R.M.K. ENGINEERING COLLEGE

[An Autonomous Institution]

R.S.M Nagar, Kavaraipettai, Gummidipoondi Taluk, Thiruvallur District, Tamil Nadu- 601 206
Affiliated to Anna University, Chennai / Approved by AICTE, New Delhi/ Accredited by NAAC with A+ Grade
An ISO 9001:2015 Certified Institution / All the Eligible UG Programs are accredited by NBA, New Delhi.

M.E. COMPUTER SCIENCE AND ENGINEERING

REGULATIONS 2020

CHOICE BASED CREDIT SYSTEM

PROGRAM EDUCATIONAL OBJECTIVES

The Computer Science and Engineering Post Graduates of R.M.K. Engineering College will

PEO 1. Apply the principles and practices of Computer Science and Engineering encompassing Mathematics, Science and Basic Engineering and to employ the modern engineering tools effectively in their profession with their world class technical competence.

PEO 2. Possess expertise to function as members of multi-disciplinary teams and implement software technology solutions for real world problems of international standards and will be achievers at global level.

PEO 3. Excel in the field of software industry or in higher studies endowed with the spirit of innovation and entrepreneurship by evolving their professional knowledge on a lifelong basis.

PEO 4. Practice the profession with ethics, integrity, leadership and social responsibility with a good insight of the changing societal needs for the benefit of humanity.

PROGRAMME OUTCOMES (POs)

Engineering Graduates will be able to:

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of 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.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. 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.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

After the successful completion of the program, the post graduates will be able to:

- Analyze, design and develop solutions for real world problems by applying the core concepts of Computer Science and Engineering.

- Apply cutting edge technologies and software engineering principles and practices to develop quality software in scientific and business applications for the betterment of society and Industry.

- Employ modern technologies, environments and platforms in creating innovative ideas to become an entrepreneur and a zeal for pursuing research.

Mapping of POs/PSOs to PEOs

Contribution 1: Reasonable 2:Significant 3:Strong

PEOs & POs

The M.E. COMPUTER SCIENCEAND ENGINEERING Program outcomes leading to the achievement of the objectives are summarized in the following Table.

PROGRAM EDUCATIONAL OBJECTIVES	PROGRAM OUTCOMES											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
I	3	3	3	3	2	2	2	1	1	1	1	1
II	3	3	3	3	2	1	1	1	3	3	1	3
III	3	3	3	3	2	2	2	3	3	3	2	1
IV	2	2	2	2	2	3	2	3	3	1	1	1

PROGRAM EDUCATIONAL OBJECTIVES	PROGRAM SPECIFIC OUTCOMES		
	PSO1	PSO2	PSO3
I	3	3	3
II	2	3	2
III	3	3	3
IV	1	1	1

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES

A broad relation between the Course Outcomes and Programme Outcomes is given in the following table

YEAR	SEMESTER	COURSE NAME	Programme Outcome (PO)											
			1	2	3	4	5	6	7	8	9	10	11	12
YEAR I	SEMESTER 1	Applied Probability and Statistics	✓	✓	✓	✓							✓	
		Research Methodologies and Intellectual Property Rights	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Advanced Computer Architecture	✓	✓	✓	✓								✓
		Advanced Data Structures and Algorithms	✓	✓	✓	✓								✓
		Advanced Software Engineering	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓
		Machine Learning Techniques	✓	✓	✓	✓	✓		✓			✓		✓
		Data Structures Laboratory	✓	✓	✓	✓	✓				✓	✓	✓	✓
		Technical Seminar	✓	✓	✓	✓	✓	✓			✓		✓	✓
	SEMESTER 2	Big Data Analytics	✓	✓	✓	✓	✓	✓						✓
		Internet of Things	✓	✓	✓	✓	✓			✓				✓
		Network Design and Technologies	✓	✓	✓	✓	✓	✓	✓		✓			✓
		Web Application Development using Python (Lab Integrated)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Professional Elective –I												
		Professional Elective –II												
		Data Analytics Laboratory	✓	✓	✓	✓	✓		✓		✓		✓	✓
		Term Paper Writing and Seminar	✓	✓	✓	✓	✓	✓			✓		✓	✓
YEAR II	SEMESTER 3	Professional Elective –III												
		Professional Elective –IV												
		Professional Elective –V												
		Project Work Phase – I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

	SEMESTER 4	Project Work Phase – II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

PROFESSIONAL ELECTIVE														
YEAR	**SEMESTER**	**COURSE NAME**	**Programme Outcome (PO)**											
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
YEAR I	**SEMESTER 2**	Image Processing and Computer Vision	✓	✓	✓	✓	✓							✓
		Natural Language Processing	✓	✓	✓	✓	✓	✓						✓
		Advanced Database Systems	✓	✓	✓	✓	✓				✓			✓
		Distributed and Cloud Computing	✓	✓	✓	✓	✓		✓	✓	✓			✓
		Ontology and Semantic Web	✓	✓	✓	✓								✓
		Cyber Security and Ethical Hacking	✓	✓	✓	✓	✓	✓		✓				✓
		Knowledge Engineering	✓	✓	✓	✓								✓
		Adhoc and Wireless Sensor Networks	✓	✓	✓	✓								✓
		Blockchain Technologies	✓	✓	✓	✓	✓							✓
		Mobile Computing and Application Development	✓	✓	✓	✓	✓				✓	✓		✓
YEAR II	**SEMESTER 3**	Cognitive Computing	✓	✓	✓	✓								✓
		Computational Intelligence	✓	✓	✓	✓								✓
		Optimization Algorithms	✓	✓	✓	✓								✓
		Soft Computing	✓	✓	✓	✓								✓
		Reinforcement Learning	✓	✓	✓	✓								✓

		Video Analytics	✓	✓	✓	✓	✓				✓	✓		✓
		Engineering Predictive Analysis	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
		Data Exploration and Visualization	✓	✓	✓	✓	✓				✓	✓		✓
		Quantum Computing	✓	✓	✓	✓								✓
		Cyber Forensics	✓	✓	✓	✓		✓		✓				✓
		Intelligent Agent Systems	✓	✓	✓	✓								✓
		Social Network Analysis	✓	✓	✓	✓	✓	✓		✓				✓
		Deep Learning	✓	✓	✓	✓	✓							✓
		Software Reliability Metrics and Models	✓	✓	✓	✓								✓
		Game Theory and Programming	✓	✓	✓	✓								✓
		Statistical Learning Theory	✓	✓	✓	✓								✓
		Augmented Reality	✓	✓	✓	✓								✓
		High Performance Computing	✓	✓	✓	✓								✓
		Intelligent Robots	✓	✓	✓	✓								✓
		UAV and Drone Technology	✓	✓	✓	✓								✓
		Performance Analysis of Computer Systems	✓	✓	✓	✓								✓
		Queueing and Reliability Modelling	✓	✓	✓	✓								✓

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M.E. COMPUTER SCIENCE AND ENGINEERING

REGULATIONS - 2020

CHOICE BASED CREDIT SYSTEM

I – IV SEMESTERS CURRICULA & I – II SEMESTERS SYLLABI

SEMESTER I

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	20MA121	Applied Probability and Statistics	FC	4	4	0	0	4
2.	20CS121	Research Methodologies and Intellectual Property Rights	HS	3	3	0	0	3
3.	20CS122	Advanced Computer Architecture	PC	3	3	0	0	3
4.	20CS123	Advanced Data Structures and Algorithms	PC	4	4	0	0	4
5.	20CS124	Advanced Software Engineering	PC	3	3	0	0	3
6.	20CS125	Machine Learning Techniques	PC	3	3	0	0	3
PRACTICALS								
7.	20CS131	Data Structures Laboratory	PC	4	0	0	4	2
8.	20CS132	Technical Seminar	EEC	2	0	0	2	1
			TOTAL	**26**	**20**	**0**	**6**	**23**

SEMESTER II

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	20CS221	Big Data Analytics	PC	3	3	0	0	3
2.	20CS222	Internet of Things	PC	3	3	0	0	3
3.	20CS223	Network Design and Technologies	PC	3	3	0	0	3
4.	20CS224	Web Application Development using Python (Lab Integrated)	PC	5	3	0	2	4
5.		Professional Elective –I	PE	3	3	0	0	3
6.		Professional Elective –II	PE	3	3	0	0	3
PRACTICALS								
7.	20CS231	Data Analytics Laboratory	PC	4	0	0	4	2
8.	20CS232	Term Paper Writing and Seminar	EEC	2	0	0	2	1
			TOTAL	**26**	**18**	**0**	**8**	**22**

SEMESTER III

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.		Professional Elective –III	PE	3	3	0	0	3
2.		Professional Elective –IV	PE	3	3	0	0	3
3.		Professional Elective –V	PE	3	3	0	0	3
PRACTICALS								
4.	20CS331	Project Work Phase – I	EEC	12	0	0	12	6

			TOTAL	**21**	**9**	**0**	**12**	**15**

SEMESTER IV

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PRACTICALS								
1.	20CS431	Project Work Phase – II	EEC	24	0	0	24	12
			TOTAL	**24**	**0**	**0**	**24**	**12**

TOTAL NO. OF CREDITS: 72

FOUNDATION COURSE (FC)

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20MA121	Applied Probability and Statistics	FC	4	4	0	0	4

HUMANITIES AND SOCIAL SCIENCES (HS)

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
2.	20CS121	Research Methodologies and Intellectual Property Rights	HS	3	3	0	0	3

PROFESSIONAL CORE (PC)

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20CS122	Advanced Computer Architecture	PC	3	3	0	0	3
2.	20CS123	Advanced Data Structures and Algorithms	PC	4	4	0	0	4
3.	20CS124	Advanced Software Engineering	PC	3	3	0	0	3
4.	20CS125	Machine Learning Techniques	PC	3	3	0	0	3
5.	20CS131	Data Structures Laboratory	PC	4	0	0	4	2

6.	20CS221	Big Data Analytics	PC	3	3	0	0	3
7.	20CS222	Internet of Things	PC	3	3	0	0	3
8.	20CS223	Network Design and Technologies	PC	3	3	0	0	3
9.	20CS224	Web Application Development using Python (Lab Integrated)	PC	5	3	0	2	4
10.	20CS231	Data Analytics Laboratory	PC	4	0	0	4	2

PROFESSIONAL ELECTIVES (PE)

SEMESTER II - PROFESSIONAL ELECTIVE – I / II

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20CS951	Image Processing and Computer Vision	PE	3	3	0	0	3
2.	20CS952	Natural Language Processing	PE	3	3	0	0	3
3.	20CS953	Advanced Database Systems	PE	3	3	0	0	3
4.	20CS954	Distributed and Cloud Computing	PE	3	3	0	0	3
5.	20CS955	Ontology and Semantic Web	PE	3	3	0	0	3
6.	20CS956	Cyber Security and Ethical Hacking	PE	3	3	0	0	3
7.	20CS957	Knowledge Engineering	PE	3	3	0	0	3
8.	20CS958	Adhoc and Wireless Sensor Networks	PE	3	3	0	0	3
9.	20CS959	Blockchain Technologies	PE	3	3	0	0	3
10.	20CS960	Mobile Computing and Application Development	PE	3	3	0	0	3

PROFESSIONAL ELECTIVES (PE)

SEMESTER III - PROFESSIONAL ELECTIVE – III / IV / V

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20CS961	Cognitive Computing	PE	3	3	0	0	3
2.	20CS962	Computational Intelligence	PE	3	3	0	0	3

3.	20CS963	Optimization Algorithms	PE	3	3	0	0	3
4.	20CS964	Soft Computing	PE	3	3	0	0	3
5.	20CS965	Reinforcement Learning	PE	3	3	0	0	3
6.	20CS966	Video Analytics	PE	3	3	0	0	3
7.	20CS967	Engineering Predictive Analysis	PE	3	3	0	0	3
8.	20CS968	Data Exploration and Visualization	PE	3	3	0	0	3
9.	20CS969	Quantum Computing	PE	3	3	0	0	3
10.	20CS970	Cyber Forensics	PE	3	3	0	0	3
11.	20CS971	Intelligent Agent Systems	PE	3	3	0	0	3
12.	20CS972	Social Network Analysis	PE	3	3	0	0	3
13.	20CS973	Deep Learning	PE	3	3	0	0	3
14.	20CS974	Software Reliability Metrics and Models	PE	3	3	0	0	3
15.	20CS975	Game Theory and Programming	PE	3	3	0	0	3
16.	20CS976	Statistical Learning Theory	PE	3	3	0	0	3
17.	20CS977	Augmented Reality	PE	3	3	0	0	3
18.	20CS978	High Performance Computing	PE	3	3	0	0	3
19.	20CS979	Intelligent Robots	PE	3	3	0	0	3
20.	20CS980	UAV and Drone Technology	PE	3	3	0	0	3
21.	20CS981	Performance Analysis of Computer Systems	PE	3	3	0	0	3
22.	20CS982	Queueing and Reliability Modelling	PE	3	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	20CS132	Technical Seminar	EEC	2	0	0	2	1
2.	20CS232	Term Paper Writing and Seminar	EEC	2	0	0	2	1

3.	20CS331	Project Phase I	EEC	12	0	0	12	6
4.	20CS431	Project Phase II	EEC	24	0	0	24	12

SUMMARY

S. NO.	SUBJECT AREA	CREDITS AS PER SEMESTER				CREDITS TOTAL	PERCENTAGE
		I	II	III	IV		
1.	**HS**	3				**3**	**4.17%**
2.	**FC**	4				**4**	**5.56%**
3.	**PC**	15	15			**30**	**41.67%**
4.	**PE**		6	9		**15**	**20.83%**
5.	**EEC**	1	1	6	12	**20**	**27.78%**
	TOTAL	**23**	**22**	**15**	**12**	**72**	

HUMANITIES AND SOCIAL SCIENCES (HS) / FOUNDATION COURSES (FC) / PROFESSIONAL CORE (PC) / PROFESSIONAL ELECTIVES (PE) / EMPLOYABILITY ENHANCEMENT COURSES (EEC)

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20MA121	APPLIED PROBABILITY AND STATISTICS	L	T	P	C
		4	0	0	4

OBJECTIVES:

The syllabus is designed to:

- Acquaint the students with the fundamental concept of probability.
- Introduce the two dimensional random variable.
- Develop an understanding on the principles of estimation theory.
- Explain the concept of testing of hypothesis.
- Import the knowledge of random vectors and matrices.

UNIT I PROBABILITY AND RANDOM VARIABLES 12

Probability – Axioms of probability – Conditional probability – Baye's Theorem - Random variables – Probability function – Moments – moment generating function.

UNIT II TWO DIMENSIONAL RANDOM VARIABLES 12

Joint distributions – Marginal and conditional distributions – Functions of two dimensional random variables – Regression curve – Correlation.

UNIT III ESTIMATION THEORY 12

Unbiased estimators – Method of moments – Maximum likelihood estimation - Curve fitting by principle of least squares – Regression lines.

UNIT IV TESTING OF HYPOTHESIS 12

Sampling distributions – Type I and Type II errors – Small and large samples – Tests based on Normal, t, Chi square and F distributions for testing of mean, variance and proportions – Tests for independence of attributes and goodness of fit.

UNIT V MULTIVARIATE ANALYSIS 12

Random vectors and matrices – Mean vectors and covariance matrices – Multivariate normal density and its properties – Principal components – Population principal components – Principal components from standardized variables.

TOTAL: 60 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

- Make use of probability concepts in problems of uncertainty.
- Illustrate and apply concepts of pairs of random variables, compute marginal distributions and estimate correlation curve and regression.
- Identify and evaluate the unbiased estimators.
- Apply testing of hypothesis in real life problems.
- Perform exploratory analysis of multivariate data.

REFERENCES:

1. J. L. Devore, "Probability and Statistics for Engineering and the Sciences", 8th Edition, Cengage Learning, 2014.
2. Dallas E. Johnson, "Applied Multivariate Methods for Data Analysis", Thomson and Duxbury press, 1st Edition, 1998.
3. S. C. Gupta and V. K, Kapoor, "Fundamentals of Mathematical Statistics", Sultan and Sons, 10th Edition, New Delhi, 2001.
4. R. A. Johnson, I. Miller and J. Freund, "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
5. Richard A. Johnson and Dean W. Wichern, "Applied Multivariate Statistical Analysis", 5th Edition, Pearson Education, Asia, 2002.

20CS121	RESEARCH METHODOLOGIES AND INTELLECTUAL PROPERTY RIGHTS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand basic concepts employed in quantitative and qualitative research methods.
- To define research problem and design.
- To apply statistical methods for data collection.
- To understand the concepts of report writing.
- To introduce fundamental aspects of Intellectual Property Rights to students who are going to play a major role in development and management of innovative projects in industries.

UNIT I RESEARCH METHODOLOGY 9

Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India. Introduction to internet, Use of Internet & www, using search engines using advanced search tools.

UNIT II DEFINING THE RESEARCH PROBLEM AND RESEARCH DESIGN 9

Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs. Uses of literature review, Source of information, Organization of information on index cards.

UNIT III DESIGN OF SAMPLE SURVEYS AND DATA PATTERN EVALUATION 9

Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs, Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Data Preprocessing - Feature Extraction – Classification – Decision Making - Case Study Method.

UNIT IV INTERPRETATION AND REPORT WRITING 9

Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports. Benchmarking – Process – Types and Examples, Working with LaTeX.

UNIT V INTELLECTUAL PROPERTY 9

Introduction – Invention and Creativity – Intellectual Property (IP) – Importance – Protection of IPR – Basic types of property - IP – Patents – Copyrights and related rights – Trade Marks and rights arising from Trademark registration – Definitions – Industrial Designs and Integrated circuits – Protection of Geographical Indications at national and International levels – Application Procedures. Case Studies on – Patents (Basumati rice, turmeric, Neem, etc.)

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

- Outline basic concepts employed in quantitative and qualitative research methods.
- Formulate research problem and design.
- Apply statistical methods to collect data and do literature survey.
- Write quality research paper.
- Highlight current trends in IPR and Govt. steps in fostering IPR.

REFERENCES:

1. C.R. Kothari, Gaurav Garg, "Research Methodology: Methods and Techniques", New Age International, 4th Edition, 2018.
2. Subbaram N.R. "Handbook of Indian Patent Law and Practice", S. Viswanathan (Printers and Publishers) Pvt. Ltd., 1998.
3. Ranjit Kumar, "Research Methodology a step-by step guide for beginners". (For the topic Reviewing the literature under module 2), SAGE Publications Ltd, 3rd Edition, 2011
4. Intellectual Property Today: Volume 8, No. 5, May 2001, [www.iptoday.com].
5. Meredith Zozus, "The Data Book: Collection and Management of Research Data" (Chapman & Hall/CRC , 2017.
6. Wendy Olsen, "Data Collection Key Debates and Methods in Social Research", SAGE Publications Ltd, 2011.
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9. Thomas Lancaster, "Avoid Plagiarism", First Edition, SAGE Publications Ltd, 2019.
10. Ehtiram Raza Khan, Huma Anwar, "Research Methods of Computer Science", First Edition, UNIVERSITY SCIENCE PRESS (An Imprint of Laxmi Publications Pvt. Ltd.), 2016.
11. Jonathan Lazar, Jinjuan Heidi Feng, Harry Hochheiser, "Research Methods in Human-Computer Interaction", 1st Edition, Morgan Kaufmann, 2nd Edition, 2017.
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		L	T	P	C
20CS122	**ADVANCED COMPUTER ARCHITECTURE**	**3**	**0**	**0**	**3**

OBJECTIVES:

- To understand and analyze performance related parameters and Instruction Level Parallelism.
- To understand the design of the memory hierarchy.
- To learn the different multiprocessor issues.
- To expose the different types of multicore architectures.
- To explain vector, SIMD and GPU architectures.

UNIT I FUNDAMENTALS OF COMPUTER DESIGN AND ILP 9

Fundamentals of Computer Design – Measuring and Reporting Performance – Instruction Level Parallelism and its Exploitation – Concepts and Challenges –Exposing ILP - Advanced Branch Prediction - Dynamic Scheduling - Hardware-Based Speculation - Exploiting ILP - Instruction Delivery and Speculation - Limitations of ILP – Multithreading.

