ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS
M.E. COMPUTER SCIENCE AND ENGINEERING
(SPECIALIZATION IN BIG DATA ANALYTICS)
REGULATIONS – 2023
VISION AND MISSION

VISION OF THE DEPARTMENT

The vision of the Department is to create computing professionals, researchers and entrepreneurs with high technical competency and communication skills by setting high standards in academic excellence and meeting the future needs of the society.

MISSION OF THE DEPARTMENT

The mission of the Department of Computer Science and Engineering is to

- Provide motivated faculty and state of the art facilities for education and research, both in foundational aspects and of relevance to emerging computing trends.
- Develop knowledgeable, industry-ready students with pertinent competencies.
- Inculcate responsibility through sharing of knowledge and innovative computing solutions that benefit the society-at-large.
- Engage in collaborative research with academia and industry for seamless transfer of knowledge resulting in patentable solutions.
- Generate adequate resources for research activities from sponsored projects and consultancy.

PROGRAM EDUCATIONAL OBJECTIVES:

1. Prepare students to understand the foundational concepts in Computer Science and Engineering.
2. Enable students to integrate theory and practice for problem solving.
3. Empower students to critically analyze current trends and future issues from a system perspective at multiple levels of detail and abstraction.
4. Prepare students to critically analyze existing literature, identify the gaps and propose innovative and research oriented solutions for Big Data.
5. Enable students to pursue lifelong multidisciplinary learning as professional engineers and scientists.
6. Enable students to effectively communicate technical information, function effectively on teams, and apply computer engineering solutions within a global, societal, and environmental context by following ethical practices.

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PROGRAM OUTCOMES (POs):

Engineering Graduates will be able to:

PO #	Graduate Attribute	Programme Outcomes
1	Research Aptitude	An ability to independently carry out research / Investigations, identify problems and develop solutions to solve practical problems.
2	Technical documentation	An ability to write and present a substantial technical report/ document.
3	Technical competence	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
4	Handle complex problems	Use research based knowledge, methods, appropriate techniques, resources and tools to solve complex engineering issues with an understanding of the limitations.
5	Environmental Sustainability and societal Ethics	Ensure development of socially relevant and ecofriendly indigenous products by applying technical knowledge, ethical principles and, sound engineering practices
6	Life-long learning	Recognize the need for independent, life-long learning and engage in the broadest context of technological change.

MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVES WITH PROGRAMME OUTCOMES

A broad relation between the programme educational objective and the outcomes is given in the following table

PROGRAMME EDUCATIONAL OBJECTIVES	PO1	PO2	PO3	PO4	PO5	PO6
1.	1	1	3	2	1	3
2.	3	2	3	3	1	3
3.	3	2	3	3	1	3
4.	3	1	3	2	1	2
5.	1	1	1	1	1	3
6.	2	1	3	3	3	3

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Mapping of Course Outcome and Programme Outcome

Year	Semester	Course Name	PO1	PO2	PO3	PO4	PO5	PO6
Year I	Sem 1	Advanced Mathematics for Scientific Computing	3	3	3	3	2	2
		Research Methodology and IPR						
		Data Structures and Algorithms	2.5	-	3	2.2	-	-
		Multicore Architectures	3	3	3	2	1	2
		Big Data Mining and Analytics	3	3	3	2.6	2.4	2.4
		Database Technologies	2	1	3	2.2	-	2.2
		Data Structures and Algorithms Laboratory	2	-	2.4	2.33	-	-
		Big Data Computing Laboratory	3	2	3	2.6	2	2
	Sem 2	Advanced Operating Systems	3	-	2.4	2.4	2	-
		Big Data Query Languages	3	1.6	3	3	2	-
		Machine Learning	2.8	2.2	2.4	2.2	2.5	2
		Professional Elective I						
		Professional Elective II						
		Professional Practices	2.8	2.2	2.6	3	2.4	2.4
Year 2	Sem 3	Cyber Security	2.4	2.4	2	2.2	2	2
		Professional Elective III						
		Professional Elective IV						
		Professional Elective V						
		Project Work I						
	Sem 4	Project Work II						

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REGULATIONS – 2023
CHOICE BASED CREDIT SYSTEM
CURRICULA AND SYLLABI

SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA3154	Advanced Mathematics for Scientific Computing	FC	4	0	0	4	4
2.	RM3151	Research Methodology and IPR	RMC	2	1	0	3	3
3.	CP3151	Data Structures and Algorithms	PCC	3	0	0	3	3
4.	CP3153	Multicore Architectures	PCC	3	0	0	3	3
5.	BD3151	Big Data Mining and Analytics	PCC	3	0	0	3	3
6.	CP3152	Database Technologies	PCC	3	0	0	3	3
PRACTICALS								
7.	CP3161	Data Structures and Algorithms Laboratory	EEC	0	0	4	4	2
8.	BD3111	Big Data Computing Laboratory	EEC	0	0	3	3	1.5
			TOTAL	**18**	**1**	**7**	**26**	**22.5**

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	CP3251	Advanced Operating Systems	PCC	3	0	0	3	3
2.	BD3201	Big Data Query Languages	PCC	3	0	2	5	4
3.	CP3252	Machine Learning	PCC	3	0	3	6	4.5
4.		Professional Elective I	PEC	3	0	0	3	3
5.		Professional Elective II	PEC	3	0	0	3	3
PRACTICALS								
6.	CP3261	Professional Practices	EEC	0	0	4	4	2
			TOTAL	**15**	**0**	**9**	**24**	**19.5**

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	CP3351	Cyber Security	PCC	3	0	0	3	3
2.		Professional Elective III	PEC	3	0	2	5	4
3.		Professional Elective IV	PEC	3	0	0	3	3
4.		Professional Elective V	PEC	3	0	0	3	3
PRACTICALS								
5.	BD3311	Project Work I	EEC	0	0	12	12	6
			TOTAL	**12**	**0**	**14**	**26**	**19**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	BD3411	Project Work II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL NO. OF CREDITS: 73

FOUNDATION COURSES (FC)

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MA3154	Advanced Mathematics for Scientific Computing	FC	4	0	0	4	4

PROFESSIONAL CORE COURSES (PCC)

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CP3151	Data Structures and Algorithms	PCC	3	0	0	3	3
2.	CP3153	Multicore Architectures	PCC	3	0	0	3	3
3.	BD3151	Big Data Mining and Analytics	PCC	3	0	0	3	3
4.	CP3152	Database Technologies	PCC	3	0	0	3	3
5.	CP3161	Data Structures and Algorithms Laboratory	PCC	0	0	4	4	2
6.	BD3111	Big Data Computing Laboratory	PCC	0	0	3	3	1.5
7.	CP3251	Advanced Operating Systems	PCC	3	0	0	3	3

8.	BD3201	Big Data Query Languages	PCC	3	0	2	5	4
9.	CP3252	Machine Learning	PCC	3	0	3	6	4.5
10.	CP3351	Cyber Security	PCC	3	0	0	3	3

RESEACH METHODOLOGY AND IPR (RMC)

S. NO.	COURSECODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	RM3151	Research Methodology and IPR	RMC	2	1	0	3	3

PROFESSIONAL ELECTIVE COURSES (PEC)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CONTACT PERIODS	CREDITS
1.	BD3001	Linked Open Data and its Applications	PEC	3	0	0	3	3
2.	BD3002	Data Intensive Computing	PEC	3	0	0	3	3
3.	BD3003	Data Visualization	PEC	3	0	0	3	3
4.	BD3004	Real Time Data Streaming	PEC	3	0	0	3	3
5.	BD3005	Big Data Acquisition	PEC	3	0	0	3	3
6.	CP3056	Cloud Computing Technologies	PEC	3	0	2	5	4
7.	CP3063	Ethical Hacking	PEC	3	0	0	3	3
8.	CP3062	Digital Image and Video Processing	PEC	3	0	2	5	4
9.	CP3073	Principles of Cryptography	PEC	3	0	0	3	3
10.	CP3068	Internet of Things	PEC	3	0	2	5	4
11.	CP3052	Advanced Software Engineering	PEC	3	0	0	3	3
12.	CP3060	Deep Learning	PEC	3	0	2	5	4
13.	CP3082	Web Content Design and Management	PEC	3	0	2	5	4
14.	CP3075	Semantic Web	PEC	3	0	0	3	3
15.	CP3070	Mobile Application Development	PEC	3	0	0	3	3
16.	CP3055	Blockchain Technologies	PEC	3	0	2	5	4
17.	CP3083	Multimedia Systems and Applications	PEC	3	0	0	3	3
18.	CP3067	Information Retrieval Techniques	PEC	3	0	0	3	3
19.	CP3072	Parallel Algorithms	PEC	3	0	0	3	3
20.	CP3077	Soft Computing	PEC	3	0	0	3	3
21.	CP3065	Game Theory	PEC	3	0	0	3	3

