN RECOGNITION	12 hrs

Elements Of Formal Grammars – String Generation as Pattern Description – Recognition of SyntacticDescription – Parsing – Stochastic Grammars and Applications - Graph based Structural Representation.

Unit – 5	FEATURE SELECTION AND GENERATION	12 hrs

Feature Selection: Pre-processing – Hypothesis Testing – ROC Curve – Feature Subset Selection. FeatureGeneration: Basis Vectors and Images – KL Transform – Singular Value Decomposition – Independent Component Analysis.

Text / Reference Books:

1. Duda R.O., and Hart.P.E., David G Stork, Pattern Recognition, Second Edition, Wiley, May 2021.
2. Duda R.O., Hart P.E., Pattern Classification, Wiley, Second edition, January 2012.
3. Sergios Theodoridis and K. Koutroumbas , Pattern Recognition, Fourth edition, Elsevier, 2008.
4. Robert J.Schalkoff, Pattern Recognition:, Statistical, Structural and Neural Approaches,John Wiley &Sons Inc., New York, 2007.
5. Trevor H, Robert T,Jerome Friedman, The Elements of Statistical Learning, SpringerSeries,2017
6. C.M. Bishop, Pattern Recognition and Machine Learning, Springer First edition, August 2016

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	2	2	2	2
CO2	3	3	3	2	2	2	2
CO3	3	3	3	2	2	2	2
CO4	3	3	3	2	2	2	2
CO5	3	3	3	2	2	2	2

CSCEC06	NATURAL LANGUAGE PROCESSING	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain the fundamental concepts, challenges, and real-world applications of Natural Language Processing	Understand
CO2	Apply text processing techniques including character encoding, segmentation, and corpus analysis for language data processing	Apply
CO3	Analyze lexical syntax and language modelling techniques including POS tagging and N-gram models	Analyze
CO4	Apply syntactic and semantic analysis techniques for language understanding and interpretation	Apply
CO5	Analyze and develop NLP applications such as sentiment analysis, text summarization, machine translation, and question answering systems	Analyze

b. Syllabus

Unit – 1	INTRODUCTION TO NLP	12 hrs

Introduction to various levels of natural language processing, Ambiguities and computational challengesin processing various natural languages. Introduction to Real life applications of NLP such as spell and grammar checkers, information extraction, question answering, and machine translation.

Unit – 2	TEXT PROCESSING	12 hrs

Character Encoding, Word Segmentation, Sentence Segmentation, Introduction to Corpora, Corpora Analysis.

Unit – 3	LEXICAL SYNTAX AND LANGUAGE MODELLING	12 hrs

Introduction to word types, POS Tagging, Maximum Entropy Models for POS tagging, Multi-word Expressions. The role of language models. Simple N-gram models. Estimating parameters and smoothing. Evaluating language models.

Unit – 4	SYNTAX & SEMANTICS	12 hrs

Introduction to phrases, clauses and sentence structure, Shallow Parsing and Chunking, Shallow Parsing with Conditional Random Fields (CRF), Lexical Semantics, Word Sense Disambiguation, WordNet, Thematic Roles, Semantic Role Labelling with CRFs.

Unit – 5	APPLICATIONS OF NLP	12 hrs

NL Interfaces, Text Summarization, Sentiment Analysis, Machine Translation, Question answering.

Text / Reference Books:

1. Chris Manning and Hinrich Schütze, Foundations of Statistical Natural Language Processing, MITPress Cambridge, MA, Second edition, 2003.
2. NitinIndurkhya, Fred J. Damerau, Handbook of Natural Language Processing, CRC Press, Secondedition,2010.
3. James Allen, Natural Language Understanding, Pearson Publication, Eighth edition. 2012.
4. Daniel Jurafsky and James H. Martin , Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition , Pearson Education 2014, 2e
5. Steven Bird, Ewan Klein, Edward Loper, Natural Language Processing with Python: Analyzing Text with the Natural Language Toolkit, O'Reilly, 2009 ISBN-13978-0596516499

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	2	2	2	2
CO2	3	2	2	2	2	2	2
CO3	3	2	2	2	2	2	2
CO4	3	2	2	2	2	2	2
CO5	3	2	2	2	2	2	2

CSCEC07	PRINCIPLES OF DEEP LEARNING	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain deep learning architectures, activation functions, optimization techniques, and neural network regularization methods	Understand
CO2	Analyze convolutional neural network architectures and apply transfer learning techniques for deep learning applications	Analyze
CO3	Apply deep learning frameworks, preprocessing techniques, and training strategies for neural network optimization	Apply
CO4	Analyze recurrent neural networks and sequence-to-sequence architectures for sequential data processing	Analyze
CO5	Apply autoencoders and deep generative models for representation learning and generative tasks	Apply

b. Syllabus

Unit – 1	INTRODUCTION TO DEEP LEARNING & ARCHITECTURES	12 hrs
Machine Learning Vs. Deep Learning – Representation Learning – Width Vs. Depth of Neural Networks -Activation Functions: RELU – LRELU – ERELU –Unsupervised Training of Neural Networks – Regularization Dropout - Drop connect – Optimization methods for neural networks – Adagrad – Adadelta – Rmsprop Adam – NAG.		
Unit – 2	**CONVOLUTIONAL NEURAL NETWORKS & TRANSFER LEARNING**	**12 hrs**
Architectural Overview – Motivation - Layers – Filters – Parameter sharing – Regularization - Popular CNN Architectures: LeNet – ResNet – Vggnet – AlexNet. Transfer learning Techniques –DenseNet – PixelNet.		
Unit – 3	**TRAINING NEURAL NETWORKS**	**12 hrs**
Deep Learning Hardware and Software – CPUs – GPUs – TPUs – PyTorch – TensorFlow – Dynamic vs Static computation graphs – Data Preprocessing – Data Augmentation – Batch Normalization – Transfer Learning – Deep Transfer Learning Strategies – Update Rules - Hyperparameter Tuning – Learning RateScheduling – Variants of CNN – ResNet – GoogleNet – Xception etc		
Unit – 4	**RECURRENT NEURAL NETWORKS**	**12 hrs**

Recurrent Neural Networks – Bidirectional RNNs – Encoder-decoder sequence to sequence Architectures – Backpropagation Through Time for training RNN – Long Short Term Memory Networks.

Unit – 5	AUTO ENCODERS AND DEEP GENERATIVE MODELS	12 hrs

Under complete Autoencoders – Regulraized Autoencoders – Sparse Autoencoders – Denoising Autoencoders –Representational Power – Layer – Size and Depth of Autoencoders – Stochastic Encodersand Decoders – Contractive Encoders – Deep Belief networks – Boltzmann Machines – Deep Boltzmann Machine – Generative Adversarial Networks.

Text / Reference Books:

1. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning (AdaptiveComputation and Machine Learning series), First edition, The MIT Press, 2016
2. Josh Patterson, Adam Gibson, Deep Learning: A Practitioner's Approach, First edition,O'Reilly Media, 2017
3. Giancarlo Zaccone, Md. Rezaul Karim, Ahmed Menshawy, Deep Learning withTensorFlow: Explore neural networks with Python, First edition, Packt Publisher, 2017

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	2	2	2	2
CO2	3	3	3	2	2	2	2
CO3	3	3	3	2	2	2	2
CO4	3	3	3	2	2	2	2
CO5	3	3	3	2	2	2	2

CSCEC08	DEEP LEARNING IN COMPUTER VISION	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain image processing, computer vision, and deep learning concepts used in visual recognition systems	Understand
CO2	Analyze convolutional neural network architectures and convolutional feature extraction techniques for visual recognition tasks	Analyze
CO3	Apply deep learning-based object detection techniques for localization and recognition problems	Apply
CO4	Analyze object tracking, optical flow, and action recognition techniques for video analytics applications	Analyze
CO5	Apply deep learning models for image segmentation, image synthesis, and advanced computer vision applications	Apply

b. Syllabus

Unit – 1	INTRODUCTION TO IMAGE PROCESSING, COMPUTER VISION AND DEEP LEARNING	12 hrs
Introduction to Computer Vision-Digital Images-Structure of Human Eye And Vision - Color Models - Image Processing Goals and Tasks - Contrast and Brightness Correction - Image Convolution - Edge Detection - Basic Image Processing- Neural Networks And Machine Learning - Convolutional Neural Networks (CNNs) and its Building Blocks - Object Detection/Localization with Deep Learning - Pre-TrainedImagenet Networks - Training Large-Scale (Imagenet-Level) Networks.		
Unit – 2	**CONVOLUTION FEATURES FOR VISUAL RECOGNITION**	**12 hrs**
Recap: Image Classification - Alexnet, VGG and Inception Architectures - Resnet and Beyond - Fine-Grained Image Recognition - Detection and Classification of Facial Attributes - Content-Based Image Retrieval - Computing Semantic Image Embedding Using Convolutional Neural Networks - Employing Indexing Structures for Efficient Retrieval of Semantic Neighbours - Face Verification - The Re-Identification Problem in Computer Vision - Facial Keypoints Regression - CNN for Key Points Regression - Convolutional Features for Visual Recognition - Case Study: Smile Detection.		
Unit – 3	**OBJECT DETECTION**	**12 hrs**

Object Detection Problem - Sliding Windows - HOG-Based Detector - Detector Training - Viola-Jones FaceDetector - Attentional Cascades and Neural Networks - Region-Based Convolutional Neural Network - From R-CNN to Fast R-CNN - Faster R-CNN - Region-Based Fully-Convolutional Network - Single Shot Detectors - Speed Vs. Accuracy Trade-off - Fun with Pedestrian Detectors - Uncover Common Architectures & Training Patterns - Spot Underfitting and Overfitting - Decay And Learning Rate Schedulers.

Unit – 4	OBJECT TRACKING AND ACTION RECOGNITION	12 hrs

Introduction to Video Analysis - Optical Flow - Deep Learning in Optical Flow Estimation - Visual Object Tracking - Examples of Visual Object Tracking Methods - Multiple Object Tracking - Examples of Multiple Object Tracking Methods - Introduction to Action Recognition - Action Classification - Action Classificationwith Convolutional Neural Networks - Action Localization.

Unit – 5	IMAGE SEGMENTATION AND SYNTHESIS	12 hrs

Image Segmentation – Over Segmentation - Deep Learning Models for Image Segmentation - Human Pose Estimation as Image Segmentation - Style Transfer - Generative Adversarial Networks - Image SuperResolution - Imagenet: Large Scale Visual Recognition Challenge - Image Transformation with Neural Networks - Case Study: Age + Gender Recognition - Case Study: Emotion And Facial Expression Recognition.

Text / Reference Books:

1. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning (Adaptive Computation andMachine Learning series), First edition, The MIT Press, 2016
2. Grokking Deep Learning by Andrew W. Trask, 2019, Manning publications
3. Neural Networks and Deep Learning by Michael Nielsen.2015, Determination Press (2015);eBook (NeuralNetworksAndDeepLearning.com); CC BY-NC 3.0
4. Deep Learning for Computer Vision: Expert techniques to train advanced neural networks usingTensorFlow and Keras, 2018, Packt Publishing; 1 edition (23 January 2018), ISBN: 1788295625
5. Computer Vision: Algorithms and Applications (Texts in Computer Science) 2011th Edition byRichard Szeliski, @ 2010 Springer
6. C. Solomon, T. Breckon, Fundamentals of Digital Image Processing.A Practical Approach withExamples in Matlab, Wiley-Blackwell, ISBN: 978-0-470-84472-
7. Digital Image Processing Using MATLAB, 2nd Edition by Rafael C. González, Richard EugeneWoods, Steven L. Eddins, 2017, Gatesmark Publishing; 2nd edition (2009)
8. Feature Extraction and Image Processing for Computer Vision, Third Edition, Mark Nixon, 2012,Academic Press, ISBN: 0123965497
9. Image Processing: The Fundamentals, Maria Petrou,Costas Petrou, 2nd edition, © 2010 JohnWiley & Sons, ISBN: 047074586X,2010

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	2	2	2	2

CO2	3	3	3	2	2	2	2
CO3	3	3	3	2	2	2	2
CO4	3	3	3	2	2	2	2
CO5	3	3	3	2	2	2	2

CSCEC09	ARTIFICIAL EMOTIONAL INTELLIGENCE	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain the concepts, foundations, and applications of Artificial Emotional Intelligence and affective computing	Understand
CO2	Analyze affective computing techniques, emotional context recognition, and intelligent interaction systems	Analyze
CO3	Apply emotion recognition techniques for facial, speech, and text-based emotional analysis	Apply
CO4	Analyze machine learning and deep learning models for emotion classification and multimodal emotional intelligence systems	Analyze
CO5	Evaluate ethical issues, privacy concerns, and societal implications related to Artificial Emotional Intelligence systems	Evaluate

b. Syllabus

Unit – 1	INTRODUCTION TO ARTIFICIAL EMOTIONAL INTELLIGENCE	12 hrs
Introduction to Artificial Emotional Intelligence- Concept of Emotional Intelligence, Defining the Research Problem in AEI, Difference between AI and AEI, Affective Computing emotion, application, mood, attitude/sentiment, personality chatbots, robots, smartphones with emotional intelligence.		
Unit – 2	**AFFECTIVE COMPUTING AND INTERACTION**	**12 hrs**
Affective Technology Interaction- Visual, Verbal and Vocal, Intelligent agents, Feature Extraction Techniques, Eulerian Motion Magnification, Viola-Jones face detector, Computational Appraisal Theory, Emotion and Learning, reinforcement learning based approaches, recognizing emotional context, facial affect recognition		
Unit – 3	**EMOTION RECOGNITION**	**12 hrs**

Emotionally Intelligent-Human Computer Interaction, Emotion and Perception, Facial Emotion Recognition, Text Emotion Recognition, Speech Emotion Recognition techniques, Auto encoders and relation to PCA, Learning representations and multimodal.

Unit – 4	EMOTIONS CLASSIFICATION	12 hrs

Supervised learning, Unsupervised learning, Reinforcement learning, Clustering, Classifiers: Bayes, K- Nearest Neighbor, Artificial Neural Network models, Spatio-temporal analysis, Convolutional Neural Networks, Recurrent Neural Networks, Back propagation through time. Neurological Mechanisms involved in Emotion

Unit – 5	ETHICAL ISSUES RELATED TO EMOTIONS AND AI	12 hrs

Ethical issues related to emotion and AI privacy and surveillance, Manipulation of behaviour, Artificial Moral Agents, Machine Ethics, Singularity and Super-intelligence Dual-process theories of emotion, Constructivist theories, Appraisal theories.

Text / Reference Books:

1. André Mainville, Creating Emotional Artificial Intelligence, 2017, Blurb publishers
2. Richard Yonck, Heart of the Machine: Our Future in a World of Artificial Emotional Intelligence, Arcade, 2017
3. Phil Kwest, Intelligence: Understanding IQ, Emotional Intelligence, Artificial Intelligence, and how to use them to reach success in life (Intelligent Change, Intelligence Analysis, Smart, Understanding), Kindle Edition, 2020
4. Ekaterina, I., Georgii, B.: Optimization of Machine Learning Algorithm of Emotion Recognition in Terms of Human Facial Expressions. Procedia Computer Science, Elsevier Volume 169, P. 244-248 (2020)
5. Mellouk, W., Handouzi, W.: Facial Emotion Recognition Using Deep Learning: Review and Insights. The 2nd International Workshop (FIoE), Procedia Comp. Sci. Elsevier Vol. 175, Pages 689-694 (2020)
6. Sharma, V: Designing of Face Recognition System. *International Conference on Intelligent Computingand Control Systems (ICCS)* PP 459-461 Published by IEEE (2019)
7. Erol, B. A., Majumdar, A., Benavidez, P., Rad, P., Choo, R. K., Jamshidi, M.: Towards Artificial Emotional Intelligence for Cooperative Social Human-Machine Interaction. IEEE Transaction on the computational social system, Volume 7, Issue 1 (2019)
8. Amorim, M., Cohen, Y., Reis, J., Rodrigues, M.: Exploring Opportunities of Artificial Emotional Intelligence In-Service Production System. IFAC-Papers OnLine Volume 52, Issue 13, Pages 1145-1149Elsevier (2019)

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	2	2	2	2
CO2	3	3	3	2	2	2	2
CO3	3	3	3	2	2	2	2
CO4	3	3	3	2	2	2	2
CO5	3	3	3	2	2	2	2