UNIT II MEMORY HIERARCHY DESIGN 9

Introduction – Optimizations of Cache Performance – Memory Technology and Optimizations – Protection: Virtual Memory and Virtual Machines – Design of Memory Hierarchies – Case Studies.

UNIT III MULTIPROCESSOR ISSUES 9

Introduction- Centralized, Symmetric and Distributed Shared Memory Architectures –Cache Coherence Issues – Performance Issues – Synchronization – Models of Memory Consistency – Case Study- Interconnection Networks – Buses, Crossbar and Multi-stage Interconnection Networks.

UNIT IV MULTICORE ARCHITECTURES 9

Homogeneous and Heterogeneous Multi-core Architectures – Intel Multicore Architectures – SUN CMP architecture – IBM Cell Architecture. Introduction to Warehouse-scale computers- Architectures- Physical Infrastructure and Costs- Cloud Computing –Case Study- Google Warehouse-Scale Computer.

UNIT V VECTOR, SIMD AND GPU ARCHITECTURES 9

Introduction-Vector Architecture – SIMD Extensions for Multimedia – Graphics Processing Units – Case Studies – GPGPU Computing – Detecting and Enhancing Loop Level Parallelism-Case Studies.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

- Analyze performance related parameters and Instruction Level Parallelism.
- Discuss the memory hierarchy design and optimization techniques for cache performance
- Interpret various issues of multiprocessor.
- Point out the salient features of different multicore architectures and how they exploit parallelism.
- Understand vector, SIMD and GPU architectures.

REFERENCES:

1. John L. Hennessey and David A. Patterson, “Computer Architecture – A Quantitative Approach”, Morgan Kaufmann / Elsevier, 6th edition, 2019.
2. Darryl Gove, “Multicore Application Programming: For Windows, Linux, and Oracle Solaris”, Pearson, 2011.
3. David B. Kirk, Wen-mei W. Hwu, “Programming Massively Parallel Processors”, Morgan Kauffman, 3rd Edition 2016.
4. David E. Culler, Jaswinder Pal Singh, “Parallel computing architecture: A hardware / software approach”, Morgan Kaufmann /Elsevier Publishers, 2013.
5. Kai Hwang and Zhi.Wei Xu, “Scalable Parallel Computing”, Tata McGraw Hill, New Delhi, 2003.
6. Czarnul, Pawel, Chapman & Hall, “Parallel programming for modern high performance computing systems”, CRC, 2018.

20CS123	ADVANCED DATA STRUCTURES AND ALGORITHMS	L	T	P	C
		4	0	0	4

OBJECTIVES:

- To understand the usage of algorithms in computing.
- To learn and use hierarchical data structures and its operations
- To learn the usage of graphs and its applications.
- To select and design data structures and algorithms that is appropriate for problems.
- To study about NP Completeness of problems.

UNIT I ROLE OF ALGORITHMS IN COMPUTING 12

Algorithms – Algorithms as a Technology- Insertion Sort – Analyzing Algorithms – Designing Algorithms- Growth of Functions: Asymptotic Notation – Standard Notations and Common Functions- Recurrences: The Substitution Method – The Recursion-Tree Method.

UNIT II HIERARCHICAL DATA STRUCTURES 12

Binary Search Trees: Basics – Querying a Binary search tree – Insertion and Deletion- Red-Black trees: Properties of Red-Black Trees – Rotations – Insertion – Deletion -B-Trees: Definition of B-trees – Basic operations on B-Trees – Deleting a key from a B-Tree- Fibonacci Heaps: structure – Mergeable-heap operations- Decreasing a key and deleting a node-Bounding the maximum degree.

UNIT III GRAPHS 12

Elementary Graph Algorithms: Representations of Graphs – Breadth-First Search – Depth-First Search – Topological Sort – Strongly Connected Components- Minimum Spanning Trees: Growing a Minimum Spanning Tree – Kruskal and Prim- Single-Source Shortest Paths: The Bellman-Ford algorithm – Single-Source Shortest paths in Directed Acyclic Graphs – Dijkstra‘s Algorithm; All-Pairs Shortest Paths: Shortest Paths and Matrix Multiplication – The Floyd- Warshall Algorithm.

UNIT IV ALGORITHM DESIGN TECHNIQUES 12

Dynamic Programming: Matrix-Chain Multiplication – Elements of Dynamic Programming – Longest Common Subsequence- Greedy Algorithms: An Activity-Selection Problem – Elements of the Greedy Strategy- Huffman Codes.

UNIT V NP COMPLETE AND NP HARD 12

NP-Completeness: Polynomial Time – Polynomial-Time Verification – NP- Completeness and Reducability – NP-Completeness Proofs – NP-Complete Problems.

TOTAL: 60 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

- Evaluate the complexity of algorithms in computing problems.
- Apply hierarchical data structures for various applications.
- Design algorithms using graph data structure to solve real-life problems.
- Apply suitable design strategy for problem solving.

- Analyze NP Complete problems.

REFERENCES:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, "Introduction to Algorithms", Third Edition, Prentice-Hall, 2011.
2. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, "Data Structures and Algorithms", Pearson Education, Reprint 2006.
3. Robert Sedgewick and Kevin Wayne, "ALGORITHMS", Fourth Edition, Pearson Education, 2016.
4. S.Sridhar, "Design and Analysis of Algorithms", First Edition, Oxford University Press. 2014.
5. Jean-Paul Tremblay and Paul Sorenson, "An Introduction to Data Structures with Application", McGraw-Hill, 2017.
6. Soltys, Michael, "An introduction to the analysis of algorithms", World Scientific, 2018.
7. Sandeep Sen, Amit Kumar, "Design and Analysis of Algorithms. A contemporary Perspective", Cambridge University Press, 2019.

20CS124	ADVANCED SOFTWARE ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand Software process models.
- To gain knowledge of the system design concepts.
- To understand software testing approaches.
- To do project management and cost estimation.
- To be familiar with DevOps practices.

UNIT I PROCESS MODELS AND REQUIREMENTS MODELING 9

Prescriptive process models–Specialized process models–The unified process–personal and team process models–Product and Process–Agile development–Extreme Programming–Other Agile process models–Human aspects of Software Engineering. Understanding Requirements–Scenario based methods–Class Based Methods – Behavior, Patterns and Web/Mobile Apps.

UNIT II SOFTWARE DESIGN 9

The design process–Design concepts–The Design model - Architectural design – Component level Design - Object-oriented design using the UML – User Interface Design–Pattern based design–Web App design– Mobile App design.

UNIT III SOFTWARE TESTING AND SOFTWARE CONFIGURATION MANAGEMENT 9

Software Testing Strategies–Testing Conventional Applications–Testing Object Oriented Applications–Testing Web applications–Testing Mobile Apps–Software Configuration management – The SCM process–Configuration Management for Web and Mobile App.

UNIT IV MANAGING SOFTWARE PROJECTS 9

Project Management Concepts – Software and Project Metrics – Estimation of Software projects – Project Scheduling: PERT/CPM, Time-line Charts – Risk Management – Maintenance and Re-engineering.

UNIT V IMPLEMENTATION PLATFORM 9

DevOps: Motivation-Cloud as a platform-Operations- Deployment Pipeline: Overall Architecture - Building and Testing – Deployment - Case study: Migrating to Microservices.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

- Understand the advantages of various software process models.
- Architect and design using architectural styles and design patterns.
- Apply software testing approaches.
- Gain knowledge on project management approaches as well as cost and schedule estimation strategies.
- Automate the different stages of software delivery pipeline/workflow using DevOps.

REFERENCES:

1. Roger S. Pressman, "Software Engineering – A Practioner's Approach", MC Graw Hill, 8th edition, 2019.
2. Ian Sommerville, "Software Engineering", 10th Edition, Pearson Education Asia, 2015.
3. Len Bass, Ingo Weber and Liming Zhu, — "DevOps: A Software Architect's Perspective", Pearson Education, 2016.
4. Bernd Bruegge, Alan H Dutoit, "Object-Oriented Software Engineering", 3rd edition, Pearson Education, 2014.
5. Carlo Ghezzi, Mehdi Jazayeri, Dino Mandrioli, "Fundamentals of Software Engineering", 2nd edition, PHI Learning Pvt. Ltd., 2010.
6. Craig Larman, "Applying UML and Patterns", 3rd edition, Pearson Education, 2005.
7. Rajib Mall, "Fundamentals of Software Engineering", 3rd edition, PHI Learning Pvt. Ltd., 2014.
8. Stephen Schach, "Software Engineering", 8th edition, McGraw-Hill, 2010.

20CS125	MACHINE LEARNING TECHNIQUES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce students to the basic concepts and techniques of Machine Learning.
- To have a thorough understanding of the linear models.
- To study the various probability based learning techniques.
- To understand graphical models of machine learning algorithms.
- To gain knowledge on deep learning.

UNIT I INTRODUCTION **9**

Learning – Types of Machine Learning – Supervised Learning – The Brain and the Neuron – Design a Learning System – Perspectives and Issues in Machine Learning – Concept Learning Task – Concept Learning as Search – Finding a Maximally Specific Hypothesis – Version Spaces and the Candidate Elimination Algorithm – Linear Discriminants – Perceptron – Linear Separability – Linear Regression.

UNIT II LINEAR MODELS **9**

Multi-layer Perceptron – Going Forwards – Going Backwards: Back Propagation Error – Multi- layer Perceptron in Practice – Examples of using the MLP – Overview – Deriving Back- Propagation – Radial Basis Functions and Splines – Concepts – RBF Network – Curse of Dimensionality – Interpolations and Basis Functions – Support Vector Machines.

UNIT III TREE AND PROBABILISTIC MODELS **9**

Learning with Trees – Decision Trees – Constructing Decision Trees – Classification and Regression Trees – Ensemble Learning – Boosting – Bagging – Different ways to Combine Classifiers – Probability

and Learning – Data into Probabilities – Basic Statistics – Gaussian Mixture Models – Nearest Neighbor Methods – Unsupervised Learning – K means Algorithms – Vector Quantization – Self Organizing Feature Map.

UNIT IV DIMENSIONALITY REDUCTION AND GRAPHICAL MODELS 9

Dimensionality Reduction – Linear Discriminant Analysis – Principal Component Analysis – Factor Analysis – Independent Component Analysis – Locally Linear Embedding – Isomap – Least Squares Optimization – Markov Chain Monte Carlo Methods – Sampling – Proposal Distribution – Markov Chain Monte Carlo – Graphical Models – Bayesian Networks – Markov Random Fields – Hidden Markov Models – Tracking Methods.

UNIT V DEEP LEARNING 9

Introduction to Deep Learning – AI, ML and DL – Before Deep Learning : a brief history of ML – Gradient-Based Learning – Hidden Units – Architecture Design – Back-Propagation and Other Differentiation Algorithms – Parameter Norm Penalties – Norm Penalties as Constrained Optimization - Regularization and Under-Constrained Problems – Dataset Augmentation.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

- Suggest supervised, unsupervised or semi-supervised learning algorithms for any given problem.
- Apply the appropriate linear models for any given problem.
- Understand the foundation of probabilistic models and apply unsupervised algorithms for clustering.
- Select the appropriate graphical models of machine learning.
- Apply deep learning algorithms to improve efficiency.

REFERENCES:

1. EthemAlpaydin, “Introduction to Machine Learning (Adaptive Computation and Machine Learning Series)”, Third Edition, MIT Press, 2014.
2. Taylor Arnold, Michael Kane, Bryan W Lewis “Computational Approach to Statistical Learning”, CRC Press, 2019.
3. Christoph Molnar, “Interpretable Machine Learning - A Guide for Making Black Box Models Explainable”, Creative Commons License, 2020.
4. Jason Bell, “Machine Learning – Hands on for Developers and Technical Professionals”, Second Edition, Wiley, 2020.
5. Peter Flach, “Machine Learning: The Art and Science of Algorithms that Make Sense of Data”, First Edition, Cambridge University Press, 2012.
6. Stephen Marsland, “Machine Learning – An Algorithmic Perspective”, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
7. Tom Mitchell, “Machine Learning”, McGraw-Hill, 2017.
8. Sebastian Raschka and VahidMirjalili, “Python Machine Learning: Machine Learning and Deep Learning with Python, scikit-learn, and TensorFlow 2”, 3rd Edition,Packt Publishing Ltd, 2019.
9. Andriy Burkov, “Machine Learning Engineering”, True Positive Inc, 2020.
10. Kevin P. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012.
11. Ian J. Goodfellow, YoshuaBengio, Aaron Courville, “Deep Learning”, MIT Press, 2017.
12. Francois Chollet, “Deep Learning with Python”, Manning Publications, Second Edition, 2020.

		L	T	P	C
20CS131	**DATA STRUCTURES LABORATORY**	**0**	**0**	**4**	**2**

OBJECTIVES:

- To implement and analyze the Sorting techniques.
- To acquire the knowledge of using advanced tree structures.
- To learn the usage of heap structures.
- To understand the usage of graph structures and spanning trees.
- To apply algorithmic design techniques to solve real world problems.

LIST OF EXPERIMENTS:

Each student has to work individually on assigned lab exercises. Lab sessions could be scheduled as one contiguous four-hour session per week or two two-hour sessions per week. There will be about 15 exercises in a semester. It is recommended that all implementations are carried out in Java. If C or C++ has to be used, then the threads library will be required for Concurrency.

Exercises should be designed to cover the following topics:

EXPERIMENTS:

1. Implementation of Merge Sort and Quick Sort-Analysis
2. Implementation of a Binary Search Tree
3. Red-Black Tree Implementation
4. Heap Implementation
5. Fibonacci Heap Implementation
6. Graph Traversals
7. Spanning Tree Implementation
8. Shortest Path Algorithms (Dijkstra's algorithm, Bellmann Ford Algorithm)
9. Implementation of Matrix Chain Multiplication
10. Activity Selection and Huffman Coding Implementation.

TOTAL: 60 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

- Design and analyze Sorting techniques.
- Design and implement advanced tree structures.
- Design and develop programs using heap structures.
- Implement algorithms of graph structures and spanning trees.
- Design and develop efficient algorithms with minimum complexity using design techniques.

		L	T	P	C
20CS132	**TECHNICAL SEMINAR**	**0**	**0**	**2**	**1**

OBJECTIVES

- To develop their technical reading ability.
- To analyze technical articles to understand complex problems and make effective presentations.
- To develop speaking skills and communicate the article in an effective manner.

Guidelines for Technical Seminar:

i. Students will select research topics on their own; the topics may be on recent trends in Computer Science and Engineering but normally beyond the curriculum.

ii. The selected topic will be presented by the student in order to evaluate the appropriateness of the

topic.

iii. During the final seminar sessions each student is expected to prepare and present a topic on engineering/ technology, for duration of not less than 15 minutes.

iv. A Faculty guide is to be allotted and he / she will guide and monitor the progress of the student and maintain attendance also.

v. The student should prepare and present a seminar in the selected topic and evaluation would be carried out based on following criteria.

   a. Innovativeness of the topic.
   b. Literature survey carried out related to topic by searching library/internet/journals like IEEE, ACM, Springer etc.
   c. Persistence in the efforts and resourcefulness.
   d. Presentation and communication skills.

vi. At the end of the semester, he / she can submit a report on his / her topic of seminar and marks are given based on the report.

TOTAL: 30 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

- Develop their technical reading ability.
- Analyze technical articles to understand complex problems and make effective presentations.
- Develop speaking skills and communicate the article in an effective manner.

SEMESTER II

		L	T	P	C
20CS221	**BIG DATA ANALYTICS**	**3**	**0**	**0**	**3**

OBJECTIVES:

- To understand the competitive advantages of big data analytics.
- To understand the hadoop framework.
- To learn data analysis methods.
- To learn stream computing.
- To gain knowledge on Hadoop related tools such as HBase, Cassandra, Pig, and Hive for big data analytics.

UNIT I INTRODUCTION TO BIG DATA 7

Big Data – Definition, Characteristic Features – Big Data Applications - Big Data vs Traditional Data - Risks of Big Data - Structure of Big Data - Challenges of Conventional Systems - Web Data – Evolution of Analytic Scalability - Evolution of Analytic Processes, Tools and methods - Analysis vs Reporting - Modern Data Analytic Tools.

UNIT II HADOOP FRAMEWORK 9

Distributed File Systems - Large-Scale File System Organization – HDFS concepts - MapReduce Execution, Algorithms using MapReduce, Matrix-Vector Multiplication – Hadoop YARN.

UNIT III DATA ANALYSIS 13

Statistical Methods: Regression modelling, Multivariate Analysis - Classification: SVM & Kernel Methods - Rule Mining - Cluster Analysis, Types of Data in Cluster Analysis, Partitioning Methods, Hierarchical Methods, Density Based Methods, Grid Based Methods, Model Based Clustering Methods, Clustering High Dimensional Data – Predictive Analytics – Exploratory Data analysis - Training a logistic regression classifier - Classification and Regression trees.

UNIT IV MINING DATA STREAMS 7

Streams: Concepts – Stream Data Model and Architecture - Sampling data in a stream - Mining Data Streams and Mining Time-series data - Real Time Analytics Platform (RTAP) Applications – Social Media Analytics - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions, Big Data processing in cloud.

UNIT V BIG DATA FRAMEWORKS 9

Introduction to NoSQL – Aggregate Data Models – Hbase: Data Model and Implementations – Hbase Clients – Examples – Cassandra: Data Model – Examples – Cassandra Clients – Hadoop Integration. Pig – Grunt – Pig Data Model – Pig Latin – developing and testing Pig Latin scripts. Hive – Data Types and File Formats – HiveQL Data Definition – HiveQL Data Manipulation – HiveQL Queries

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

- Understand how to leverage the insights from big data analytics.
- Use Hadoop framework.
- Analyze data by utilizing various statistical and data mining approaches.
- Perform analytics on real-time streaming data.
- To gain knowledge on Hadoop related tools such as HBase, Cassandra, Pig, and Hive for big data analytics.
- Apply hadoop related tools in big data applications.

REFERENCES:

1. Subhashini Chellappan Seema Acharya, "Big Data and Analytics", 2nd edition, Wiley Publications, 2019.
2. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", Wiley and SAS Business Series, 2012.
3. David Loshin, "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph", 2013.
4. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, Second Edition, 2007.
5. Michael Minelli, Michelle Chambers, and AmbigaDhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013.
6. P. J. Sadalage and M. Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", Addison-Wesley Professional, 2012.
7. Richard Cotton, "Learning R – A Step-by-step Function Guide to Data Analysis", O'Reilly Media, 2017.
8. David Loshin, "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph", 2013.
9. Suresh Kumar Mukhiya and Usman Ahmed, "Hands-on Exploratory Data Analysis with Python", Packt publishing , March 2020.
10. Marcello Trovati, Richard Hill, Ashiq Anjum,Shao Ying Zhu, "Big Data Analytics and cloud computing – Theory,Algorithms and Applications", Springer International Publishing,2016.
11. Michael R. Berthold, Christian Borgelt, Frank Höppner, Frank Klawonn, "Guide to Intelligent Data Analysis: How to Intelligently Make Sense of Real Data", Springer, 2010.

20CS222	INTERNET OF THINGS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the fundamentals of Internet of Things.
- To discuss the IoT architecture and models.
- To learn about the basics of IOT protocols.
- To build a small low cost embedded system using Raspberry Pi.
- To apply the concept of Internet of Things in the real world scenario.

UNIT I INTRODUCTION TO IoT 9

Internet of Things - Physical Design- Logical Design- IoT Enabling Technologies - IoT Levels & Deployment Templates - Domain Specific IoTs - IoT and M2M - IoT System Management with NETCONF-YANG- IoT Platforms Design Methodology.