22.	CP3051	Adhoc and Wireless Sensor Networks	PEC	3	0	0	3	3
23.	SE3053	Software Security	PEC	3	0	0	3	3
24.	CP3080	Virtualization Techniques	PEC	3	0	0	3	3
25.	CP3059	Database Administration and Tuning	PEC	3	0	0	3	3
26.	CP3058	Data Warehousing and Data Mining Techniques	PEC	3	0	0	3	3
27.	CP3076	Social Network Analysis	PEC	3	0	0	3	3
28.	SE3054	Software Testing and Quality Assurance	PEC	3	0	0	3	3
29.	CP3079	User Interface Design	PEC	3	0	0	3	3
30.	SE3052	Software Reliability Metrics and Models	PEC	3	0	0	3	3
31.	CP3081	Visualization Techniques	PEC	3	0	0	3	3
32.	BD3051	Foundations of Data Science	PEC	3	0	0	3	3
33.	CP3071	Wireless Communications	PEC	3	0	0	3	3
34.	CP3053	Agile Methodologies	PEC	3	0	0	3	3
35.	CP3078	Statistical Natural Language Processing	PEC	3	0	0	3	3
36.	CP3074	Quantum Computing	PEC	3	0	0	3	3
37.	SE3051	Formal Methods in Software Systems	PEC	3	0	0	3	3
38.	CP3066	GPU Computing	PEC	3	0	0	3	3
39.	CP3061	Devops and Microservices	PEC	3	0	0	3	3
40.	CP3064	Full Stack Web Application Development	PEC	3	0	2	5	4
41.	CP3054	Bioinformatics	PEC	3	0	0	3	3
42.	CP3069	Mixed Reality	PEC	3	0	0	3	3
43.	CP3057	Cyber Physical Systems	PEC	3	0	0	3	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CP3261	Professional Practices	EEC	0	0	4	4	2
2.	BD3311	Project Work I	EEC	0	0	12	12	6
3.	BD3411	Project Work II	EEC	0	0	24	24	12

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SUMMARY

	NAME OF THE PROGRAMME: M.E. COMPUTER SCIENCE AND ENGINEERING (BIG DATA ANALYTICS)						
	SUBJECT AREA	CREDITS PER SEMESTER				CREDITS TOTAL	% Distribution
		I	II	III	IV		
1.	FC	4	-	-	-	4	5.48
2.	PCC	15.5	11.5	3	-	30	41.10
3.	PEC	-	6	10	-	16	21.92
4.	RMC	3	-	-	-	3	4.11
5.	EEC	-	2	6	12	20	27.40
6.	**TOTAL CREDIT**	**22.5**	**19.5**	**19**	**12**	**73**	**100**

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MA3154 ADVANCED MATHEMATICS FOR SCIENTIFIC COMPUTING L T P C
4 0 0 4

UNIT I LINEAR PROGRAMMING 12

Formulation – Graphical solution – Simplex method – Two phase method -Transportation and Assignment Problems

UNIT II SIMULATION 12

Discrete Event Simulation – Monte – Carlo Simulation – Stochastic Simulation – Applications to real time problems.

UNIT III ESTIMATION THEORY 12

Estimators: Unbiasedness, Consistency, Efficiency and Sufficiency – Maximum Likelihood Estimation – Method of moments.

UNIT IV TESTING OF HYPOTHESIS 12

Sampling distributions – Estimation of parameters - Statistical hypothesis – Tests based on Normal, t, Chi-square and F distributions for mean, variance and proportion, 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

COURSE OUTCOMES:

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

CO1 Formulate and find optimal solution in the real life optimizing/allocation/assignment problems involving conditions and resource constraints.

CO2 Simulate appropriate application/distribution problems.

CO3 Obtain the value of the point estimators using the method of moments and method of maximum likelihood.

CO4 Apply the concept of various test statistics used in hypothesis testing for mean and variances of large and small samples.

CO5 Get exposure to the principal component analysis of random vectors and matrices.

REFERENCES:

1. Jay L. Devore, “Probability and Statistics for Engineering and the Sciences”, Cengage Learning, 9th Edition, Boston, 2016.
2. Johnson, R.A, Irwin Miller and John Freund., “Miller and Freund’s Probability and Statistics for Engineers”, Pearson Education, 9th Edition, New York, 2016.
3. Johnson, R.A., and Wichern, D.W., “Applied Multivariate Statistical Analysis”, Pearson Education, Sixth Edition, New Delhi, 2013.
4. Ross. S.M., “Probability Models for Computer Science”, Academic Press, SanDiego, 2002.
5. Taha H.A.,, “Operations Research: An Introduction”, Prentice Hall of India Pvt. Ltd. 10th Edition, New Delhi, 2017.
6. Winston, W.L., “Operations Research”, Thomson – Brooks/Cole, Fourth Edition, Belmont, 2003.

CO-PO Mapping

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

RM3151 RESEARCH METHODOLOGY AND IPR L T P C
2 1 0 3

UNIT I RESEARCH PROBLEM FORMULATION 9

Objectives of research, types of research, research process, approaches to research; conducting literature review- information sources, information retrieval, tools for identifying literature, Indexing and abstracting services, Citation indexes, summarizing the review, critical review, identifying research gap, conceptualizing and hypothesizing the research gap

UNIT II RESEARCH DESIGN AND DATA COLLECTION 9

Statistical design of experiments- types and principles; data types & classification; data collection - methods and tools

UNIT III DATA ANALYSIS, INTERPRETATION AND REPORTING 9

Sampling, sampling error, measures of central tendency and variation,; test of hypothesis- concepts; data presentation- types of tables and illustrations; guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript; guidelines for writing thesis, research proposal; References – Styles and methods, Citation and listing system of documents; plagiarism, ethical considerations in research

UNIT IV INTELLECTUAL PROPERTY RIGHTS 9

Concept of IPR, types of IPR – Patent, Designs, Trademarks and Trade secrets, Geographical indications, Copy rights, applicability of these IPR; , IPR & biodiversity; IPR development process, role of WIPO and WTO in IPR establishments, common rules of IPR practices, types and features of IPR agreement, functions of UNESCO in IPR maintenance.

UNIT V PATENTS 9

Patents – objectives and benefits of patent, concept, features of patent, inventive steps, specifications, types of patent application; patenting process - patent filling, examination of patent, grant of patent, revocation; equitable assignments; Licenses, licensing of patents; patent agents, registration of patent agents.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of the course, the student can

CO1: Describe different types of research; identify, review and define the research problem

CO2: Select suitable design of experiment s; describe types of data and the tools for collection of data

CO3: Explain the process of data analysis; interpret and present the result in suitable form

CO4: Explain about Intellectual property rights, types and procedures

CO5: Execute patent filing and licensing

REFERENCES:

1. Cooper Donald R, Schindler Pamela S and Sharma JK, “Business Research Methods”, Tata McGraw Hill Education, 11e (2012).
2. Soumitro Banerjee, “Research methodology for natural sciences”, IISc Press, Kolkata, 2022,
3. Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007.
4. David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007.
5. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, “Professional Programme Intellectual Property Rights, Law and practice”, September 2013.

CP3151 DATA STRUCTURES AND ALGORITHMS L T P C
3 0 0 3

UNIT I BASIC STRUCTURES AND ALGORITHM 9

Stack- Queue - Linked List Implementation - Min/Max heap – Algorithm Analysis- Asymptotic Analysis- Solving Recurrence Relation – Amortized Analysis

UNIT II BALANCED TREE STRUCTURES 9

Binary Search Trees – AVL Trees – Red-Black Trees – Multi-way Search Trees –B-Trees – Splay Trees – Tries -Analysis

UNIT III MELDABLE HEAP STRUCTURES 9

Leftist Tree- Leftist Heaps – Binomial Heaps – Fibonacci Heaps – Skew Heaps – Lazy Binomial Heaps –Deap-Analysis

UNIT IV NP COMPLETENESS 9

NP Classes- Polynomial Time Verification – Theory of Reducibility - NP Completeness Proof for Vertex Cover & Hamiltonian Cycle

UNIT V APPROXIMATION ALGORITHMS 9

Approximation Algorithms: Vertex Cover & Euclidean Travelling Salesperson Problem- Randomized Algorithms: Closest Pair Problem & Minimum Spanning Trees

TOTAL: 45 PERIODS

REFERENCES

1. Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, “Fundamentals of Data Structures in C”, Second Edition, University Press, 2008.
2. Ellis Horowitz and Sartaj Sahni, “Fundamental of Computer Algorithms”, Galgotia, 1985.
3. R.C.T Lee, S.S Tseng, R.C Chang and Y.T Tsai, “Introduction to the Design and Analysis of Algorithms”, Tata McGraw-Hill Edition, 2012.
4. Thomas H Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, “Introduction to Algorithms”, Third Edition, Prentice Hall, 2010.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Understand, design and implement balanced search structures

CO2:Analyse algorithms for time complexity

CO3:Understand and implement different meldable priority queues
CO4:Appreciate Approximation and randomized algorithm design
CO5:Apply various data structures for solving problems

CO-PO Mapping

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

CP3153 MULTICORE ARCHITECTURES L T P C
3 0 0 3

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 – Limitations of ILP – Multithreading – SMT and CMP Architectures – The Multicore era.