CSCEC10	DATA VISUALIZATION	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain the fundamentals, trends, tools, and applications of data visualization techniques	Understand
CO2	Apply visualization tools and charting techniques for representing categorical, temporal, and relational data	Apply
CO3	Analyze and prepare datasets for effective visual representation and information communication	Analyze
CO4	Apply principles of visual perception and dashboard categorization for effective dashboard design	Apply
CO5	Design interactive and user-friendly dashboards for real-world business and analytical applications	Create

b. Syllabus

Unit – 1	FUNDAMENTALS OF DATA VISUALIZATION	12 hrs
Basics of Data visualization - Trends in Data Visualization - Interactive Graphics - Visualization Designers –Use of Data Visualization - Visualization Process Into Practice - Basic Productivity Applications -MICROSOFT EXCEL – iWORK - GOOGLE CHARTS - Visualization Software - TABLEAU DESKTOP.		
Unit – 2	**VISUALIZATION TOOLS, DISTRIBUTIONS AND CHART INTERFACE**	**12 hrs**
Business Intelligence Tools - Programming Packages - Selecting Tools to Build Data Graphics - Comparisons of Categories and Time – Distributions – Proportions – Relationships – Locations - Trends—Showing Comparisons Over Time or Composition Over Time - Word Frequency and Sentiment - Connections and Networks - Chart Interface		
Unit – 3	**DESIGN STANDARDS FOR THE VISUAL DATA**	**12 hrs**

data into information for visual representation – UNDERSTAND YOUR DATA - Review the Data Dictionary – different kinds of data - PREPARING YOUR DATA - Survey Data - RENAME THE VARIABLES - IDENTIFY MISSING VALUES - Compute Descriptive Statistics - Explore the Data Visually - Devise the Problem, Challenge, and/or Questions - Design Standards for visual data

Unit – 4	INFORMATION DASHBOARD CATEGORIZATION AND VISUAL PERCEPTION	12 hrs

Information dashboard - categorizing dashboards - typical dashboard data - dashboard design issues andbest practices - visual perception - limits of short-term memory - visually encoding data – Gestalt principles -principles of visual perception for dashboard design

Unit – 5	INFORMATION DASHBOARD DESIGN WITH CASE STUDIES	12 hrs

INFORMATION DASHBOARD DESIGN II: Characteristics of dashboards - key goals in visual design process - dashboard display media - designing dashboards for usability- meaningful organization - maintainingconsistency- aesthetics of dashboards - testing for usability - case studies: sales dashboard, CIO dashboard, Telesales dashboard, marketing analysis dashboard

Text / Reference Books:

1. Sosulski kristen, Data visualization made simple insights into becoming visual, 2019, Routledge
2. Kieran Healy , Data Visualization: A Practical Introduction Paperback, 2018
3. Cole Nussbaumer Knaflic, Storytelling with Data: A Data Visualization Guide for Business Professionals, 2015
4. Chun-houh Chen, Wolfgang Härdle, Antony Unwin, Handbook of Data Visualization, Springer, 2008
5. Stephen Few, Information Dashboard Design: Displaying Data for At-a-Glance Monitoring, 2013

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	2	2	2	2
CO2	3	3	3	2	2	2	2
CO3	3	3	3	2	2	2	2
CO4	3	3	3	2	2	2	2
CO5	3	3	3	2	2	2	2

CSCEC11	HUMAN COMPUTER INTERACTION	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain interaction paradigms, interface guidelines, ergonomics, and communication models in Human Computer Interaction	Understand
CO2	Apply user interface and user experience design principles in interactive system development	Apply
CO3	Analyze implementation and evaluation techniques for interactive systems and mobile interfaces	Analyze
CO4	Analyze cognitive, communication, and collaboration models used in interaction design	Analyze
CO5	Apply HCI principles in ubiquitous computing, web, multimedia, and context-aware user interface applications	Apply

b. Syllabus

Unit – 1	INTRODUCTION	12 hrs
Historical Developments, Communication, Hardware, Interaction Paradigms: Models of interaction – Interaction Framework – Ergonomics – Software/interface guidelines – Interaction Styles – Context of Interaction – Interaction Paradigms – Mobile device interaction paradigms.		
Unit – 2	**DESIGN PROCESS**	**12 hrs**
User Interface Design, User Experience Design, Task analysis, Dialog notation and design – Interaction design – Universal design – HCI in the software process.		
Unit – 3	**IMPLEMENTATION AND EVALUATION**	**12 hrs**
Implementation issues: Elements of windowing systems – user interface management systems – Response time – Colors – Short cuts – Symbols – Adaptable interfaces – Self Configuring systems for mobile devices. Evaluation through expert analysis and user participation – Evaluation methodologies – Evaluation criteria: functionality – usability – learnability – initiative.		

Unit – 4	**MODELS AND THEORIES**	**12 hrs**
Cognitive models – Communication and collaboration models: Models of the system Modelling Rich interaction.		
Unit – 5	**APPLICATIONS**	**12 hrs**
Socio – organization issues and stakeholder requirement- Ubiquitous Computing, Context – aware User Interfaces Hypertext, multimedia and the World Wide Web.		

Text / Reference Books:

1. Dix, Finlay, Abowd &Beale, Human Computer Interaction, Prentice Hall, Third edition, 2009.
2. J. Preece, Y. Rogers, H. Sharp, D. Benyon, S. Holland and T. Carey, Human Computer Interaction,Addison Wesley, 1994.
3. Linda Mcaulay, HCI for Software Designers, International Thompson Computer Press, USA,1998.
4. Ben Schneiderman, Designing the User Interface, Pearson Education, New Delhi,2005.
5. Alan Cooper, The Essentials of User Interface Design, IDG Books, New Delhi,1995.
6. Jacob Nielsen, Usability Engineering, Academic Press, 1993.

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	3	2	3	1	2
CO2	3	3	3	1	3	3	3
CO3	3	3	2	2	3	1	3
CO4	3	1	3	1	2	2	2
CO5	3	2	3	3	3	3	3

CSCEC12	SOFTWARE TESTING	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain software testing principles, defect management concepts, and the software testing process	Understand
CO2	Apply black-box and white-box testing techniques for effective test case design and defect identification	Apply
CO3	Analyze different levels of software testing and testing strategies for software quality assurance	Analyze
CO4	Apply software testing tools, test planning, and test management techniques in software testing environments	Apply
CO5	Analyze software test automation, quality metrics, review mechanisms, and testing maturity models for software quality improvement	Analyze

b. Syllabus

Unit – 1	INTRODUCTION	12 hrs
What is software testing and why it is so hard? Testing Process, Basic Definitions – Software TestingPrinciples - The Tester's Role in a Software Development Organization - Origins of Defects - Defect Classes - Error, Fault, Failure, and Incident - The Defect Repository and Test Design – Defect Examples –Developer/Tester Support for Developing a Defect Repository.		
Unit – 2	**TEST CASE**	**12 hrs**
Test Case Design Strategies - The Smarter Tester - Functional Testing (Black Box) – Boundary Value Analysis - Equivalence Class Testing – Decision Table Based Testing, Cause Effect -Graphing Technique – error guessing - compatibility testing - Requirements based testing –positive and negative testing – Structural Testing (White Box) – Path testing, code functional testing - DD-Paths, Cyclomatic Complexity,Graph Metrics, Data Flow Testing, Mutation testing Test Adequacy Criteria –		

static testing vs. structural testing.

Unit – 3	LEVELS OF TESTING	12 hrs

Levels of Testing – Unit testing - Planning - Designing - Running and Recording results - Integration testing – Designing –Planning – scenario testing -System testing - Types – Acceptance testing - Performance testing - Regression Testing - Slice based testing - Debugging, Domain Testing - Alpha - Beta Tests - ObjectOriented Testing.

Unit – 4	TESTING TOOLS AND TEST MANAGAEMENT	12 hrs

Static Testing Tools - Dynamic Testing Tools - Characteristics of Modern Tools - Test Planning - Test Plan Components - Test Plan Attachments - Test Items - Test management - Reporting Test Results – The roleof three groups in Test Planning and Policy Development – Introducing the test specialist - Skills neededby a test specialist - Building a Testing Group - Working with JUnit.

Unit – 5	CONTROLLING AND MONITORING	12 hrs

Software test automation – skills needed for automation – scope of automation – design and architecturefor automation – requirements for a test tool – challenges in automation - Test metrics and measurements –project, progress and productivity metrics – Status Meetings – Reports and Control Issues – Criteria for Test Completion – SCM – Types of reviews – Developing a review program – Components of Review Plans– Reporting Review Results. – Evaluating software quality – defect prevention – testing maturity model.

Text / Reference Books:

1. Srinivasan Desikan and Gopalaswamy Ramesh, Software Testing – Principles and Practices, Firstedition, Pearson education, 2006
2. Aditya P.Mathur, Foundations of Software Testing, Second edition, Pearson Education, 2008
3. Boris Beizer, Software Testing Techniques, Second edition, Dreamtech, 2003
4. Elfriede Dustin, Effective Software Testing, First edition, Pearson Education, 2003
5. Renu Rajani, Pradeep Oak, Software Testing – Effective Methods, Tools and Techniques, First edition,Tata McGraw Hill, 2004

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	3	1	1	2	3
CO2	2	1	3	1	1	3	3
CO3	3	3	3	2	3	2	2

CO4	3	2	3	3	3	3	3
CO5	2	1	3	1	1	3	3

CSCEC13	**BLOCK CHAIN TECHNOLOGY**	**4 Credits**

a. Course Outcome (CO)

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

	Course Outcome	**Level**
CO1	Explain blockchain fundamentals, decentralization concepts, and consensus mechanisms	Understand
CO2	Analyze cryptocurrency systems and public blockchain platforms including Bitcoin and Ethereum	Analyze
CO3	Apply smart contract concepts and private blockchain frameworks for decentralized applications	Apply
CO4	Analyze consortium blockchain platforms, ICO mechanisms, and enterprise blockchain solutions	Analyze
CO5	Evaluate blockchain security challenges and applications in finance, healthcare, IoT, and supply chain systems	Evaluate

b. Syllabus

Unit – 1	**FUNDAMENTALS OF BLOCKCHAIN**	**12 hrs**
Introduction – Origin of Blockchain – Blockchain Solution – Components of Blockchain – Blockchain Types – Decentralization and Distribution – Consensus Protocol -		
Unit – 2	**CRYPTOCURRENCY AND PUBLIC BLOCKCHAIN SYSTEM**	**12 hrs**
Bitcoin and Cryptocurrency – Basics of cryptocurrency – Types of Cryptocurrency – Usage of Cryptocurrency – Public Blockchain – Bitcoin Blockchain – Ethereum Blockchain		
Unit – 3	**SMART CONTRACTS AND PRIVATE BLOCKCHAIN SYSTEM**	**12 hrs**

Smart Contract – Characteristics of Smart Contract – Types of Smart Contract – Smart Contracts in Ethereum – Smart Contracts in Industry – Key Characteristics of Private Blockchain – Private Blockchain and Open Source

Unit – 4	**CONSORTIUM BLOCK CHAIN AND INITIAL COIN OFFERING**	**12 hrs**

Key Characteristics of Consortium Blockchain – Hyperledger platform – overview of Ripple and Corda –Blockchain Fund raising methods – Launching ICO – Pros and Cons of ICO – ICO Platforms

Unit – 5	**SECURITY IN BLOCKCHAIN AND APPLICATIONS**	**12 hrs**

Security Aspects in Blockchain - Security and Privacy Challenges of Blockchain in General- Performance and Scalability - Identity Management and Authentication - Regulatory Compliance and Assurance – Applications - Blockchain in Banking and Finance - Blockchain in Education - blockchain in Healthcare – Blockchain in Real-estate – Blockchain in Supply Chain – The Blockchain and IoT.

Text / Reference Books:

1. Chandramouli Subramanian, Asha A George, Abhilash K A and MeenaKarthikeyan, Blockchain Technology , University Press, 2020
2. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder, Bitcoinand cryptocurrency technologies: a comprehensive introduction. Princeton University Press, 2016.
3. J.A.Garay et al, The bitcoin backbone protocol - analysis and applications EUROCRYPT 2015 LNCS VOI9057, (VOL II), pp 281-310.
4. Salman Baset, Luc Desrosiers, Nitin Gaur, Petr Novotny, Venkatraman Ramakrishna, Anthony O'Dowd, Hands- On Block chain with Hyperledger, Packt Publishing , 2018

c. Mapping of Course Outcomes to Program Outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	3	3	3	2	2	2	2
CO2	3	3	3	2	2	2	2
CO3	3	3	3	2	2	2	2
CO4	3	3	3	2	2	2	2
CO5	3	3	3	2	2	2	2

CSCEC14	CLOUD COMPUTING	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain cloud computing concepts, service models, deployment models, and cloud infrastructure fundamentals	Understand
CO2	Analyze cloud architecture, virtualization techniques, and cloud computing design principles	Analyze
CO3	Apply cloud services, SOA concepts, and cloud platforms for developing cloud-based applications	Apply
CO4	Analyze cloud security, privacy, SLA, and trust management issues in cloud environments	Analyze
CO5	Apply cloud technologies and platforms such as Hadoop, OpenStack, and MPI for scalable distributed computing applications	Apply

b. Syllabus

Unit – 1	INTRODUCTION TO CLOUD COMPUTING	12 hrs
Introduction to Cloud Computing – History and Fundamentals – Characteristics of Cloud Computing – Advantages and Challenges – Traditional vs Cloud Computing – Business Drivers – Cloud Service Models (IaaS, PaaS, SaaS) – Cloud Deployment Models – Cloud Infrastructure and Service Management – Future of Cloud Computing.		
Unit – 2	**CLOUD ARCHITECTURE AND VIRTUALIZATION**	**12 hrs**
Cloud Computing Architecture – Design Principles – Cloud Computing Life Cycle – Load Balancing – Mobile Cloud Computing – Virtualization Concepts and Techniques – -How virtualization work – KVM,		

VMware, VirtualBox – Types of Virtualization – Virtualization in Cloud.

Unit – 3	CLOUD SERVICES AND APPLICATIONS	12 hrs

Service Oriented Architecture (SOA) – Web Services and SOA – SOA Components and Infrastructure – Business Process Management (BPM) – Cloud Applications – Google App Engine – Microsoft Azure – Amazon Web Services (AWS) – Google Cloud Platform – Cloud Storage and Cloud Databases, Dropbox Cloud-Apple iCloud.

Unit – 4	CLOUD SECURITY AND MANAGEMENT	12 hrs

Cloud Security Fundamentals – CIA Security Model – Security Architecture – Security Issues in Virtualization – Data Security and Privacy – Threats in Cloud – Disaster Recovery and Business Continuity – Service Level Agreements (SLA) – Quality of Cloud Services – Trust Management and Migration.

Unit – 5	CLOUD TECHNOLOGIES AND PLATFORMS	12 hrs

High Performance Computing – Message Passing Interface (MPI) – MapReduce Model – Hadoop Ecosystem – OpenStack Architecture – OpenNebula and Eucalyptus – Emerging Cloud Technologies – Adoption of Cloud Computing – Application Areas – Cloud Certifications – Case Studies of Cloud Platforms and Services.

Text / Reference Books:

1. Mastering Cloud Computing, Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, Tata McGraw Hill Education, 2013.
2. Cloud Computing: Concepts, Technology & Architecture, Pearson Education, 2014.
3. AWS Certified Cloud Practitioner Study Guide, Ben Piper and David Clinton, Sybex/Wiley, 2021.
4. Building Google Cloud Platform Solutions, Packt Publishing, 2019.
5. Cloud Computing Bible, Wiley India, 2020.
6. Mastering Cloud Computing, Rajkumar Buyya et al., 2nd Edition, Elsevier, 2026
7. Integration of Cloud Computing with Emerging Technologies, Routledge, 2024.

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	3	3	3	3	3
CO2	2	3	2	3	3	2	3
CO3	2	3	3	3	3	2	2
CO4	3	3	3	3	3	2	3
CO5	2	3	3	3	3	3	3

CSCEC15	WEB SERVICES	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain web protocols, Internet technologies, and communication mechanisms used in web-based systems	Understand
CO2	Apply XML-based web service technologies and standards for distributed web applications	Apply
CO3	Analyze technologies and architectures supporting web service development including MVC, J2EE, and .NET	Analyze
CO4	Apply web transaction management and web service security standards in service-oriented applications	Apply
CO5	Analyze web service discovery, composition, and implementation approaches including SOAP and REST-based services	Analyze

b. Syllabus

Unit – 1	FUNDAMENTALS OF WEB PROTOCOLS	12 hrs
Web Technology - Web 2.0 technologies, Introduction to Ajax, Ajax Design Basics, Introduction to WWW,TCP/IP, HTTP, ARP, ICMP FTP, UDP, routing protocols (RIP, OSPF, BGP), Network Management Protocols(SNMP), and Application-level protocols (FTP, TELNET, SMTP), URL, Web Browsers, Web Servers.		
Unit – 2	**ESSENTIAL WEB SERVICES**	**12 hrs**
Web services, Evolution and differences with Distributed computing, XML - Name Spaces - Structuring With Schemas and DTD - Transformation - XML Infrastructure WSDL, SOAP, UDDI, ebXML		

- SOAP And Web Services in E-Com - Overview Of .NET And J2EE.

Unit – 3	TECHNOLOGIES FOR WEB SERVICE SUPPORT	12 hrs

Platform for Web Services Development, MVC Design Pattern, Web services - EJB, .NET, J2EE Architecture, J2EE Components & Containers, Specification, Application servers, Struts, Introduction to JSON.

Unit – 4	WEB TRANSACTIONS	12 hrs

Web Transactions, Coordination, Orchestration, and Choreography – tools BPEL, WS- CDL Overview of Web service standards -BPEL4WS. WS-Security and the Web services security specifications, WSReliableMessaging, WS-Policy, WS-Attachments.