UNIT II ARCHITECTURES AND MODELS 9

IoT Architectures – Core IoT Functional Stack, Sensors and Actuators Layer, Communications Network Layer, Applications and Analytics Layer – IoT Data Management and Compute Stack, Fog Computing, Edge Computing, Cloud Computing – Sensors, Actuators, Smart Objects, Sensor networks: Wireless Sensor Networks, communication protocols for Wireless Sensor Networks.

UNIT III IoT PROTOCOLS 9

Communications Criteria – IoT Access Technologies: IEEE 802.15.4, IEEE 802.15.4g and 802.15.4e, IEEE 1901.2a, IEEE 802.11ah, LoRaWAN, NB-IoT and Other LTE Variations– IP as IoT Network Layer – Business case – Optimization – Profiles and compliances – Application Protocols – Transport Layer – Application Transport Methods - M2M Protocols: BACNet Protocol – Modbus – Zigbee Architecture.

UNIT IV BUILDING IoT WITH RASPBERRY PI & ARDUINO 9

Logical Design using Python – IoT Physical Devices & Endpoints - IoT Device -Building blocks - Raspberry Pi -Board - Linux on Raspberry Pi - Raspberry Pi Interfaces -Programming Raspberry Pi with Python - Other IoT Devices - Arduino.

UNIT V DATA ANALYTICS AND IoT IN INDUSTRY 9

Data Analytics for IoT – Big Data Analytics Tools and Technology – Edge Streaming Analytics – Network Analytics - Manufacturing, Architecture, Protocols – Utilities, Grid Blocks - Smart Cities, Architecture, Use cases – Transportation, Architecture, Use cases.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

- Understand the fundamentals of Internet of Things.
- Understand the significance of IoT architecture and models.
- Analyze various protocols for IoT.
- Design a portable IoT using Rasperry Pi.
- Analyze applications of IoT in real time scenario.

REFERENCES:

1. Arshdeep Bahga, Vijay Madisetti, “Internet of Things – A hands-on approach”, Universities Press, 2015. (Unit 1,4)
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton, Jerome Henry, “IoT

Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things", CISCO Press, 2017. (Unit 2,3,5)

3. Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things – Key applications and Protocols", Wiley, 2012. (Unit 3)
4. Srinivasa K.G., Siddesh G.M., Hanumantha Raju R., "Internet of Things", Cengage Learning India Pvt Ltd, First Edition, 2018. (Unit 4)
5. Mohammed A. Matin, "Wireless Sensor Networks: Technology and Protocols", InTech, 2012.
6. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things", Springer, 2011.
7. Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", CRC Press, 2012.
8. Jan Ho¨ ller, VlasiosTsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things -Introduction to a New Age of Intelligence", Elsevier, 2014.

20CS223 NETWORK DESIGN AND TECHNOLOGIES

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the principles required for network design.
- To explore various technologies in the wireless domain.
- To outline various cellular networks.
- To study about 3G and 4G cellular networks.
- To understand the paradigm of Software defined network.

UNIT I NETWORK DESIGN 9

Advanced multiplexing – Code Division Multiplexing, DWDM and OFDM – Shared media networks – Switched networks – End to end semantics – LAN cabling topologies – Ethernet Switches, Routers, Firewalls and L3 switches – Remote Access Technologies and Devices – Modems and DSLs – SLIP and PPP – Core networks, and distribution networks. Design Concepts – Design Process – Network Layout – Design Traceability – Design Metrics – Selecting Technologies and Devices for Campus and Enterprise Networks – Optimizing Network Design.

UNIT II WIRELESS NETWORKS 9

IEEE802.16 and WiMAX – Security – Advanced 802.16 Functionalities – Mobile WiMAX - 802.16e – Network Infrastructure – WLAN – Configuration – Management Operation – Security – IEEE 802.11e and WMM – QoS – Comparison of WLAN and UMTS – Bluetooth – Protocol Stack – Security – Profiles.

UNIT III CELLULAR NETWORKS 9

GSM – Mobility Management and call control – GPRS – Network Elements – Radio Resource Management – Mobility Management and Session Management – Small Screen Web Browsing over GPRS and EDGE – MMS over GPRS – UMTS – Channel Structure on the Air Interface – UTRAN – Core and Radio Network Mobility Management – UMTS Security.

UNIT IV 4G NETWORKS 9

LTE – Network Architecture and Interfaces – FDD Air Interface and Radio Networks – Scheduling – Mobility Management and Power Optimization – LTE Security Architecture – Interconnection with UMTS and GSM – LTE Advanced (3GPPP Release 10) - 4G Networks and Composite Radio Environment – Protocol Boosters – Hybrid 4G Wireless Networks Protocols – Green Wireless Networks – Physical Layer and Multiple Access – Channel Modelling for 4G – Introduction to 5G.

UNIT V SOFTWARE DEFINED NETWORKS 9

Introduction – Centralized and Distributed Control and Data Planes – Open Flow – SDN Controllers – General Concepts – VLANs – NVGRE – Open Flow – Network Overlays – Types – Virtualization – Data Plane – I/O – Design of SDN Framework.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

- Design a network at a high-level using different networking technologies.
- Analyze the various protocols of wireless networks.
- Analyze the various protocols of cellular networks.
- Discuss the features of 4G and 5G networks.
- Experiment with software defined networks.

REFERENCES:

1. James D. McCabe, "Network Analysis, Architecture, and Design", Morgan Kaufmann, Third Edition, 2007. (Unit 1)
2. Priscilla Oppenheimer, "Top-down Network Design: [a Systems Analysis Approach to Enterprise Network Design]", Cisco Press, 3rd Edition, 2011. (Unit 1)
3. Larry Peterson and Bruce Davie, "Computer Networks: A Systems Approach", 5th edition, Morgan Kauffman, 2018.
4. Erik Dahlman, Stefan Parkvall, Johan Skold, "4G: LTE/LTE-Advanced for Mobile Broadband", Academic Press, 3rd edition 2016.
5. Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks", Wiley, 2015.
6. Martin Sauter, "From GSM to LTE, An Introduction to Mobile Networks and Mobile Broadband", Wiley, 2017.
7. Martin Sauter, "Beyond 3G - Bringing Networks, Terminals and the Web Together: LTE, WiMAX, IMS, 4G Devices and the Mobile Web 2.0", Wiley, Third Edition 2017.
8. Naveen Chilamkurti, Sherali Zeadally, Hakima Chaouchi, "Next-Generation Wireless Technologies", Springer, 2013.
9. Paul Goransson, Chuck Black, "Software Defined Networks: A Comprehensive Approach", Morgan Kauffman, 2014.
10. Savo G Glisic, "Advanced Wireless Networks – 4G Technologies", John Wiley & Sons, Third Edition 2016.
11. Thomas D.Nadeau and Ken Gray, "SDN – Software Defined Networks", O'Reilly Publishers, 2013.
12. Ying Dar Lin, Ren-Hung Hwang and Fred Baker, "Computer Networks: An Open Source Approach", McGraw Hill, 2011.

20CS224 WEB APPLICATION DEVELOPMENT USING PYTHON

L	T	P	C
3	0	2	4

OBJECTIVES:

- To learn the core programming features of Python.
- To apply object oriented concepts in Python.
- To implement web applications using Django framework.
- To understand the back end data model and accessing.
- To build web applications using Django forms and APIs.

UNIT I PYTHON BASICS 9+6

Python basics- Standard types -Flow Control –Exception handling – Files -Functions- Strings- List- Tuples- Dictionaries.

UNIT II PYTHON: OBJECT ORIENTED PROGRAMMING 9+6

Class Definitions – Instantiation – SubClassing – Inner Classes – Regular Expressions -Inheriting from other classes- Class and Static Methods – Private Methods- Polymorphism - Importing python modules and libraries-Creating objects-Manipulating and working with objects.

UNIT III WEB PROGRAMMING 9+6

Python Web Programming: Client/Server Concepts, Progressive web apps. Creating the Project. – Running the Development Server – Creating the Application – Designing a Model – Setting up the Database – Setting up the Application – Dynamic Web Sites – Communication – Data Storage – Presentation.

UNIT IV DJANGO ARCHITECTURE 9+6

Django and Python - DJango stake on MVC: Models - Views and Template – Overall Django Architecture - 3 Core Files: models.py- urls.py- views.py –URL's – Modeling HTTP: Requests; Responses and Middleware – Views / Logic.

UNIT V DJANGO FORMS AND APIS 9+6

Templates – Forms - Validation – Authentication - Advanced Forms processing techniques - Django REST framework – Djangopiston.

OUTCOMES:

At the end of this course, students will have a fundamental understanding of how to Implementing Python based applications:

- Use python data structures to solve problems in Python.
- Apply object oriented concepts in Python.
- Develop web applications using Django framework.
- Understand Django architecture.
- Build and deploy web applications using Django forms and APIs.

REFERENCES:

1. Allen B. Downey, "Think Python - How to Think Like a Computer Scientist", 2nd Edition, Shroff / O'Reilly Publication, 2016.
2. Dennis Sheppard, "Beginning Progressive Web App Development - Creating a Native App Experience on the Web", Apress Publishers, 2017.
3. Steve Holden and David Beazley, "Python Web Programming", SAMS, 2002.
4. Fabrizio Romano, Gaston C. Hillar, ArunRavindran, "Learn Web Development with Python Get Hands-on with Python Programming and Django Web Development", Packt Publishing, 2018.
5. William S Vincent, "Django for Beginners: Build websites with Python and Django", Independently Published, 2018.
6. Jeff Forcier ; Paul Bissex, "Python Web Development with Django", 1st Edition, Wesley Chun; Pearson Education; 2009.
7. Nigel George, "Mastering Django: Core, The Complete Guide to Django 1.8 LTS", Packt Publishers, 2016.
8. Daniel Rubio, "Beginning Django - Web Application Development and Deployment with Python", Apress, 2017.
9. Adrian Holovaty and Jacob Kaplan - Moss, "The Definitive Guide to django - Web Development

Done Right", Apress, 2008.
10. Jake Kronika, Aidas Bendoraitis, "Django 2 Web Development Cookbook: 100 practical recipes on building scalable Python web apps with Django 2", Packt Publishing, 03rd Edition, 2018.
11. Beazley, David M. Jones, Brian Kenneth, "Python cookbook", O'Reilly Media, 3rd Edition, 2014.

WEB APPLICATION DEVELOPMENT USING PYTHON LABORATORY

1. Learn how to install Django in a Linux System
2. Use forms processing of Django for creating simple applications
3. Demonstrate creating views in DJango
4. Create a public site that lets people view polls and vote in them
5. Create an administrative interface that lets you add, change and delete polls
6. Create a session in Django
7. Create an RSS Feed using Django
8. Demonstrate Cookies handling
9. Demonstrate E-mail sending
10. Demonstrate RESTful APIs
11. Mini-project

TOTAL: 75 PERIODS
[45 THEORY + 30 PRACTICALS]

		L	T	P	C
20CS231	**DATA ANALYTICS LABORATORY**	**0**	**0**	**4**	**2**

OBJECTIVES:

- To implement programs using Map Reduce for processing big data
- To analyse big data using linear models
- To analyse big data using machine learning techniques such as SVM / Decision tree classification and clustering
- To learn to visualize data using various representations.
- To realize storage of big data using H base, Mongo DB.

LIST OF EXPERIMENTS

Hadoop

1. Install, configure and run Hadoop and HDFS
2. Implement word count / frequency programs using MapReduce
3. Implement an MR program that processes a weather dataset

R / Python

4. Implement Linear and logistic Regression
5. Implement SVM / Decision tree classification techniques
6. Implement clustering techniques
7. Visualize data using any plotting framework
8. Analysis of social media data.

9. Implement an application that stores big data in Hbase / MongoDB / Pig using Hadoop / R.

TOTAL: 60 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

- Process big data using Hadoop framework.
- Build and apply linear and logistic regression models.
- Perform data analysis with machine learning models.
- Perform graphical data analysis.
- Build large datasets using Hbase, Mongo DB.

LIST OF SOFTWARE FOR A BATCH OF 30 STUDENTS:

Hadoop
YARN
R Package
Hbase
MongoDB

REFERENCES:

1. Alan Gates and Daniel Dai, "Programming Pig – Dataflow scripting with Hadoop", O'Reilly, Second edition, 2016.
2. Gareth James, Daniela Witten, Trevor Hastie and Robert Tibshirani, "An Introduction to Statistical Learning with Applications in R", Springer Publications, 2017. (Corrected 8th Printing)
3. Hadley Wickham, "ggplot2 – Elegant Graphics for Data Analysis", Springer Publications, 2nd Edition, 2016.
4. Kristina Chodorow, "MongoDB: The Definitive Guide – Powerful and Scalable Data Storage", O'Reilley, 3rd Edition, 2019.
5. Lars George, "HBase: The Definitive Guide", O'Reilley, 2015.
6. Tom White, "Hadoop: The Definitive Guide – Storage and Analysis at Internet Scale", O'Reilley, 4th Edition, 2015.

20CS232	TERM PAPER WRITING AND SEMINAR	L	T	P	C
		0	0	2	1

OBJECTIVES:

- Analyze an author's point of view by making inferences.
- Use background knowledge and understand the meaning of research articles.
- Draw general conclusions from specific details in literature.
- Write papers/articles with a clear introduction, supporting details, methodology, results and conclusion.
- Communicate and effectively present the technical research paper.

In this course, students will develop their scientific and technical reading and writing skills that they need to understand and construct research articles. A term paper requires a student to obtain information from a variety of sources (i.e., Journals, dictionaries, reference books) and then place it in logically developed ideas. The work involves the following steps:

1. Selecting a subject in CSE, narrowing the subject into a topic
2. Stating an objective and collecting the relevant bibliography from IEEE, ACM, Elsevier,

Springer, Wiley, Taylor & Francis, Inderscience and IET Journals or IEEE/ACM conferences and Books.

3. Preparing a working outline based on literature survey and Critical Review of papers
4. Linking the papers and preparing a draft of the papers in one area of CSE.
5. Preparing conclusions based on the reading of all the papers and identification of a problem
6. Specify the Mathematical and algorithmic requirements to solve the problem
7. Specify how to change architecture, analyzing existing algorithm and modify existing algorithm and propose a new work and implementation of the proposed work
8. Writing the Final Paper and giving final Presentation by comparing the proposed work with existing work based on suitable metrics
9. Performing Plagiarism check on the Final paper.

- Please keep a file where the work carried out by you is maintained.

Activity	Instructions	Submission week	Evaluation
Selection of area of interest in CSE and Topic in the CSE subject and Stating the Objectives of the work	You are requested to select an area of interest in CSE such as Artificial Intelligence, Machine Learning, Natural Language Processing, Computer Networks, Information Security, Data Mining, Information Retrieval, Image Processing, Cloud and Distributed Systems, Software Engineering and other topics in CSE and state an objective of the proposed work.	2nd week	**3 %** Based on clarity of thought, current relevance and clarity in writing
Collecting Literature/ Information about your area & topic From Reputed Journals such as IEEE Transactions, ACM Transactions and Science Direct.	List Special Interest Groups such as ACM SIG or any other Professional society, journals, Conferences, symposia , workshops, Thesis title, Web presences (mailing lists, forums, news sites) and List 3 authors who publish regularly in your area and also attach a call for papers (CFP) from your area.	3rd week	**3%**(the selected information must be area specific in CSE and of international and national standard)
Collection of Journal papers in the topic in the context of the objective – collect 20 & then filter	• You have to provide a complete list of references you will be using- Based on your objective -Search various digital libraries and Google Scholar • When picking papers to read - try to: • Pick papers that are related to each other in some ways and/or that are in the same field so that	4th week	**5%** (the list of standard papers and reason for selection)

	you can write a meaningful survey out of them, • Favour papers from well-known journals and conferences and more recent papers, • Pick a recent survey of the field so you can quickly gain an overview, • Find relationships with respect to each other and to your topic area (classification scheme/categorization) • Mark in the hard copy of papers whether complete work or section/sections of the paper are being considered		
Reading and notes for first 5 papers	Reading Paper Process • For each paper form • What is the main topic of the article? • What was/were the main issue(s) the author said they want to discuss? • Why did the author claim it was important? • How does the work build on other‘s work, in the author‘s opinion? • What simplifying assumptions does the author claim to be making? • What did the author do? • How did the author claim they were going to evaluate their work and compare it to others? • What did the author say were the limitations of their research? • What did the author say were the important directions for future	5th week	**8%** (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)

	research? Conclude with limitations/issues not addressed by the paper (from the perspective of your survey)		
Reading and notes for next 5 papers	Repeat Reading Paper Process by focusing on Abstract, Introduction, Related work, Architecture, Proposed methodology/solution/Algorithm, Results comparison and conclusions.	6th week	**6%** (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Draft outline 1 and Linking papers	Prepare a draft Outline, your survey goals, along with a classification / categorization diagram. Can prepare UML Diagrams, User Interface Design, Algorithm and Database design, Use of Benchmark Datasets etc.	7th week	**6%** (this component will be evaluated based on the linking and classification among the papers)
Abstract	Prepare a draft abstract of the proposed work in CSE area and give a presentation	8th week	**5%** (Clarity, purpose and conclusion) **5%P**resentation & Viva Voce
Introduction Background	Write an introduction and background sections by explaining the existing algorithms present in the literature, their limitations and the need for proposing a new algorithm.	9th week	**5%** (clarity)
Sections of the paper	Write the sections of your paper based on the classification / categorization diagram in keeping with the goals of your survey.	10thweek	**10%** (this component will be evaluated based on the linking and classification among the papers)
Algorithm and Architecture Analysis	Specify how to make a new architecture for your system, creating a new algorithm or modifying an existing algorithm, Analyze the existing algorithm based on time and memory complexity, modify the existing algorithm to enhance the overall performance and provide the description of the proposed system architecture.	11thweek	**10**% (Analysis of algorithms and Proposed Architecture)
Mathematical Requirements	Specify the Mathematical requirements to solve the problems and include relevant mathematics into the proposed algorithm	12thweek	**5%the** (Mathematical requirements and clarity)

Conclusions and Final Draft	Write your conclusions , future work and Complete the final draft of your paper. Identify the metrics for comparing your work and compare your work with the existing work in the result section. Write the performance improvement using the metrics in the conclusion part briefly.	13th week	**5%** (conclusions – clarity and your ideas) **10%** (formatting, English, Clarity and linking)
Plagiarism Checking	Perform plagiarism check on the final paper	14th week	**4%** Plagiarism Check Report
Seminar	A brief 15 slides on your paper	15th week	**10%**(based on presentation and Viva-voce)

TOTAL: 30 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

- Analyze and infer the domain knowledge of the research papers.
- Find information by using reference tools, including online resources.
- Use syntactic clues to interpret the meaning of complex research articles.
- Understand technical research paper writing process.
- Effectively communicate and present the technical paper in a research forum.

20CS951 IMAGE PROCESSING AND COMPUTER VISION

L	T	P	C
3	0	0	3

OBJECTIVES:

- To discuss the image processing concepts and operations.
- To understand various image transformations.
- To familiarize various the image processing techniques.
- To understand intermediate-level vision.
- To understand 3D vision and motion.

UNIT I IMAGE PROCESSING FUNDAMENTALS 9

Introduction – Elements of visual perception, Steps in Image Processing Systems – Digital Imaging System - Image Acquisition – Sampling and Quantization – Pixel Relationships – File Formats – colour images and models - Image Operations – Arithmetic, logical, statistical and spatial operations.

UNIT II IMAGE ENHANCEMENT AND RESTORATION 9

Image Transforms -Discrete and Fast Fourier Transform and Discrete Cosine Transform ,Spatial Domain - Gray level Transformations Histogram Processing Spatial Filtering – Smoothing and Sharpening. Frequency Domain: Filtering in Frequency Domain – Smoothing and Sharpening filters – Homomorphic Filtering., Noise models, Constrained and Unconstrained restoration models.

UNIT III IMAGE SEGMENTATION AND MORPHOLOGY 9

Detection of Discontinuities – Edge Operators – Edge Linking and Boundary Detection – Thresholding – Region Based Segmentation – Motion Segmentation, Image Morphology: Binary and Gray level morphology operations - Erosion, Dilation, Opening and Closing Operations Distance Transforms- Basic morphological Algorithms. Features – Textures - Boundary representations and Descriptions- Component

Labeling – Regional descriptors and Feature Selection Techniques.