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

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

UNIT IV EXPLOITING DIFFERENT TYPES OF PARALLELISM 9

Homogeneous and Heterogeneous Multi-core Architectures – Intel Multicore Architectures – SUN CMP architecture – IBM Cell Architecture. Introduction to Warehouse-Scale computers, Cloud Computing – Architectures and Issues. Vector, SIMD and GPU Architectures– Vector Architecture – SIMD Extensions for Multimedia – Graphics Processing Units – Case Studies – GPGPU Computing.

UNIT V DOMAIN SPECIFIC ARCHITECTURES 9

Introduction to Domain Specific Architectures - Guidelines for DSAs. Case Studies - Example Domain: Deep Neural Networks - Google's Tensor Processing Unit - Microsoft Catapult - Intel Crest - Pixel Visual Core. CPUs Versus GPUs Versus DSAs.

TOTAL: 45 PERIODS

REFERENCES

1. John L. Hennessey and David A. Patterson, "Computer Architecture – A Quantitative Approach", Morgan Kaufmann / Elsevier, 6th edition, 2019.
2. Wen–mei W.Hwu,"GPU Computing Gems", Morgan Kaufmann / Elsevier, 2011.

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3. Yan Solihin, “Fundamentals of Parallel Multicore Architecture”, Chapman & Hall/CRC Press, 2016.
4. David B. Kirk, Wen-mei W. Hwu, “Programming Massively Parallel Processors”, Morgan Kauffman, 2010.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Discuss and evaluate the performance of computer systems

CO2:Discuss and point out the various ways of exploiting ILP

CO3:Point out the various optimizations that can be performed to improve the memory hierarchy design

CO4:Discuss the issues related to multiprocessing and suggest solutions

CO5:Point out the salient features of different multicore architectures and how they exploit different types of parallelism

CO6:Point out the salient features of different example domain specific architectures

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	1	2
CO2	3	3	3	2	1	2
CO3	3	3	3	2	1	2
CO4	3	3	3	2	1	2
CO5	3	3	3	2	1	2
CO6	3	3	3	2	1	2

BD3151 BIG DATA MINING AND ANALYTICS L T P C
3 0 0 3

UNIT I DATA MINING AND LARGE SCALE FILES 9

Introduction to Statistical modeling – Machine Learning – Computational approaches to modeling – Summarization – Feature Extraction – Statistical Limits on Data Mining – Distributed File Systems– Map-reduce – Algorithms using Map Reduce – Efficiency of Cluster Computing Techniques.

UNIT II SIMILAR ITEMS 9

Nearest Neighbor Search – Shingling of Documents – Similarity preserving summaries – Locality sensitive hashing for documents – Distance Measures – Theory of Locality Sensitive Functions – LSH Families – Applications of Locality-Sensitive Hashing - Methods for High Degree of Similarities.

UNIT III MINING DATA STREAMS 9

Stream Data Model – Sampling Data in the Stream – Filtering Streams – Counting Distance Elements in a Stream – Estimating Moments – Counting Ones in Window – Decaying Windows

UNIT IV LINK ANALYSIS AND FREQUENT ITEMSETS 9

Page Rank –Efficient Computation – Topic Sensitive Page Rank – Link Spam – Hubs and Authorities - Market Basket Model – Apriori algorithm – Handling Larger Datasets in Main Memory – Limited Pass Algorithm – Counting Frequent Items.

UNIT V CLUSTERING 9

Introduction to Clustering Techniques – Hierarchical Clustering –Algorithms – K-Means – CURE – Clustering in Non–Euclidean Spaces – Streams and Parallelism – Case Study: Advertising on the Web – Recommendation Systems

TOTAL: 45 PERIODS

REFERENCES

1. Jure Leskovec, AnandRajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, Second Edition, 2014.
2. Jiawei Han, MichelineKamber, Jian Pei, “Data Mining Concepts and Techniques”, Morgan Kaufman Publications, Third Edition, 2011.
3. Ian H.Witten, Eibe Frank “Data Mining – Practical Machine Learning Tools and Techniques”, Morgan Kaufman Publications, Third Edition, 2011.
4. David Hand, HeikkiMannila and Padhraic Smyth, “Principles of Data Mining”, MIT Press,2001.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Design algorithms by employing Map Reduce technique for solving Big Data problems.
CO2:Identify similarities using appropriate measures.
CO3:Point out problems associated with streaming data and handle them.
CO4:Discuss algorithms for link analysis and frequent itemset mining.
CO5:Design solutions for problems in Big Data by suggesting appropriate clustering techniques.

CO-PO Mapping

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

CP3152 DATABASE TECHNOLOGIES L T P C
3 0 0 3

UNIT I RELATIONAL MODEL 9

Entity Relationship Model – Relational Data Model – Mapping Entity Relationship Model to Relational Model – Relational Algebra – Structured Query Language – Database Normalization – First Normal Form – Second Normal Form – Third Normal Form – Boyce Codd Normal Form – Fourth Normal Form – Fifth Normal Form.

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UNIT II PARALLEL AND DISTRIBUTED DATABASES 9

Parallel Databases – I/O Parallelism - Inter-Query and Intra-Query Parallelism– Inter-Operation and Intra-operation Parallelism – Performance evaluation for Parallel DB Systems –Distributed Database Architecture – Distributed Data Storage – Distributed Transactions – Distributed Query Processing – Distributed Transaction Management – Load balancing tools for DDB – DDB Security.

UNIT III ADVANCED DATABASES 9

XML Data Model – DTD – XML Schema – XML Querying – Web Databases – Open Database Connectivity – Java Database Connectivity – Accessing Relational Database using PHP – Analytical Operations involved in Processing Spatial Data –Spatial Data Types and Models– Spatial Operators and Spatial Queries–Spatial Data Indexing–Multimedia Database Concepts - Introduction to Deductive Databases–Prolog/Datalog Notation– Clausal Form and Horn Clauses– Interpretations of Rules.

UNIT IV ACTIVE TEMPORAL AND DEDUCTIVE DATABASES 9

Event Condition Action Model – Design and Implementation Issues for Active Databases – Termination, Confluence, Determination and Modularization – Temporal Databases –Interpreting Time in Relational Databases – Deductive Databases – Data log Queries

UNIT V NOSQL DATABASES 9

NoSQL Database vs.SQL Databases – CAP Theorem –Migrating from RDBMS to NoSQL – MongoDB – CRUD Operations– MongoDB Sharding – MongoDB Replication – Web Application Development using MongoDB with PHP and Java.

TOTAL: 45 PERIODS

REFERENCES

1. Ramez Elmasri, Shamkant B. Navathe, Fundamentals of Database Systems, Seventh Edition, Pearson Education, 2016.
2. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, Database System Concepts, Seventh Edition, McGraw Hill Education 2020.
3. Brad Dayley, “Teach Yourself NoSQL with MongoDB in 24 Hours”, Sams Publishing, 2014.
4. Thomas Cannolly and Carolyn Begg, “Database Systems, A Practical Approach to Design, Implementation and Management”, Third Edition, Pearson Education, 2007.
5. V.S.Subramanian, “Principles of Multimedia Database Systems”, Harcourt India Pvt. Ltd.,2001.
6. C.J.Date, A.KannanandS.Swamynathan, “An Introduction to Database Systems”, Eighth Edition, Pearson Education, 2006.
7. ShashankTiwari, ”Professional NoSQL”, Wiley, 2011.
8. David Lane, Hugh.E.Williums, Web Database Applications with PHP and MySQL, O’Reilly Media; 2nd edition, 2004

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Design a Relational Database for an Enterprise.

CO2:Design a Distributed Database, Active Database and Temporal Database for an Enterprise.

CO3:Gain the knowledge in advanced databases.

CO4:Comprehend the use of XML Database, Web Database, Spatial Database, Multimedia Database and Deductive Database.

CO5:Use MongoDB NoSQL Database to Maintain Data of an Enterprise.