Unit – 5	CASE STUDIES	12 hrs

Web Service Case Study - Web Service Search Engine, Web Service Discovery, Web Service Composition. Web Service – SOAP vs Web Service – REST.

Text / Reference Books:

1. Steve Clarke, UK Murray E. Jennex, S, Web Services, 1st Edition, IGI Global, 2018
2. Martin Karlin, Java Web Services: Up and Running: A Quick, Practical, and Thorough Introduction,Second edition, O'Reilly Media, 2013
3. Leonard Richardson , Sam Ruby , David Heinemeier Hansson, RESTful Web Services, 1st edition,O'Reilly Media, 2007
4. Frank. P. Coyle, XML, Web Services and the Data Revolution", 1st edition, Pearson Education, 2002
5. Sandeep Chatterjee - Ph.D., James Webber - Ph.D., Developing Enterprise Web Services: An Architect's Guide, 1st edition, Pearson Education, 2003

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	2	2	2	3	2	1
CO2	1	2	2	3	2	1	1
CO3	-	1	1	2	2	1	1
CO4	1	1	2	2	3	1	2
CO5	1	2	2	2	2	1	2

CSCEC16	ETHICAL HACKING	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain information security fundamentals, networking concepts, and Internet security models	Understand
CO2	Analyze ethical hacking methodologies, vulnerability assessment, and penetration testing concepts	Analyze
CO3	Apply cryptographic and security concepts to analyze social engineering and security threats	Apply
CO4	Analyze network attacks, foot printing techniques, spoofing attacks, and web-based vulnerabilities	Analyze
CO5	Apply wireless and IoT security assessment techniques and recommend appropriate countermeasures against cyber threats	Apply

b. Syllabus

Unit – 1	INFORMATION SECURITY OVERVIEW	12 hrs
Fundamentals of Information Security - Elements- Characteristics-Security Model-Tools-Basic concepts of computer networking-Models-components-Addressing and Routing - Importance of Internet security.		
Unit – 2	**INTRODUCTION TO ETHICAL HACKING**	**12 hrs**
Hacking concepts- Types and Classes-Potential security threats - viruses, worms and other malwares - Need of ethical hacking- Benefits and Limitations - Phases of Ethical hacking - Vulnerability Analysis - Basics of Penetration testing/hacking		

Unit – 3	CRYPTOGRAPHY ESSENTIALS AND SOCIAL ENGINEERING	12 hrs

Issues Regarding Classification and Prediction – Classification by Decision Tree Introduction – Bayesian Classification – Rule Based Classification – Classification by Back propagation – Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods – Prediction – Accuracy and Error Measures – Evaluating the Accuracy of a Classifier or Predictor – Ensemble Methods – Model Section

Unit – 4	FOOTPRINTING AND NETWORK ATTACKS	12 hrs

Footprinting - concepts and methodology- Types - Network and Packet sniffing basics-Types- -Fake authentication attacks-DDoS attacks-ARP Request spoofing attacks-ARP poisoning attacks - Spying on network devices- DNS spoofing-SSL Stripping, SQL Injection.

Unit – 5	WIRELESS AND IOT HACKING	12 hrs

Hacking wireless networks-standards and authentication modes-threats-Hacking methodology-Discovering technology uses in website - Web Hacking- WEP/WPA hacking and traffic analyzer Tools-Wireless Vulnerability Scanning Tools - IoT threats and vulnerabilities - IoT hacking methodology - Hacking tools and countermeasures.

Text / Reference Books:

1. Kevin Beaver, Ethical Hacking for Dummies, Sixth Edition, Wiley, 2018
2. Rafay Baloch, Ethical Hacking and Penetration Testing Guide, First edition, CRC Press, 2014
3. Jon Erickson, Hacking: The Art of Exploitation, Second Edition, No Starch Press, 2008
4. Georgia Weidman, Penetration Testing: A Hands-On Introduction to Hacking, First edition, No StarchPress, 2014

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	2	2	3	1	1
CO2	2	3	2	3	3	1	2
CO3	2	2	2	2	3	1	3
CO4	1	2	2	2	3	1	2
CO5	3	2	2	2	3	1	2

CSCEC17	INTERNET OF THINGS	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain IoT concepts, architectures, protocols, enabling technologies, and societal applications of IoT systems	Understand
CO2	Apply IoT design methodologies and embedded system concepts for developing IoT-based solutions	Apply
CO3	Develop IoT applications using Raspberry Pi platforms, interfaces, APIs, and web services	Apply
CO4	Develop IoT applications using Arduino and Intel Galileo platforms with appropriate programming techniques	Apply
CO5	Analyze IoT cloud integration, data analytics, security, privacy, and real-world IoT applications	Analyze

b. Syllabus

Unit – 1	FUNDAMENTALS OF IOT	12 hrs
Introduction-Characteristics-Physical design - Protocols – Logical design – Enabling technologies - IoT Levels – Domain Specific IoTs – IoT vs M2M. IoT Example: The Refrigerator - IoT Devices - IoT Devices vs.Computers - Trends in the Adoption of IoT - IoT Is Powerful and Pervasive - Societal Benefits of IoT		
Unit – 2	**IOT DESIGN METHODOLOGY**	**12 hrs**
IoT systems management – IoT Design Methodology – Specifications Integration and Application Development. Embedded Systems - Generic Embedded Systems Structure - Components of		

Embedded Systems - Analog/Digital Conversion.		
Unit – 3	**BUILDING IOT WITH RASPBERRY PI**	**12 hrs**
Basic Equipment - Design Methods for Networked Devices - Physical device – Raspberry Pi Interfaces –Programming – APIs / Packages – Web services.		
Unit – 4	**BUILDING IOT WITH GALILEO/ARDUINO**	**12 hrs**
Intel Galileo Gen2 with Arduino- Interfaces - Arduino IDE – Programming - APIs and Hacks		
Unit – 5	**CASE STUDIES AND IOT CLOUD**	**12 hrs**
Various Real time applications of IoT- Connecting IoT to cloud – Cloud Storage for Iot – Data Analytics forIoT – Software & Management Tools for IoT – IOT - Risks, Privacy, and Security		

Text / Reference Books:

1. Arshdeep Bahga, Vijay Madisetti, Internet of Things – A hands-on approach, First edition, UniversitiesPress,, 2015
2. Samuel Greengard, The Internet of Things, First edition, MIT Press, 2015
3. Cuno Pfister, Getting Started with the Internet of Things: Connecting Sensors and Microcontrollersto the Cloud, First edition, Make Community, 2011
4. Ing. Klaus Schwab, The Fourth Industrial Revolution, First edition, Currency, 2017
5. Stefan Avesand David Boyle, From Machine-to-Machine to the Internet of Things Introduction to aNew Age of Intelligence, First edition, Elsevier Ltd, 2014

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	2	2	2	3	2	1
CO2	1	2	2	3	2	1	1
CO3	-	1	1	2	2	1	1
CO4	1	1	2	2	3	1	2
CO5	1	2	2	2	2	1	2

CSCEC18	INTERNET OF THINGS FOR HEALTH CARE	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain IoT architectures, sensor networks, enabling technologies, and Internet of Health Things concepts	Understand
CO2	Apply IoT communication protocols, embedded systems, and cloud-enabled IoT platforms for healthcare applications	Apply
CO3	Analyze wearable electronics, physiological sensors, and body sensor networks for smart healthcare systems	Analyze
CO4	Apply remote patient monitoring concepts and cloud computing technologies for healthcare IoT solutions	Apply
CO5	Analyze security issues, privacy concerns, and real-world healthcare IoT applications including emergency response systems	Analyze

b. Syllabus

Unit – 1	FUNDAMENTALS OF IOT	12 hrs
Introduction to the Internet of Things - Evolution - Characteristics – IoT Architectures- Basic Buildingblocks- IoT Enabling Technologies- Fundamentals of Sensor networks – Basic concepts of the Internet of Health Things (IoHT).		
Unit – 2	**IOT COMMUNICATION PROTOCOLS AND EMBEDDED SYSTEMS**	**12 hrs**
IoT Communication models - Client-Server Communication Paradigm- Standards- Models- APIs and Protocols - Design Methodology – Embedded computing devices- Analysis - control and management		

ofsensor data- Systems on Chip (SOC)– Raspberry Pi – Interfacing – Microcontroller boards- Arduino IDE and Cloud - NodeMCU v2		
Unit – 3	**WEARABLE ELECTRONICS**	**12 hrs**
Fundamentals of Wearable IoT device - Body sensor networks - Driving circuits and converters for sensors- Sensor interface - Temperature sensor- Pressure sensor – Heart rate sensor-Accelerometer andoxygen sensors saturation sensor - Light sensor - IR sensor – ECG smart healthcare monitoring - Other Physiological data biosignals measurements – imaging devices Wearable gadgets – Actuators – Benefits of Mobile healthcare (m-health).		
Unit – 4	**REMOTE PATIENT MONITORING AND CLOUD COMPUTING**	**12 hrs**
Introduction and Scope of Remote Patient Monitoring System(RPMS) – Types-Key Components - Devicehardware – RPM devices - Client-side mobile application- - Microcontroller interface to the mobile gateway RPMS use cases – Role of Cloud computing for IoT solutions- Types of Cloud Computing Models - Cloud Services – Cloud platforms for IoT Deployments.		
Unit – 5	**SECURITY ISSUES AND CASE STUDIES FOR IOT-BASED EMERGENCY HEALTHCARE SYSTEM**	**12 hrs**
Security Issues- Threats and Countermeasures- Case studies – Wearable Health and Monitoring system– Remote patient communications - Response measures for COVID-19 - Contact tracing		

Text / Reference Books:

1. Venkata Krishna, Sasikumar Gurumoorthy, Mohammad S. Obaidat, Internet of Things and Personalized Healthcare Systems, First edition, , Springer Briefs in Applied Sciences, and Technology, Forensic and Medical Bioinformatics, 2019
2. Nishu Gupta , Sara Paiva , IoT and ICT for Healthcare Applications, First edition, Springer NatureSwitzerland AG, 2020
3. Jerome Henry, IoT Fundamentals - Networking Technologies, Protocols and Use Cases for the Internet of Things, First edition, Pearson, 2017
4. Arshdeep Bahga, Vijay Madisetti, Internet of Things – A hands-on approach, First edition, UniversitiesPress,, 2015
5. Akash Kumar Bhoi Victor Hugo C. de AlbuquerqueHareesha K.S, IoT in Healthcare and AmbientAssisted Living, First edition, Springer Nature Switzerland AG, 2020

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	1	2	1	3	1	1
CO2	3	3	2	3	3	1	2
CO3	2	1	3	2	3	2	3
CO4	1	2	2	2	3	1	2
CO5	3	2	2	2	3	2	3

CSCEC19	TEXT ANALYTICS	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain text extraction techniques, keyword extraction methods, and evaluation metrics used in text analytics	Understand
CO2	Apply document classification and clustering techniques for multilingual and large-scale text datasets	Apply
CO3	Analyze anomaly detection, trend analysis, sentiment tracking, and visualization techniques in textual data	Analyze
CO4	Apply text stream processing and topic modelling techniques for event and trend detection	Apply
CO5	Analyze real-world text analytics applications in finance, healthcare, and social media domains	Analyze

b. Syllabus

Unit – 1	TEXT EXTRACTION	12 hrs
Introduction- Rapid automatic keyword extraction: candidate keywords, keyword scores, adjoining keywords, extracted keywords-Benchmark evaluation: precision and recall, efficiency, stop list generation, Evaluation on new articles.		
Unit – 2	**DOCUMENT CLASSIFICATION AND CLUSTERING**	**12 hrs**

Multilingual document clustering: Multilingual LSA, Constrained clustering with k-means classification,Classification algorithms for Document Classification, Content-based spam email classification, Topic modelling and Entity resolution.

Unit – 3	ANOMALY AND TREND DETECTION	12 hrs

Text visualization techniques: Visualization in text analysis, Tag clouds, tag clouds, authorship and changetracking, Data Exploration and the search for novel patterns, sentiment tracking, visual analytics and FutureLens, scenario discovery.

Unit – 4	TEXT STREAMS	12 hrs

Events and trends in text streams: Introduction, Text streams, Feature extraction and data reduction, Event detection, Trend detection, Event and trend descriptions. Embedding semantics in LDAtopic models: Introduction, vector space modelling, latent semantic analysis, probabilistic latent semantic analysis, Latent Dirichlet allocation.

Unit – 5	APPLICATIONS	12 hrs

Predicting Stock Price Movements Based on Newspaper Headlines, Working with Social media Text Data, Decision support system for Health care.

Text / Reference Books:

1. Michael W. Berry & Jacob Kogan, Text Mining Applications and Theory, First edition, Wiley publications, 2010
2. Aggarwal, Charu C., and ChengXiangZhai, Mining text data, First edition, Springer Science &Business Media, 2012
3. Miner, Gary, Practical text mining and statistical analysis for non-structured text data applications, ,Academic Press, 2012
4. Srivastava, Ashok N., and MehranSahami, Text mining: Classification, clustering, and applications", ,Chapman and Hall/CRC, 2009
5. Buitelaar, Paul, Philipp Cimiano, and Bernardo Magnini, Ontology learning from text: methods, evaluation and applications, , IOS press, 2005

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	3	2	3	1	2
CO2	3	3	3	1	3	3	3
CO3	3	3	2	2	3	1	3
CO4	3	1	3	1	3	3	3
CO5	3	2	3	3	3	3	3

CSCEC20	SOCIAL MEDIA ANALYTICS	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain the fundamentals of social media analytics, social networks, and network analysis techniques	Understand
CO2	Apply web analytics tools, link analysis, and natural language processing techniques for social media data analysis	Apply
CO3	Analyze Facebook and other social media platform analytics for audience engagement and campaign performance evaluation	Analyze
CO4	Apply data processing, visualization, influence analysis, and prediction techniques for social media analytics applications	Apply
CO5	Analyze social spam, malicious behaviour, privacy issues, and real-world case studies in social media environments	Analyze

b. Syllabus

Unit – 1	FUNDAMENTALS OF SOCIAL MEDIA ANALYTICS	12 hrs
Introduction to Social Media Analytics (SMA) - Social media landscape, Need for SMA; SMA in Small organizations; SMA in large organizations; Application of SMA in different areas - Network fundamentalsand models: The social networks perspective - nodes, ties and influencers - Social network and web dataand methods - Graphs and Matrices- Basic measures for individuals and networks – Information visualization.		
Unit – 2	**MAKING CONNECTIONS IN SMA WITH TOOLS AND TECHNIQUES**	**12 hrs**

Making connections: Link analysis. Random graphs and network evolution. Social contexts: Affiliation andidentity- Web analytics tools: Click stream analysis, A/B testing, online surveys, Web crawling and Indexing. Natural Language Processing Techniques for Micro-text Analysis.

Unit – 3	FACEBOOK ANALYTICS AND OTHER SOCIAL MEDIA ANALYTICS	12 hrs

Facebook Analytics: Introduction, parameters, demographics - Analyzing page audience. Reach and Engagement analysis - Post- performance on FB. Social campaigns. Measuring and Analyzing social campaigns, defining goals and evaluating outcomes, Network Analysis - Other Social media analytics: Linkedin, Instagram, YouTube Twitter etc. Google analytics.

Unit – 4	PROCESSING AND VISUALIZING SMA DATA	12 hrs

Processing and Visualizing Data, Influence Maximization, Link Prediction, Collective Classification, Applications in Advertising and Game Analytics - Collecting and analyzing social media data; visualizationand exploration - Scraping and Extracting Conversational Topics on Internet Forums.

Unit – 5	SOCIAL SPAM AND MALICIOUS BEHAVIOR	12 hrs

Social Spam and Malicious Behavior, Geospatial social data mining, Privacy in a Networked World, Predicting the future with social media, Social tagging and folksonomies. Case Studies : analysis on case studies in different application domains

Text / Reference Books:

1. Matthew Ganis, AvinashKohirkar, "Social Media Analytics: Techniques and Insights for Extracting Business Value Out of Social Media", Pearson, 1st edition, 2016
2. Jim Sterne, "Social Media Metrics: How to Measure and Optimize Your Marketing Investment", Wiley, 1st edition, 2010
3. Marshall Sponder, "Social Media Analytics", McGraw Hill, 1st edition, 2011

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	3	2	3	1	3
CO2	3	3	3	1	3	3	3
CO3	3	3	2	2	3	1	3
CO4	3	3	3	1	3	3	3
CO5	3	3	3	3	3	3	3

CSCEC21	MOBILE APP DEVELOPMENT	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain mobile architectures, mobile device technologies, and mobile application development concepts	Understand
CO2	Apply embedded system concepts and interface design principles for mobile application development	Apply
CO3	Develop mobile applications with networking, multimedia, GPS, cloud integration, and social media capabilities	Apply
CO4	Apply Android development concepts including activities, intents, lifecycle management, and application frameworks	Apply
CO5	Design user interfaces and database-enabled Android applications using layouts, event handling, and SQLite	Create

b. Syllabus

Unit – 1	MOBILE ARCHITECTURES	12 hrs
Mobile Network Architecture – Mobile Device Architecture – Mobile Application Development – MobileWeb Applications – Business Communication		
Unit – 2	**DESIGN AND INTERFACES**	**12 hrs**
Introduction – Basics of embedded systems design – Embedded OS - Design constraints for mobile applications, both hardware and software related – Architecting mobile applications – User		

interfaces for mobile applications – touch events and gestures – Achieving quality constraints – performance, usability, security, availability and modifiability.