UNIT IV INTERMEDIATE-LEVEL VISION 9

Binary shape analysis – Boundary pattern analysis – Line detection – Circle and Ellipse Detection – Hough Transform.

UNIT V 3D VISION AND MOTION 9

Methods for 3D vision – projection schemes – shape from shading – photometric stereo – shape from texture - triangulation – bundle adjustment – Dense motion estimation - 3D reconstruction – Recognition.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

- Apply image processing concepts and operations.
- Understand various image transformations.
- Critically analyze different approaches to image processing applications.
- Perform shape detection and analysis for computer vision
- Implement 3D vision and motion.

REFERENCES:

1. Anil K Jain, "Fundamentals of Digital Image Processing", PHI, 2011.
2. Rafael C.Gonzalez and Richard E.Woods, "Digital Image Processing", Fourth Edition, Pearson Education, 2018, New Delhi.
3. S.Sridhar, "Digital Image Processing", Second Edition, Oxford University Press, 2011.
4. Kavyan Najarian and Robert Splerstor, "Biomedical signals and Image processing", CRC – Taylor and Francis, New York, 2006.
5. E. R. Davies, "Computer & Machine Vision", Fourth Edition, Academic Press, 2016. (Unit 4,5)
6. R. Szeliski, "Computer Vision: Algorithms and Applications", Springer 2011. (Unit 5)
7. D. L. Baggio et al., "Mastering OpenCV with Practical Computer Vision Projects", Packt Publishing, 2012.
8. Jan Erik Solem, "Programming Computer Vision with Python: Tools and algorithms for analyzing images", O'Reilly Media, 2012.
9. Arcangelo Distante, Cosimo Distante, "Handbook of Image Processing and Computer Vision: Volume 3: From Pattern to Object", Springer, 2020.
10. Davies E.R., "Computer Vision: Principles, Algorithms, Applications, Learning", Elsevier, Academic Press, 2018.
11. "Understanding digital image processing", Tyagi, Vipin, Taylor & Francis Group, 2018.

20CS952 NATURAL LANGUAGE PROCESSING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To learn the fundamentals of natural language processing
- To perform word level analysis.
- To understand the significance of Syntactic analysis.
- To understand the role of semantics and pragmatics.
- To learn discourse algorithms and various lexical resources.

UNIT I INTRODUCTION 9

Origins and challenges of NLP – Language Modeling: Grammar-based LM, Statistical LM - Regular Expressions, Finite-State Automata – English Morphology, Transducers for lexicon and rules, Tokenization, Detecting and Correcting Spelling Errors, Minimum Edit Distance.

UNIT II WORD LEVEL ANALYSIS 9

Unsmoothed N-grams, Evaluating N-grams, Smoothing, Interpolation and Backoff – Word Classes, Part-of-Speech Tagging, Rule-based, Stochastic and Transformation-based tagging, Issues in PoS tagging – Hidden Markov and Maximum Entropy models.

UNIT III SYNTACTIC ANALYSIS 9

Context-Free Grammars, Grammar rules for English, Treebanks, Normal Forms for grammar – Dependency Grammar – Syntactic Parsing, Ambiguity, Dynamic Programming parsing – Shallow parsing – Probabilistic CFG, Probabilistic CYK, Probabilistic Lexicalized CFGs - Feature structures, Unification of feature structures.

UNIT IV SEMANTICS AND PRAGMATICS 10

Requirements for representation, First-Order Logic, Description Logics – Syntax-Driven Semantic analysis, Semantic attachments – Word Senses, Relations between Senses, Thematic Roles, selectional restrictions – Word Sense Disambiguation, WSD using Supervised, Dictionary & Thesaurus, Bootstrapping methods – Word Similarity using Thesaurus and Distributional methods.

UNIT V DISCOURSE ANALYSIS AND LEXICAL RESOURCES 8

Discourse segmentation, Coherence – Reference Phenomena, Anaphora Resolution using Hobbs and Centering Algorithm – Coreference Resolution – Resources: Porter Stemmer, Lemmatizer, Penn Treebank, Brill's Tagger, WordNet, PropBank, FrameNet, Brown Corpus, British National Corpus (BNC).

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

- Apply the fundamentals of natural language processing.
- Perform word level analysis.
- Analyze the syntax using various methods.
- Understand the role of semantics and pragmatics.
- Use discourse algorithms and various lexical resources.

REFERENCES:

1. Daniel Jurafsky, James H. Martin, “Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech”, Pearson Publication, 2019.
2. Steven Bird, Ewan Klein and Edward Loper, “Natural Language Processing with Python”, First Edition, O’Reilly Media, 2009.
3. Breck Baldwin, “Language Processing with Java and LingPipe Cookbook”, Atlantic Publisher, 2015.
4. Richard M Reese, “Natural Language Processing with Java”, O’Reilly Media, 2015.
5. Nitin Indurkhya and Fred J. Damerau, “Handbook of Natural Language Processing”, Second Edition, Chapman and Hall/CRC Press, 2010.
6. Tanveer Siddiqui, U.S. Tiwary, “Natural Language Processing and Information Retrieval”, Oxford University Press, 2008.

20CS953 ADVANCED DATABASE SYSTEMS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand basics of Database and the Query Languages.
- To learn and apply Parallel and Object Oriented Databases in real-world applications.
- To Use Distributed and XML Databases.
- To learn and understand Web Databases.
- To use advanced Indexing in emerging database applications.

UNIT I INTRODUCTION TO RDMBS AND SQL 10

Significance of Databases - Database System Applications - Advantages and Disadvantages of different Database Management systems - Comparison between DBMS, RDBMS, Distributed and Centralized DB - Relational Query Languages - The SQL Query Language - Querying Multiple Relations - Creating Relations in SQL -, Destroying and Altering Relations - Adding and Deleting Tuples - Integrity Constraints (ICs) - Primary and Candidate Keys in SQL - Foreign Keys, Referential Integrity in SQL - Enforcing Referential Integrity, Categories of SQL Commands - DDL - DML - TCL - DCL - Views - Embedded SQL * - Transaction Processing - Consistency and Isolation - Atomicity and Durability - Dynamic SQL.

UNIT II PARALLEL DATABASES AND OBJECT ORIENTED DATABASES 10

Parallel Query Evaluation - Parallelizing individual operations - I/O Parallelism - Intra query Parallelism – Intra operation Parallelism - Inter operation Parallelism - Design of Parallel Systems.

Object Oriented Paradigm - Introduction to OODBMS - Persistence in OODBMS - Issues in OODBMS - Advantages and Disadvantages of OODBMS - Comparison of ORDBMS and OODBMS - Object Management Group - Object Data Standard ODMG 3.0, 1999 - Object Store.

UNIT III DISTRIBUTED AND XML DATABASES 8

Distributed DBMSs - Concepts and Design : Introduction - Overview of Networking - Functions and Architectures of a DDBMS - Distributed Relational Database Design - Transparencies in a DDBMS - Distributed Transaction Management - Distributed Concurrency Control - Distributed Deadlock Management - Distributed Database Recovery - Distributed Query Optimization. Semistructured Data and XML: Semistructured Data - Introduction to XML - XML-Related Technologies - XML Schema - XML Query Languages - XML and Databases - XML in Oracle.

UNIT IV WEB DATABASES 8

Introduction - jquery – Overview of Ajax – Creating an web Application – Overview of the JSON Web Token No SQL : Azure SQL Database, Azure Cosmos DB, and MongoDB

UNIT V ADVANCED INDEXING TECHNIQUES AND APPLICATION DEVELOPMENT 9

Bloom Filter – Indexing of spatial Data – Hash Indices – Performance Tuning – Distributed Directory Systems – Block Chain Databases – Overview – Properties – Data Management – Performance Enhancement – Emerging Applications

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

- Write queries to retrieve data.
- Model and represent the real world data using Object Oriented Database.
- Represent the data using XML database for better interoperability.
- Develop and Deploy Web databases.
- Use Advanced Indexing Techniques and apply Block Chaining Concepts.

REFERENCES:

1. Henry F Korth, Abraham Silberschatz, S. Sudharshan "Database System Concepts", Seventh Edition, McGraw-Hill Education, March 2019. (Unit I, II, V)
2. Thomas Cannolly and Carolyn Begg, Database Systems, "Database Systems: a practical approach to design, implementation, and management", Sixth Edition, Pearson Education, 2015. (Unit II)
3. David Taniar, Clement H. C. Leung, Wenny Rahayu, Sushant Goel, "High Performance Parallel Database Processing and Grid Databases (Wiley Series on Parallel and Distributed Computing)", Wiley, 2008. (Unit III)
4. Bipin Joshi , "Beginning Database Programming Using ASP.NET Core 3", Apress, 2019. (Unit IV)
5. C. J. Date, A.Kannan and S. Swamynathan, "An Introduction to Database Systems", Eighth Edition, Pearson Education, 2006. (Unit I)

20CS954 DISTRIBUTED AND CLOUD COMPUTING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To learn distributed systems and communication.
- To understand distributed resource management.
- To study cloud computing architecture, models and services.
- To understand virtualization.
- To expose various cloud computing platforms.

UNIT I INTRODUCTION TO DISTRIBUTED SYSTEM AND COMMUNICATION 8

Introduction to Distributed Systems – Characteristics – Issues in Distributed Systems – Distributed Architectural Models – Communication Primitives – Remote Procedure Call – Physical Clock Synchronization – Logical Clocks, Vector Clocks and Casual Ordering – Multicast Ordering.

UNIT II DISTRIBUTED RESOURCE MANAGEMENT 10

Distributed Mutual Exclusion Algorithm – Distributed Deadlock Detection Algorithms– Election Algorithm – Distributed File System – Design Issues – Distributed Shared Memory – Global States and Snapshot – Check Point and Recovery – Two Phase Commit Protocol – Non Blocking Commit Protocol.

UNIT III CLOUD COMPUTING, ARCHITECTURE MODELS AND SERVICES 9

Introduction to Cloud Computing – Definition of Cloud – Evolution of Cloud Computing – Cloud Characteristics – Elasticity in Cloud – On-demand Provisioning – NIST Cloud Computing Reference Architecture– Architectural Design Challenges – Deployment Models: Public, Private and Hybrid Clouds – Service Models: laaS – PaaS – SaaS – Benefits of Cloud Computing.

UNIT IV CLOUD ENABLING TECHNOLOGIES 10

Service Oriented Architecture – SOAP – RESTful Web Services – Basics of Virtualization – Types of

Virtualization –Full and Para Virtualization– Implementation Levels of Virtualization – Tools and Mechanisms – Virtualization of CPU – Memory – I/O Devices – Desktop Virtualization – Server Virtualization –Network and Storage Virtualization – Containers.

UNIT V CLOUD MANAGEMENT, SECURITY AND COMPUTING PLATFORMS 8

Resource Provisioning – Resource Provisioning Methods – Security Overview – Cloud Security Challenges – Software-as-a-Service Security – Virtual Machine Security – Application and Data Security Cloud Storage – HDFS – Map Reduce – Google App Engine(GAE) – Programming Environment for GAE – Architecture of GFS – Cloud Software Environments – Openstack, Heroku, Docker, Case Studies: Amazon EC2, AWS, Microsoft Azure, Google Compute Engine.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

- Appreciate distributed communication.
- Understand distributed resource management.
- Articulate the main concepts, key technologies, strengths and limitations of cloud computing.
- Learn the key and enabling technologies that help in the development of cloud.
- Explore the core issues of cloud computing such as resource management and security.

REFERENCES:

1. Andrew S. Tanenbaum, Maarten Van Steen, "Distributed Systems – Principles and Paradigms", Third Edition, Pearson Education, 2017.
2. Kai Hwang, Geoffrey C. Fox, Jack G. Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann, 2012.
3. Barrie Sosinky, "Cloud Computing bible", Wiley, 2011.
4. Buyya R., Broberg J., Goscinski A., "Cloud Computing: Principles and Paradigm", John Wiley, 2011.
5. Mukesh Singhal, "Advanced Concepts in Operating Systems", McGraw-Hill Series in Computer Science, 2008.
6. John W. Rittinghouse, James F. Ransome, "Cloud Computing: Implementation Management, and Security", CRC Press, 2010.
7. Ruchi Doshi, Temitayo Fagbola, Mehul Mahrishi, "Cloud Computing: Master the Concepts, Architecture and Applications with Real-world examples and Case studies", BPB Publications, 2019.

20CS955 ONTOLOGY AND SEMANTIC WEB

L	T	P	C
3	0	0	3

OBJECTIVES:

- To learn the fundamentals of semantic web and to conceptualize and depict Ontology for semantic web.
- To understand the languages for semantic web.
- To learn and utilize ontology learning algorithms in the development of an application.
- To know the fundamental concepts of ontology management.
- To learn the applications related to semantic web.

UNIT I THE QUEST FOR SEMANTICS 9

Building Models – Calculating with Knowledge – Exchanging Information – Semantic Web

Technologies – Layers – Architecture – Components – Types – Ontological Commitments – Ontological Categories – Philosophical Background – Sample Knowledge Representation Ontologies – Top Level Ontologies – Linguistic Ontologies – Domain Ontologies – Semantic Web – Need – Foundation.

UNIT II LANGUAGES FOR SEMANTIC WEB AND ONTOLOGIES 9

Web Documents in XML – RDF – Schema – Web Resource Description using RDF – RDF Properties – Topic Maps and RDF – Overview – Syntax Structure – Semantics – Pragmatics –Traditional Ontology Languages – LOOM – OKBC – OCML – Flogic Ontology Markup Languages – SHOE – OIL – DAML+OIL – OWL.

UNIT III ONTOLOGY LEARNING FOR SEMANTIC WEB 9

Taxonomy for Ontology Learning – Layered Approach – Phases of Ontology Learning – Importing and Processing Ontologies and Documents – Ontology Learning Algorithms – Methods for evaluating Ontologies.

UNIT IV ONTOLOGY MANAGEMENT AND TOOLS 9

Overview – Need for management – Development process – Target Ontology – Ontology mapping – Skills management system – Ontological class – Constraints – Issues – Evolution – Development of Tools and Tool Suites – Ontology Merge Tools – Ontology based Annotation Tools.

UNIT V APPLICATIONS 9

Web Services – Semantic Web Services – Case Study for specific domain – Security issues – Web Data Exchange and Syndication – Semantic Wikis – Semantic Portals – Semantic Metadata in Data Formats – Semantic Web in Life Sciences – Ontologies for Standardizations – Rule Interchange Format.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

- Create ontology for a given domain.
- Develop an application using ontology languages and tools.
- Understand the concepts of semantic Web.
- Use ontology related tools and technologies for application creation.
- Design and develop applications using semantic web.

REFERENCES:

1. Pascal Hitzler, Markus Krötzsch, Sebastian Rudolph, “Foundations of Semantic Web Technologies”, Chapman & Hall/CRC, 2010.
2. Asuncion Gomez-Perez, Oscar Corcho, Mariano Fernandez-Lopez, “Ontological Engineering: with Examples from the Areas of Knowledge Management, e- Commerce and the Semantic Web”, Springer, 2004.
3. Grigoris Antoniou, Frank van Harmelen, “A Semantic Web Primer (Cooperative Information Systems)”, MIT Press, Third Edition 2012.
4. Alexander Maedche, “Ontology Learning for the Semantic Web”, First Edition, Springer. 2002.
5. John Davies, Dieter Fensel, Frank Van Harmelen, “Towards the Semantic Web: Ontology Driven Knowledge Management”, John Wiley, 2003.
6. John Davies, Rudi Studer, Paul Warren, (Editor), “Semantic Web Technologies: Trends and Research in Ontology-Based Systems”, Wiley, 2006.

20CS956 CYBER SECURITY AND ETHICAL HACKING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To explain the basics of number theory and cyber security.
- To understand cybercrimes and cyber offences.
- To learn risk assessment.
- To outline the policies of security management.
- To explore Ethical Hacking basics.

UNIT I INTRODUCTION TO NUMBER THEORY AND CYBER SECURITY 9

Introduction to Number Theory: Divisibility – Modular Arithmetic – Prime Numbers – Test for Primality – Fermat's and Euler's Theorem - The Chinese Remainder Theorem.

Defining Cyberspace and Cybersecurity – Effective Cybersecurity – Security Governance and Security Management – Security Governance Principles and Desired Outcomes – Security Governance Components – Security Governance Approach.

UNIT II CYBER CRIMES AND CYBER OFFENCES 9

Introduction to cyber crime - Classification, Cyber offences: Planning of attacks, social engineering - Cyberstalking, Cybercafe and Cybercrimes, BotNets – Tools and methods used in cyber crime - Identity Theft (ID).

UNIT III INFORMATION RISK ASSESSMENT 9

Risk Assessment Concepts - Asset Identification - Threat Identification - Control Identification - Vulnerability Identification – Risk Assessment Approaches.

UNIT IV SECURITY MANAGEMENT 9

Security Management: The Security Management Function – Security Policy – Technical Security Management: Security Architecture - Malware Protection Activities - Malware Protection Software - Intrusion Detection.

UNIT V ETHICAL HACKING 9

Introduction to Ethical Hacking – Footprinting – System Hacking: Introduction - Cracking Passwords – Password Cracking Websites – Password Guessing – Password Cracking Tools – Password Cracking Countermeasures – Escalating Privileges – Introduction to penetration testing – Phases of Penetration Testing.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

- Understand the basics of number theory and cyber security.
- Identify cybercrimes and cyber offences.
- Learn risk assessment.
- Understand policies of security management.
- Explore Ethical Hacking basics.

REFERENCES:

1. William Stallings, "Cryptography and Network Security: Principles and Practice", Seventh Edition, Pearson Education, 2017.(Unit 1)
2. Nina Godbole, Sunit Belapure, "Cyber Security, Understanding cyber crimes, computer forensics and legal perspectives", Wiley Publications, Reprint 2016. (Unit 2)
3. William Stallings, "Effective Cybersecurity: A Guide to Using Best Practices and Standards", Pearson Education, 2019.(Unit 1,3,4)
4. EC-Council, "Ethical Hacking and Countermeasures: Attack Phases", Cengage Learning, Second Edition 2017.(Unit 5)
5. Scott Barman, "Writing Information Security Policies", New Riders Publications, 2007.

6. Jon Erickson, "Hacking: The Art of Exploitation", 2nd Edition, No Starch Press Inc., 2008.
7. Michael T. Simpson, Kent Backman, James E. Corley, "Hands-On Ethical Hacking and Network Defense", Cengage Learning, Third Edition, 2017.
8. Patrick Engebretson, "The Basics of Hacking and Penetration Testing – Ethical Hacking and Penetration Testing Made Easy", Second Edition, Elsevier, 2013.
9. Rafay Boloch, "Ethical Hacking and Penetration Testing Guide", CRC Press, 2014.
10. Victor Shoup, "A Computational Introduction to Number Theory and Algebra", Cambridge University Press (Version 2), 2008.
11. Abhijit Das, "Computational Number Theory", CRC Press, 2016.

20CS957 KNOWLEDGE ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the concepts of Knowledge Engineering.
- To explain logic based reasoning.
- To understand Reasoning under uncertainty.
- To examine the various Knowledge representation and reasoning.
- To apply Expert systems for various applications.

UNIT I KNOWLEDGE ENGINEERING CONCEPTS 7

Knowledge Engineering in AI – Knowledge base Systems – Knowledge base systems Vs Database systems – Rules Vs Triggers – Domain Expert – Expert Systems – Architecture of Expert Systems – Expert System Shell - JESS- Heuristic Search – A*, AO* and Mini-max algorithms - Knowledge representation using Rules- Rule Matching and Rule Firing- Active and Passive rules- Procedural Versus Declarative Knowledge - Logic Programming - Forward versus Backward Reasoning – Rules in Production Systems- Working Memory- Conflict Resolution- Rete's Algorithm – Discriminant Networks Knowledge representation using Semantic Networks – Frames- Conceptual Dependency – Scripts – Ontology – Semantic Web – Knowledge Based Reasoning Methods.