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CO-PO Mapping

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

CP3161 DATA STRUCTURES AND ALGORITHMS LABORATORY L T P C
0 0 4 2

LIST OF EXPERIMENTS:

1. Linked list implementation of Stack and Queue ADTs
2. Binary Search tree
3. Min/Max Heap
4. AVL tree
5. Red- Black tree
6. Splay Tree
7. Leftist Heap
8. Binomial Heap

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Apply suitable data structures in problem solving.
CO2:Select suitable search structures for an application
CO3:Understand priority queue implementations
CO4:Differentiate between approximation and Randomized algorithms
CO5:Understand NP complete problem solutions

TOTAL: 60 PERIODS

CO-PO Mapping

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

BD3111 BIG DATA COMPUTING LABORATORY L T P C
0 0 3 1.5

LIST OF EXPERIMENTS

1. Set up a pseudo-distributed, single-node Hadoop cluster backed by the Hadoop Distributed File System, running on Ubuntu Linux. After successful installation on one node, configuration of a multi-node Hadoop cluster (one master and multiple slaves).
2. MapReduce application for word counting on Hadoop cluster
3. Unstructured data into NoSQL data and do all operations such as NoSQL query with API.

4. K-means clustering using map reduce
5. Page Rank Computation
6. Mahout machine learning library to facilitate the knowledge build up in big data analysis.
7. Application of Recommendation Systems using Hadoop/mahout libraries

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Set up single and multi-node Hadoop Clusters.
CO2:Apply Map Reduce technique for various algorithms.
CO3:Design new algorithms that uses Map Reduce to apply on Unstructured and structured data.
CO4:Develop Scalable machine learning algorithms for various Big data applications using Mahout
CO5:Represent NoSQL data.

CO-PO Mapping

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

CP3251 ADVANCED OPERATING SYSTEMS L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Distributed Operating Systems – Issues – Communication Primitives – Limitations of a Distributed System – Lamport's Logical Clocks – Vector Clocks – Causal Ordering of Messages

UNIT II DISTRIBUTED OPERATING SYSTEMS 9

Distributed Mutual Exclusion Algorithms – Classification – Preliminaries – Simple Solution – Lamport's Algorithm – Ricart-Agrawala Algorithm – Suzuki-Kasami's Broadcast Algorithm – Raymond's Tree-Based Algorithm – Distributed Deadlock Detection – Preliminaries – Centralized Deadlock Detection Algorithms – Distributed Deadlock Detection Algorithms – Path Pushing Algorithm – Edge Chasing Algorithm – Hierarchical Deadlock Detection Algorithms – Agreement Protocols – Classification – Solutions to the Byzantine Agreement Problem – Lamport-Shostak- Pease Algorithm

UNIT III DISTRIBUTED RESOURCE MANAGEMENT 9

Distributed File Systems – Design Issues – Google File System – Hadoop Distributed File System– Distributed Shared Memory – Algorithms for Implementing Distributed Shared Memory – LoadDistributing Algorithms – Synchronous and Asynchronous Check Pointing and Recovery – FaultTolerance – Two-Phase Commit Protocol – Nonblocking Commit Protocol

UNIT IV REAL TIME OPERATING SYSTEMS 9

Basic Model of Real - Time Systems – Characteristics – Application of Real - Time Systems – Real - Time Task Scheduling – Handling Resource Sharing

UNIT V MOBILE AND CLOUD OPERATING SYSTEMS 9

Android – Overall Architecture – Linux Kernel – Hardware Support – Native User-Space – Dalvik and Android's Java – System Services – Introduction to Cloud Operating Systems

TOTAL: 45 PERIODS

REFERENCES

1. Mukesh Singhal and Niranjan G. Shivaratri, "Advanced Concepts in Operating Systems —Distributed, Database and Multiprocessor Operating Systems", Tata MC Graw-Hill, 2001.
2. Rajib Mall, "Real-Time Systems: Theory and Practice", Pearson Education India, 2006.
3. Karim Yaghmour, "Embedded Android", O'Reilly, First Edition, 2013.
4. Nikolay Elenkov, "Android Security Internals: An In-Depth Guide to Android's Security Architecture", No Starch Press, 2014.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Identify the features of distributed operating systems.
CO2:Demonstrate the various protocols of distributed operating systems.
CO3:Identify the different features of real time operating systems.
CO4:Discuss the features of mobile operating systems.
CO5:Discuss the features of cloud operating systems.

CO-PO Mapping

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

BD3201 BIG DATA QUERY LANGUAGES L T P C
3 0 2 4

UNIT I INTRODUCTION TO BIG DATA 9

Introduction to Big Data – Overview – Key Roles – Examples – Data Analytics Lifecycle – Overview – Phase – Case Study – Review of Basic Data Analytic Methods using R – Introduction – Exploratory – Statistical Methods – Advanced Analytics Technology and Tools in Database Analytics – SQL Essentials – In Database Text Analysis – Advanced SQL.

UNIT II INTRODUCTION TO R PROGRAMMING 9

Introduction to R – Vectors – Filtering – Matrices – Creating Matrices – Applying Functions to Matrix Rows and Columns – Lists – Creating List – General List Operations – Data Frames – Creating Data Frames – Matrix like Operations in Frames – Applying Functions to Data Frames – Factors and Tables – Math and Simulations in R – Input/Output – Reading and Writing Files – Graphics – Creating Three-Dimensional Plots – Linear Models – Non-linear models – Clustering

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UNIT III DATA ANALYSIS USING R AND HADOOP 9

Features of R Language - HADOOP Features – HDFS and Map Reduce architecture – R and Hadoop Integrated Programming Environment- RHIPE Introduction – Architecture of RHIPE – RHIPE function reference. RHADOOP Introduction – Architecture of RHADOOP – RHADOOP function reference, SQL on HADOOP.

UNIT IV PROGRAMMING WITH PIG 9

Introduction – installation and execution – PIG Data Model – PIG Latin – Input, Output- Relational Operators – User Defined Functions – Join Implementations – Integrating Pig with Legacy Code and Map Reduce

UNIT V PROGRAMMING WITH HIVE 9

Introduction – Data Types and File Formats – HiveQL: Data Definition – Databases in Hive – Data Manipulation – Queries – Views

PRACTICAL EXERCISES 30

1. Perform descriptive and predictive analytics using "**R programming**"
2. Loading data into HDFS using R & Perform various **HDFS** commands
3. MapReduce application for word counting on **R HADOOP** after successful installation of three R packages (**rhdfs, rmr, and rhbase**)
4. "**Pig**" installation & **Develop Pig Scripts** and call **UDF's** to accomplish functionalities to meet the problem objectives & Embedding PIG Latin in Python

TOTAL: 75 PERIODS

REFERENCES

1. Data Science and Big Data Analytics – Discovering, Analysing, Visualizing and presenting data – EMC Education Services, EMC2, Wiley Publications, 2015.
2. Jared P. Lander, "R for Everyone: Advanced Analytics and Graphics", Addison-Wesley Data & Analytics Series, 2013.
3. Prajapati, V, "Big Data Analytics with R and Hadoop", Packt Publishing Ltd, 2013.
4. Gates, A. Programming Pig." O'Reilly Media, Inc.", 2011.
5. Capriolo, E., Wampler, D., &Rutherglen, J., "Programming Hive", O'Reilly Media, Inc.",2012
6. Tom White " Hadoop: The Definitive Guide" Third Edition, O"reilly Media, 2011.
7. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.
8. Norman Matloff , "The Art of R Programming: A Tour of Statistical Software Design", NoStarch Press, 2011.
9. Zikopoulos, P., Parasuraman, K., Deutsch, T., Giles, J., & Corrigan, D.V Harness the Power of Big Data The IBM Big Data Platform. McGraw Hill Professional, 2012.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Design the Big data using tools.

CO2:Design applications using R & HADOOP.

CO3:Design applications using RHADOOP& RHIPE.

CO4:Develop Pig scripts for Big data applications.

CO5:Design Big data applications schema and use HIVEQL.

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CO-PO Mapping

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

CP3252 **MACHINE LEARNING** **L T P C**
3 0 3 4.5

UNIT I INTRODUCTION TO DATA WAREHOUSING 9

Machine Learning–Types of Machine Learning : Supervised Learning, Unsupervised Learning – Machine Learning process- Testing machine learning algorithms - Parametric Vs non-parametric models - Mathematical Basics for Machine Learning : Probability and Statistics for Machine Learning – Probability Distributions – Decision Theory – Information theory – Bias Variance tradeoff.

UNIT II SUPERVISED LEARNING METHODS 9

Regression: Introduction - Linear Regression - Least Squares - Under fitting and Overfitting - Cross-Validation - Lasso Regression - Logistic Regression; Classification: Linear and Non-linear models -- Support Vector Machines - Kernel Methods; K-Nearest Neighbours; Learning with Trees: constructing Decision Tree using ID3 - Classification and regression trees (CART); Decision by Committee : Ensemble Methods -- Bagging -- Boosting -- Random Forest; Evaluation of Classification Algorithms.

UNIT III UNSUPERVISED AND REINFORCEMENT LEARNING 9

Clustering- K-means – Mixtures of Gaussians – Vector Quantization – The Self Organizing Feature Map- Dimensionality Reduction, Linear Discriminant Analysis, Principal Components Analysis, Independent Components Analysis - Reinforcement Learning : Q learning, Deterministic and Non-deterministic Rewards and Actions Temporal Difference Learning - Markov Decision Process.