Unit – 3	NETWORKING APPLICATIONS	12 hrs

Designing applications with multimedia and web access capabilities – Integration with GPS and social media networking applications – Accessing applications hosted in a cloud computing environment – Design patterns for mobile applications

Unit – 4	ANDROID	12 hrs

Overview of Android – What does Android run On? – Android Internals-Android for mobile apps development – Environment setup for Android apps Development – Framework – Android- SDK, Eclipse – Emulators – What is an Emulator / Android AVD? – Android Emulation – Creation and set up – First Android Application – Design criteria for Android Application: Hardware Design Consideration – Design Demands For Android application – Intent, Activity, Activity Lifecycle and Manifest

Unit – 5	USER INTERFACES	12 hrs

Simple UI -Layouts and Layout properties: Introduction to Android UI Design – Introducing Layouts – Event driven Programming in Android (Text Edit, Button clicked etc.) – Activity Lifecycle of Android - Menu :Basics, Custom v/s System Menus, Create and Use Handset menu Button (Hardware) – Basic operation of SQLite Database

Text / Reference Books:

1. Architecting Mobile Solutions for the Enterprise, Dino Esposito, Microsoft press, 2015
2. Professional Mobile Application Development, Author: JEFF MCWHERTER, SCOTT GOWELL,Publisher: Wiley India Pvt Lt, 2014
3. Mobile Application Penetration Testing Paperback – Import, 11 Mar 2016, Vijay Kumar Velu

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	3	3	2	3	2	2
CO2	2	2	3	3	3	3	3
CO3	3	3	2	3	3	2	2
CO4	3	3	3	3	3	2	3
CO5	3	3	3	3	3	3	3

CSCEC22	DOCKER AND KUBERNETES	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain web services, cloud computing concepts, orchestration mechanisms, and microservices architecture	Understand
CO2	Apply Docker containerization techniques for building, managing, and deploying containerized applications	Apply
CO3	Apply Kubernetes architecture and deployment techniques for orchestrating distributed applications	Apply
CO4	Analyze scaling, load balancing, and auto-scaling mechanisms in Kubernetes environments	Analyze
CO5	Apply automation, monitoring, and self-healing techniques using Kubernetes-native tools and deployment strategies	Apply

b. Syllabus

Unit – 1	INTRODUCTION TO WEB SERVICES AND CLOUD COMPUTING AND ORCHESTRATION	12 hrs
Fundamentals of Web services, WSDL, SOAP, UDDI, Web Transactions, Coordination, Orchestration, and Choreography, Overview of cloud computing and its benefits - Introduction to cloud orchestration and its importance in managing distributed systems - Key components of cloud orchestration,		

including resource provisioning, scaling, and automation, need for popular containerization platform like Docker and Kuberenetes, Microservices Architecture.		
Unit – 2	**CONTAINERIZATION WITH DOCKER**	**12 hrs**
Introduction to containerization: Understand the concept of containerization and its benefits, including application isolation, portability, and scalability - Building and managing containers using Docker: build, manage, and deploy containers using Docker - Docker file, container registries, and container lifecycle management.		
Unit – 3	**INTRODUCTION TO KUBERNETES**	**12 hrs**
Overview of Kubernetes: Kubernetes in cloud orchestration and its key features. Learn about Kubernetes architecture, including master nodes, worker nodes, and control plane components - Deploying applications on Kubernetes clusters: deploying applications on Kubernetes clusters.		
Unit – 4	**SCALING AND LOAD BALANCING WITH KUBERNETES**	**12 hrs**
Scaling applications using Kubernetes deployments and replicas - Load balancing techniques with Kubernetes services - Auto-scaling based on resource utilization and custom metrics.		
Unit – 5	**AUTOMATION AND MONITORING WITH KUBERNETES**	**12 hrs**
Automating deployments and updates with Kubernetes controllers - Implementing self-healing capabilities with Kubernetes - Monitoring and observability using Kubernetes-native tools (e.g., Prometheus, Grafana) and Deployment.		

Text / Reference Books:

1. Poulton, N. (2023). Docker Deep Dive: Zero to Docker in a single book. NIGEL POULTON LTD.
2. Burns, B., Beda, J., Hightower, K., & Evenson, L. (2022). Kubernetes: up and running. " O'Reilly Media, Inc.".
3. Davis, C. (2019). Cloud Native Patterns: Designing Change-Tolerant Software. Simon and Schuster.
4. Arundel, J., & Domingus, J. (2019). Cloud Native DevOps with Kubernetes: building, deploying, and scaling modern applications in the Cloud. O'Reilly Media

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	1	2	2	3	1	1
CO2	2	3	2	1	3	1	2
CO3	2	1	2	2	3	3	3
CO4	1	2	1	2	3	1	2
CO5	3	1	2	2	3	1	1

CSCEC23	COMPUTATIONAL SOCIAL SCIENCE	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain the foundations, interdisciplinary nature, and challenges of computational social science	Understand
CO2	Apply data collection, preprocessing, text analysis, and computational techniques for social science research	Apply
CO3	Analyze social opinion dynamics and apply machine learning techniques for social science applications	Analyze
CO4	Apply social network analysis, community detection, and simulation techniques for modelling social systems	Apply
CO5	Evaluate ethical issues, privacy concerns, and emerging challenges in computational social science research	Evaluate

b. Syllabus

Unit – 1	OVERVIEW OF COMPUTATIONAL SOCIAL SCIENCE	12 hrs
Introduction to Computational Social Science- Exploring the current challenges that social science encounters during the digital revolution, social emergence, Interdisciplinary - Nature and relevance		

to computer science, Social Science vs. Data Science, Historical overview and key milestones in the field.

Unit – 2	DATA COLLECTION AND MANAGEMENT	12 hrs

Basics of data collection methods in computational social science – surveys -online data - social media data- experiments, Data framing techniques - Text as data - Place of text analysis in social research, other advanced data analysis methods, Web scrapping – API's-preprocessing and cleaning techniques, security issues in data collection and management, Word Embedding and Transformers, Image as data-computer vision tools for social science.

Unit – 3	SOCIAL OPINION DYNAMICS AND ML FOR SOCIAL SCIENCE	12 hrs

Understanding norms, influence, collective feeling - Online vs offline communities- Measurement of social norms, Introduction to Machine learning - Basics of supervised and unsupervised learning - Regression, classification, clustering algorithms and deep learning, Retrieving Information - Topic Modeling Topics LDA and Structural Topic Model- Model Application.

Unit – 4	SOCIAL NETWORKS AND COMPUTER SIMULATIONS	12 hrs

Introduction to social network analysis and its applications in social science research, Understand sampling- populations - source of bias in sampling-sample frames, Community detection models and algorithms - Visualization and interpretation of social networks

Unit – 5	ETHICAL CONSIDERATIONS AND CASE STUDIES	12 hrs

Ethics in Computational Social Science - Privacy concerns and data protection, Solving case studies, Computational Social Science Research Design - Future Directions and Challenges - Emerging trends in computational social science- Opportunities for interdisciplinary collaboration.

Text / Reference Books:

1. Hanna Wallach. 2018. Computational social science computer science and social data. Commun. ACM 61, 3 (March 2018), 42–44. DOI:https://doi.org/10.1145/3132698
2. Lazer, D., Pentland, A. S., Adamic, L., Aral, S., Barabasi, A. L., Brewer, D., & Jebara, T. (2009). Life in the network: the coming age of computational social science. Science (New York, NY), 323(5915), 721.
3. Grimmer and Stewart (2013). Text as Data: The Promises and Pitfalls of Automated Content Analysis. Political Analysis.
4. Salganik, Matthew J., Bit by Bit: Social Research in the Digital Age, Princeton University Press, 2018. Free Online Version: https://www.bitbybitbook.com/en/1st-ed/preface/
5. Tufekci, Zeynep. 2018. "Facebook's Surveillance Machine ." New York Times.
6. Eubanks, Virginia. 2018. "A Child Abuse Prediction Model Fails Poor Families." Excerpt from Automating Inequality.

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7

CO1	3	1	2	2	3	2	1
CO2	2	3	3	3	3	3	2
CO3	3	2	2	2	3	2	3
CO4	2	3	2	2	3	2	3
CO5	2	2	1	2	3	1	2

CSCEC24	IOT SECURITY AND TRUST	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain security requirements, threats, vulnerabilities, and security architectures in IoT systems	Understand
CO2	Analyze IoT security frameworks, secure boot processes, authentication mechanisms, and edge security techniques	Analyze
CO3	Apply threat modelling and identity management approaches for secure IoT system design	Apply
CO4	Analyze trust establishment mechanisms, cryptographic models, and identity management frameworks in IoT	Analyze
CO5	Apply access control schemes and lightweight cryptographic techniques for securing IoT applications and use cases	Apply

b. Syllabus

Unit – 1	SECURITY REQUIREMENTS IN IOT ARCHITECTURE	12 hrs

Security Requirements in IoT Architecture, Security in Enabling Technologies, Security Concerns in IoT Applications. Security Architecture in the Internet of Things, Security Requirements in IoT, Insufficient Authentication/Authorization, Insecure Access Control, Threats to Access Control, Privacy, and Availability, Attacks Specific to IoT.

Unit – 2	**IOT SECURITY FRAMEWORK**	**12 hrs**

IOT security frame work, Security in hardware, Boot process, OS & Kernel, application, run time environment and containers. Vulnerabilities, Secrecy and Secret, Key Capacity, Authentication / Authorization for Smart Devices, Transport Encryption, Attack and Fault trees, secure IoT system implementation, Need and methods of Edge Security.

Unit – 3	**ELEMENTARY BLOCKS OF IOT SECURITY & MODELSFOR IDENTITY MANAGEMENT**	**12 hrs**

Vulnerability of IoT and elementary blocks of IoT Security, Threat modelling – Key elements. Identity management Models and Identity management in IoT, Approaches using User-centric, Device-centric and Hybrid.

Unit – 4	**IDENTITY MANAGEMENT AND TRUST ESTABLISHMENT**	**12 hrs**

Trust management lifecycle, Identity and Trust, Web of trust models. Establishment: Cryptosystems – Mutual establishment phases – Comparison on security analysis. Identity management framework.

Unit – 5	**ACCESS CONTROL IN IOT AND LIGHT WEIGHT CRYPTOGRAPHY**	**12 hrs**

Capability-based access control schemes, Concepts, identity-based and identity-driven, Lightweight cryptography, need and methods , IoT use cases

Text / Reference Books:

1. The IoT Architect's Guide to Attainable Security and Privacy 1st Edition by Damilare D. Fagbemi , David Wheeler , JC Wheeler , 2019, CRC Press
2. Practical Internet of Things Security: Design a security framework for an Internet connected ecosystem, 2nd Edition 2nd edition by Brian Russell, Drew Van Duren, 2018, PACKT
3. Internet of Things (IoT) Trust Concerns: Draft NISTIR 8222 [Print Replica] Kindle Edition
4. by National Institute of Standards and Technology, 2018
5. Trust-Based Communication Systems for Internet of Things Applications Prateek Agrawal (Editor), Vishu Madaan (Editor), Anand Sharma (Editor), Dilip Kumar Sharma (Editor), Akshat Agrawal (Editor), Sandeep Kautish (Editor), ISBN: 978-1-119-89633-3 June 2022, Springer Nature
6. John R. Vacca, “Computer and Information Security Handbook”, Elsevier, 2013.
7. Parikshit Narendra Mahalle , Poonam N. Railkar, “Identity Management for Internet of Things”, River Publishers, 2015.
8. William Stallings, “Cryptography and Network security: Principles and Practice”, 5th Edition, 2014, Pearson Education, India.
9. Maryline Laurent, Samia Bouzefrane, “Digital Identity Management”, Elsevier, 2015.
10. Joseph Migga Kizza, “Computer Network Security”, Springer, 2005.

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	3	3	2	3	2	2
CO2	2	2	3	3	3	3	3
CO3	3	3	2	3	3	2	2
CO4	3	3	3	3	3	2	3
CO5	3	3	3	3	3	3	3

CSCEC25	FUNDAMENTALS OF NOSQL DATABASE	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain NoSQL database concepts, types, characteristics, and differences from relational database systems	Understand
CO2	Analyze NoSQL database tools, replication models, sharding techniques, and distributed database architectures	Analyze
CO3	Apply key-value and document-oriented NoSQL databases for scalable data management applications	Apply
CO4	Apply column-oriented NoSQL databases and query mechanisms using Apache HBase and Cassandra	Apply
CO5	Analyze graph databases, NoSQL development tools, and real-world NoSQL database applications	Analyze

b. Syllabus

Unit – 1	NOSQL DATABASE AND ITS TYPE	12 hrs

Overview and History of NoSQL Databases. Definition of the Four Types of NoSQL Database, The Value of Relational Databases, Getting at Persistent Data, Concurrency, Integration, Impedance Mismatch, Application and Integration Databases, Attack of the Clusters, The Emergence of NoSQL, Key Points.

Unit – 2	NOSQL DATABASE TOOLS, REPLICATION AND SHARDING, DISTRIBUTION MODELS	12 hrs

Comparison of relational databases to new NoSQL stores, MongoDB, Cassandra, HBASE, Neo4j use and deployment, Application, RDBMS approach, Challenges NoSQL approach, Key-Value and Document Data Models, Column-Family Stores, Aggregate-Oriented Databases. Replication and sharding, MapReduce on databases. Distribution Models, Single Server, Sharding, Master-Slave Replication, Peer-to-Peer Replication, Combining Sharding and Replication.

Unit – 3	KEY/VALUE DATABASES AND DOCUMENT ORIENTED DATABASE AND ITS APPLICATIONS	12 hrs

Key/Value databases using MongoDB, Key-Value Store Features, Query Features, Structure of Data, Scaling, Suitable Use Cases, Storing Session Information, Document Databases, Document oriented Database Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, Event Logging, Content Management Systems, Blogging Platforms, Web Analytics or Real-Time Analytics, E-Commerce Applications, Complex Transactions Spanning Different Operations, Queries against Varying Aggregate Structure

Unit – 4	COLUMN-ORIENTED NOSQL DATABASES, TOOLS AND QUERY FEATURES	12 hrs

Column- oriented NoSQL databases using Apache HBASE, Column-oriented NoSQL databases using Apache Cassandra, Architecture of HBASE, Column-Family Data Store Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, Event Logging, Content Management Systems, Blogging Platforms, Counters, Expiring Usage.

Unit – 5	GRAPH NOSQL DATABASES AND USE CASES	12 hrs

Graph NoSQL databases using Neo4,NoSQL database development tools and programming languages, Graph Databases, Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases.

Text / Reference Books:

1. Sadalage, P. & Fowler, NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Wiley Publications,1st Edition ,2019.
2. Next Generation Databases: Nosqland Big Data Paperback – January 1, 2018 by Harrison
3. Fundamentals of NoSQL by C. Balakrishnan 2021 Lambert
4. SQL & Nosql Databases Paperback – 16 July 2019 by Andreas Meier , Michael Kaufmann
5. MongoDB: The Definitive Guide, 3rd Edition by Shannon Bradshaw, Eoin Brazil, Kristina Chodorow Released December 2019 Publisher(s): O'Reilly Media, Inc. ISBN: 9781491954461

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	3	3	2	3	2	2
CO2	2	2	3	3	3	3	3
CO3	3	3	2	3	3	2	2
CO4	3	3	3	3	3	2	3
CO5	3	3	3	3	3	3	3

CSCEC26	Deep Learning for Natural Language Processing	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain word embedding techniques and vector representation models used in Natural Language Processing	Understand
CO2	Analyze neural network architectures, backpropagation techniques, and recurrent neural network models for sequence modelling	Analyze
CO3	Apply recursive neural networks and convolutional neural networks for semantic analysis and speech recognition tasks	Apply
CO4	Apply recursive neural networks and convolutional neural networks for semantic analysis and speech recognition tasks	Apply
CO5	Analyse the use of seq2seq model for simple applications	Analyze

b. Syllabus

Unit – 1	SIMPLE WORD VECTOR REPRESENTATIONS	12 hrs

word2vec, GloVe- The Skip-Gram Model, Distributed Representations of Words and Phrases and their Compositionality- Efficient Estimation of Word Representations in Vector Space-GloVe: Global Vectors for Word Representation-Improving Distributional Similarity with Lessons Learned from Word Embedding-Evaluation methods for unsupervised word embedding.