UNIT II LOGIC BASED REASONING 9

Role of Logic – Propositional logic – Predicate logic – Syntax – Semantics – Interpretations – Denotation – Satisfaction and models – Pragmatics – Explicit and Implicit Beliefs - Logical Consequence – Expressing Knowledge - Basic and Complex Facts – Terminological facts – Entailment – Abstract Individuals - Other Sorts of Facts – Resolution – The Propositional Case – Predicate Logic – Handling Variables and Quantifiers – First Order Resolution- Answer Extraction – Skolemization – Clause Form – Equality - Dealing with Computational Intractability - The First-Order Case - Herbrand Theorem - The Propositional Case - The Implications - SAT Solvers - Most General Unifiers - Other Refinements

UNIT III REASONING UNDER UNCERTAINTY 9

Vagueness- Uncertainty – Degrees of Belief- Defaults – Default Reasoning – Closed World Assumption – Situation Logic - Non Monotonic Logic- Truth Maintenance Systems - Fuzzy Logic – Inference using Fuzzy Rules – Modal Logic – Temporal Logic – Temporal reasoning – Temporal Constraint networks – Epistemic Logic- Statistical Reasoning – Bayesian Networks – Plausibility Theory - Reasoning and Decision Making under Uncertainty.

UNIT IV KNOWLEDGE REPRESNTATION AND REASONING 9

Control Knowledge – Reasoning with Horn Clauses – Computing Selective Linear Definite clause resolution Derivatives – Rule Formation and Search Strategy – Algorithm Design – Specifying Goal order – Committing to Proof methods – Controlling Back Tracking – Negation as Failure – Dynamic Databases - Structured Descriptions – Descriptions – Description Language – Meaning and Entailment – Interpretations – Truth in an Interpretation – Computing Entailments – Simplifying the Knowledge base

– Normalization – Structure Matching – Subsumption Computation – Taxonomies and Classification – Inheritance Networks – Handling Defeasible Inheritance – Inheritance Networks.

UNIT V EXPERT SYSTEMS AND APPLICATIONS 9

Expert Systems – Inference Engine – Forward and Backward Chaining Inference – MYCIN - DENDRAL – Knowledge Acquisition - Rote Learning – Learning from Examples – Machine Learning- Neural Networks – Regression Analysis- Predictive Models - Deep Learning – Robotics and Automation -Field and Service Robotics –Assistive Robotics -Military Applications - Medicare – Education – Business Intelligence – Recommendation Systems – Social Network Analysis – Natural Language Processing – Information Retrieval Systems.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

- Explain the concepts of Knowledge Engineering.
- Interpret logic based reasoning.
- Understand Reasoning under uncertainty.
- Distinguish various Knowledge representation and reasoning.
- Solve various applications using Expert systems.

REFERENCES:

1. Ronald Brachman, Hector Levesque, "Knowledge Representation and Reasoning", 1st Edition, Morgan Kaufmann, 2004.
2. Richard A Frost, "Introduction to Knowledge Based Systems", Macmillan Publishing Co, 1986.
3. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Fourth Edition, Pearson, 2020.
4. John F. Sowa, "Knowledge Representation: Logical, Philosophical, and Computational Foundations", Brooks Cole Publishing Co., Pacific Grove, CA, ©2000. Actual publication date, 16 August 1999.
5. Elaine Rich, Kevin Knight, Shivashankar B. Nair, "Artificial Intelligence", Third Edition, Tata McGraw-Hill Education Pvt. Ltd., 2010.
6. Donald A Waterman, "A Guide to Expert Systems", Addison Wesley, 1986.
7. Schall, Daniel, "Social Network-Based Recommender Systems", Springer, 2015.
8. Deepak Khemani, "A First Course in Artificial Intelligence", McGraw Hill Education, 2017.
9. Ian J. Goodfellow, YoshuaBengio, Aaron Courville, "Deep Learning", MIT Press, 2017.
10. Francois Chollet, "Deep Learning with Python", Manning Publications, Second Edition, 2020.

20CS958 ADHOC AND WIRELESS SENSOR NETWORKS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the fundamentals of routing protocols of wireless ad hoc networks.
- To explore various mobility models for MANETs.
- To elaborate various issues in wireless sensor networks.
- To analyze the performance of IEEE 802.15.4.
- To understand the security issues in ad hoc and sensor networks.

UNIT I FUNDAMENTALS AND ROUTING PROTOCOLS OF WIRELESS AD HOC NETWORKS 9

Introduction – Applications of Mobile Ad Hoc Networks (MANETs) – Medium Access Control Layer –

Topology Control – Routing Protocols – Broadcasting – Multicasting – Internet Connectivity for MANETs – Security in MANETs - Scenario Based Performance Analysis of Various Routing Protocols in MANETs.

UNIT II MOBILITY MODELS AND OVERHEAD CONTROL MECHANISMS IN MANETS **9**

Description of Various Mobility Models – Simulation and Analysis of Various Mobility Models – Overhead Analysis in Hierarchical Routing Scheme – Overhead Minimization Techniques – Energy Models.

UNIT III WIRELESS SENSOR NETWORKS (WSN) **9**

Applications of WSNs – Hardware and Software Issues in WSN – Design Issues of MAC Protocols – Deployment – Localization – Synchronization – Calibration – Network Layer Issues – Classification of Routing Protocols – Transport Layer Issues – Data Aggregation and Dissemination – Database Centric and Querying.

UNIT IV PERFORMANCE ANALYSIS AND EVALUATION **9**

Overview of IEEE 802.15.4 and its Characteristics – Data Gathering Paradigm – Simulation Environment and Result Analysis of IEEE 802.15.4 - Zigbee Routing Protocols – Traffic Generators – Traffic Model - Simulation Environment and Result Analysis of Zigbee Routing Protocols.

UNIT V SECURITY IN ADHOC AND SENSOR NETWORKS **9**

Security Attacks – Key Distribution and Management – Intrusion Detection – Software based Anti-tamper techniques – Water marking techniques – Defence against routing attacks – Secure Ad hoc routing protocols – Broadcast authentication WSN protocols – TESLA – Biba – Sensor Network Security Protocols – SPINS.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

- Identify suitable routing protocols for various scenarios of ad hoc networks.
- Explore various mobility models for MANETs.
- Identify different issues in wireless sensor networks.
- Analyze the performance of IEEE 802.15.4.
- Identify and critique security issues in ad hoc and sensor networks.

REFERENCES:

1. Subir Kumar Sarkar, “Wireless Sensor and Ad Hoc Networks Under Diversified Network Scenarios”, Auerbach Publications, 2012.
2. Holger Karl, Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks”, Wiley India Private Limited, 2011.
3. Erdal Çayirci, Chunming Rong, “Security in Wireless Ad Hoc and Sensor Networks”, John Wiley and Sons, 2009.
4. Carlos De Morais Cordeiro, Dharma Prakash Agrawal, “Ad Hoc and Sensor Networks: Theory and Applications”, World Scientific Publishing, Second Edition, 2011.
5. Waltenegus Dargie, Christian Poellabauer, “Fundamentals of Wireless Sensor Networks Theory and Practice”, Wiley India Private Limited, 2014.
6. Adrian Perrig, J.D. Tygar, “Secure Broadcast Communication: In Wired and Wireless Networks”, Kluwer Academic Publishers, Springer, 2002.
7. C Siva Ram Murthy, B S Manoj, “Adhoc Wireless Networks Architectures and Protocols”, Pearson 2014.

20CS959 **BLOCKCHAIN TECHNOLOGIES**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand blockchain system's fundamental components, how they fit together and examine a decentralization using blockchain.
- To explain how Cryptocurrency works.
- To explain the components of Ethereum and Programming Languages for Ethereum.
- To study the basics of Web3 and Hyperledger.
- To give an insight of alternative blockchains and its emerging trends.

UNIT I INTRODUCTION TO BLOCKCHAIN 9

History of Blockchain – Types of Blockchain – Consensus – Decentralization using Blockchain – Blockchain and Full Ecosystem Decentralization – Platforms for Decentralization – Symmetric Cryptography - Mathematics – Asymmetric Cryptography – public and private keys – Elliptic curve cryptography – Discrete logarithm problem in ECC – Hash Functions – Merkle Trees - Elliptical curve digital signature algorithm.

UNIT II INTRODUCTION TO CRYPTOCURRENCY 9

Bitcoin – Digital Keys and Addresses – Transactions – Mining – Bitcoin Networks and Payments – Wallets – innovation in Bitcoin – Alternative Coins – Theoretical Foundations – Bitcoin Limitations – Name Coin – Prime Coin – Zcash – Smart Contracts – Ricardian Contracts.

UNIT III ETHEREUM 9

The Ethereum Network – Components of Ethereum Ecosystem – Ethereum Programming Languages: Runtime Byte Code – Blocks and Blockchain – Fee Schedule – Supporting Protocols – Solidity Language.

UNIT IV WEB3 AND HYPERLEDGER 9

Introduction to Web3 – Contract Deployment – POST Requests – Development frameworks Hyperledger as a protocol – The Reference Architecture – Hyperledger Fabric – Distributed Ledger – Corda.

UNIT V ALTERNATIVE BLOCKCHAINS AND NEXT EMERGING TRENDS 9

Kadena – Ripple- Rootstock – Quorum – Tendermint – Scalability – Privacy – Other Challenges – Blockchain Research – Notable Projects.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

- Understand the technology components of Blockchain and how it works behind the scenes.
- Understand the Bitcoin and its limitations by comparing with other alternative coins.
- Develop deep understanding of the Ethereum model, its consensus model, code execution.
- Understand the architectural components of a Hyperledger and its development framework.
- Explore the alternative blockchains and its emerging trends.

REFERENCES:

1. Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained", Second Edition, Packt Publishing, 2018.
2. ArshdeepBahga, Vijay Madisetti, "Blockchain Applications: A Hands-On Approach", VPT, 2017.
3. Andreas Antonopoulos, Satoshi Nakamoto, "Mastering Bitcoin", O'Reilly Publishing, 2014.
4. Roger Wattenhofer, "The Science of the Blockchain" CreateSpace Independent Publishing Platform, 2016.
5. A. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction", Princeton University Press, 2016.
6. Alex Leverington, "Ethereum Programming", Packt Publishing, 2017.

7. Antony Lewis "The Basics of Bitcoins and Blockchains: An Introduction to Cryptocurrencies and the Technology that Powers Them", Mango Publishing 2018.
8. Andreas M. Antonopoulos, "Mastering Bitcoin: Programming the Open Block chain", O'Reilly Publishing, 2017.
9. Massimo Ragnedda, Giuseppe Destefanis, "Blockchain and Web 3.0: Social, Economic, and Technological Challenges", Routledge, 2019.

20CS960	MOBILE COMPUTING AND APPLICATION DEVELOPMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn the basics of wireless communication and cellular networks.
- To study the popular mobile networking technologies.
- To explore various protocols that support mobility at network layer and transport layer.
- To understand the intricacies of UI required by mobile applications and the design aspects of mobile application.
- To study various mobile app development platforms and learn developing mobile applications.

UNIT I WIRELESS COMMUNICATION AND CELLULAR NETWORKS 7

Multiple Access Techniques: FDMA, TDMA, CDMA, OFDMA – Duplexing Techniques: FDD, TDD – Cellular Networks – Tessellation, Frequency Reuse and Handoff – Generations of Cellular Networks – Pillars of 5G – Standardization Activities -Use cases and Requirements – System Concept – Spectrum and Regulations: Spectrum for 4G – Spectrum Challenges in 5G – Spectrum Landscape and Requirements – Spectrum Access Modes and Sharing Scenarios.

UNIT II WIRELESS MOBILE NETWORKS 8

3GPP – UMTS and IMT-2000: Architecture, User Equipment, RNS, UTRAN, Node B, RNC Functions – IP Multimedia Subsystem – 4G Cellular Networks – LTE – Control Plane – NAS and RRC – User Plane – PDCP, RLC And NAC – IMT– Advanced Standard – Features Of LTE– Advanced - 5G Architecture: Software Defined Networking – Network Function Virtualization – Basics about RAN Architecture –High-Level Requirements for 5G Architecture – Functional Architecture and 5G Flexibility

UNIT III MOBILITY SUPPORT IN TCP/IP 8

Mobile IP – Mobile Agent, Foreign Agent, Care of Address, Registration, Advertisement and Discovery, Tunneling, IP within IP – Mobility Support in IPV6 – Mobility Header, Mobility Options, Dynamic Home Agent Address Discovery, Cache Management, Bidirectional Tunneling – TCP Over Wireless Networks – Indirect TCP –Snoop TCP – Mobile TCP WAP – Architecture – WDP – WTLS – WTP – WSP – WAE – WTA Architecture – WML.

UNIT IV APPLICATION DESIGN 11

Aspects of Mobility – Middleware and Gateways – Mobile Devices and Profiles – Generic UI Development – Multimodal and Multichannel UI – Mobile Memory Management – Design Patterns for Limited Memory – Work Flow for Application Development – Techniques for Composing Applications – Dynamic Linking – Plug-ins and Rule of Thumb for Using DLLs – Concurrency and Resource Management – Look and Feel, Intents and Services – Storing and Retrieving Data – Communication via the Web – Notification and Alarms.

UNIT V APPLICATION DEVELOPMENT 11

Google Android Platform – Eclipse Simulator – Android Application Architecture – Event Based Programming – Apple Iphone Platform – UI Tool Kit Interfaces – Cross Platform Design and Tools – Event Handling and Graphics Services – Layer Animation – Location Based Services – Resilient Programming Practices – Packaging and Deployment – Security And Hacking.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

- Have knowledge on the architecture and protocols of wireless communication and cellular networks.
- Understand wireless mobile networks.
- Deploy various protocols that support mobility at network layer and transport layer.
- Design and implement the user interfaces for mobile applications.
- Develop mobile applications.

REFERENCES:

1. Clint Smith, Daniel Collins, "Wireless Networks", Third Edition, McGraw Hill Publications, 2014.
2. Share Conder, Lauren Darcey, "Android Wireless Application Development", Volume I, Third Edition, Pearson, 2014.
3. M. Bala Krishna, Jaime Lloret Mauri, "Advances in Mobile Computing and Communications - Perspectives and Emerging Trends in 5G Networks", CRC Press, 2016.
4. Anwer Al-dulaimi, Xianbin Wang , Chih-Lin I, Wiley, "5G Networks: Fundamental Requirements, Enabling Technologies, and Operations Management", Wiley-IEEE Press, 2018.
5. Jonathan Rodriquez, "Fundamentals of 5G Mobile Networks", Wiley, 2015.
6. Asif Oseiran, Jose F.Monserrat and Patrick Marsch, "5G Mobile and Wireless Communications Technology", Cambridge University Press, 2016.
7. Jochen Schiller, "Mobile Communications", Second Edition, Pearson, 2009.
8. Donny Wals, "Mastering iOS 12 Programming", Packt, 2018.

SEMESTRE III

		L	T	P	C
20CS961	**COGNITIVE COMPUTING**	**3**	**0**	**0**	**3**

OBJECTIVES:

- To explain cognitive computing and design principles.
- To distinguish between NLP and cognitive computing.
- To apply advanced analytics to cognitive computing.
- To discuss application of cognitive computing in business.
- To illustrate various applications of cognitive computing.

UNIT I FOUNDATION & DESIGN PRINCIPLES 9

Foundation of Cognitive Computing: cognitive computing as a new generation, the uses of cognitive systems, system cognitive, gaining insights from data, Artificial Intelligence as the foundation of cognitive computing, understanding cognition.

Design Principles for Cognitive Systems: Components of a cognitive system, building the corpus, bringing data into cognitive system, machine learning, hypotheses generation and scoring, presentation and visualization services.

UNIT II NLP IN COGNITIVE SYSTEM 9

Natural Language Processing in support of a Cognitive System: Role of NLP in a cognitive system, semantic web, Applying Natural language technologies to Business problems.

Representing knowledge in Taxonomies and Ontologies: Representing knowledge, Defining Taxonomies and Ontologies, knowledge representation, models for knowledge representation, implementation considerations.

UNIT III BIG DATA Vs COGNITIVE COMPUTING 9

Relationship between Big Data and Cognitive Computing: Dealing with human-generated data, defining big data, architectural foundation, analytical data warehouses, Hadoop, data in motion and streaming data, integration of big data with traditional data.

Applying Advanced Analytics to cognitive computing: Advanced analytics is on a path to cognitive computing, Key capabilities in advanced analytics, Using advanced analytics to create value, Impact of open source tools on advanced analytics.

UNIT IV COGNITIVE COMPUTING IN BUSINESS 9

The Business Implications of Cognitive Computing: Preparing for change, advantages of new disruptive models, knowledge meaning to business, difference with a cognitive systems approach, meshing data together differently, using business knowledge to plan for the future, answering business questions in new ways, building business specific solutions, making cognitive computing a reality, cognitive application changing the market- IBM Watson as a cognitive systems.

UNIT V APPLICATIONS 9

The process of building a cognitive application: Emerging cognitive platform, defining the objective, defining the domain, understanding the intended users and their attributes, questions and exploring insights, training and testing- Building a cognitive health care application- Smarter cities-Cognitive Computing in Government.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Explain cognitive computing and design principles.
CO2: Distinguish between NLP and cognitive computing.
CO3: Apply advanced analytics to cognitive computing.
CO4: Discuss application of cognitive computing in business.
CO5: Illustrate various applications of cognitive computing.

REFERENCES:

6. Judith H Hurwitz, Marcia Kaufman, Adrian Bowles, “Cognitive computing and Big Data Analytics” , Wiley, 2015.
7. Vijay Raghvan, Venu Govindaraju, C.R. Rao, Cognitive Computing: Theory and Applications“, by Elsevier publications, North Holland Publication, 1st Edition, 2016.
8. Bernadette Sharp (Author), Florence Sedes (Author), Wieslaw Lubaszewski (Author), Cognitive Approach to Natural Language Processing Hardcover, First Edition May 2017.
9. Arun Kumar Sangaiah, Arunkumar Thangavelu, et al., Cognitive Computing for Big Data Systems Over IoT: Frameworks, Tools and Applications: Lecture Notes on Data Engineering and Communications Technologies 1st edition 2018
10. Min Chen and Kai Hwang, Big-Data Analytics for Cloud, IoT and Cognitive Computing Wiley Publication, 1st Edition, 2017.
11. Mallick, Pradeep Kumar, Borah, Samarjeet," Emerging Trends and Applications in Cognitive Computing”, IGI Global Publishers, 2019.

20CS962	COMPUTATIONAL INTELLIGENCE	L	T	P	C
		3	3	0	0

OBJECTIVES:

- To explain the concepts, paradigms, algorithms and implementation of CI and its constituent methodologies.
- To apply the evolutionary algorithms on practical problems in engineering and computer science.
- To discuss different swarm intelligence algorithms.
- To describe the models of artificial immune system
- To summarize fuzzy sets and fuzzy rough sets.

UNIT I ARTIFICIAL NEURAL NETWORKS 9

The Artificial Neuron - Supervised Learning Neural Networks-Supervised Learning rules - Unsupervised Learning Neural Networks-Reinforcement Learning–Learning through awards-Model free Reinforcement Learning– Performance Measures Performance Factor

UNIT II EVOLUTIONARY COMPUTATION 9

Introduction to Evolutionary Computation-Genetic Algorithms-Genetic Programming–Basic Evolutionary Programming– Generic Evolution Strategy Algorithm–Basic Differential Evolution–Basic Cultural Algorithm- Belief Space–Convolution Applications of various evolutionary computation techniques.

UNIT III SWARM INTELLIGENCE 9

Basic Particle Swarm Optimization–Social Network Structures-Basic Variations-Basic PSO Parameters-Ant Colony Optimization–Ant Algorithms-Simple Ant Colony Optimization Algorithm-Ant System–Ant Colony System- Max-Min Ant System-Basic Artificial Bee Colony Algorithm.