UNIT IV PROBABILISTIC GRAPHICAL MODELS AND EVOLUTIONARY LEARNING 9

Graphical Models – Undirected Graphical Models : Markov Random Fields – Directed Graphical Models : Bayesian Networks – Conditional Independence properties – Markov Random Fields, Hidden Markov Models – Conditional Random Fields(CRFs) - Evolutionary Learning : The Genetic Algorithm , Generating offspring - Map Colouring, Punctuated Equilibrium - Example: The Knapsack Problem - Limitations of the GA.

UNIT V NEURAL NETWORKS AND DEEP LEARNING 9

Neural Networks: The Brain and the Neuron - Perceptron learning algorithm; Multi-Layer Perceptron: Back propagation algorithm - Multi-layer perceptron in Practice, Deep Learning: Introduction - Convolution Neural Networks - Recurrent Neural Networks – Stochastic Neurons : the Boltzmann Machine – Deep Belief Networks.

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SUGGESTED LIST OF EXPERIMENTS **45**

1. Problem solving using Regression models: Linear regression, Logistic regression and to evaluate the performance.
2. Problem solving using Classification: SVM, K-nearest Neighbour, and Decision Trees and evaluate the performance.
3. Solving problems based on Decision by committee approach: Bagging and Boosting application
4. Problem solving using unsupervised learning models: Clustering algorithms and to evaluate the performance.
5. Application of dimensionality reduction techniques for numeric and text and image data.
6. Game development and robotic application development using reinforcement learning model.
7. Implement Bayesian Inference in Gene Expression Analysis
8. Implement Sequential Learning using Hidden Markov Model
9. Application of CRFs in Natural Language Processing
10. Building and training Nueral networks using back propagation algorithm with gradient descent.
11. Image Classification using Convolutional Neural Networks with cross validation.

TOTAL: 90 PERIODS

REFERENCES

1. Stephen Marsland, “Machine Learning – An Algorithmic Perspective”, Chapman and Hall, CRC Press, Second Edition, 2014.
2. Christopher Bishop, “Pattern Recognition and Machine Learning” Springer, 2007.
3. Kevin P. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012.
4. EthemAlpaydin, “Introduction to Machine Learning”, MIT Press, Third Edition, 2014.
5. Tom Mitchell, “Machine Learning”, McGraw-Hill, 1997.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Explain the basic concepts of machine learning

CO2:Analyze linear and non-linear techniques for classification problems

CO3:Apply unsupervised and reinforcement algorithms, probabilistic and evolutionary approaches for the given problems

CO4:Analyze importance of neural networks in machine learning and deep learning.

CO5:Identify applications suitable for different types of Machine Learning and to Implement appropriate learning algorithm for an application and to analyze the results.

CO-PO Mapping

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

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CP3261 **PROFESSIONAL PRACTICES** **L T P C**
0 0 4 2

UNIT I EVOLUTION OF IT ORGANIZATIONS 12

Governance Structure-Decentralized and Ad Hoc Governance – Centralized Governance - Agile and DevOps- Digital Transformation and Cloud Computing- Continuous Governance and Automation – Vision, mission, and goals- Business verticals – Technology landscape – Offerings and revenues – Geography and niche products–Growth trajectory-Comprehend the roles and functions of supporting organizations (R&D, Innovation, Infrastructure, L&D, Knowledge Management, Asset Creation).

UNIT II PROJECT DEVELOPMENT LIFE CYCLE (PDLC) 12

Know Your Customer (KYC) process – Business case preparation – Cost-benefit analysis – Benchmarking – Approval and execution. Artefacts: User Requirements Specification (URS), System Requirements Specification (SRS), High-Level Design (HLD), Low-Level Design (LLD), testing phases

UNIT III CUSTOMER ACQUISITION PROCESS 12

Non-Disclosure Agreement (NDA) - Request for Information (RFI) - Request for Quotation (RFQ) - Request for Proposal (RFP) - Award of Contracts, Various types of Contracts such as Fixed Price (FP), Time and Material (T&M), Outcome-Based.

UNIT IV PROJECT EXECUTION MODELS 12

Water Fall, Agile, Incremental – Scrum Framework – Clauses in contracts – SDLC – Roles and Responsibilities – Industry 4.0 – Quality Requirements and Quality Management – NFR – Software Estimation – Research and Innovation – Risk Assessment and Risk Management-Code of Ethics.

UNIT V INDUSTRY STANDARDS 12

Cyber security & Data- governance – CMMI – Security standards (ISO27001) – Environment standard (ISO12000).

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Understand the IT organizations governance and various factors influencing them.

CO2:Understand the customer acquisition process and the working models of various IT organizations and services.

CO3:Understand the technologies for various requirements & develop competences in those respective technical areas to deliver transformational projects.

CO4:Understand the value creation by the supporting organisation to deliver world class software projects and to gain highest customer satisfaction to the QCD.

CO5:Apply breakthrough technical competencies in producing futuristic models, estimation of NFRs, Risks.

CO-PO Mapping

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

CP3351 **CYBER SECURITY** **L T P C**
3 0 0 3

UNIT I INTRODUCTION **9**

Need for Cyber security - History of Cyber security - Defining Cyberspace and Cyber security- Standards - CIA Triad – Cyber security Framework

UNIT II ATTACKS AND COUNTERMEASURES **9**

Malicious Attacks, Threats, and Vulnerabilities – Scope of cyber-attacks – Tools used to attack computer systems – security breach – Risks, vulnerabilities and threats. Malware – malicious software attack – social engineering attack – wireless network attack – web application attack
Access control - Audit – Authentication - Biometrics - Denial of Service Filters - Ethical Hacking – Firewalls - Scanning, Security policy, Threat Management - Applying software update and patches - Intrusion Detection Systems -Virtual Private Networks –Cryptographic Techniques

UNIT III SECURING THE INFRASTRUCTURE **9**

Infrastructure Security in the Real World - Understanding Access-Control and Monitoring Systems - Understanding Video Surveillance Systems - Understanding Intrusion-Detection and Reporting Systems

UNIT IV SECURING LOCAL HOSTS AND NETWORKS **9**

Local Host Security in the Real World - Securing Devices - Protecting the Inner Perimeter - Protecting Remote Access
Local Network Security in the Real World - Networking Basics - Understanding Networking Protocols - Understanding Network Servers - Understanding Network Connectivity Devices - Understanding Network Transmission Media Security

UNIT V TOOLS **9**

Zenmap – Hydra –Kismet – John the Ripper – Airgeddon – Deauther Board – Aircrack-ng – EvilOSX

TOTAL: 45 PERIODS

REFERENCES

1. William Stallings, Effective Cybersecurity: A Guide to Using Best Practices and Standards, 1st edition, 2019.
2. Charles J. Brooks, Christopher Grow, Philip A. Craig, Donald Short, Cybersecurity Essentials, Wiley Publisher, 2018.
3. Yuri Diogenes, ErdalOzkaya, Cyber security - Attack and Defense Strategies, Packt Publishers, 2018.

4. Carol C. Woody, Nancy R. Mead, Cyber Security Engineering: A Practical Approach forSystems and Software Assurance, Addison-Wesley, 2016.
5. Thomas A. Johnson Cyber Security- Protecting Critical Infrastructures from Cyber Attack andCyber Warfare, CRC Press, 2015.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Analyze and evaluate the cyber security needs of an organization.

CO2:Analyze the security issues in networks and computer systems to secure an infrastructure.

CO3:Design operational cyber security strategies and policies.

CO4:Apply critical thinking and problem-solving skills to detect current and future attacks on an organization's computer systems and networks.

CO5:Understand the functionality of cyber security tools.