Unit – 2	NEURAL NETWORKS AND BACK PROPAGATION	12 hrs

Long Short-Term Memory-Gated Feedback Recurrent Neural Networks-Empirical Evaluation of Gated Recurrent Neural Networks on Sequence Modelling-Recursive neural networks for parsing, -Parsing with Compositional Vector Grammars-Sub gradient- Parsing Natural Language with Recursive Neural Networks

Unit – 3	RECURSIVE NEURAL NETWORKS	12 hrs

Recursive Deep Models for Semantic Compositionality Over a Sentiment Treebank-Dynamic Pooling and Unfolding Recursive Auto encoders for Paraphrase Detection-Improved Semantic Representations From Tree-Structured Long Short-Term Memory Networks. Speech recognition-Convolutional neural networks for sentence classification- A Convolutional Neural Network for Modelling Sentences- Deep Neural Networks for Acoustic Modelling in Speech Recognition

Unit – 4	MACHINE TRANSLATION	12 hrs

Achieving Open Vocabulary Neural Machine Translation with Hybrid Word-Character Models- Addressing the Rare Word Problem in Neural Machine Translation- Advances in natural language processing- Neural machine translation by jointly learning to align and translate

Unit – 5	SEQ2SEQ AND LARGE SCALE DL	12 hrs

Sequence to Sequence with Neural Networks- A Neural Conversation Model- Latent Programs with Gradient Descent-: Dynamic Memory Networks

Text and References Books:

1. Raaijmakers, Stephan. Deep Learning for Natural Language Processing. Simon and Schuster, 2022.

2. Deep Learning for Natural Language Processing, Karthiek Reddy Bokka, Shubhangi Hora, Tanuj Jain, Monicah Wambugu, June 2019, Packt Publishing, ISBN: 9781838550295

3. Rothman, Denis, and Antonio Gulli. Transformers for Natural Language Processing: Build, train, and fine-tune deep neural network architectures for NLP with Python, PyTorch, TensorFlow, BERT, and GPT-Packt Publishing Ltd, 2022

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	3	2	1	1	2
CO2	2	3	3	1	2	3	3

CO3	3	3	2	2	3	1	3
CO4	3	1	3	1	3	3	3
CO5	3	2	3	3	3	3	3

CSCEC27	**CYBER SECURITY**	**4 Credits**

a. Course Outcome (CO)

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

	Course Outcome	**Level**
CO1	Explain cyber security concepts, threat landscapes, cyber warfare, and critical infrastructure protection mechanisms	Understand
CO2	Analyze cyber crimes, social engineering attacks, online frauds, and cyber threat case studies	Analyze
CO3	Apply cyber laws, IT regulations, and legal frameworks related to emerging technologies and cyber crimes	Apply
CO4	Analyze data privacy, data protection regulations, and security challenges associated with big data and social media	Analyze
CO5	Apply cyber security management, governance, compliance, auditing, and risk assessment techniques for organizational security	Apply

b. Syllabus

Unit – 1	OVERVIEW OF CYBER SECURITY	12 hrs

Cyber security increasing threat landscape, Cyber security terminologies- Cyberspace, attack, attack vector, attack surface, threat, risk, vulnerability, exploit, exploitation, hacker., Non-state actors, Cyber terrorism, Protection of end user machine, Critical IT and National Critical Infrastructure, Cyberwarfare, Case Studies.

Unit – 2	CYBER CRIMES	12 hrs

Cyber crimes targeting Computer systems and Mobiles- data diddling attacks, spyware, logic bombs, DoS, DDoS, APTs, virus, Trojans, ransomware, data breach., Online scams and frauds- email scams, Phishing, Vishing, Smishing, Online job fraud, Online sextortion, Debit/ credit card fraud, Online payment fraud, Cyberbullying, website defacement, Cybersquatting, Pharming, Cyber espionage, Cryptojacking, Darknet- illegal trades, drug trafficking, human trafficking., Social Media Scams & Frauds- impersonation, identity theft, job scams, misinformation, fake newscyber crime against persons - cyber grooming, child pornography, cyber stalking., Social Engineering attacks, Cyber Police stations, Crime reporting procedure, Case studies.

Unit – 3	CYBER LAW	12 hrs

Cyber crime and legal landscape around the world, IT Act,2000 and its amendments. Limitations of IT Act, 2000. Cyber crime and punishments, Cyber Laws and Legal and ethical aspects related to new technologies- AI/ML, IoT, Blockchain, Darknet and Social media, Cyber Laws of other countries, Case Studies.

Unit – 4	DATA PRIVACY AND DATA SECURITY	12 hrs

Defining data, meta-data, big data, nonpersonal data. Data protection, Data privacy and data security, Personal Data Protection Bill and its compliance, Data protection principles, Big data security issues and challenges, Data protection regulations of other countries- General Data Protection Regulations(GDPR),2016 Personal Information Protection and Electronic Documents Act (PIPEDA)., Social media- data privacy and security issues

Unit – 5	Cyber security Management , Compliance and Governance	12 hrs

Cyber security Plan- cyber security policy, cyber crises management plan., Business continuity, Risk assessment, Types of security controls and their goals, Cyber security audit and compliance, National cyber security policy and strategy

Text / Reference Books:

1. Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Sumit Belapure and Nina Godbole, Wiley India Pvt. Ltd.
2. Information Warfare and Security by Dorothy F. Denning, Addison Wesley.
3. Security in the Digital Age: Social Media Security Threats and Vulnerabilities by Henry A. Oliver, Create Space Independent Publishing Platform.
4. Data Privacy Principles and Practice by Natraj Venkataramanan and Ashwin Shriram, CRC Press
5. Information Security Governance, Guidance for Information Security Managers by W. KragBrothy, 1st Edition, Wiley Publication.
6. Auditing IT Infrastructures for Compliance By Martin Weiss, Michael G. Solomon, 2nd Edition,

Jones Bartlett Learning.

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	2	2	2
CO2	3	3	2	2	2	2	2
CO3	3	3	2	2	2	2	2
CO4	3	3	2	2	2	2	2
CO5	3	3	2	2	2	2	2

CSCEC28	STATISTICS FOR DATA SCIENCE	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain statistical learning concepts, regression techniques, and model evaluation methods	Understand
CO2	Apply resampling methods and cross-validation techniques for model assessment and performance analysis	Apply

CO3	Analyze model selection, regularization, and dimension reduction techniques for high-dimensional data	Analyze
CO4	Apply classification techniques including logistic regression and discriminant analysis for predictive modelling	Apply
CO5	Analyze non-linear modelling and ensemble learning techniques for complex data analysis	Analyze

b. Syllabus

Unit – 1	**INTRODUCTION TO STATISTICAL LEARNING**	**12 hrs**
Statistical Learning – Trade-Off between Prediction Accuracy and Model Interpretability – Regression vs Classification Problems - Assessing Model Accuracy – Measuring the Quality of Fit – Bias-Variance Trade- Off – Linear Regression – Multiple Linear Regression – Other Factors in Regression Model		
Unit – 2	**RESAMPLING METHODS**	**12 hrs**
Cross Validation – Validation Set Approach – Leave-One-Out Cross Validation – k-fold Cross Validation – Bias-Variance Trade-Off for k-fold Cross Validation – Cross Validation on Classification Problems – Bootstrap.		
Unit – 3	**LINEAR MODEL SELECTION AND REGULARIZATION**	**12 hrs**
Subset Selection – Best Subset Selection – Stepwise Selection – Choosing the Optimum Model - Shrinkage Methods – Ridge Regression – Lasso – Selecting the Tuning Parameter – Dimension Reduction Methods – Principal Components Regression – Partial Least Squares – High Dimensional Data		
Unit – 4	**CLASSIFICATION**	**12 hrs**
Logistic Regression – Estimating Regression Coefficients – Linear Discriminant Analysis - Comparison of Classification Methods – Quadratic Discriminant Analysis		
Unit – 5	**MOVIING BEHIND LINEARITY**	**12 hrs**
Polynomial Regression – Regression Splines – Smoothing Splines – Local Regression – Decision Trees – Bagging – Random Forests - Boosting		

Text / Reference Books:

1. James, G., Witten, D., Hastie, T., Tibshirani, R. An introduction to statistical learning with applications in R. Springer, 2013.
2. Hastie, T., Tibshirani, R., Friedman, J. The Elements of Statistical Learning, 2nd edition. Springer, 2009.
3. Murphy, K. Machine Learning: A Probabilistic Perspective. - MIT Press, 2012.
4. Montgomery, Douglas C., and George C. Runger. Applied statistics and probability for engineers. John Wiley & Sons, 2010

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	2	2	2
CO2	3	3	2	2	2	2	2
CO3	3	3	2	2	2	2	2
CO4	3	3	2	2	2	2	2
CO5	3	3	2	2	2	2	2

CSCEC29	COMPUTER GRAPHICS	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain computer graphics fundamentals, display technologies, and graphics hardware components	Understand
CO2	Apply two-dimensional transformation techniques and homogeneous coordinate systems for graphical object manipulation	Apply

CO3	Apply three-dimensional transformations, projections, and viewing techniques in computer graphics applications	Apply
CO4	Analyze scan conversion, polygon filling, and clipping algorithms for graphical rendering	Analyze
CO5	Analyze visible surface determination algorithms and rendering techniques for efficient graphical visualization	Analyze

b. Syllabus

Unit – 1	**INTRODUCTION TO COMPUTER GRAPHICS**	**12 hrs**
Overview of Computer Graphics, Computer Graphics Application and Software, Description of some graphics devices, Input Devices for Operator Interaction, Active and Passive Graphics Devices, Display Technologies, Storage Tube Graphics Displays, Calligraphic Refresh Graphics Displays, Raster Refresh (Raster-Scan) Graphics Displays, Cathode Ray Tube Basics, Color CRT Raster Scan Basics, Video Basics, The Video Controller, Random Scan Display Processor, LCD displays.		
Unit – 2	**TWO DIMENSIOINAL TRANSFORMATIONS**	**12 hrs**
Transformations and Matrices, Transformation Conventions, 2D Transformations, Homogeneous Coordinates and Matrix Representation of 2D Transformations, Translations and Homogeneous Coordinates, Rotation, Reflection, Scaling, Combined Transformation, Transformation of Points, Transformation of The Unit Square, Solid Body Transformations, Rotation About an Arbitrary Point, Reflection through an Arbitrary Line, A Geometric Interpretation of Homogeneous Coordinates, The Window-to-Viewport Transformations.		
Unit – 3	**THREE DIMENSIONAL TRANSFORMATIONS**	**12 hrs**
Introduction, Three-Dimensional Scaling, Three-Dimensional Shearing, Three-Dimensional Rotation, Three-Dimensional Reflection, Three-Dimensional Translation, Multiple Transformation, Rotation about an Arbitrary Axis in Space, Reflection through an Arbitrary Plane, Matrix Representation of 3D Transformations, Composition of 3D Transformations, Affine and Perspective Geometry, Perspective Transformations, Techniques for Generating Perspective Views, Vanishing Points, the Perspective Geometry and camera models, Orthographic Projections, Axonometric Projections, Oblique Projections, View volumes for projections.		
Unit – 4	**SCAN CONVERSION AND FILLING ALGORITHMS**	**12 hrs**
Scan Converting Lines, Mid-point criteria, Problems of Aliasing, end-point ordering and clipping lines, Scan Converting Circles, Scan Converting Ellipses, Filling Polygons, edge data structure, Clipping Lines algorithms– Cyrus-Beck, Cohen-Sutherland and Liang Barsky, Clipping Polygons, Problem with multiple components.		
Unit – 5	**VISIBLE SURFACE DETERMINATION**	**12 hrs**
Techniques for efficient Visible-Surface Algorithms, Categories of algorithms, Back face removal, The z- Buffer Algorithm, Scan-line method, Painter's algorithms (depth sorting), Area sub-division method, BSP trees, Visible-Surface Ray Tracing, comparison of the methods.		

Text / Reference Books:

1. J. D. Foley, A. Van Dam, S. K. Feiner and J. F. Hughes, Computer Graphics - Principles and Practice, Pearson Education, First edition, 2003.
2. D. Hearn and M. Pauline Baker, Computer Graphics (C Version), Pearson Education, 2nd Edition, 2004.
3. F. S. Hill Jr., Computer Graphics using OpenGL, Pearson Education, Third edition, 2007.

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	2	2	2
CO2	3	3	2	2	2	2	2
CO3	3	3	2	2	2	2	2
CO4	3	3	2	2	2	2	2
CO5	3	3	2	2	2	2	2

CSCEC30	DIGITAL WATERMARKING AND STEGANOGRAPHY	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain the fundamentals, applications, models, and coding techniques used in digital watermarking systems	Understand

CO2	Analyze informed watermark embedding, coding techniques, and watermark error analysis methods	Analyze
CO3	Apply perceptual models and robust watermarking techniques for secure multimedia data embedding	Apply
CO4	Analyze watermark security, authentication mechanisms, and attacks against watermarking systems	Analyze
CO5	Apply steganographic methods and steganalysis techniques for secure information hiding applications	Apply

b. Syllabus

Unit – 1	**INTRODUCTION**	**12 hrs**
Information Hiding – Steganography and Watermarking – History of watermarking – Importance of digital watermarking – Applications – Properties – Evaluating watermarking systems. WATERMARKING MODELS & MESSAGE CODING: Notation – Communications – Communication based models – Geometric models – Mapping messages into message vectors – Error correction coding – Detecting multi-symbol watermarks.		
Unit – 2	**WATERMARKING WITH SIDE INFORMATION AND ANALYSING ERRORS**	**12 hrs**
Informed Embedding – Informed Coding – Structured dirty-paper codes – Message errors – False positive errors – False negative errors – ROC curves – Effect of whitening on error rates.		
Unit – 3	**PERCEPTUAL MODELS**	**12 hrs**
Evaluating perceptual impact – General form of a perceptual model – Examples of perceptual models – Robust watermarking approaches – Redundant Embedding, Spread Spectrum Coding, Embedding in Perceptually significant coefficients.		
Unit – 4	**WATERMARK SECURITY AND AUTHENTICATION**	**12 hrs**
Security requirements – Watermark security and cryptography – Attacks – Exact authentication – Selective authentication – Localization – Restoration		
Unit – 5	**STEGANOGRAPHY**	**12 hrs**
Steganography communication – Notation and terminology – Information theoretic foundations of steganography –Dynamicity – Practical steganographic methods – Minimizing the embedding impact – Steganalysis		

Text / Reference Books:

1. Ingemar J. Cox, Matthew L. Miller, Jeffrey A. Bloom, Jessica Fridrich, Ton Kalker, "Digital Watermarking and Steganography", Margan Kaufmann Publishers, New York, 2008.
2. Ingemar J. Cox, Matthew L. Miller, Jeffrey A. Bloom, "Digital Watermarking", Margan Kaufmann Publishers, New York, 2003.
3. Michael Arnold, Martin Schmucker, Stephen D. Wolthusen, "Techniques and Applications of Digital Watermarking and Contest Protection", Artech House, London, 2003.
4. Juergen Seits, "Digital Watermarking for Digital Media", IDEA Group Publisher, New York, 2005.
5. Peter Wayner, "Disappearing Cryptography – Information Hiding: Steganography & Watermarking", Morgan Kaufmann Publishers, New York, 2002.

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	2	2	2
CO2	3	3	2	2	2	2	2
CO3	3	3	2	2	2	2	2
CO4	3	3	2	2	2	2	2
CO5	3	3	2	2	2	2	2

CSCEC31	PARALLEL AND DISTRIBUTED COMPUTING	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain the fundamentals of parallel computing architectures, parallelism concepts, and GPU-based computing models	Understand
CO2	Apply parallel algorithm design techniques, decomposition methods, and load balancing strategies for efficient computation	Apply
CO3	Analyze distributed system models, communication paradigms, and distributed programming techniques	Analyze
CO4	Analyze synchronization, coordination, agreement, and consensus mechanisms in distributed systems	Analyze
CO5	Apply distributed transaction management, concurrency control, and distributed architecture concepts in distributed computing platforms	Apply

b. Syllabus

Unit – 1	PARALLELISM FUNDAMENTALS AND PARALLEL ARCHITECTURES	12 hrs
Motivation – Key Concepts and Challenges – Overview of Parallel computing – Flynn's Taxonomy – Multi- Core Processors – Shared vs Distributed memory. Introduction to OpenMP Programming – Instruction Level Support for Parallel Programming – SIMD – Vector Processing – GPUs.		
Unit – 2	**PARALLEL ALGORITHM AND DESIGN**	**12 hrs**
Preliminaries – Decomposition Techniques – Characteristics of Tasks and Interactions – Mapping Techniques for Load balancing – Parallel Algorithm Models.		
Unit – 3	**INTRODUCTION TO DISTRIBUTED SYSTEMS**	**12 hrs**
Introduction – Characterization of Distributed Systems – Distributed Shared Memory – Message Passing – Programming Using the Message Passing Paradigm – Group Communication – Case Study (RPC and Java RMI).		
Unit – 4	**COORDINATION**	**12 hrs**
Time and Global States – Synchronizing Physical Clocks – Logical Time and Logical Clock – Coordination and Agreement – Distributed Mutual Exclusion – Election Algorithms – Consensus and Related Problems.		

Unit – 5	DISTRIBUTED TRANSACTIONS – DISTRIBUTED SYSTEM ARCHITECTURE AND ITS VARIANTS	12 hrs

Transaction And Concurrency Control – Nested Transactions – Locks – Optimistic Concurrency Control – Timestamp Ordering Distributed Transactions – Flat and Nested – Atomic – Two Phase Commit Protocol – Concurrency Control. Distributed File System: Architecture – Processes – Communication Distributed Web-based System: Architecture – Processes – Communication. Overview of Distributed Computing Platforms.