UNIT IV ARTIFICIAL IMMUNE SYSTEMS 9

Natural Immune System-Learning the Antigen Structure-Artificial Immune System Algorithm-Classical View Models-Clone Selection Theory Models-Network Theory Models-Artificial Immune Network-Adapted artificial Immune Network.

UNIT V FUZZY SYSTEMS 9

Fuzzy Sets-Fuzzy Logic and Reasoning-Fuzzy Inferencing- Fuzzy Controllers-Mamdani Fuzzy Controller-Takagi- Sugeno Controller–Introduction to Rough sets.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Explain the concepts, paradigms, algorithms and implementation of CI and its constituent methodologies.

CO2: Apply the evolutionary algorithms on practical problems in engineering and computer science.

CO3: Discuss different swarm intelligence algorithms.

CO4: Describe the models of artificial immune system

CO5: Summarize fuzzy sets and fuzzy rough sets.

REFERENCES:

1. A. P. Engelbrecht, Computational Intelligence: An Introduction, John Wiley & Sons, 2007.
2. X. Yu and M. Gen, Introduction to Evolutionary Algorithms, Springer Verlag, 2010.
3. Russel, S.; Norvig, P.; John F. Canny, Artificial Intelligence – A Modern Approach, 4th Edition, Pearson Education, 2020.
4. Neural Networks, Fuzzy Logic and Genetic Algorithms, S. Rajasekaran and G.A.V.Pai,PHI, 2003.
5. Leszek Rutkowski, "Computational Intelligence Methods and Techniques", Springer 2008.
6. Lakhmi C.Jain, "Computational Intelligence Paradigms Innovative Applications", Springer 2008.
7. Adam Slowik,Swarm Intelligence Algorithms,CRC PRESS 2020
8. SN Shahbazova,Recent Developments in Fuzzy Logic and Fuzzy Sets,Springer 2020

		L	T	P	C
0CS963	**OPTIMIZATION ALGORITHMS**	**3**	**0**	**0**	**3**

OBJECTIVES:

- To explain the basic concept of optimization techniques
- To apply in-depth knowledge on different advanced optimization techniques to solve engineering problems.
- To demonstrate the practical aspects of optimization
- To discuss the concept of modern methods of optimization and its applications to real world problems.
- To explain computational aspects of optimization techniques

UNIT I INTRODUCTION TO OPTIMIZATION 9

Introduction, Historical Development, Engineering Applications of Optimization, Statement of an Optimization Problem, Classification of Optimization Problems, Optimization Techniques, Engineering Optimization Literature

UNIT II CLASSICAL OPTIMIZATION TECHNIQUES 9

Single-Variable Optimization, Multivariable Optimization with No Constraints, Multivariable Optimization with Equality Constraints, Multivariable Optimization with Inequality Constraints, Convex Programming Problem

UNIT III PRACTICAL ASPECTS OF OPTIMIZATION 9

Reduction of Size of an Optimization Problem, Fast Reanalysis Techniques, Derivatives of Static Displacements and Stresses, Derivatives of Eigen values and Eigen vectors, Derivatives of Transient Response, Sensitivity of Optimum Solution to Problem Parameters, Multilevel Optimization, Parallel Processing, Multiobjective Optimization

UNIT IV MODERN METHODS OF OPTIMIZATION 9

Genetic Algorithms - Simulated Annealing - Ant colony optimization - Tabu search – Neural-Network based Optimization – Fuzzy optimization techniques – Applications. Use of Matlab to solve optimization problems.

UNIT V COMPUTATIONAL ASPECTS OF OPTIMIZATION 9

Choice of Method, Comparison of Unconstrained Methods, Comparison of Constrained Methods, Availability of Computer Programs, Scaling of Design Variables and Constraints, Computer Programs for Modern Methods of Optimization

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Explain the basic concept of optimization techniques
CO2: Apply in-depth knowledge on different advanced optimization techniques to solve engineering problems.
CO3: Illustrate the practical aspects of optimization
CO4: Discuss the concept of modern methods of optimization and its applications to real world problems.
CO5: Explain the computational aspects of optimization techniques

REFERENCES:

1. Rao S. S. - 'Engineering Optimization, Theory and Practice' - New Age International Publishers, 4th Edition, 2014.
2. Deb K. - 'Optimization for Engineering Design Algorithms and Examples', PHI - 2000
3. Arora J. - 'Introduction to Optimization Design' - Elsevier Academic Press, New Delhi – 2004
4. Saravanan R. - 'Manufacturing Optimization through Intelligent Techniques' - Taylor & Francis (CRC Press), 2006
5. Hardley G. -'Linear Programming' - Narosa Book Distributors Private Ltd., 2002

		L	T	P	C
20CS964	**SOFT COMPUTING**	**3**	**0**	**0**	**3**

OBJECTIVES:

- To learn the key aspects of soft computing, conventional AI and computational intelligence.
- To explain the basics of genetic algorithms.
- To gain knowledge of neural networks.
- To discuss about the fuzzy inferencing and reasoning.
- To apply neuro-Fuzzy modelling.

UNIT I INTRODUCTION TO SOFT COMPUTING 9

Evolution of Computing – Soft Computing Constituents – From Conventional AI to Computational Intelligence – Machine Learning Basics

UNIT II GENETIC ALGORITHMS 9

Introduction to Genetic Algorithms (GA) – Applications of GA – Building Block Hypothesis -Representation– Fitness Measures – Genetic Operators-. GA based Machine Learning.

UNIT III NEURAL NETWORKS 9

Machine Learning using Neural Network, Adaptive Networks – Feed Forward Networks – Supervised Learning Neural Networks – Radial Basis Function Networks – Reinforcement Learning – Unsupervised Learning Neural Networks – Adaptive Resonance Architectures – Advances in Neural Networks.

UNIT IV FUZZY LOGIC 9

Fuzzy Sets – Operations on Fuzzy Sets – Fuzzy Relations – Membership Functions-Fuzzy Rules and Fuzzy Reasoning – Fuzzy Inference Systems – Fuzzy Expert Systems – Fuzzy Decision Making.

UNIT V NEURO-FUZZY MODELING 9

Adaptive Neuro-Fuzzy Inference Systems – Coactive Neuro-Fuzzy Modeling – Classification and Regression Trees – Data Clustering Algorithms – Rule based Structure Identification – NeuroFuzzy Control – Case Studies.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Distinguish conventional AI and computational intelligence.
CO2: Discuss basics of genetic algorithms.
CO3: Apply the knowledge of neural networks in various situations.
CO4: Explain fuzzy inferencing and reasoning
CO5: Build neuro fuzzy system for clustering and classification.

REFERENCES:

1. Jyh-Shing Roger Jang, Chuen-Tsai Sun, EijiMizutani, "Neuro-Fuzzy and Soft Computing", Prentice-Hall of India, 2004.
2. David E.Goldberg, "Genetic Algorithms in Search, Optimization and Machine Learning", Pearson Education India, 2013.
3. Timothy Ross, "Fuzzy Logic with Engineering Applications", Wiley, 2016
4. S. Rajasekaran, G.A. Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications", Prentice Hall, 2010.
5. KwangH.Lee, "First course on Fuzzy Theory and Applications", Springer, 2005.
6. George J. Klir and Bo Yuan, "Fuzzy Sets and Fuzzy Logic-Theory and Applications", Prentice Hall, 1996.
7. James A. Freeman and David M. Skapura, "Neural Networks Algorithms, Applications, and Programming Techniques", Addison Wesley, 2003.
8. S.N.Sivanandam and S.N.Deepa, "Principles of Soft Computing", Wiley India Pvt Ltd, 2011.

20CS965 REINFORCEMENT LEARNING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To discuss about the value functions for optimal decision-making and dynamic programming
- To explain basic exploration methods
- To illustrate reinforcement learning algorithms.
- To outline learning agents that make intelligent decision making.
- To summarize operational reinforcement learning.

UNIT I BASIC RL CONCEPTS 9

Machine Learning, Introduction to Reinforcement Learning, Importance of RL, Taxonomy of RL approaches, Fundamental concepts in RL. Multi Arm Bandit Testing, Markov Decision Processes, Policies and Value Functions, Monte Carlo Policy Generation, Value Iteration with Dynamic Programming.

UNIT II DEEP Q-LEARNING 9

Formulation of Temporal –Difference Learning, Q-Learning, SARSA, Q-Learning Vs SARSA, Case Study, Industrial Example. Deep Q-Networks: Deep Learning Architectures, Deep Q-Learning, Rainbow DQN.

UNIT III POLICY GRADIENT METHODS 9

Policy Gradient Theorem, Benefits, Policy functions, Basic Implementations: Mante Carlo (ReInforce), ReInforce with Baseline, Gradient Variant Reduction, n-step Actor-Critic and Actor – Critic (A2C), Comparison of Basic Policy Gradient Algorithm. Off-policy Algorithms, Deterministic Policy Gradients, Trust Region Methods, Retrace, Actor – Critic with Experience Replay(ACER), Actor-Critic Using Kronecker – Factored Trust Regions (ACKTR)

UNIT IV ENTROPY REGULARIZATION 9

Maximum Entropy Reinforcement Learning, Soft Actor – Critic, Extensions to Maximum Entropy Methods, Performance comparison, Partially observable Markov Decision Process, Case Study, Contextual Markov Decision Process, MDP with changing actions, Regularized MDPs.

UNIT V PRACTICAL REINFORCEMENT LEARNING 9

Hierarchical Reinforcement Learning, Multi Agent Reinforcement Learning, The RL Life Cycle, Problem Definition, RL Engineering & Refinement. Operational Reinforcement Learning: Implementation & Deployment.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Explain what RL is and how the algorithms help solve problems
CO2: Apply RL fundamentals including Markov decision processes, dynamic programming, and temporal difference learning
CO3: Discuss a range of value and policy gradient methods
CO4: Illustrate all possible policies with entropy methods
CO5: Apply advanced RL solutions such as meta learning, hierarchical learning, multi-agent, and imitation learning

REFERENCES:

1. Dr. Phil Winder, Reinforcement Learning: Industrial Applications of Intelligent Agents, First edition, O'Reilly Media, Incorporated, 2020.

2. Richard S. Sutton, Andrew G. Barto, Reinforcement Learning, second edition, An Introduction, The MIT Press, 2018.

3. Boris Belousov, Hany Abdulsamad, Pascal Klink, Simone Parisi, Reinforcement Learning Algorithms: Analysis and Applications, , Springer; 1st ed. 2021 edition.

4. Hku Mba Team-4, Anirudha Bopche, Ha Lin Chau, Jiang Jiaxin, Study On Deep Reinforcement Learning, Kindle Edition 2017.

5. Parag Kulkarni, Reinforcement and Systemic Machine Learning for Decision Making, Wiley-IEEE Press, 1st edition, 2012.

6. Mehdi Samieiyeganeh, Parisa Bahraminikoo, G. Praveen Babu, Review on use of Reinforcement Learning in Artificial Intelligence, GRIN Verlag; 1st edition, 2012.

7. Sudharsan Ravichandiran, Sean Saito, Rajalingappaa Shanmugamani, Yang, Wenzhuo, Python Reinforcement Learning, Solve complex real-world problems by mastering reinforcement learning algorithms using OpenAI Gym and TensorFlow, Packt Publishing

Limited, First edition, 2019.

8. Marco Wiering, Martijn van Otterlo, Reinforcement Learning, State-of-the-Art, Springer; 2012th edition,2012.

20CS966	VIDEO ANALYTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To explain about video representation and its various formats.
- To discuss the fundamental concepts of motion estimation and video filtering techniques.
- To define the video segmentation and tracking.
- To describe the fundamental concepts of video compression.
- To demonstrate human face recognition and GAIT analysis.

UNIT I VIDEO FUNDAMENTALS 9

Basic Concepts and Terminology – Analog Video Standards – Digital Video Basics – Analogto Digital Conversion – Color Representation and Chroma Sub Sampling – Video Sampling Rate and Standards Conversion – Digital Video Formats – Video Features – Colour, Shape and Textural Features.

UNIT II MOTION ESTIMATION AND VIDEO FILTERING 9

Motion Estimation: Image Formation – Motion Models – 2D Apparent Motion Estimation – Differential Methods – Matching Methods – Non-linear Optimization methods – Transform Domain Methods – 3D Motion and Shape Estimation- Video Filtering: Theory of Spatial-Temporal Filtering – Video Format Conversion – Multi-Frame Noise Filtering – Restoration – Multi-Frame Super Resolution.

UNIT III VIDEO SEGMENTATION AND TRACKING 9

Image segmentation – Change Detection – Motion Segmentation – Motion Tracking – Image and Video Matting – Performance Evaluation. Image Compression: Basics of Image Compression – Lossless Image Compression – Discrete Cosine Transform coding and JPEG – Wavelet Transform Coding and JPEG2000.

UNIT IV VIDEO COMPRESSION 9

Video Compression Approaches – Early Video Compression Standards – MPEG Standard – HEVC Standard – Scalable Video Compression – Stereo and Multi-View Video Compression –Case Study: Vector-Matrix Operations in Image and Video Processing – ILL-Posed Problems in Image and Video Processing.

UNIT V HUMAN FACE RECOGNITION & GAIT ANALYSIS 9

Introduction: Overview of Recognition algorithms – Human Recognition using Face: Face Recognition from still images, Face Recognition from video, Evaluation of Face Recognition Technologies- Human Recognition using gait: HMM Framework for Gait Recognition, View Invariant Gait Recognition, Role of Shape and Dynamics in Gait Recognition.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Explain theoretical foundations of image and video processing methods
CO2: Apply popular and successful techniques to solve common image and video processing problems
CO3: Demonstrate the video segmentation and tracking.
CO4: Describe various methods for video compression.
CO5: Build a framework for human activity recognition.

REFERENCES:

1. Oges Marques, "Practical Image And Video Processing Using MATLAB", Wiley-IEEE Press, 2011
2. Murat Tekalp A, "Digital Video Processing", Second Edition, Prentice Hall, 2015.
3. Rama Chellappa, Amit K.Roy-Chowdhury, Kevin Zhou.S, "Recognition of Humans and their Activities using Video", Morgan&Claypool Publishers, 2005.
4. Roy, R. Dixit, R. Naskar, R. S. Chakraborty, "Digital Image Forensics: Theory and Implementation", Springer, 2018.
5. Henrique C. M. Andrade, Bugra Gedik, Deepak S. Turaga, "Fundamentals of Stream Processing: Application Design, Systems, and Analytics", Cambridge University Press, 2014.
6. Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley, 2014.

20CS967	**ENGINEERING PREDICTIVE ANALYSIS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To explain terminology, technology and applications of predictive analysis
- To apply data preparation techniques and generate appropriate association rules.
- To discuss various descriptive models, their merits, demerits and application.
- To describe various predictive modelling methods.
- To introduce the text mining tools, technologies and case study which is used in day-to-day analytics cycle

UNIT I INTRODUCTION TO PREDICTIVE ANALYTICS 9

Overview of Predictive Analytics- Setting Up the Problem - Data Understanding- Single Variable- Data Visualization in One Dimension- Data Visualization, Two or Higher Dimensions- The Value of Statistical Significance- Pulling It All Together into a Data Audit.

UNIT II DATA PREPARATION AND ASSOCIATION RULES 9

Data Preparation- Variable Cleaning- Feature Creation- Item sets and Association Rules- Terminology- Parameter Settings- How the Data Is Organized- Measures of Interesting Rules- Deploying Association Rules- Problems with Association Rules- Building Classification Rules from Association Rules.

UNIT III MODELLING 9

Descriptive Modeling- Data Preparation Issues with Descriptive Modeling- Principal Component Analysis- Clustering Algorithms- Interpreting Descriptive Models- Standard Cluster

Model Interpretation

UNIT IV PREDICTIVE MODELLING 9

Decision Trees- Logistic Regression -Neural Network Model – K-Nearest Neighbours – Naive Bayes – Regression Models - Linear Regression - Other Regression Algorithms.

UNIT V TEXT MINING 9

Motivation for Text Mining- A Predictive Modeling Approach to Text Mining- Structured vs. Unstructured Data- Why Text Mining Is Hard- Data Preparation Steps- Text Mining Features- Modeling with Text Mining Features- Regular Expressions- Case Studies:- Survey Analysis.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Explain terminology, technology and applications of predictive analysis
CO2: Apply data preparation techniques to effectively interpret big data
CO3: Discuss various descriptive models, their merits, demerits and application.
CO4: Describe principles of predictive analytics and apply them to achieve real, pragmatic solutions.
CO5: Illustrate the features and applications of text mining.

REFERENCES:

1. Dean Abbott, "Applied Predictive Analytics-Principles and Techniques for the Professional Data Analyst", Wiley, 2014
2. Jiawei Han and Micheline Kamber, Data Mining Concepts and Techniques, Third Edition, Elsevier, 2012.
3. Conrad Carlberg, "Predictive Analytics: Microsoft Excel", 1st Edition, Que Publishing, 2012.
4. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani. An Introduction to Statistical Learning with Applications in R Springer 2013
5. Alberto Cordoba, "Understanding the Predictive Analytics Lifecycle", Wiley, 2014
6. Anasse Bari, Mohammad Chaouchi, Tommy Jung, Predictive Analytics for Dummies, 2nd Edition, 2017.

20CS968	DATA EXPLORATION AND VISUALIZATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To outline an overview of exploratory data analysis and phases involved in data analytics
- To acquire an in-depth knowledge in EDA techniques
- To experiment the data visualization
- To describe the methods of time series analysis
- To explain the basics of tree and hierarchical representation of big data

UNIT I EXPLORATORY DATA ANALYSIS 9

EDA fundamentals – Understanding data science – Significance of EDA – Making sense of data – Comparing EDA with classical and Bayesian analysis – Software tools for EDA –

UNIT II EDA TECHNIQUES 9

Visual Aids For EDA-choosing the best chart, EDA with personal email, Data transformation techniques-merging database, reshaping and pivoting, Descriptive Statistics-types of kurtosis, quartiles, Grouping Datasets-data aggregation, group wise transformation.