CO-PO Mapping

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

BD3001 LINKED OPEN DATA AND ITS APPLICATIONS L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Introduction–Principles of Linked Data– URIs, RDF data model, RDF Serialisation, Relationship links, Identity links, Vocabulary Links– Linked Data Design Considerations–Web of Data– Bootstrapping – Topology

UNIT II RDF & SPARQL 9

RDF database systems–RDF and Semantic Web – Encoding, storage, indexing – Query processing – reasoning– SPARQL– Improving Linked Data quality

UNIT III PUBLISHING & CONSUMING LINKED OPEN DATA 9

Publishing Linked Data – Publishing patterns – Recipes for publishing – Consuming Linked– Data Querying Linked Data Architecture of Linked Data Applications - Advertising on the Web: Issues in Online Advertising - Online Algorithms - The Matching Problem

UNIT IV RECOMMENDATION SYSTEMS 9

Recommendation systems: A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering, Dimensionality Reduction

UNIT V LARGE-SCALE MACHINE LEARNING 9

Mining social network graphs – Social Networks as Graphs, Clustering of Social-Network Graphs, Discovery of Communities, Partitioning of Graphs, Overlapping Communities, Simrank, Counting

Triangles, Large scale machine learning– Machine-Learning Model, Perceptrons, SVM, Learning from Nearest Neighbours

TOTAL: 45 PERIODS

REFERENCES

1. Tom Heath, Christian Bizer: Linked Data: Evolving the Web into a Global Data Space, Morgan & Claypool Publishers, 2011.
2. David Wood: Linking Government Data", Springer Science & Business Media, 2011.
3. Jure Leskovec, AnandRajaraman, Jeffrey David Ullman: Mining of Massive Datasets, Cambridge University Press, Third Edition,2020.
4. Olivier Curé, Guillaume Blin: RDF Database Systems: Triples Storage and SPARQL Query Processing, Morgan Kaufmann, 2014.
5. Bob DuCharme: Learning SPARQL, "O'Reilly Media, Inc.", 2011

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Create, Store & Retrieve LOD.
CO2:Design methodologies for publishing & consuming LOD.
CO3:Use RDF & SPARQL to query LOD.
CO4:Design recommendation algorithms based on LOD.
CO5:Design algorithms for handling LOD using large-scale machine learning.

CO-PO Mapping

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

BD3002 DATA INTENSIVE COMPUTING L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Definition of data intensive computing - Data science - Big data -5Vs – Architecture - Data-intensive computing platforms: notion of parallel and distributed computing systems used in both HPC and commercial domains - similarities and differences in hardware and software stacks

UNIT II DATA PARALLEL FRAMEWORKS 9

Runtime and high-level programming frameworks in data-intensive computing - MapReduce/Hadoop, MPI/OpenMP/OpenCL, Spark, etc.

UNIT III FILE AND STORAGE SYSTEMS 9

Parallel I/O and storage systems for handling large amount of data efficiently – HDFS, MooseFS, iRODS, Ceph, GlusterFS, Lustre

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UNIT IV NOSQL DATA MODELS **9**

Key-value store (Dynamo) - column store (BigTable, HBase, Cassendra) - document-based (MongoDB, CouchDB) - object store - graph-based, etc.

UNIT V VIRTUALIZATION **9**

Data intensive computing under virtualization environment – OpenStack, Docker

TOTAL: 45 PERIODS

REFERENCES

1. Furht, Borko, and Armando Escalante, “Handbook of data intensive computing”, Springer Science & Business Media, 2011.
2. Tom White, “Hadoop: The Definitive Guide”, O'Reilly Media. October 2010.
3. Benjamin Depardon, Gaël Le Mahec, Cyril Séguin. Analysis of Six Distributed File Systems. [Research Report] 2013, pp.44. ⟨hal-00789086⟩
4. Radez, Dan. “OpenStack Essentials”. Packt Publishing Ltd, 2016.
5. Turnbull, James. “The Docker Book: Containerization is the new virtualization.”, 2014.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Design applications that involve data intensive computing.

CO2:Suggest appropriate architecture for data intensive computing systems.

CO3:Decide on the appropriate techniques of Map Reduce, Mongo DB, for the different applications.

CO4:Identify parallel processing techniques for data intensive computing.

CO-PO Mapping

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

BD3003 DATA VISUALIZATION **L T P C**

3 0 0 3

UNIT I INTRODUCTION **9**

Context of data visualization – Definition, Methodology, Visualization design objectives. Key Factors – Purpose, visualization function and tone, visualization design options – Data representation, Data Presentation, Seven stages of data visualization, widgets, data visualization tools.

UNIT II VISUALIZING DATA METHODS **9**

Mapping - Time series - Connections and correlations – Indicator-Area chart-Pivot table- Scatter charts, Scatter maps - Tree maps, Space filling and non-space filling methods-Hierarchies and Recursion - Networks and Graphs-Displaying Arbitrary Graphs-node link graph-Matrix representation for graphs- Info graphics

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UNIT III DATA VISUALIZATION USING R **9**

Reading and getting data into R (External Data): Using CSV files, XML files, Web Data, JSON files, Databases, Excel files. Working with R Charts and Graphs: Histograms, Boxplots, Bar Charts, Line Graphs, Scatter plots, Pie Charts

UNIT IV INTERACTIVE DATA VISUALIZATION **9**

Drawing with data – Scales – Axes – Updates, Transition and Motion – Interactivity - Layouts – Geomapping – Exporting, Framework – T3, .js, tableau

UNIT V SECURITY DATA VISUALIZATION **9**

Port scan visualization - Vulnerability assessment and exploitation - Firewall log visualization - Intrusion detection log visualization -Attacking and defending visualization systems – Creating security visualization system.

TOTAL: 45 PERIODS

REFERENCES

1. Scott Murray, “Interactive data visualization for the web”, O‟Reilly Media, Inc., 2013
2. Jared P. Lander, “R for Everyone: Advanced Analytics and Graphics”, Addison Wesley Data & Analytics Series, 2013.
3. Ben Fry, “Visualizing Data”, O‟Reilly Media, Inc., 2007.
4. Greg Conti, “Security Data Visualization: Graphical Techniques for Network Analysis”, NoStarch Press Inc, 2007.
5. Matthew O. Ward, George Grinstein, Daniel Keim, “Interactive Data Visualization: Foundation, Techniques and Applications”, Second Edition, A. K. Peters/CRC Press, 2015.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Understand the representation of complex and voluminous data.
CO2:Design and use various methodologies present in data visualization.
CO3:Understand the various process and tools used for data visualization.
CO4:Use interactive data visualization to make inferences.
CO5:Discuss the process involved and security issues present in data visualization.

CO-PO Mapping

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

BD3004 REAL TIME DATA STREAMING **L T P C**
3 0 0 3

UNIT I INTRODUCTION TO DATA STREAMS **9**

Data stream models - basic streaming methods– applications. Change detection - maintaining histograms from data streams

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UNIT II STREAM MINING ALGORITHMS 9

Evaluating streaming algorithms - learning from data streams - evaluation issues – open issues. Clustering from data streams - clustering examples - clustering variables. Frequent pattern mining - frequent Itemset mining - heavy hitters - mining frequent item set from data streams - sequence pattern mining.

UNIT III CLASSIFICATION METHODS IN DATA STREAMS 9

Decision trees from data streams - very fast decision tree algorithm (VFDT) – extensions - OLIN: info-fuzzy algorithms. Novelty detection in data streams -learning and novelty - novelty detection as a one-class classification problem - learning new concepts - the online novelty and drift detection algorithms.

UNIT IV ANALYSIS OF STREAM DATA 9

Multi-dimensional analysis of data - architecture for on-line analysis of data streams - stream data cube computation. Load shedding in data stream systems - load shedding for aggregation queries - load shedding in aurora - load shedding for sliding window joins - load shedding for classification queries.

UNIT V ADVANCED CONCEPTS ON STREAM COMPUTING 9

Synopsis construction in data streams - sampling methods - wavelets – sketches – histograms. Join processing in data streams - indexing and querying data streams - dimensionality reduction and forecasting on streams - distributed mining of data streams.

TOTAL: 45 PERIODS

REFERENCES

1. Charu C. Aggarwal, “Data Streams: Models and Algorithms”, Kluwer Academic Publishers, Springer 2007 Edition.
2. Joao Gama, “Knowledge Discovery from Data Streams”, CRC Press, 2010.
3. Byron Ellis, “Real Time Analytics: Techniques to Analyze and Visualize Streaming Data”, John Wiley and Sons, 2014.
4. Shilpi Saxena, Saurabh Gupta, “Practical Real-time Data Processing and Analytics”, Pack publishing 2017.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Understand the applicability and utility of different machine learning algorithms.
CO2:Describe and apply current research trends in data-stream processing.
CO3:Analyze the suitability of stream mining algorithms for data stream systems.
CO4:Program and build stream processing systems, services and applications.
CO5:Solve problems in real-world applications that process data streams.

CO-PO Mapping

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

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BD3005 **BIG DATA ACQUISITION** **L T P C**
3 0 0 3

UNIT I INTRODUCTION TO BIG DATA ACQUISITION 6

Big Data framework - fundamental concepts of Big Data management and analytics – Current challenges and trends in Big Data Acquisition.

UNIT II DATA COLLECTION AND TRANSMISSION 9

Big data collection- Strategies- Types of data sources- Structured vs Unstructured data- ELT vs ETL - storage infrastructure requirements -collection methods-log files- Sensors- Methods for acquiring network data (Libcap-based and zero-copy packet capture technology) –Specialized network monitoring softwares (Wireshark, Smartsniff and Winnetcap)- Mobile equipments - Transmission methods- Issues.

UNIT III DATA PRE-PROCESSING 9

Data pre-processing overview-Sampling - Missing Values - Outlier Detection and Treatment - Standardizing Data - Categorization - Weights of Evidence Coding - Variable Selection and Segmentation.