Text / Reference Books:

1. George Coulouris, Jean Dollimore, Tim Kindberg, and Gordon Blair, Distributed Systems: Concepts and Design, Pearson / Addison – Wesley, Fifth Edition, 2012
2. Ananth Grama, Anshul Gupta, George Karypis and Vipin Kumar, Introduction to Parallel Computing, Pearson, Second Edition, 2008.
3. Andrew S. Tanenbaum and Maarten Van Steen, Distributed Systems: Principles and Paradigms, Pearson, Second Edition, 2006
4. Pradeep K. Sinha, Distributed Operating System: Concepts and Design, PHI Learning Pvt. Ltd., 2007

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	2	2	2
CO2	3	3	2	2	2	2	2
CO3	3	3	2	2	2	2	2
CO4	3	3	2	2	2	2	2
CO5	3	3	2	2	2	2	2

CSCEC32	AGILE PROCESS AND DEVOPS	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain Agile principles, Scrum framework, Agile methodologies, and software process models	Understand
CO2	Apply Agile requirements engineering techniques, backlog management, and Agile project tracking tools	Apply
CO3	Analyze Agile forecasting, estimation, sprint planning, and project management techniques for software development	Analyze
CO4	Apply sprint execution, progress monitoring, velocity tracking, and Agile release management practices	Apply
CO5	Apply Agile testing, CI/CD pipelines, DevOps tools, and container orchestration techniques for software deployment and monitoring	Apply

b. Syllabus

Unit – 1	AGILE METHODOLOGY	12 hrs

Introduction to Agile: Agile versus traditional method comparisons and process tailoring Software Process Models – overview, Introduction to Agile – Various Agile methodologies – Scrum, XP, Lean, and Kanban, Agile Manifesto, Scrum: Scrum process, roles – Product Owner – Scrum Master – Team, Project Manager, product manager, architect, events, and artefacts.

Unit – 2	AGILITY REQUIREMENTS ENGINEERING	12 hrs

Product Inception: Product vision, stakeholders, initial backlog creation; Agile Requirements - User personas, story mapping, user stories, 3Cs, INVEST, acceptance criteria, sprints, requirements, product backlog and backlog grooming; Tools: Agile tracking tools such as JIRA; Scaled agile frameworks: SAFe, Scrum@Scale, Disciplined Agile.

Unit – 3	AGILE FORECASTING AND PROJECT MANAGEMENT	12 hrs

Definition of Done, Definition of Ready; Estimation; Agile forecasting and project Management - Big visible information radiators, velocity, progress tracking, Track Done pattern, project forecasting, Ux Design, Control the Flow: Sprint Planning, Sprint Reviews, Sprint Retrospectives, Sprint Planning - Agile release and iteration (sprint) planning, Develop Epics and Stories, Estimating Stories, Prioritizing Stories (WSJF technique from SAFe), Create product roadmap.

Unit – 4	SPRINT IN AGILE	12 hrs

Sprints: Iterations/Sprints Overview. Velocity Determination, Iteration Planning Meeting, Iteration, Planning Guidelines, Development, Testing, Daily Stand-up Meetings, Progress Tracking, Velocity Tracking, Monitoring and Controlling: Burn down Charts, Inspect & Adapt (Fishbone Model), Agile Release Train.

Unit – 5	AGILE TESTING AND DEVOPS	12 hrs
Testing: Functionality Testing, UI Testing, Performance Testing, Security Testing, Tools - Selenium Agile Testing: Principles of agile testers; The agile testing quadrants, Agile automation, Test automation pyramid DevOps: Continuous Integration and Continuous Delivery CI/CD: Jenkins Creating pipelines, Setting up runners Containers and container orchestration (Dockers and Kubernetes) for application development and deployment; Checking build status; Fully Automated Deployment; Continuous monitoring with Nagios; Introduction to DevOps on Cloud.		

Text / Reference Books:

1. Agile Project Management: Creating Innovative Products, Second Edition By Jim Highsmith, Addison-Wesley Professional, 2009
2. Agile Project Management: Managing for Success, By James A. Crowder, Shelli Friess, Springer 2014
3. Learning Agile: Understanding Scrum, XP, Lean, and Kanban, By Andrew Stellman, Jennifer Greene, 2015, O Reilly
4. DevOps: Continuous Delivery, Integration, and Deployment with DevOps: Dive ... By Sricharan Vadapalli, Packt, 2018
5. Agile Testing: A Practical Guide For Testers And Agile Teams, Lisa Crispin, Janet Gregory, Pearson,2010
6. More Agile Testing: Learning Journeys for the Whole Team By Janet Gregory, Lisa Crispin, Addison Wesley, 2015.
7. DevOps: Puppet, Docker, and Kubernetes By Thomas Uphill, John Arundel, Neependra Khare, Hideto Saito, Hui-Chuan Chloe Lee, Ke-Jou Carol Hsu, Packt, 2017

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	2	2	2
CO2	3	3	2	2	2	2	2
CO3	3	3	2	2	2	2	2
CO4	3	3	2	2	2	2	2
CO5	3	3	2	2	2	2	2

CSCEC33	SOFTWARE PROJECT MANAGEMENT	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain software project management concepts, project evaluation methods, and strategic assessment techniques	Understand
CO2	Apply project planning, scheduling, and network-based activity management techniques for software projects	Apply
CO3	Analyze software project risks and apply risk management strategies including PERT-based estimation techniques	Analyze
CO4	Apply project monitoring, cost control, earned value analysis, and contract management techniques in software projects	Apply
CO5	Analyze organizational behavior, leadership, teamwork, and decision-making practices in software project environments	Analyze

b. Syllabus

Unit – 1	INTRODUCTION TO SOFTWARE PROJECT MANAGEMENT AND PROJECT EVALUATION	12 hrs

Project Definition – Types of Project –Problem with Software Project- Activities covered By Software Project Management – Management Control Cycle. Step wise approach for planning the software project- Product break down structure for identifying the project activities- Strategic Assessment – Technical Assessment –Cost Benefit Evaluation Techniques – Risk Evaluation

Unit – 2	ACTIVITY PLANNING	12 hrs

Objectives – Project Schedule –Activity based approach- Product based approach- Hybrid approach Sequencing and Scheduling Activities –Network Planning Models – Forward Pass – Backward Pass.

Unit – 3	RISK MANAGEMENT	12 hrs

Nature Of Risk – Types Of Risk – Managing Risk – Software project risk and strategies to reduce the risk- PERT using three estimates.

Unit – 4	MONITORING CONTROL	12 hrs

Creating Framework – Collecting The Data – Visualizing Progress – Cost Monitoring – Earned Value Analysis Change Control – Managing Contracts – Introduction – Types Of Contract – Contract Management.

Unit – 5	MOVIING BEHIND LINEARITY	12 hrs

Introduction – Understanding Behaviour – Organizational Behaviour: A Background – Selecting The Right Person For The Job – Working in group- Decision Making- Leadership.

Text / Reference Books:

1. Mike Cotterell, Bob Hughes, Rajib Mall - Software Project Management, Fifth edition, Tata McGraw- Hill, 2011.
2. Greg Horine-Project Management Absolute Beginner's Guide, Third Edition, Que Publishing, 2012.
3. Subramanian Chandramouli and Saikat Dutt, Software Project Management, First edition, Pearson Education, 2015.

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	2	2	2
CO2	3	3	2	2	2	2	2
CO3	3	3	2	2	2	2	2
CO4	3	3	2	2	2	2	2
CO5	3	3	2	2	2	2	2

CSCEC34	DESIGN PATTERNS	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain the fundamentals, advantages, and architectural foundations of software design patterns	Understand
CO2	Apply design principles, encapsulation strategies, and structural design patterns for flexible software development	Apply
CO3	Analyze behavioral design patterns such as Observer and Template Method patterns for reusable software design	Analyze
CO4	Apply creational and object management design patterns including Factory, Singleton, and Object Pool patterns	Apply
CO5	Analyze industrial case studies and evaluate the role of design patterns in developing maintainable and scalable software systems	Analyze

b. Syllabus

Unit – 1	INTRODUCTION TO DESIGN PATTERNS	12 hrs

Introduction to Design Patterns: Design Patterns Arose from Architecture and Anthropology – Architectural to Software Design Patterns – Advantages of Design Patterns – Adapter Pattern – Strategy Pattern – Bridge Pattern – Abstract Factory Pattern.

Unit – 2	PRINCIPLES AND STRATEGIES OF DESIGN PATTERNS	12 hrs

New Paradigm of Design - Principles and Strategies of Design Patterns -Open-Closed Principle – Designing from Context - Encapsulating Variation. Commonality and Variability Analysis - Analysis Matrix - Decorator Pattern - Open Closed Principle – The Principle of encapsulating variation – Abstract Classes vs Interfaces.

Unit – 3	VALUES OF PATTERNS AND TEMPLATE METHOD PATTERN	12 hrs

Values of Patterns - Observer Pattern - Categories of Patterns - Template Method Pattern – Applying the Template Method to the Case Study - Using Template Method Pattern to Reduce Redundancy .

Unit – 4	APPLICATIONS OF DESIGN PATTERNS	12 hrs

Applying Design Patterns - Design Patterns - Factories - Singleton Pattern and the Double- Checked Locking Pattern - Applying Singleton Pattern to Case Study. Object Pool Pattern - Management of Objects - Factory Method Pattern - Object Oriented Pool Patterns.

Unit – 5	EXPECT FROM DESIGN PATTERNS WITH CASE STUDY	12 hrs

Case Studies - What to Expect from Design Patterns - The Pattern Community An Invitation – A Parting Thought – Industrial Case Study.

Text / Reference Books:

1. Smith, J. M. (2012). Elemental design patterns. Addison-Wesley.
2. Shalloway, A., & Trott, J. R. (2016). Design patterns explained: A new perspective on object-oriented design, 2/E. Pearson Education India.
3. Gamma, E., Helm, R, Johnson, R., Vlissides, J. (2015). Design patterns: elements of reusable object- oriented software Pearson India.
4. Freeman, E., Robson, E., Bates, B., & Sierra, K. (2016) Head First Design Patterns: A Brain-Friendly Guide," O'Reilly Media, Inc.".
5. Freeman, E., Robson, E. (2020) Head First Design Patterns: Building Extensible and Maintainable Object-Oriented Software," O'Reilly Media, Inc.".

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	2	2	2
CO2	3	3	2	2	2	2	2
CO3	3	3	2	2	2	2	2
CO4	3	3	2	2	2	2	2
CO5	3	3	2	2	2	2	2

CSCEC35	WIRELESS SENSOR NETWORKS	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain wireless sensor network architectures, standards, wireless technologies, and sensor node concepts	Understand
CO2	Analyze MAC protocols and communication mechanisms for efficient wireless sensor network operations	Analyze
CO3	Apply localization, routing, deployment, and data dissemination techniques in wireless sensor networks	Apply
CO4	Analyze energy-efficient mechanisms, power control strategies, and operating system concepts for WSNs	Analyze
CO5	Apply sensor network platforms, simulators, and programming tools for developing wireless sensor network applications	Apply

b. Syllabus

Unit – 1	OVERVIEW OF WSN SYSTEMS	12 hrs

Introduction, Applications of Wireless Sensor Networks, WSN Standards, IEEE 802.15.4, Zigbee. Network Architectures and Protocol Stack – Network architectures for WSN – classification of WSN – protocol stack for WSN. Wireless Transmission Technology and Systems – Radio Technology – Available Wireless Technologies. Wireless Sensor Technology – Sensor Node Technology – Hardware and Software – Sensor Taxonomy – WN Operating Environment.

Unit – 2	MEDIUM ACCESS CONTROL PROTOCOLS FOR WIRELESS SENSOR NETWORKS	12 hrs

Fundamentals of MAC Protocols – MAC Protocols for WSNs – Contention-based protocols: Power-Aware Multi-Access with Signalling – Data-Gathering MAC – Contention-Free Protocols: Low-Energy Adaptive Clustering Hierarchy – B-MAC – S-MAC. Dissemination Protocol for Large Sensor Networks.

Unit – 3	DEPLOYMENT AND CONFIGURATION	12 hrs

Target tracking – Localization and Positioning – Coverage and Connectivity – Single-hop and Multi-hop Localization – Self-Configuring Localization Systems. Routing Protocols and Data Management for Wireless Sensor Networks – Routing Challenges and Design Issues in Wireless Sensor Networks – Routing Strategies in Wireless Sensor Networks – Routing protocols: data-centric, hierarchical, location based energy efficient routing etc. Querying – Data Dissemination and Gathering.

Unit – 4	ENERGY – POWER CONTROL AND OS FOR WSN	12 hrs

Need for energy efficiency and power control in WSN – passive power conservation mechanisms – active power conservation mechanisms. Operating System Design Issues – TinyOS – Contiki – Task management – Proto threads – Memory and IO management.

Unit – 5	SENSOR NETWORK PLATFORMS AND TOOLS	12 hrs

Sensor Node Hardware – Tmote – Micaz – Programming Challenges – Node-level Software Platforms – Node-level Simulators – State-centric Programming.

Text / Reference Books:

1. KazemSohraby, Daniel Minoli, TaiebZnati, Wireless Sensor Networks, Technology, Protocols and Applications, Wiley, 2007
2. Holger Karl, Andreas Willig, Protocols And Architectures for Wireless Sensor Networks, John Wiley, 2005.
3. Jun Zheng, Abbas Jamalipour, Wireless Sensor Networks: A Networking Perspective, Wiley, 2009.
4. Ian F. Akyildiz, Mehmet Can Vuran, Wireless Sensor Networks, Wiley, 2010
5. Ibrahiem M. M. El Emary, S. Ramakrishnan, Wireless Sensor Networks: From Theory to Applications, CRC Press Taylor & Francis Group, 2013

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	2	2	2
CO2	3	3	2	2	2	2	2
CO3	3	3	2	2	2	2	2
CO4	3	3	2	2	2	2	2
CO5	3	3	2	2	2	2	2

CSCEC36	APROXIMATION ALGORITHMS	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain the fundamentals of approximation algorithms and approximation techniques for NP-hard optimization problems	Understand
CO2	Apply greedy and local search algorithms for solving combinatorial optimization problems	Apply
CO3	Analyze semi-definite programming techniques for approximation problems in graphs and optimization	Analyze
CO4	Apply cut-based and metric-based approximation algorithms for network optimization problems	Apply
CO5	Analyze hardness of approximation through reductions and complexity-theoretic proof techniques	Analyze

b. Syllabus

Unit – 1	INTRODUCTION TO APPROXIMATION ALGORITHMS	12 hrs
Algorithm and problem solving – Conventional algorithm design paradigms – Approximation Algorithms, – Concept of Approximation – Sample Problem Statements – Vertex Cover – TSP – Set Cover – Subset Problem.		
Unit – 2	**GREEDY ALGORITHMS AND LOCAL SEARCH**	**12 hrs**
Scheduling Jobs with Deadline on a Single Machine – k-center problem – Scheduling Jobs on Identical Parallel Machines – TSP – Finding Minimum Degree Spanning Trees – Edge Coloring.		
Unit – 3	**SEMI DEFINITE PROGRAMMING**	**12 hrs**
Introduction to SDP – Finding Large Cuts – Approximating Quadratic Programs – Finding Correlation Clustering – Coloring 3-colorable Graphs.		
Unit – 4	**CUTS AND METRICS**	**12 hrs**
Multiway Cut Problem – Minimum Cut based Algorithm – LP Rounding Algorithm for Multiway Cut Problem – Multicut Problem – Balanced Cuts.		
Unit – 5	**PROVING THE HARDNESS OF APPROXIMATION**	**12 hrs**
Reductions from NP-Complete Problems – Reductions that preserve Approximation – Reductions from Label Cover – Reductions from Unique games.		

Text / Reference Books:

1. David P. Williamson, David B. Shmoys, The Design of Approximation Algorithms, Cambridge University Press, 2011
2. J Kleinberg, E Tardos, Algorithm Design, Pearson, First edition, 2005.
3. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran., Fundamentals of Computer Algorithms, University Press, 2008.
4. Thomas H. Cormen, C.E. Leiserson, R L.Rivest and C. Stein, Introduction to Algorithms, MIT Press, Third edition, 2010

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	2	2	2
CO2	3	3	2	2	2	2	2
CO3	3	3	2	2	2	2	2
CO4	3	3	2	2	2	2	2
CO5	3	3	2	2	2	2	2

CSCEC37	PARALLEL ALGORITHMS	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Explain parallel algorithm design principles, task channel models, and complexity measures for parallel computation	Understand
CO2	Apply parallel algorithms for solving linear systems and matrix-based computational problems	Apply
CO3	Apply parallel searching and sorting algorithms for efficient data processing	Apply
CO4	Analyze parallel graph algorithms for traversal, shortest path, spanning tree, and connectivity problems	Analyze
CO5	Analyze performance metrics, scalability models, and message-passing techniques in parallel computing systems	Analyze

b. Syllabus

Unit – 1	PARALLEL ALGORITHM DESIGN	12 hrs
Task channel model – Foster's method of design – Boundary Value Problem – Finding the maximum sum – Complexity measure for parallel algorithms.		
Unit – 2	**PARALLEL ALGORITHMS FOR SOLVING LINEAR SYSTEMS**	**12 hrs**
Back substitution – Gaussian elimination – Iterative methods – Row and Column Oriented Design.		
Unit – 3	**PARALLEL SEARCHING ALGORITHMS**	**12 hrs**
Finding largest and smallest element – median – kth largest/smallest element – Parallel sorting algorithms: Odd-Even transposition – Shell sort – Quick sort.		
Unit – 4	**PARALLEL GRAPH ALGORITHMS**	**12 hrs**
Parallel graph search and tree traversal algorithms – Minimum spanning tree: Prim's algorithm, parallel algorithms for path problems: Single source shortest paths – Dijkstra's Algorithm – All Pair Shortest Paths – Dijkstra's Algorithm – Floyd Warshall algorithm – Connected Components.		
Unit – 5	**PERFORMANCE ANALYSIS**	**12 hrs**
Speed-up – efficiency – Amdahl's Law – Gustafson – Barsis's Law – The Karp Flatt metric – Isoefficiency metric – Scalability function – Message-Passing Programming – Circuit Satisfiability.		