UNIT III VISUALIZING DATA 9

The Seven Stages Of Visualizing Data, Processing-load and displaying data – functions, sketching and scripting, Mapping-Location, Data, two sided data ranges, smooth interpolation of values over time

UNIT IV TIME SERIES ANALYSIS 9

Overview of time series analysis-showing data as an area, drawing tabs, handling mouse input, Connections And Correlations – Preprocessing-introducing regular expression, sophisticated sorting, Scatterplot Maps-deployment issues

UNIT V TREES, HIERARCHIES, AND RECURSION 9

Treemaps - treemap library, directory structure, maintaining context, file item, folder item, Networks and Graphs-approaching network problems-advanced graph example, Acquiring data, Parsing data

TOTAL: PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Explain the overview of exploratory data analysis and phases involved in data analytics
CO2: Explore in-depth knowledge in EDA techniques
CO3: Apply the visualization techniques in data
CO4: Describe the methods of time series analysis
CO5: Represent the data in tree and hierarchical formats

REFERENCES:

1. Suresh Kumar Mukhiya and Usman Ahmed, “Hands-on Exploratory Data Analysis with Python”,Packt publishing , March 2020
2. Ben Fry, “Visualizing Data”,O’reilly publications, 2007
3. Danyel Fisher & Miriah Meyer, “Making Data Visual: A Practical Guide To Using Visualization For Insight”, O’reilly publications, 2018
4. Claus O. Wilke,”Fundamentals of Data Visualization”, O’reilly publications, 2019
5. EMC Education Services, Data Science and Big data analytics: Discovering, Analyzing,Visualizing and Presenting Data, Wiley Publishers, 2015

20CS969	QUANTUM COMPUTING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To analyse the behaviour of basic quantum algorithms
- To discuss simple quantum algorithms and information channels in the quantum circuit model
- To apply the quantum algorithms in superdense coding and quantum teleportation
- To analyse the algorithms with super-polynomial speed-up
- To illustrate a simple quantum error-correcting code

UNIT I FOUNDATION **9**

Overview of traditional computing – Church-Turing thesis – circuit model of computation – reversible computation – quantum physics – quantum physics and computation – Dirac notation and Hilbert Spaces – dual vectors – operators – the spectral theorem – functions of operators – tensor products – Schmidt decomposition theorem

UNIT II QUBITS AND QUANTUM MODEL OF COMPUTATION **9**

State of a quantum system – time evolution of a closed system – composite systems – measurement – mixed states and general quantum operations – quantum circuit model – quantum gates – universal sets of quantum gates – unitary transformations – quantum circuits

UNIT III QUANTUM ALGORITHMS – I **9**

Superdense coding – quantum teleportation – applications of teleportation – probabilistic versus quantum algorithms – phase kick-back – the Deutsch algorithm – the Deutsch-Jozsa algorithm – Simon's algorithm – Quantum phase estimation and quantum Fourier Transform – eigenvalue estimation

UNIT IV QUANTUM ALGORITHMS – II **9**

Order-finding problem – eigenvalue estimation approach to order finding – Shor's algorithm for order finding – finding discrete logarithms – hidden subgroups – Grover's quantum search algorithm – amplitude amplification – quantum amplitude estimation – quantum counting – searching without knowing the success probability 101

UNIT V QUANTUM COMPUTATIONAL COMPLEXITY AND ERROR CORRECTION **9**

Computational complexity – black-box model – lower bounds for searching – general black-box lower bounds – polynomial method – block sensitivity – adversary methods – classical error correction – classical three-bit code – fault tolerance – quantum error correction – three- and nine-qubit quantum codes – fault-tolerant quantum computation

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Analyse the behaviour of basic quantum algorithms
CO2: Discuss simple quantum algorithms and information channels in the quantum circuit model
CO3: Apply the quantum algorithms in superdense coding and quantum teleportation
CO4: Analyse the algorithms with super polynomial speed-up
CO5: Illustrate a simple quantum error-correcting code

REFERENCES:

1. P. Kaye, R. Laflamme, and M. Mosca, "An introduction to Quantum Computing", Oxford University Press, 2007.
2. E. Rieffel and W. Polak "Quantum Computing A Gentle Introduction", The MIT Press Cambridge, 2011.
3. Jack D. Hidary "Quantum Computing: An Applied Approach" Springer, 2019.
4. V. Sahni, "Quantum Computing", Tata McGraw-Hill Publishing Company, 2007.
5. Michael A. Nielsen and Issac L. Chuang, "Quantum Computation and Quantum Information", Tenth Edition, Cambridge University Press, 2010

20CS970	CYBER FORENSICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To explain the basics of digital forensics
- To apply various forensics tools in evidence collections
- To illustrate analysis and validation methods in cyber forensics
- To summarize the mobile and cloud forensics
- To discuss about social media forensics and anti-forensics

UNIT I INTRODUCTION TO DIGITAL FORENSICS 9

An Overview of Digital Forensics – Preparing for Digital Investigations – Maintaining Professional Conduct – Computer Crime – Company Policy Violation – Understanding Data Recovery Workstations and Software – Data Acquisition: Storage Formats – Acquisition methods and Tools

UNIT II EVIDENCE COLLECTION AND FORENSICS TOOLS 9

Processing Crime and Incident Scenes - Identifying digital evidence – collecting evidence – preparing for a search - securing a digital incident – seizing and storing a digital evidence - obtaining a digital hash - Current Digital Forensics Tools: Software and Hardware Tools.

UNIT III FORENSICS ANALYSIS AND VALIDATION 9

Data Collection and analysis - Validating Forensics Data – Data Hiding Techniques – Email and Social Media Investigations: Role of Email, client and server – Investigating email crimes – Digital forensics for social media.

UNIT IV MOBILE AND CLOUD FORENSICS 9

Introduction – Mobile Phone Technology – Forensic Challenges and process – Digital Cell Phone Investigations – Geographic Positioning Systems – Cameras – Common Extraction Types – Information Sources and Location information – Cloud Computing and Digital Forensics

UNIT V SOCIAL MEDIA FORENSICS AND ANTI-FORENSICS 9

Introduction to Social Media – Social Engineering Forensics – Anti-forensics definition and concepts– Anti-forensics methods – Eliminate Trails – Hide and Destroy evidence – Mobile anti-forensics

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Explain the overview of digital forensics and data acquisition techniques.
CO2: Apply various forensics tools in processing digital crime scenes for evidences.
CO3: Illustrate analysis and validation methods in cyber forensics

CO4: Compare the mobile and cloud forensics
CO5: Describe social media forensics and anti-forensics

REFERENCES:

1. Bill Nelson, Amelia Phillips, Frank Enfinger, Christopher Steuart, "Guide to Computer Forensics and Investigations", Cengage Learning, Sixth Edition, 2018.
2. Greg Gogolin, "Digital Forensics Explained", CRC Press, Second Edition, 2021.
3. Roderick S. Graham, Shawn K. Smith, Cybercrime and Digital Deviance, Taylor & Francis, First Edition, 2020.
4. Thomas J. Holt, Adam M. Bossler, Kathryn C. Seigfried-Spellar - Cybercrime and Digital Forensics - An Introduction, 2017.
5. MarjieT.Britz, Computer Forensics and Cyber Crime: An Introduction, 3rd Edition, Pearson Education, 2013.
6. David Lilburn Watson, Andrew Jones, Digital Forensics Processing and Procedures, Syngress, 2013.
7. Kenneth C. Brancik, Insider Computer Fraud Auerbach Publications Taylor & Francis Group–2008.
8. John R.Vacca, Computer Forensics: Computer Crime Scene Investigation, Second Edition, Charles River Media Inc, 2005.

20CS971	INTELLIGENT AGENT SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To explain agent development
- To discuss about knowledge representation in logic agents
- To describe planning agents
- To summarize the concepts of agents and uncertainty
- To explain about higher level agents
-

UNIT I FUNDAMENTALS 9

Definitions – Foundations – History – Intelligent Agents – Problem Solving – Searching – Heuristics – Constraint Satisfaction Problems – Game playing.

UNIT II KNOWLEDGE REPRESENTATION AND REASONING 9

Logical Agents – First Order Logic – First Order Inference – Unification – Chaining – Resolution Strategies – Knowledge Representation – Objects – Actions – Events.

UNIT III PLANNING AGENTS 9

Planning Problem – State Space Search – Partial Order Planning – Graphs – Nondeterministic Domains – Conditional Planning – Continuous Planning – MultiAgent Planning.

UNIT IV AGENTS AND UNCERTAINITY 9

Acting under uncertainty – Probability Notation – Bayes Rule and Use – Bayesian Networks – Other Approaches – Time and Uncertainty – Temporal Models – Utility Theory – Decision Network – Complex Decisions.

UNIT V HIGHER LEVEL AGENTS 9

Knowledge in Learning – Relevance Information – Statistical Learning Methods – Reinforcement Learning – Communication – Formal Grammar – Augmented Grammars– Future of AI.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Explain development of software agents
CO2: Discuss about knowledge representation in logic agent and intelligent agents
CO3: Describe continuous, conditional and multi-agent planning.
CO4: Describe and build agents that receive percepts from the environment and perform actions
CO5: Determine the appropriate agent design from the characteristics and environments.

REFERENCES:

1. Stuart Russell and Peter Norvig, "Artificial Intelligence A Modern Approach", 2nd Edition,
   Prentice Hall, 2002.
2. Michael Wooldridge, "An Introduction to Multi Agent System", John Wiley, 2002.
3. Patrick Henry Winston, "Artificial Intelligence", 3nd Edition, AW, 1999.
4. Nils.J.Nilsson, "Principles of Artificial Intelligence", Narosa Publishing House, 1992
5. Lin Padgham , Michael Winikoff Format ,"Developing Intelligent Agent Systems: A Practical Guide:"Kindle Edition ,2008
6. Zaiyong Tang , Xiaoyu Huang and Kallol Bagchi ,"Agent-Based Intelligent System Modeling"2009

20CS972 SOCIAL NETWORK ANALYSIS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To outline the components of the social network.
- To explain the modeling and visualization of the social network.
- To classify descriptive and inferential methods.
- To discuss about the evolution of the social network.
- To illustrate the applications in real time systems.

UNIT I INTRODUCTION 9

Basics of Social Network Analysis: Introduction- The Social network and How to Represent it-Types of Networks-Network parts and Level of Analysis-Networks as Social Structure and Institution- Theoretical Assumptions-Causality in Social Network Studies- A Brief History of Social Network Analysis-Mathematical Foundations: Graphs-Paths and components-Adjacency matrices-Ways and modes-Matrix products-Sources of network data-Types of nodes and types of ties- Data Collection: Network questions-Question formats-Interviewee burden-Data collection and reliability-Archival data collection-Data from electronic sources.

UNIT II MODELING AND VISUALIZATION 9

Data Management: Data import-Cleaning network data- Data transformation-Normalization-

Cognitive social structure data-Matching attributes and networks-Converting attributes to matrices-Data export,- Multivariate Techniques Used in Network Analysis: Multidimensional scaling-Correspondence analysis-Hierarchical clustering,- Visualization: Layout-Embedding node attributes-Node filtering-Ego networks-Embedding tie characteristics-Visualizing network change-Exporting visualizations-Closing comments.

UNIT III DESCRIPTIVE AND INFERENTIAL METHODS 9

Descriptive Methods in Social Network Analysis: Graph and Matrix-Social Network Representation – Density – Centrality, Centralization and Prestige- Cliques – Multidimensional Scaling(MDS) and Dendogram – Structural Equivalence-Two mode Networks and Bipartite Matrix-Inferential Methods in Social Network Analysis: Permutation and QAP (Quadratic Assignment Procedure) Correlation-P* or Exponential Random Graph Model(ERGM)

UNIT IV EVOLUTION 9

Evolution in Social Networks – Framework - Tracing Smoothly Evolving Communities - Models and Algorithms for Social Influence Analysis - Influence Related Statistics - Social Similarity and Influence - Influence Maximization in Viral Marketing - Algorithms and Systems for Expert Location in Social Networks - Expert Location without Graph Constraints - with Score Propagation – Expert Team Formation - Link Prediction in Social Networks - Feature based Link Prediction – Bayesian Probabilistic Models - Probabilistic Relational Models.

UNIT V APPLICATIONS 9

A Learning Based Approach for Real Time Emotion Classification of Tweets, A New Linguistic Approach to Assess the Opinion of Users in Social Network Environments, Explaining Scientific and Technical Emergence Forecasting, Social Network Analysis for Biometric Template Protection

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Define the internal components and terminology of the social network.

CO2: Explain fundamental exploratory multivariate techniques and visualizing network data.
CO3: Discuss most common descriptive and inferential statistical tools available.
CO4: Discuss about the evolution of the social network.
CO5: Illustrate the real time applications of social network analysis.

REFERENCES:

1. Song Yang , Franziska B. Keller, Social Network Analysis Methods and Examples, SAGE Publications,Inc. 2017
2. Stephen P Borgatti, Martin G. Everett, Jeffrey C. Johnson, Analyzing Social Networks, Second Edition, 2017
3. Charu C. Aggarwal, Social Network Data Analytics, Springer; 2014
4. Przemyslaw Kazienko, Nitesh Chawla, Applications of Social Media and Social Network Analysis, Springer,2015
5. Ajith Abraham, Aboul Ella Hassanien, Vaclav Snasel, Computational Social Network Analysis: Trends, Tools and Research Advances, Springer, 2012.
6. Borko Furht, Handbook of Social Network Technologies and Applications, Springer, 1st edition, 2011 .
7. Guandong Xu , Yanchun Zhang and Lin Li, Web Mining and Social Networking – Techniques and applications‖, Springer, 1st edition, 2012.

20CS973 **DEEP LEARNING**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To explain the basics of deep neural networks
- To discuss advanced deep learning models
- To apply CNN and RNN architectures of deep neural networks
- To summarize the evaluation metrics for deep learning models
- To apply autoencoders and generative models for suitable applications

UNIT I INTRODUCTION 9

Linear Algebra: Scalars - Vectors - Matrices and tensors; Probability Distributions - Gradient-based Optimization - Machine Learning Basics: Capacity - Overfitting and underfitting - Hyperparameters and validation sets - Estimators - Bias and variance - Stochastic gradient descent - Challenges motivating deep learning;

UNIT II DEEP NETWORKS 9

Deep feedforward networks - Learning XOR - Gradient based learning - Hidden Units – Architecture Design – Back Propagation - Regularization – Optimization for Training Deep Models – pure optimization – Challenges – Basic Algorithms – Parameter initialization Strategies – Algorithms with Adaptive Learning Rates – Approximate Second-Order methods – Optimization Strategies and Meta Algorithms

UNIT III CONVOLUTIONAL AND RECURRENT NEURAL NETWORKS 9

Convolution Operation – motivation – Pooling – Infinitely Strong prior – Variants – Structured Output – Data Types – Efficient Convolutional Algorithms – Random or Unsupervised features – Neuroscientific Basis - Deep Learning – Sequence Modelling - Computational Graphs - RNN - Bidirectional RNN – Encoder-Decoder - Sequence to Sequence RNN - Deep Recurrent Networks - Recursive Neural Networks -- Long Term Dependencies; Leaky Units – Strategies for multiple time scales – LSTM and Gated RNNs – Optimization.

UNIT IV MODEL EVALUATION 9

Performance metrics - Baseline Models - Hyperparameters: Manual Hyperparameter - Automatic Hyperparameter - Grid search - Random search - Debugging strategies.

UNIT V AUTOENCODERS AND GENERATIVE MODELS 9

Autoencoders: Undercomplete autoencoders -- Regularized autoencoders – Power, Layer Size and Depth - Stochastic encoders and decoders -- Learning with autoencoders – contractive Autoencoders – Applications of autoencoders - Deep Generative Models – Boltzmann Machine – Restricted Boltzmann Machine – Deep Belief Networks.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Explain the basic mathematical and conceptual background of deep learning.
CO2: Describe the deep neural network architecture and the optimization.

CO3: Apply CNN and RNN and its variants for suitable applications.
CO4: Determine performance metrics and evaluate the model.
CO5: Apply autoencoders and generative models for suitable applications

REFERENCES:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, ``Deep Learning", MIT Press, 2016.
2. Salman Khan, Hossein Rahmani, Syed Afaq Ali Shah, Mohammed Bennamoun, ``A Guide to Convolutional Neural Networks for Computer Vision", Synthesis Lectures on Computer Vision, Morgan & Claypool publishers, 2018.
3. Yoav Goldberg, ``Neural Network Methods for Natural Language Processing", Synthesis Lectures on Human Language Technologies, Morgan & Claypool publishers, 2017.
4. Francois Chollet, ``Deep Learning with Python", Manning Publications Co, 2018.
5. Charu C. Aggarwal, ``Neural Networks and Deep Learning: A Textbook", Springer International Punlishing, 2018.
6. Josh Patterson, Adam Gibson, ``Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017.

20CS974	**SOFTWARE RELIABILITY METRICS AND MODELS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES

- **To explain the fundamental concepts of software reliability**
- **To discuss the basics of Software reliability modelling.**
- **To describe the software reliability requirements.**
- **To explain the concepts of measurements in software engineering.**
- **To discuss the measurement of internet product attributes and quality management models.**

UNIT I INTRODUCTION TO SOFTWARE RELIABILITY **9**

Basic Concepts – Basic Definitions, Dependability Concept, Failure Behaviours of X-ware System, Failure Behaviour of X-ware System with Service Restoration situation with respect to the state of the Art in Reliability Evaluation.

UNIT II SOFTWARE RELIABILITY MODELING **9**

Introduction - Historical Perspective and Implementation - Exponential Failure - Time, class of Models - Weibull and Gamma Failure Time - Infinite Failure category models - Bayesian Models - Model Relationships.

UNIT III SOFTWARE RELIABILITY MEASUREMENT EXPERIENCE **9**

Introduction - Measurement Framework - Establishing Software reliability requirements -

Expressing Software reliability - Specifying reliability requirements - Project Investigation at JPL - Linear Combination of Model Results.

UNIT IV FUNDAMENTALS OF MEASUREMENT **9**

Measurements in Software Engineering – Scope of Software metrics – Measurements theory – Goal based Framework – Software Measurement Validation.

UNIT V MEASURING SOFTWARE PRODUCT **9**

Measurement of Internet Product Attributes – Size and Structure – External Product Attributes – Measurement of Quality – Software Reliability: Measurement and Prediction.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Explain the definition, concepts and reliability evaluation.
CO2: Discuss the basics of software reliability modeling.
CO3: Describe the requirements of software reliability measurement.
CO4: Determine and validate the measures in software reliability.
CO5: Discuss the measurement of internet product attributes and quality management models.

REFERENCES:

1. Michael M.Lyu, Software Reliability Engineering , Tata McGraw Hill ,2003
2. Norman Fenton, James Bieman, Software Metrics: A Rigorous and Practical Approach‖, 3rd edition, CRC Press, 2015
3. John D. Musa, Anthony Iannino and Kazuhira Okumoto, "Software Reliability, Measurement, Prediction, Application, Series in Software Engineering and Technology", McGraw Hill, 1987
4. Roger S.Pressman Bruce R.Maxim,"Software Engineering "A Practitioner's Approach,Eigth Edition.2021
5. Jean Claude Laprie and Karama Kanoun "Software Reliability and System Reliability"Springer Publications.2000 McGraw Hill.
6. John D. Musa, Software Reliability Engineering‖, Tata McGraw Hill, 1999

20CS975	**GAME THEORY AND PROGRAMMING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To explain game programming fundamentals.
- To learn about the processes, mechanics, issues in game design.
- To gain knowledge of the game design and Artificial intelligence.
- To understand the design and scripting languages of game programming.
- To know about networked games and analyse code for sample games.

UNIT I INTRODUCTION 9

Evolution of video game programming-The Game Loop-Time and games-Game objects-2D rendering Foundations-Sprites-Scrolling-Tile maps-Vectors -Matrices.

UNIT II 3D GRAPHICS FOR GAMES 9

3D graphics-Basics-Coordinate-spaces-Lighting and Shading-visibility-Input Devices-Event based input system-Mobile Input-Basic sound-3D sound-Digital Signal Processing-Physics-Planes, Rays, and line segments-Collision geometry-Collision detection-Physics base movement-Physics middleware.

UNIT III GAME DESIGN AND AI 9

Cameras-Types of cameras-Perspective projection-Camera implementation-Camera support algorithm- Real AI versus Game AI-Pathfinding-State based behaviours-Strategy and planning.

UNIT IV USER INTERFACE AND SCRIPTING LANGUAGES 9

Menu system-HUD elements-Radar-other UI considerations-Scripting languages-Implementing a scripting language-Tokenization-Syntax Analysis-Code Execution or Generation-Data Formats-Case study UI mods in world of warcraft.

UNIT V NETWORKED GAMES 9

Protocols-Network Topology-Server/Client-Peer-to-Peer-Cheating-Sample game -Side scroller for iOS, Tower defence for PC/Mac-Code Analysis.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Explain the essential 2D graphical and mathematical techniques for game programming.
CO2: Illustrate 3D graphics like coordinate spaces, lighting and shading, z-buffering, and quaternions
CO3: Apply artificial intelligence techniques in game design.
CO4: Construct a basic game engine using UI and scripting languages.
CO5: Develop code for sample games.

REFERENCES:

1. Sanjay Madhav, Game Programming Algorithms and Techniques: A platform -Agnostic Approach-Game Design,1st Edition, Addison-Wesley Professional,2013**.**
2. Jouni Smed, Harri Hakonen, Algorithms and Networking for Computer Games, 2nd Edition,Wiley Publications,2017.
3. Ernest Adams and Andrew Rollings, “Fundamentals of Game Design”, Prentice Hall 3rd Edition,2014.
4. JungHyun Han, “3D Graphics for Game Programming”, Chapman and Hall/CRC, 1st Edition, 2011.