UNIT IV DATA ANALYTICS 12

Predictive Analytics: Regression, Decision Tree, Neural Networks - Descriptive Analytics: Association Rules, Sequence Rules, Survival Analysis: Survival Analysis Measurements, Kaplan Meir Analysis, Parametric Survival Analysis - Social Network Analytics: Social Network Learning - Relational Neighbor Classification.

UNIT V TOOLS AND APPLICATIONS 9

Popular Big Data Techniques and tools- Map Reduce paradigm and the Hadoop system
Big Data Infrastructures - Big Data Security - Big Data Applications – Finance, Healthcare

TOTAL: 45 PERIODS

REFERENCES

1. Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", John Wiley & Sons, 2014
2. Min Chen, Shiwen Mao, Yin Zhang, Victor CM Leung,Big Data: Related Technologies, Challenges and Future Prospects, Springer, 2014.
3. Michael Minelli, Michele Chambers, Ambiga Dhiraj ,"Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends", John Wiley & Sons, 2013.
4. Raj, Pethuru, "Handbook of Research on Cloud Infrastructures for Big Data Analytics", IGI Global.
5. Jeyaraj, Rathinaraja, Ganeshkumar Pugalendhi, and Anand Paul. "Big Data with Hadoop MapReduce: A Classroom Approach", CRC Press, 2020.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Identify the various sources of Big Data.
CO2:Apply several key big data technologies used for storage, analysis and manipulation of data.
CO3:Design new algorithms for collecting Big Data from various sources.
CO4:Design algorithms for pre-processing Big Data other than the traditional approaches.
CO5:Design methodologies to extract data from structured and un-structured data for analytics.

CO-PO Mapping

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

CP3056 CLOUD COMPUTING TECHNOLOGIES L T P C
3 0 2 4

UNIT I DISTRIBUTED SYSTEMS AND ENABLING TECHNOLOGIES 9

Technologies for network based systems - System Models for Distributed and Cloud Computing - Clustering for Massive Parallelism - Design Principles of Computer Clusters - Cluster Job and Resource Management.

UNIT II VIRTUALIZATION 9

Implementation Levels of Virtualization - Virtualization Structures, Tools and Mechanisms - Virtualization of CPU, Memory, and I/O Devices - Virtual Clusters and Resource Management - Virtualization for Data-Center Automation.

UNIT III CLOUD COMPUTING 9

Characteristics - Service Models: IaaS, PaaS, SaaS - Deployment Models: Public, Private, Community, Hybrid Clouds - Data-Center Design and Interconnection Networks - Architectural Design.

UNIT IV EXPLORING CLOUD PLATFORMS AND SERVICES 9

Compute Services – Storage Services – Database Services – Application Services – Content Delivery Services – Analytics Services – Deployment and Management Services – Identity and Access Management Services – Open Source Private Cloud Softwares.

UNIT V SECURITY AND INTER-CLOUD 9

Trust Management - Defence Strategies - Distributed Intrusion/Anomaly Detection - Data and Software Protection Techniques - Reputation-Guided Protection of Data Centers - Inter-cloud Resource Management.

PRACTICAL EXERCISES 30

1. Experiment with public SaaS.
2. Create a software using public PaaS.
3. Experiment storage services in cloud.
4. Create VMs in public cloud platforms.
5. Experiment with load balancing.
6. Experiment with elasticity in the cloud.
7. Interlink storage services with VMs.
8. Set up a virtual private cloud using public cloud platforms.
9. Set up an open source private cloud.

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10. Experiment with CLI in the open source private cloud.

TOTAL: 75 PERIODS

REFERENCES

1. Kai Hwang, Geoffrey C Fox, Jack J Dongarra, “Distributed and Cloud Computing From Parallel Processing to the Internet of Things”, Morgan Kauffman imprint of Elsevier, 2012.
2. Arshdeep Bahga, Vijay Madisetti, “Cloud Computing: A Hands-On Approach”, Universities Press (India) Private Limited, 2014.
3. James E Smith and Ravi Nair, “Virtual Machines”, Elsevier, 2005.
4. Thomas Erl, Zaigham Mahood, Ricardo Puttini, “Cloud Computing, Concept, Technology & Architecture”, Prentice Hall, 2013.
5. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, “Mastering Cloud Computing”, Tata McGraw-Hill, 2013.
6. Toby Velte, Anthony Velte, Robert C. Elsenpeter, “Cloud Computing, A Practical Approach”,Tata McGraw-Hill Edition, 2010.
7. Tom White, “Hadoop: The Definitive Guide”, O’Reilly Media, 4th Edition, 2015.
8. John Rittinghouse and James Ransome, “Cloud Computing Implementation, Management and Security”, CRC Press, 2010.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Articulate the main concepts, key technologies, strengths and limitations of cloud computing.
CO2:Identify the architecture, infrastructure and delivery models of cloud computing.
CO3:Explain the core issues of cloud computing such as security, privacy and interoperability.
CO4:Choose the appropriate technologies, algorithms and approaches for the related issues.
CO5:Set up and use cloud platforms and services.

CO-PO Mapping

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

CP3063 ETHICAL HACKING L T P C
3 0 0 3

UNIT I INTRODUCTION TO HACKING 9

Penetration Test – Vulnerability Assessments versus Penetration Test – Pre-Engagement – Rules of Engagement –Penetration Testing Methodologies – OSSTMM – NIST – OWASP – Categories of Penetration Test – Types of Penetration Tests – Vulnerability Assessment Summary –Reports.

UNIT II INFORMATION SECURITY 9

Types of malware – Types of Vulnerabilities- Types of attacks and their prevention mechanism - Keystroke Logging - Denial of Service (DoS /DDoS) - Waterhole attack -brute force -phishing and fake WAP- Eavesdropping- Man-in-the-middle- Session Hijacking -Clickjacking -Cookie Theft -

URL Obfuscation- buffer overflow- DNS poisoning -ARP poisoning -Identity Theft - IoT Attacks - BOTs and BOTNETs

UNIT III INFORMATION GATHERING AND SCANNING 9

Information Gathering Techniques – Active Information Gathering – Passive Information Gathering – Sources of Information Gathering – Tracing the Location – Traceroute – ICMP Traceroute – TCP Traceroute – Usage – UDP Traceroute – Enumerating and Fingerprinting the Webservers – Google Hacking – DNS Enumeration – Enumerating SNMP – SMTP Enumeration – Target Enumeration and Port Scanning Techniques – Advanced Firewall/IDS Evading Techniques.

UNIT IV EXPLOITATION 9

Introduction to Metasploit – Reconnaissance with Metasploit – Port Scanning with Metasploit – Compromising a Windows Host with Metasploit – Client Side Exploitation Methods – E–Mails with Malicious Attachments – Creating a Custom Executable – Creating a Backdoor with SET – PDF Hacking – Social Engineering Toolkit – Browser Exploitation – Post–Exploitation – Acquiring Situation Awareness – Hashing Algorithms – Windows Hashing Methods – Cracking the Hashes – Brute force Dictionary Attacks – Password Salts –Rainbow Tables – John the Ripper – Gathering OS Information – Harvesting Stored Credentials.

UNIT V ENTERPRISE SECURITY 9

Gaining and Maintaining Access : Systems hacking – Windows and Linux – Metasploit and Kali Linux, Keylogging, Buffer Overflows, Privilege Escalation, Network hacking - ARP Poisoning, Password Cracking, WEP Vulnerabilities, MAC Spoofing, MAC Flooding, IPSpoofing, SYN Flooding, Smurf attack, Applications hacking : SMTP/Email-based attacks, VOIP vulnerabilities, Directory traversal, Input Manipulation, Brute force attack, Unsecured login mechanisms, SQL injection, XSS, Mobile apps security, Malware analysis : Netcat Trojan, wrapping definition, reverse engineering, Additional Security Mechanisms : IDS/IPS, Honeypots and evasion techniques, Secure Code Reviews (Fortify tool, OWASP Secure Coding Guidelines)

TOTAL: 45 PERIODS

REFERENCES

1. Rafay Baloch, “Ethical Hacking and Penetration Testing Guide”, CRC Press, 2014.
2. Certified Ethical Hacker Study Guide v9, Sean-Philip Oriyano, Sybex; Study Guide Edition,2016
3. CEH official Certified Ethical Hacking Review Guide, Wiley India Edition, 2007
4. Patrick Engebretson, “The Basics of Hacking and Penetration Testing – Ethical Hacking and Penetration Testing Made Easy”, Syngress Media, Second Revised Edition, 2013
5. Michael T. Simpson, Kent Backman, James E. Corley, “Hands-On Ethical Hacking and Network Defense”, Cengage Learning, 2012
6. Kevin Beaver, “Ethical Hacking for Dummies”, Sixth Edition, Wiley, 2018.
7. Jon Erickson , “Hacking: The Art of Exploitation”, Second Edition, Rogunix, 2007

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Use the various security tools to assess the computing system.