Text / Reference Books:

1. Ananth Grama, Anshul Gupta, George Karypis and Vipin Kumar, Introduction to Parallel Computing, Second edition, Addison-Welsey, 2009.
2. Michael J Quinn, Parallel Programming in C with MPI & OpenMP, Second edition, Tata McGraw Hill, 2009.
3. Thomas H. Cormen, C.E. Leiserson, R L.Rivest and C. Stein, Introduction to Algorithms, MIT Press, Third edition, 2010

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	2	2	2
CO2	3	3	2	2	2	2	2
CO3	3	3	2	2	2	2	2
CO4	3	3	2	2	2	2	2
CO5	3	3	2	2	2	2	2

SKILL ENHANCEMENT COURSES

CSCSE01	FUNCTIONAL PROGRAMMING	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Understand the concepts of functional programming and able to write programs	Understand
CO2	Develop simple programs using tuples and lists	Apply
CO3	Able to write higher order functions	Create
CO4	Understand and develop the program development and deployment	Skill
CO5	Develop simple projects using functional programming	Apply

b. Syllabus

Unit – 1	INTRODUCTION TO FUNCTIONAL PROGRAMMING	12 hrs
Computers and modelling – Pictures and Functions – Haskell programming language – expressions and evaluation – definitions – functions – hugs – Haskell libraries – data types – designing and writing programs		
Unit – 2	**TUPLES AND LISTS**	**12 hrs**
Tuples – lists – strings – list comprehensions – library database – generic functions : polymorphism – Haskell list functions - string type – pictures – applications in lists – pattern matching – lists and list patterns – primitive recursion – finding primitive recursive definitions – general recursion with lists – text processing		
Unit – 3	**REASONING AND GENERALIZATION**	**12 hrs**
Reasoning – understanding definitions – testing and proof – little logic – induction – examples of proof by induction – generalizing the proof goal – patterns of computation over lists – higher order functions – functions as arguments – folding and primitive recursion – splitting up lists		
Unit – 4	**FUNCTIONS AND PROGRAM DEVELOPMENT**	**12 hrs**
Function level definitions – function composition – function as values and results – partial application – currying and uncurrying – verification and general functions. Program development cycle – development in practice.		
Unit – 5	**CASE STUDIES**	**12 hrs**
Huffman Codes: Modules in Haskell – Modular Design – coding and decoding – building Huffman trees – design and implementation.		

Text / Reference Books:

1. The Haskell standard Prelude
2. Richard Bird, Thinking Functionally With Haskell, Cambridge University Press, October 2014.
3. Miran Lipovača, Learn You a Haskell for Great Good! A Beginner's Guide, No Starch Press, 2011.
4. Simon Thompson, Haskell: The Craft of Functional Programming, Addison-Wesley, 1996.

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	2	2	2
CO2	3	3	2	2	2	2	2
CO3	3	3	2	2	2	2	2
CO4	3	3	2	2	2	2	2
CO5	3	3	2	2	2	2	2

CSCSE02	ADVANCED JAVA PROGRAMMING	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Develop programs and simple applications using swings and beans	Apply
CO2	Connect java with relational database and create, access and modify the data	Analyse
CO3	Develop client server programs and do message programming	Skill
CO4	Create applications using servlets	Apply
CO5	Develop web pages using JSP	Create

b. Syllabus

Unit – 1	SWINGS AND JAVA BEANS	12 hrs
Introduction To Swing, MVC Architecture, Applets, Applications and Pluggable Look and Feel, Basic swing components : Text Fields, Buttons, Toggle Buttons, Checkboxes, and Radio Buttons. Java Bean architecture – Characteristics of Java Bean – Providing Properties and Methods		
Unit – 2	**JDBC**	**12 hrs**
Overview of RDBMS – Introduction to Call Level Interface(CLI) - Introduction to JDBC – JDBC architecture – Types of JDBC drivers – Establishing a JDBC connection – Using Statement – Using Prepared Statement – Using Callable Statement – Scrollable and Updatable Resultset – Inserting and Fetching from BLOB columns – Managing Transactions in JDBC – Auto Increment Columns		
Unit – 3	**NETWORK PROGRAMMING**	**12 hrs**
Network Programming With java.net Package, Client and Server Programs, Content And Protocol – Handlers		
Unit – 4	**SERVLET PROGRAMMING**	**12 hrs**
Server side programming with Java Servlet, HTTP and Servlet, Servlet API, life cycle, configuration and context, Request and Response objects, Session handling and event handling, Introduction to filters with writing simple filter application		
Unit – 5	**JSP PROGRAMMING**	**12 hrs**
JSP architecture, JSP page life cycle, JSP elements, Expression Language, Tag Extensions, Tag Extension API, Tag handlers, JSP Fragments, Tag Files, JSTL, Core Tag library, overview of XML Tag library, SQL Tag library and Functions Tag library		

Text / Reference Books:

1. Java Programming, Black Book, Dreamtech
2. Java Server Programming Black Book
3. Advanced Java Technology, By M.T. Savaliya, Dreamtech

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	2	2	2
CO2	3	3	2	2	2	2	2
CO3	3	3	2	2	2	2	2
CO4	3	3	2	2	2	2	2
CO5	3	3	2	2	2	2	2

OPEN ELECTIVE COURSES

CSCOE01	FUNDAMENTALS OF CYBER SECURITY	4 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Able to understand the concept of cyber security and issues and challenges associated with it	Understand
CO2	Understand the cybercrimes, their nature and legal remedies	Understand
CO3	Analyse various privacy and security concerns on online social media and learn how to report	Analyse
CO4	Understand the concepts of e-commerce and digital payments	Understand
CO5	Understand the basic security aspects related to computers and mobiles	Understand

b. Syllabus

Unit – 1	INTRODUCTION TO CYBER SECURITY	12 hrs

Defining Cyberspace and Overview of Computer and Web-technology, Architecture of cyberspace, Communication and web technology, Internet, World wide web, Advent of internet, Internet infrastructure for data transfer and governance, Internet society, Regulation of cyberspace, Concept of cyber security, Issues and challenges of cyber security.

Unit – 2	CYBER CRIME AND CYBER LAW	12 hrs

Classification of cyber crimes, Common cyber crimes- cyber crime targeting computers and mobiles, cyber crime against women and children, financial frauds, social engineering attacks, malware and ransomware attacks, zero day and zero click attacks, Cybercriminals modus-operandi , Reporting of cyber crimes, Remedial and mitigation measures, Legal perspective of cyber crime, IT Act 2000 and its amendments, Cyber crime and offences, Organisations dealing with Cyber crime and Cyber security in India, Case studies.

Unit – 3	SOCIAL MEDIA OVERVIEW AND SECURITY	12 hrs

Introduction to Social networks. Types of Social media, Social media platforms, Social media monitoring, Hashtag, Viral content, Social media marketing, Social media privacy, Challenges, opportunities and pitfalls in online social network, Security issues related to social media, Flagging and reporting of inappropriate content, Laws regarding posting of inappropriate content, Best practices for the use of Social media, Case studies.

Unit – 4	E – COMMERCE AND DIGITAL PAYMENTS	12 hrs

Definition of E- Commerce, Main components of E-Commerce, Elements of E-Commerce security, E-Commerce threats, E-Commerce security best practices, Introduction to digital payments, Components of digital payment and stake holders, Modes of digital payments- Banking Cards, Unified Payment Interface (UPI), e-Wallets, Unstructured Supplementary Service Data (USSD), Aadhar enabled payments, Digital payments related common frauds and preventive measures. RBI

guidelines on digital payments and customer protection in unauthorised banking transactions. Relevant provisions of Payament Settlement Act,2007,		
Unit – 5	**DIGITAL DEVICES SECURITY, TOOLS AND TECHNOLOGIES FOR CYBER SECURITY**	**12 hrs**
End Point device and Mobile phone security, Password policy, Security patch management, Data backup, Downloading and management of third party software, Device security policy, Cyber Security best practices, Significance of host firewall and Ant-virus, Management of host firewall and Anti-virus, Wi-Fi security, Configuration of basic security policy and permissions.		

Text / Reference Books:

1. Cyber Crime Impact in the New Millennium, by R. C Mishra , Auther Press. Edition 2010.
2. Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Sumit Belapure and Nina Godbole, Wiley India Pvt. Ltd. (First Edition, 2011)
3. Security in the Digital Age: Social Media Security Threats and Vulnerabilities by Henry A. Oliver, Create Space Independent Publishing Platform. (Pearson , 13th November, 2001)
4. Electronic Commerce by Elias M. Awad, Prentice Hall of India Pvt Ltd.
5. Cyber Laws: Intellectual Property & E-Commerce Security by Kumar K, Dominant Publishers.
6. Network Security Bible, Eric Cole, Ronald Krutz, James W. Conley, 2nd Edition, Wiley India Pvt. Ltd.
7. Fundamentals of Network Security by E. Maiwald, McGraw Hill

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	2	-	-	-	1	2
CO2	2	2	-	-	-	1	2
CO3	2	2	-	-	2	2	2
CO4	2	2	-	-	2	2	2
CO5	2	2	-	-	2	2	2

CSCOE02	LATEX FOR RESEARCHERS	3 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Understand the latex document structure and layout	Understand
CO2	Learn various typesetting methods for text	Apply
CO3	Learn various mathematical typesetting functions	Apply
CO4	Learn to create bibliographic databases	Apply
CO5	Learn to prepare presentations	Skill

b. Syllabus

Unit – 1	INTRODUCTION TO LATEX	9 hrs
Introduction to LaTeX – Software Installation – Basics of a LaTeX File – Text – Symbols and Commands – Document Layout and Organization		
Unit – 2	**TEXT PROCESSING**	**9 hrs**
Displayed Text – Fonts – Indenting – Lists – Generalized Lists – Theorem declarations – Tabular stops – Boxes – Tables – Literal Text Printing – Foot Notes – Marginal Notes – Comments within Text – Floating Tables		
Unit – 3	**MATH PROCESSING**	**9 hrs**
Mathematical Environments – Main elements of Math mode – Mathematical Symbols – Additional Symbols – Fine Tuning Mathematics.		
Unit – 4	**BIBLIOGRAPHY AND GRAPHICS**	**9 hrs**
Graphics Packages – Figures – Bibliographic Databases – BibTex Program – Creating a Bibliographic Database – Customizing Database Styles		
Unit – 5	**LATEX PRESENTATIONS AND LATEX PROGRAMING**	**9 hrs**
Slide Production with SLITeX – Slide production with Seminar – Electronics Documents for Screen Viewing – Special Effects with PDF – Beamer Presentations – Classes and Package Files – LaTeX Programming Commands – Sample Packages – Managing Code and Documentation.		

Text / Reference Books:

1. A Guide to LaTeX and Electronics Publishing, Adison Wesley 2004
2. Griffiths, D. F., Higham, D. J. (2016). Learning LaTeX. United States: Society for Industrial and Applied Mathematics.
3. Lamport, L. (2001). Latex: A Document Preparation System : User's Guide and Reference Manual. United States: Addison-Wesley.
4. Erickson, M., Bindner, D. (2011). A Student's Guide to the Study, Practice, and Tools of Modern Mathematics. United Kingdom: Taylor & Francis.
5. Kottwitz, S. (2021). LaTex Beginner's Guide - Second Edition: Create Visually Appealing Texts, Articles, and Books for Business and Science Using LaTex. India: Packt Publishing.
6. Tantau, T., Wright, J., Miletic, V. (2016). The BEAMER Class: User Guide for Version 3.49. (n.p.): 12th Media Services.

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	2	2	2	2
CO2	3	2	2	2	2	2	2
CO3	3	2	2	2	2	2	2
CO4	3	2	2	2	2	2	2
CO5	3	2	2	2	2	2	2

CSCOE03	Orientation on Research for PG students	3 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Basics of Research, Research types and different phases in research	Understand
CO2	Learn Research Areas, Research Opportunities in Computer Science	Understand
CO3	Illustrate how to conduct Effective Literature Survey and Problem Identification, Experimentationand Results	Analyse
CO4	Learn Reference Managers, Research Manuscript writing, publication, Journal Indexing	Apply
CO5	Understand Plagiarism, Fellowships, Higher Education opportunities in India and Abroad	Apply

b. Syllabus

Unit – 1	BASICS OF RESEARCH, RESEARCH TYPES AND DIFFERENT PHASES IN RESEARCH	9 hrs
Basics of research, types of research, Fundamental research, Applied research, Qualitative research, Mixed research, Exploratory research, Field research, Laboratory research and other type of research, Different phases in research		
Unit – 2	**RESEARCH AREAS, RESEARCH OPPORTUNITIES IN COMPUTER SCIENCE**	**9 hrs**
Research areas in computer science, Data Analytics, Systems Architecture, Web Semantics, Information Security, Pervasive and Mobile Computing, IoT, Computer Networks, Soft Computing Techniques, Information Management, Artificial Intelligence and other research areas. Research opportunities in these areas		
Unit – 3	**EFFECTIVE LITERATURE SURVEY AND PROBLEM IDENTIFICATION, EXPERIMENTATION AND RESULTS**	**9 hrs**
Literature Review, Conduction of literature review, How to read a scientific paper, Review articles, Primary research articles, Read critically, Read creatively, Literature findings and problem identification,Data sets, experimentation, results and discussion		
Unit – 4	**REFERENCE MANAGERS, RESEARCH MANUSCRIPT WRITING, PUBLICATION, JOURNAL INDEXING**	**9 hrs**
Referencing, citation and Reference Manager, steps in writing research manuscript, conference publications, proceedings of the conference, publications in Journals, Scopus indexed and SCI indexed journals		

Unit – 5	PLAGIARISM, FELLOWSHIPS, HIGHER EDUCATION OPPORTUNITIES IN INDIA AND ABROAD	9 hrs

Plagiarism - Plagiarism types - Plagiarism Checker - avoiding plagiarism – Ph.D program - PhD admissionrequirements - Fellowships offered in India for Ph.D - Junior Research Fellow (JRF) - Non-NET fellowship - Fellowships offered in other countries (abroad) for Ph.D - Post Doctoral Fellowships in India [Part Time& Full Time].

Text / Reference Books:

1. Garg.B.L., Karadia, R., Agarwal,F. and Agarwal, U.K., 2002. An introduction to ResearchMethodology, RBSA Publishers.
2. Kothari, C.R.(2008). Research Methodology: Methods and Techniques. Second Edition.New AgeInternational Publishers, New Delhi.
3. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes.
4. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing.270 p.
5. Day RA (1992) How to write and publish a scientific paper. Cambridge University press. London
6. Hempel,C. Philosophy of Natural science Englewood Cliffs, N.J: Prentice Hall, 1966.
7. Burtt, E.A. The Metaphysical Foundations of Modern Science. London, 2003.
8. Latour, B. & Woolgar. 3. Laboratory Life. The construction of scientific facts. 2nd Edition. Princeton:Princeton University Press.1986
9. Gupta S.P. (2008). Statistical Methods. 37th ed. (Rev)Sultan Chand and Sons. New Delhi.

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	2	2	2	2
CO2	3	2	2	2	2	2	2
CO3	3	2	2	2	2	2	2
CO4	3	2	2	2	2	2	2
CO5	3	2	2	2	2	2	2

CSCOE04	OFFICE AUTOMATION	3 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Understand the fundamentals of computer and the working of internet	Understand
CO2	Prepare neatly formatted documents	Create
CO3	Prepare spreadsheets and do analysis on data	Skill
CO4	Prepare presentations	Create
CO5	Understand the concepts of database and perform database operations	Analyse

b. Syllabus

Unit – 1	COMPUTER FUNDAMENTALS AND INTERNET	9 hrs

Computer & Internet: Desktop computers, Block diagram of a computer, Input and output devices, memory and storage devices, different ports and its uses, Different type of printers. Software: OS, Windows OS, Application software. Networking, different LAN and WAN connections, connecting to a network, testing connection, Internet, IP address, Hypertext, Uniform Resource Locator, Web Browsers, IP Address, Domain Name, Internet Services Providers, Internet Security, Internet Requirements, Web Search Engine, Net Surfing, Internet Services.