20CS976	STATISTICAL LEARNING THEORY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To explain the basics of statistical learning
- To discuss about the linear models for regression
- To explain linear models for classification
- To summarize the regularization methods
- To apply kernel smoothing and evaluate models

UNIT I INTRODUCTION TO STATISTICAL LEARNING 9

Introduction – Statistical Learning – Assessing model accuracy – Probability – probability densities – Two dimensions – random numbers – density functions – higher dimensions – joint and conditional densities – expected value and variances – loss of large numbers – Bayes theorem – Bayes decision rule

UNIT II LINEAR MODELS FOR REGRESSION 9

Linear regression model and least squares – subset selection – shrinkage methods – Derived Input Directions – Comparison – Multiple Outcomes –Incremental Forward stagewise regression – Piecewise - Linear Path Algorithms – Dantzig Selector – Grouped Lasso – Properties of Lasso – Pathwise Coordinate Optimization

UNIT III LINEAR MODELS FOR CLASSIFICATION 9

Linear Regression of an Indicator Matrix – Linear Discriminant Analysis – Logistic Regression – Fitting Models – Example – Quadratic Approximation and Inference – Regularized Logistic Regression – Separating Hyperplanes

UNIT IV REGULARIZATION 9

Piecewise Polynomials and Splines – Filtering and feature extraction – Smoothing Splines – Automatic Selection of Smoothing parameters – Nonparametric Logistic Regression – Multidimensional Splines – Regularization and Reproducing Kernel Hilbert Spaces – Wavlet Smoothing

UNIT V KERNEL SMOOTHING AND MODEL EVALUATION 9

One-Dimensional Kernel Smoothers – Selecting the Width – Local Regression – Structured Local Regression – Local Likelihood – Kernel Density Estimation and Classification – Radial Basis Functions – Mixture Models – Bias, Variance and Model Complexity – Bias–Variance Decomposition – Optimism – Cross-Validation

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Define the basics of probability, random numbers and density function in statistical learning

CO2: Discuss about various linear models for regression.

CO3: Explain linear regression techniques for classification.

CO4: Identify smoothing parameters and non-parametric logistic regression.

CO5: Apply kernel smoothing and evaluate models

REFERENCES:

1. Gareth James, Daniela Witten, Trevor Hastie Robert Tibshirani, An Introduction to Statistical Learning with Applications in R, Springer 2013
2. Sanjeev Kulkarni, Gilbert Harman, An Elementary Introduction to Statistical Learning Theory Wiley Series in Probability and Statistics Book 2011
3. Hastie, Tibshirani and Friedman, The Elements of Statistical Learning, Springer 2nd edition 2017
4. Taylor Arnold, Michale Kane, Bryan W. Lewis, A Computational approach to statistical learning, CRC Press 2019.
5. David Spiegelhalte , The Art of Statistics: Learning from Data (Pelican Books) 2020
6. V. N. Vapnik. Statistical Learning Theory. Wiley, 1998.
7. T. Evgeniou, M. Pontil and T. Poggio, Regularization Networks and Support Vector Machines, Advances in Computational Mathematics, 2000.

20CS977	AUGMENTED REALITY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To explain the basic concept and understand the framework of augmented reality.
- To define the hardware and software in augmented reality.
- To discuss about the technology for multimodal user interaction and perception AR, in particular the visual, audial and haptic interface and behavior.
- To apply technology for tracking the computer vision in augmented reality.
- To describe an introduction to the AR application and AR tools in software development.

UNIT I INTRODUCTION OF AUGMENTED REALITY AND CONCEPTS 9

Introduction - Augmented Reality, The Relationship Between Augmented Reality and Other Technologies, Augmented Reality Concepts - Introduction, Concepts Related to Augmented Reality, Ingredients of an Augmented Reality Experience.

UNIT II AUGMENTED REALITY HARDWARE AND SOFTWARE 9

Augmented Reality Hardware: Introduction, Reality Systems, Augmented Reality Software: Introduction, Reality Systems, Software used to Create Content for the Augmented Reality Application.

UNIT III MOBILE AUGMENTED REALITY 9

Introduction, Creating Visual Content, Creating Audio Content, Creating Content for Other Senses (Touch, Taste, Smell), Representation and Perceptual Issues, Interaction in Augmented Reality, Mobile Augmented Reality, Advantages and Disadvantages of Mobile Augmented Reality, Architectures for Mobile Augmented Reality Systems.

UNIT IV COMPUTER VISION FOR AUGMENTED REALITY 9

Marker Tracking, Multiple-Camera Infrared Tracking, Natural Feature Tracking by Detection, Incremental Tracking, Simultaneous Localization and Mapping, Outdoor Tracking.

UNIT V AUGMENTED REALITY APPLICATIONS AND FUTURE 9

Introduction, Application Areas, Collaborative Augmented Reality, Applying Augmented Reality to a Problem, Evaluating Augmented Reality Applications. Example Augmented Reality Applications. The Future of Augmented Reality- Introduction, The Current State of Augmented Reality, Trends in Augmented Reality- Trends Toward Mobile Augmented Reality Applications, A Trend Toward Easy-to-Use Authoring Tools for Augmented Reality Experiences.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Explain the basic concept and understand the framework of Augmented reality.
CO2: Identify the hardware and software used for augmented reality applications.
CO3: Describe the content for creating audio, visual and other senses, interaction and

perception in mobile augmented reality.

CO4: Apply technology for tracking the computer vision in augmented reality.
CO5: Illustrate the augmented reality applications and tools in software development.

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1. Alan B. Craig, "Understanding Augmented Reality, Concepts and Applications" Morgan Kaufmann Publishers , 2013**.**
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3. Oliver Bimber and Ramesh Raskar, "Spatial Augmented Reality: Meging Real and Virtual Worlds", 2005.
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5. Randall Shumaker and Stephanie Lackey, "Virtual, Augmented and Mixed Reality. Applications of Virtual and Augmented Reality". VAMR, Springer, 2014.
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20CS978	**HIGH PERFORMANCE COMPUTING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To explain the concepts of Modern Processors.
- To discuss about Data access Optimization.
- To discuss Parallel Computing Paradigms.
- To describe the parallel scalability
- To analyse shared memory issues in parallel programming using OpenMP.

UNIT I MODERN PROCESSORS 9

Stored Program Computer Architecture - General purpose cache- based microprocessor- Performance based metrics and benchmarks- Moore's Law- Pipelining- Super scalarity SIMD- Memory Hierarchies Cache- mapping- prefetch- Multicore processors- Mutithreaded processors- Vector Processors- Design Principles- Maximum performance estimates- Programming for vector architecture.

UNIT II DATA ACCESS OPTIMIZATION 9

Balance analysis and lightspeed estimates- Storage order- Case study: The Jacobi algorithm and Dense matrix transpose- Algorithm classification and access optimizations- Case study: Sparse matrix-vector multiply

UNIT III PARALLEL COMPUTERS 9

Taxonomy of parallel computing paradigms- Shared memory computers- Cache coherance- UMA – ccNUMA Distributed-memory computers- Hierarchical systems- Networks-Basic performance characteristics- Buses- Switched and fat- tree networks- Mesh networks- Hybrids. Basics of parallelization- Data and Functional parallelism.

UNIT IV PARALLEL SCALABILITY 9

Factors that limit parallel execution- Scalability metrics- Simple scalability laws- parallel efficiency - serial performance Vs Strong scalability- Refined performance models- Choosing the right scaling baseline- Case Study: Can slow processors compute faster- Load balance

UNIT V SHARED MEMORY PARALLEL PROGRAMMING WITH OPENMP **9**

Introduction to OpenMp - parallel execution - data scoping- OpenMp work sharing for loops- synchronization - reductions - loop scheduling - tasking - case study: OpenMp- parallel jacobi algorithm- advanced Open Mp - wavefront parallelization.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Explain the design principles and architecture of modern processors.
CO2: Discuss about data classification and data access optimization techniques.
CO3: Discuss shared- and distributed-memory parallel computer architectures and the most relevant network topologies
CO4: Describe the parallel scalability metrics and performance models.
CO5: Examine the performance issues in shared memory parallel programming using OpenMP.

REFERENCES:

1. Georg Hager, Gerhard Wellein, Introduction to High Performance Computing for Scientists and Engineers, Chapman & Hall / CRC Computational Science series, 2011.
2. Gene Wagenbreth and John Levesque, High performance Computing: Programming and Application,CRC press, Taylor and francis group, 2010.
3. MaciejBrodowicz, Matthew Anderson, and Thomas Sterling, High Performance Computing: Modern Systems and Practices, Morgankaufmann publishers, 2017.
4. High Performance Cluster Computing, Volume 1, Architecture and Systems, Rajkumar Buyya, Pearson Education. 1999.
5. Berman, Fox and Hey, Grid Computing – Making the Global Infrastructure a Reality, Wiley India., 2003
6. Hurwitz, Bllor, Kaufman, Halper, Cloud Computing for Dummies, Wiley India, 2010.

20CS979 INTELLIGENT ROBOTS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To explain the key artificial intelligence issues involved in the development of intelligent robots.
- To illustrate the design of a behavioural system using reactive architecture
- To discuss the common sensing techniques available
- To explain the various hybrid architectures and evaluation
- To discuss the localization and path planning

UNIT I INTRODUCTION AND ARCHITECTURE **9**

Definition of Intelligent Robot, A brief history of AI Robotics, The Three Types of Software Architectures- Hierarchical Paradigm, Reactive Paradigm, Hybrid Deliberative / Reactive Paradigm

UNIT II REACTIVE FUNCTIONALITY 9

Animal Behaviors, Reflexive behaviors, Schema theory, Behaviors and schema theory, Action-Perception Cycle, Gibson:Ecological Approach, Two Perceptual Systems, Two Functions of Perception

UNIT III SENSING TECHNIQUES 9

Overview, Logical Sensor, Behavioral Sensor Fusion, Designing a sensor suite, Proximity sensors, Computer Vision, Grayscale and Color Representation, Region Segmentation, Color Histogramming, Range Sensing – Stereo, Light Stripers

UNIT IV BEHAVIORAL COORDINATION 9

Overview, Potential Fields – Visualizing Potential fields, Magnitude Profiles, Potential Field Perception, Programming Single Potential Field, Combination of Fields and Behaviours, Example, Advantages and Disadvantages, Subsumption – Example, Finate State Automata, Scripts

UNIT V NAVIGATION 9

Overview, Path planning, Relational methods, Associative methods, Case study of Topological path navigation - Metric path planning – Configuration Space, Meadow maps, Generalized Voronoi Graphs, Regular Grids, Quadtrees, Graph based planners, Wavefront- Based planners, Localization and Mapping overview

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Explain the key artificial intelligence issues involved in the development of intelligent robots.
CO2: Discuss the reactive functionality of perception and acting in AI robotics.
CO3: Describe the common sensing techniques used by robots.
CO4: Explain the deliberative functions most often associated with intelligence and the behavioural capability of autonomous initiative.
CO5: Design and evaluate autonomous robots using localization and path planning

REFERENCES:

1. Robin Murphy, “Introduction to AI Robotics”, second edition, MIT Press, 2019
2. Francis X. Govers, “Artificial Intelligence for Robotics: Build intelligent robots that perform human tasks using AI techniques” 1st Edition, Kindle Edition, 2018
3. S.R. Deb, “Robotics Technology and flexible automation”, Tata McGraw-Hill Education., 2009
4. John J. Craig, “Introduction to Robotics Mechanics and Control” Third Edition, 2008
5. Peter Mckinnon, “Robotics Everything You Need to Know About Robotics from Beginner to Expert”, 2016
6. Robin Murphy, “Introduction to AI Robotics”, MIT Press, 2000

20CS980 UAV AND DRONE TECHNOLOGY L T P C

3 0 0 3

OBJECTIVES:

- To explain the fundamental concepts of UAVs
- To discuss the payload techniques and types used in UAVs
- To develop mechanisms related to the data link functions and system interface
- To describe about UAV control and navigation systems
- To comprehend UAV guidance and applications

UNIT I INTRODUCTION 9

Introduction – History of UAV – Overview of UAV – Examples of UAV systems – Expendable UAVs- Classes of UAV systems - Aerodynamics - Performance of UAV – Stability and Control – Autopilots – Propulsion – Categories of Drones

UNIT II PAYLOADS 9

Loads and Structures - Mission Planning and Control Station – Air Vehicle and Payload Control - Payloads - Reconnaissance payloads – Weapon payloads – Extra payloads – Payload types in Drones

UNIT III DATA LINKS, LAUNCH AND RECOVERY 9

Data Link Functions – Data Link Attributes – System Interface issues – Data Link Margin – Antijam margin – Propagation – Data rate reduction - Datalink tradeoffs – Launch systems – Recovery systems – Launch and recovery tradeoffs – Drone launching Mechanism

UNIT IV CONTROL AND NAVIGATION SYSTEMS 9

UAV control Architecture – Flight Control Requirements – PID Controller – Optimal, Robust, Digital Controls – Stability Augmentation – Autonomy – Control System Design Process – Coordinate Systems – Inertial Navigation System – Global Positioning System - Position fixing Navigation – Inertial Navigation Sensors

UNIT V GUIDANCE AND GROUND CONTROL 9

Elements of Guidance system – Guidance laws – LOS – Formation flight – Proportional law – Pursuit law – Waypoint guidance – Microcontroller – Components – Flight Software – Ground Control Station – Types - GCS subsystems - Human Operator - Communication System – Application of Drones – Drones in Agriculture -Drones in Defence – Drones in Surveillance

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Explain the basic elements of UAV systems, its types and performance and how they interact.

CO2: Discuss the type of payloads used in UAVs

CO3: Develop mechanisms related to UAV data links, launch and recovery methods and identify the issues.

CO4: Describe the control and navigation systems for UAV

CO5: Illustrate the guidance schemes and ground control stations of UAVs with the help of applications in various fields.

REFERENCES:

1. Paul Gerin Fahlstrom, Thomas James Gleason, “Introduction to UAV Systems”, WILEY publication, 4th edition, 2012.
2. Mohammad H. Sadraey, “Unmanned Aircraft Design - A Review of Fundamentals”, MORGAN & CLAYPOOL Publication, 2017.
3. Reg Austin, “Unmanned Aircraft Systems -UAVs Design, Development and Deployment”, WILEY publication, 2010.
4. A.R. Jha, “Theory, Design and Applications of Unmanned Aerial Vehicles”, CRC Press, 2017.
5. Richard J. Barnhart, Stephen B. Hottman, Douglas M. Marshall, Eric Shappee, “Introduction to Unmanned Aircraft Systems”, CRC Press, 2012.

20CS981 PERFORMANCE ANALYSIS OF COMPUTER SYSTEMS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the mathematical foundations needed for performance evaluation ofcomputer systems
- To understand the metrics used for performance evaluation
- To understand the analytical modeling of computer systems
- To enable the students to develop new queuing analysis for both simple and complexsystems
- To appreciate the use of smart scheduling and introduce the students to analyticaltechniques for evaluating scheduling policies
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UNIT I OVERVIEW OF PERFORMANCE EVALUATION 9

Need for Performance Evaluation in Computer Systems – Overview of Performance Evaluation Methods – Introduction to Queuing – Probability Review – Generating Random Variables for Simulation – Sample Paths, Convergence and Averages – Little‘s Law and other Operational Laws – Modification for Closed Systems.

UNIT II MARKOV CHAINS AND SIMPLE QUEUES 9

Discrete-Time Markov Chains – Ergodicity Theory – Real World Examples – Google, Aloha – Transition to Continuous-Time Markov Chain – M/M/1.

UNIT III MULTI-SERVER AND MULTI-QUEUE SYSTEMS 9

Server Farms: M/M/k and M/M/k/k – Capacity Provisioning for Server Farms – Time Reversibility and Burke‘s Theorem – Networks of Queues and Jackson Product Form – Classed and Closed Networks of Queues.

UNIT IV REAL-WORLD WORKLOADS 9

Case Study of Real-world Workloads – Phase-Type Distributions and Matrix-Alalytic Methods – Networks with Time-Sharing Servers – M/G/1 Queue and the Inspection Paradox – Task Assignment Policies for Server Farms.

UNIT V SMART SCHEDULING IN THE M/G/1 9

Performance Metrics – Scheduling Non-Preemptive and Preemptive Non-Size-Based Policies - Scheduling Non-Preemptive and Preemptive Size-Based Policies – Scheduling - SRPT and

Fairness.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Identify the need for performance evaluation and the metrics used for it
CO2: Distinguish between open and closed queuing networks
CO3: Use Little‘e law and other operational laws
CO4: Apply the operational laws to open and closed systems
CO5: Use discrete-time and continuous-time Markov chains to model real world systems
CO6: Develop analytical techniques for evaluating scheduling policies

REFERENCES:

12. K. S. Trivedi, ―Probability and Statistics with Reliability, Queueing and Computer Science Applications‖, John Wiley and Sons, 2001.
13. Krishna Kant, ―Introduction to Computer System Performance Evaluation‖, McGraw-Hill, 1992.
14. Lieven Eeckhout, ―Computer Architecture Performance Evaluation Methods‖, Morgan and Claypool Publishers, 2010.
15. Mor Harchol - Balter, ―Performance Modeling and Design of Computer Systems – Queueing Theory in Action‖, Cambridge University Press, 2013.
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17. Raj Jain, ―The Art of Computer Systems Performance Analysis: Techniques for Experimental Design, Measurement, Simulation and Modeling‖, Wiley-Interscience, 1991.

20CS982	QUEUEING AND RELIABILITY MODELLING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the basic concept of Markovian queueing systems.
- To analyze the advance Markovian queues such as bulk input, batch service and priority queues.
- To familiarize the non-Markov queues and their performance measures.
- To study the system reliability and hazard function for series and parallel systems.
- To implement Markovian Techniques for availability and maintainability which opens up newavenues for research.

UNIT I MARKOVIAN QUEUES **9**

Need for Performance Evaluation in Computer Systems – Overview of Performance Evaluation Methods – Introduction to Queuing – Probability Review – Generating Random Variables for Simulation – Sample Paths, Convergence and Averages – Little‘s Law and other Operational Laws – Modification for Closed Systems.

UNIT II ADVANCED MARKOVIAN QUEUES **9**

Discrete-Time Markov Chains – Ergodicity Theory – Real World Examples – Google, Aloha – Transition to Continuous-Time Markov Chain – M/M/1.

UNIT III NON-MARKOVIAN QUEUES 9

Server Farms: M/M/k and M/M/k/k – Capacity Provisioning for Server Farms – Time Reversibility and Burke's Theorem – Networks of Queues and Jackson Product Form – Classed and Closed Networks of Queues.

UNIT IV SYSTEM RELIABILITY 9

Case Study of Real-world Workloads – Phase-Type Distributions and Matrix-Alalytic Methods – Networks with Time-Sharing Servers – M/G/1 Queue and the Inspection Paradox – Task Assignment Policies for Server Farms.

UNIT V MAINTAINABILITY AND AVAILABILITY 9

Performance Metrics – Scheduling Non-Preemptive and Preemptive Non-Size-Based Policies - Scheduling Non-Preemptive and Preemptive Size-Based Policies – Scheduling - SRPT and Fairness.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: The students are equipped to evaluate the various system performance measures for basicqueueing systems.

CO2: Implementation of mathematical techniques to study the priority and non-priority queues.

CO3: Students will able to formulate the various kinds of Non-Markovian queueing models.

CO4: Students can analyze reliability of the systems for various probability distributions

CO5: Students can be able to formulate problems using the maintainability and availability analyses byusing theoretical approach.

REFERENCES:

1. Balagurusamy E., "Reliability Engineering", Tata McGraw Hill Publishing Company Ltd., NewDelhi, 2010.
2. Charles E. Ebeling, "An Introductiion to Reliability and Maintainability Engineering", Waveland,Illinois, 2010.
3. Shortle J.F, Gross D , Thompson J.M, Harris C.M., "Fundamentals of Queueing Theory", JohnWiley and Sons, New York, 2018.
4. Govil A.K., "Reliability Engineering", Tata-McGraw Hill Publishing Company Ltd., NewDelhi, 1983.
5. Kleinrock. L., "Queueing Systems: Volume 1", John Wiley and Sons, New York, 1975.
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