Unit – 2	WORD PROCESSING USING MS-WORD	9 hrs

Features, Creating, Saving and Opening Documents in Word, Interface, Toolbars, Ruler, Menus, Keyboard 100 Shortcut, Editing, Previewing, Printing,& Formatting a Document, Advanced Features of MS Word, Find & Replace, Using Thesaurus, Using Auto- Multiple Functions, Mail Merge, Handling Graphics, Tables & Charts, Coverting a word document into various formats like- Text, Rich Text format, Word perfect, HTML,PDF etc.

Unit – 3	WORKING WITH SPREADSHEETS	9 hrs

Worksheet basics, creating worksheet, entering into worksheet, heading information, data, text, dates, alphanumeric values, saving & quitting worksheet, Opening and moving around in an existing worksheet, Toolbars and Menus, Keyboard shortcuts, Working with single and multiple workbook, working with formulae & cell referencing, Auto sum, Coping formulae, Absolute & relative addressing, Worksheet with ranges, formatting of worksheet, Previewing & Printing worksheet, Graphs and charts, Database, Creating and Using macros, Multiple worksheets.

Unit – 4	CREATING SLIDE SHOWS AND ANIMATIONS	9 hrs

Creating a blank presentation, auto layout, Power point screen: screen layout and Views, applying design template, changing slide layout, reordering and hiding slides, slide show and editing custom slide. Formatting Text - Color schemes , Auto Shapes and Backgrounds – Graphics – Animations – Slide Show Settings.

Unit – 5	WORKING WITH DATABASES	9 hrs

Databases, Records · Fields, data types, Database Types · Library Catalogues Introduction into Microsoft Access, Creating New, and Opening Existing Databases, Creating a database using a wizard Creating a database without using a wizard, Tables - View, Primary Keys, Switching Views, Entering Data, Manipulating Data, Advanced Table Feature Examples, Relationships - How to link multiple tables together, Forms - What they are and how they work, Creating A Form Using A Wizard, Reports - What they are and how they work, Creating A Report Using A Wizard, Creating Mail Merge Labels using a Wizard

Text / Reference Books:

1. Professional Office Procedure by Susan H Cooperman, Printice Hall
2. Information Technology:Principles , Practices and Oppertunities by James A Senn, Printice Hall
3. Technology And Procedures for Administrative Professionals by Patsy Fulton-Calkins, Thomson Learning
4. Public Information Technology and E-Governance: Managing the Virtual State (Paperback) by G. David Garson

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	2	2	2	2
CO2	3	2	2	2	2	2	2
CO3	3	2	2	2	2	2	2
CO4	3	2	2	2	2	2	2
CO5	3	2	2	2	2	2	2

CSCOE05	FUNDAMENTALS OF PYTHON PROGRAMMING	3 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Understand the fundamental concepts of python and its main components	Understand
CO2	Develop (Read and Write) python programs using variables, assignments, and conditionalstatements using functions	Apply
CO3	Illustrate and implement different data structures	Analyse
CO4	Demonstrate Object-oriented concepts and file handling	Apply
CO5	Analyse and plot data using python visualization libraries	Skill

b. Syllabus

Unit – 1	INTRODUCTION TO PYTHON	9 hrs
Introduction to a programming language – Python Installation – Comments and documentation in Python- Keywords and Identifiers -Programming Errors - Writing and Running python programs.		
Unit – 2	**VARIABLES AND CONDITIONALS IN PYTHON**	**9 hrs**
Variables – Constants- Strings - Assignment statements – Expressions-Operators – Type Conversions - Control Flow statements and Loops- Functions.		
Unit – 3	**WORKING WITH LISTS AND TUPLES**	**9 hrs**
List Basics- List Indexing and Slicing-Appending-Sorting and Ranging-Tuples-Creation-Deletion-Converting tuple to list.		
Unit – 4	**WORKING WITH DICTIONARIES AND SETS**	**9 hrs**
Dictionaries-Adding-Modifying and Retrieving Values-Traversing all keys in the dictionary-Operations and methods-Sets- manipulating and accessing sets.		
Unit – 5	**GRAPH PLOTTING**	**9 hrs**
Introduction to plotting python libraries -Plots and Graphs- Applied Visualizations – Seaborn – Matplotlib		

Text / Reference Books:

1. Eric Matthes, Python Crash Course, No Starch Press, Second edition, 2019
2. Martin C. Brown, Python: The Complete Reference, McGraw Hill Education, Fourth edition, 2018
3. Ryan Marvin Mark Ng'Ang'A Amos Omondi, Python Fundamentals, Packet Publishing, Second edition, 2018
4. Zed Shaw, Learn Python 3 the Hard Way: A Very Simple Introduction to the Terrifyingly Beautiful World of Computers and Code, Addison-Wesley Professional, First edition, 2017

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	2	2	2	2
CO2	3	2	2	2	2	2	2
CO3	3	2	2	2	2	2	2
CO4	3	2	2	2	2	2	2
CO5	3	2	2	2	2	2	2

CSCOE06	OBJECT ORIENTED PROGRAMING USING C++	3 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Understand the concepts of Object Oriented Programming	Understand
CO2	Able to implement classes and objects with constructors	Apply
CO3	Understand the concept of operator overloading and friend functions	Apply
CO4	Implement inheritance with real time applications	Apply
CO5	Implement polymorphism with real time applications	Apply

b. Syllabus

Unit – 1	INTRODUCTION TO OBJECT ORIENTED PROGRAMMING	9 hrs
What is object oriented programming? Why do we need object oriented. Programming characteristics of object-oriented languages. C and C++. Returning values from functions. Reference arguments. Overloaded function. Inline function. Default arguments. Returning by reference. – Dynamic Memory allocation.		
Unit – 2	**OBJECTS AND CLASSES**	**9 hrs**
Making sense of core object concepts (Encapsulation, Abstraction, Polymorphism, Classes, Messages Association, Interfaces) Implementation of class in C++, C++ Objects as physical object, C++ object as data types constructor. Object as function arguments. The default copy constructor, returning object from function. Structures and classes. Classes objects and memory static class data. Const and classes.		
Unit – 3	**OPERATOR OVERLOADING AND FRIEND FUNCTIONS**	**9 hrs**
Overloading unary operations. Overloading binary operators, data conversion, pitfalls of operators overloading and conversion keywords. Explicit and Mutable. – Friend Functions		
Unit – 4	**INHERITANCE**	**9 hrs**
Concept of inheritance. Derived class and based class. Derived class constructors, member function, inheritance in the English distance class, class hierarchies, inheritance and graphics shapes, public and private inheritance, aggregation : Classes within classes, inheritance and program development.		
Unit – 5	**POLYMORPHISM**	**9 hrs**
Virtual Function, friend function, Static function, Assignment and copy initialization, this pointer, dynamic type information.		

Text / Reference Books:

1. The C++ Programming by Yashwant Kanetkar
2. C++ Complete Reference by Herbert Schieldt
3. Let us C++ by Yashwant Kanetkar

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	2	2	2	2
CO2	3	2	2	2	2	2	2
CO3	3	2	2	2	2	2	2
CO4	3	2	2	2	2	2	2
CO5	3	2	2	2	2	2	2

CSCOE07	R PROGRAMMING	3 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Understand the R programming constructs and simple functions	Understand
CO2	Write simple programs using decision statements and looping statements	Apply
CO3	Create user defined functions and work on vectors – lists – matrices	Understand, Apply
CO4	Handle data using data frames	Apply
CO5	Explore various visualization techniques to understand data	Skill

b. Syllabus

Unit – 1	INTRODUCTION TO R	9 hrs

What is R? – Why R? – Advantages of R over Other Programming Languages - R Studio: R command Prompt, R script file, comments – Handling Packages in R: Installing a R Package, Few commands to get started: installed.packages(), packageDescription(), help(), find.package(), library() - Input and Output – Entering Data from keyboard – Printing fewer digits or more digits – Special Values functions : NA, Inf and –inf.

Unit – 2	VARIABLES AND DATA TYPES – DECISION MAKING AND LOOPS	9 hrs

R Data Types: Vectors, Lists, Matrices, Arrays, Factors, Data Frame – R - Variables: Variable assignment, Data types of Variable, Finding Variable ls(), Deleting Variables - R Operators: Arithmetic Operators, Relational Operators, Logical Operator, Assignment Operators, Miscellaneous Operators - R Decision Making: if statement, if – else statement, if – else if statement, switch statement – R Loops: repeat loop, while loop, for loop - Loop control statement: break statement, next statement.

Unit – 3	FUNCTIONS – STRINGS – VECTORS – LISTS – MATRICES AND ARRAYS	9 hrs

R-Function : function definition, Built in functions: User defined function , calling a function, calling a function without an argument, calling a function with argument values - R-Strings – Manipulating Text in Data - R Vectors – Lists - Matrices - Arrays.

Unit – 4	WORKING WITH DATA FRAMES	9 hrs

Data Frames –Create Data Frame, Data Frame Access, Understanding Data in Data Frames - Extract Data from Data Frame, Merging Data frames merge() – Melting and Casting data

Unit – 5	DATA VISUALIZATION	9 hrs

Descriptive Statistics: Data Range, Frequencies, Mode, Mean and Median: Mean Applying Trim Option, Applying NA Option, Median - Mode - Standard Deviation – Correlation - Spotting Problems in Data with Visualization: visually Checking Distributions for a single Variable - R –Pie Charts: 3D Pie Chart – R Histograms – Density Plot - R – Bar Charts: Bar Chart Labels, Title and Colors.

Text / Reference Books:

1. Sandip Rakshit, R Programming for Beginners, McGraw Hill Education (India), 2017, ISBN : 978-93-5260-455-5.
2. Seema Acharya, Data Analytics using R, McGrawHill Education (India), 2018, ISBN: 978-93-5260-524-8.
3. Tutorials Point (I) simply easy learning, Online Tutorial Library (2018), R Programming, Retrieved from https://www.tutorialspoint.com/r/r_tutorial.pdf.
4. Andrie de Vries, Joris Meys, R for Dummies A Wiley Brand, 2nd Edition, John Wiley and Sons, Inc, 2015, ISBN: 978-1-119-05580-8

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	2	2	2	2
CO2	3	2	2	2	2	2	2
CO3	3	2	2	2	2	2	2
CO4	3	2	2	2	2	2	2
CO5	3	2	2	2	2	2	2

CSCOE08	C PROGRAMMING	3 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Learn the syntax and semantics of C language	Understand
CO2	Write simple programs using decision statements and looping statements	Apply
CO3	Develop user defined functions	Apply
CO4	Handling of arrays and operations on arrays	Apply
CO5	Learn string operations, structures and handling with files	Understand, Apply

b. Syllabus

Unit – 1	INTRODUCTION	9 hrs

Introduction to the C Language – Algorithm, Pseudo code, Flow chart, Background, C Programs, Identifiers, Data Types, Variables, Constants, Input / Output, Operators(Arithmetic, relational, logical, bitwise etc.), Expressions, Precedence and Associatively, Expression Evaluation, Type conversions

Unit – 2	DECISION STATEMENTS AND ITERATIVE STATEMENTS	9 hrs

Statements- Selection Statements(making decisions) – if and switch statements, Repetition statements (loops)-while, for, do-while statements, Loop examples, other statements related to looping – break, continue, go to, Simple C Program examples

Unit – 3	FUNCTIONS	9 hrs

Functions- Introduction to Structured Programming, Functions- basics, user defined functions, inter function communication (call by value, call by reference), Standard functions. Storage classes-auto, register, static, extern, scope rules, arrays to functions, recursive functions, example C programs

Unit – 4	ARRAYS AND POINTERS	9 hrs

Arrays– Basic concepts, one-dimensional arrays, two – dimensional arrays, multidimensional arrays, C programming examples Pointers – Introduction (Basic Concepts), pointers to pointers, compatibility, Pointer Applications, Arrays and Pointers, Pointer Arithmetic, memory allocation functions, array of pointers, pointers to void, pointers to functions, command –line arguments, Introduction to structures and unions.

Unit – 5	STRINGS – STRUCTURES – FILE OPERATIONS	9 hrs

Strings – Concepts, C Strings, String Input / Output functions, string manipulation functions, string /data conversion. Structures and Unions. Input and Output – Concept of a file, streams, text files and binary files, Differences between text and binary files, State of a file, Opening and Closing files, file input / output functions (standard library input / output functions for files), file status functions (error handling),Positioning functions.

Text / Reference Books:

1. Computer Science: A Structured Programming Approach Using C, B.A.Forouzan and R.F. Gilberg, Third Edition, Cengage Learning.
2. The C Programming Language by Brian Kernighan and Dennis Ritchie 2nd edition
3. Let Us C Yashavant kanetkar BPB.

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	2	2	2	2
CO2	3	2	2	2	2	2	2
CO3	3	2	2	2	2	2	2
CO4	3	2	2	2	2	2	2
CO5	3	2	2	2	2	2	2

CSCOE09	FOUNDATIONS OF MACHINE LEARNING	3 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Learn the syntax and semantics of C language	Understand
CO2	Write simple programs using decision statements and looping statements	Apply
CO3	Develop user defined functions	Apply
CO4	Handle of arrays and operations on arrays	Apply
CO5	Learn string operations, structures and handling with files	Understand, Apply

b. Syllabus

Unit – 1	INTRODUCTION TO AI	9 hrs
Introduction to Artificial Intelligence – Applications and Examples of AI – AI concepts, terminologies and application areas – AI Issues, concerns and Ethical Considerations – The Future with AI – AI in action.		
Unit – 2	**PYTHON BASICS**	**9 hrs**
Variables – Constants – Strings – Assignment statements – Expressions – Operators – Type Conversions – Control Flow statements and Loops- Functions. Lists – Tuples – Sets – Dictionaries.		
Unit – 3	**PYTHON ESSENTIALS FOR MACHINE LEARNING**	**9 hrs**
Numpy operations – Working with pandas – plotting with matplotlib – working with scikit-learn		
Unit – 4	**OVERVIEW OF ML & SUPERVISED LEARNING**	**9 hrs**
Overview Of Machine Learning –Supervised Learning: Regression – classification – logistic regression – k nearest neighbor algorithm – multi layer perceptron.		
Unit – 5	**UNSUPERVISED LEARNING & ENSEMBLE LEARNING**	**9 hrs**
Unsupervised Learning: Clustering – k-means clustering – other clustering algorithms – ensemble learning – classification using ensemble learning.		

Text / Reference Books:

1. Saikat Dutt, Subramanian Chandramouli, Amit Kumar Das, Machine Learning, Pearson Education India, 2018
2. Tom Mitchell, Machine Learning, McGraw Hill Education, First Edition, 2017
3. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, First edition, 2010.
4. Ethem Alpaydin,"Introduction to Machine Learningll, MIT Press, Prentice Hall of India, Third Edition 2015.
5. Eric Matthes, Python Crash Course, No Starch Press, Second edition, 2019
6. Martin C. Brown, Python: The Complete Reference, McGraw Hill Education, Fourth edition, 2018
7. Ryan Marvin Mark Ng'Ang'A Amos Omondi, Python Fundamentals, Packet Publishing, Second edition, 2018.

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	2	2	2	2
CO2	3	2	2	2	2	2	2
CO3	3	2	2	2	2	2	2
CO4	3	2	2	2	2	2	2
CO5	3	2	2	2	2	2	2

VALUE ADDED COURSES

CSCVA01	INTRODUCTION TO DATA ANALYSIS USING EXCEL	2 Credits

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Learn the excel operations in data	Understand
CO2	Apply various functions on data and analyse results	Apply, Analyse
CO3	Learn to create pivot tables and analyse results	Skill
CO4	Perform various data validation techniques in excel	Analyse
CO5	Create VBA programs to perform advance data operations	Create

b. Syllabus

Unit – 1	INTRODUCTION	6 hrs
Introduction to Excel – Various Selection techniques – customizing excel – using basic functions – formatting and proofing.		
Unit – 2	**FUNCTIONS IN EXCEL**	**6 hrs**
Mathematical functions – Protecting excel – text functions – date and time functions – advanced features – sorting and filtering text data – sorting and filtering numbers and colors – other sorting options.		
Unit – 3	**WHAT-IF ANALYSIS**	**6 hrs**
What-if Analysis: Goal seek – scenario analysis – Data tables – solver tool. Logical functions.		
Unit – 4	**DATA VALIDATION**	**6 hrs**
Number, date and time validation – customizing validations based on formula for cell – dynamic drop down list creation using data validation – dependency list – Lookup Functions – Pivot Tables – Charts and Slicers		
Unit – 5	**VBA**	**6 hrs**
Introduction to VBA – variables in VBA – decisions in VBA – loops in VBA – Worksheet operations using VBA		

Text / Reference Books:

1. Manisha Nigam (2019). Data Analysis with Excel. BPB Publications.
2. Brian Moriarity, Bernd Held and Theodor Richardson (2019). Microsoft Excel Functions and Formulas. Stylus Publishing LLC.

c. Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	2	2	2	2
CO2	3	2	2	2	2	2	2
CO3	3	2	2	2	2	2	2
CO4	3	2	2	2	2	2	2
CO5	3	2	2	2	2	2	2