CO2:Predict the vulnerabilities across any computing system using penetration testing

CO3:Identify prediction mechanism to prevent any kind of attacks

CO4:Protect the system from malicious software and worms

CO5: Analyze the risk and support the organization for effective security measures**.**

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CO-PO Mapping

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

CP3062 DIGITAL IMAGE AND VIDEO PROCESSING L T P C
3 0 2 4

UNIT I FUNDAMENTALS OF IMAGE PROCESSING 9+6

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

UNIT II IMAGE ENHANCEMENT AND RESTORATION 9+6

Image Transforms – Enhancement in the Spatial Domain –Enhancement in the Frequency Domain– Image restoration.

UNIT III IMAGE SEGMENTATION AND MORPHOLOGY 9+6

Detection of Discontinuities – Edge operators- Edge Linking and Boundary Detection – Thresholding – Region Based Segmentation – Motion Segmentation- 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 BASICS OF VIDEO PROCESSING 9+6

Introduction – Video Sampling and Interpolation- Motion Detection and Estimation – Video Enhancement and Restoration

UNIT V VIDEO SEGMENTATION, TRACKING &APPLICATIONS 9+6

Video Segmentation- Motion Segmentation- Motion Tracking in Video-Video Quality Assessment-Case Studies –Image processing in Biometrics, Image Security, Steganography and Watermarking, Stereo vision, Object Segmentation and Tracking in the Presence of Complex Background in video, Forensic video analysis.

LIST OF EXPERIMENTS 30

1. Intensity Transformations
2. Filtering in the Spatial domain
3. Filtering in the Frequency Domain
4. Image Restoration
5. Detection of Discontinuities
6. Region Based Segmentation
7. Morphological operations
8. Feature Extraction
9. Feature Selection

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10. Motion Detection and Estimation
11. Video Enhancement and Restoration
12. Video Segmentation
13. Motion Tracking in Video
14. Steganography
15. Watermarking

TOTAL: 75 PERIODS

REFERENCES

1. Rafael C.Gonzalez and Richard E.Woods, “Digital Image Processing”, Third Edition, Pearson Education, New Delhi, 2008
2. Al Bovik (Alan C Bovik, “The Essential Guide to Video Processing”, Academic Press, Second Edition, 2009.
3. S.Sridhar, “Digital Image Processing”, Oxford University Press, New Delhi, 2011.
4. Murat Tekalp, “Digital Video Processing”, Prentice Hall, 2015.
5. Oges Marques, “Practical Image and Video Processing Using MATLAB”, Wiley-IEEE Press, 2011.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Have a clear impression of the breadth and practical scope of digital image processing and have arrived at a level of understanding that it is the foundation for most of the work currently underway in this field.

CO2:Critically analyze the role of video in modern technologies.

CO3:Implement basic image and video processing algorithms.

CO4:Design and develop various applications that incorporate different techniques of Image and Video processing.

CO5:Apply and explore new techniques in the areas of Image and Video Processing.

CO-PO Mapping

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

CP3073 PRINCIPLES OF CRYPTOGRAPHY L T P C
3 0 0 3

UNIT I MATHEMATICAL PRELIMINARIES 9

Group, cyclic group, cyclic subgroup, field, probability. Number Theory: Fermat's theorem , Cauchy 's theorem, Chinese remainder theorem, primality testing algorithm, Euclid's algorithm for integers, quadratic residues, Legendre symbol, Jacobi symbol etc.

UNIT II CRYPTOGRAPHY AND ATTACKS 9

Classical Cryptography, substitution cipher, different type of attack: CMA,CPA,CCA etc, Shannon perfect secrecy, OTP, Pseudo random bit generators, stream ciphers and RC4

UNIT III SYMMETRIC KEY ENCRYPTIONS 9

Block ciphers: Modes of operation, DES and its variants, AES, Blowfish and Two fish encryption, linear and differential cryptanalysis.

UNIT IV PUBLIC KEY ENCRYPTION AND HASH FUNCTION 9

RSA cryptosystem, Elliptic curve cryptosystems, homomorphic encryption, Diffie-Hellman key exchange algorithm, Elgamal Cryptosystem, Cryptographic hash functions MD5, SHA

UNIT V DIGITAL SIGNATURES 9

Digital signatures - notion of existential unforgability under chosen message attacks, Schnorr signature scheme. Zero Knowledge Proofs and Protocols,

TOTAL: 45 PERIODS

REFERENCES

1. B. Schneier, Applied Cryptography, 2nd edition, J. Wiley and Sons.
2. N. Ferguson, B. Schneier and T. Kohno, Cryptography Engineering: Design, Principles and Practical Applications, Wiley Publishing,
3. Wade Trappe, Lawrence C Washington, “Introduction to Cryptography with coding theory”, 2nd ed, Pearson, 2007.
4. Charles P. Pfleeger, Shari Lawrence Pfleeger – Security in computing Third Edition –
5. Prentice Hall of India, 2006
6. W. Mao, “Modern Cryptography – Theory and Practice”, Pearson Education, Second Edition, 2007.
7. Douglas R Simson “ Cryptography – Theory and Practice”, CRC Press, 1995
8. William Stallings, “Cryptography and Network security Principles and Practices”, Pearson/PHI, March 2013
9. Jonathan Katz and Yehuda Lindell, “Introduction to Modern Cryptography”, 2
10. nd edition, CRC Press, 2015.
11. Paar C, Pelzl J. Understanding cryptography: a textbook for students and practitioners. Springer Science & Business Media, 2009.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Present the exploitation present in the security and learn the basic protocols
CO2:Apply the different cryptographic operations and key exchange protocols
CO3:Apply zero knowledge proofs and Exchange of Secrets
CO4:Analyze various cryptography techniques and its applications
CO5:Apply cryptographic Hash function to the real world application to achieve secured system.

CO-PO Mapping

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

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CP3068 **INTERNET OF THINGS** **L T P C**
3 0 2 4

UNIT I ARCHITECTURES AND MODELS 9+6

Introduction to IoT – Sensor networks- M2M to IoT, 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.

UNIT II CONNECTIVITY 9+6

Communications Criteria –PHY/MAC layer- Network Layer–Transport Layer –Application Transport Methods– Application Layer-Interoperability in IoT.

UNIT III SYSTEM DEVELOPMENT 9+6

Design Methodology –Case study –Basic blocks of IoT device –Raspberry Pi –Board, Interfaces, Linux, Sensors, Programming –Arduino –Other IoT Devices.

UNIT IV DATA ANALYTICS AND IoT SECURITY 9+6

Data Analytics for IoT –Big Data Analytics Tools and Technology –Cloud of Things-Edge Streaming Analytics –Network Analytics, Applications. Security history, challenges, variations – Risk Analysis Structures –Application in Operational Environment.

UNIT V IoT IN INDUSTRY 9+6

Introduction to Industrial Automation, Architecture, Protocols –Utilities, Grid Blocks-Smart Cities, Architecture, Use cases –Transportation, UAV, Health care, Architecture.

TOTAL: 75 PERIODS

REFERENCES

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, “IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things”, Cisco Press, 2017
2. Olivier Hersent, David Boswarthick, Omar Elloum, “The Internet of Things Key applications and Protocols”, Wiley, 2012.
3. Michael Miller, “The Internet of Things”, Pearson Education, 2015.
4. ArshdeepBahga, Vijay Madisetti, “Internet of Things –A hands-on approach”, Universities Press, 2015.
5. 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.
6. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), “Architecting the Internet of Things”, Springer, 2011.
7. Matt Richardson & Shawn Wallace, Getting Started with Raspberry Pi, O'Reilly(SPD), 2014
8. Sudip Misra, Chandana Royand Anandarup Mukherjee, “Introduction to Industrial Internet of Things and Industry 4.0”, CRC Press.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1;Explain the underlying architectures and models in IoT.

CO2:Analyze different connectivity technologies for IoT.

CO3:Develop simple applications using Arduino / Raspberry Pi.

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CO4:Apply data analytics techniques to IoT.
CO5:Study the needs and suggest appropriate solutions for Industrial applications

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	3	4	5	6
CO2	3	-	3	2	-	-
CO3	3	-	3	2	-	-
CO4	3	3	2	3	-	
CO5	3	2	2	2	-	3

CP3052 ADVANCED SOFTWARE ENGINEERING L T P C
3 0 0 3

UNIT I PROCESS MODELS 9

Prescriptive process models – Specialized process models –The Unified Process – Personal and Team Software process – Product and Process – Agile development – Extreme Programming – Other Agile process models – Human aspects of Software Engineering

UNIT II REQUIREMENTS MODELING 9

Requirement analysis and specification – Requirements gathering and analysis – Software Requirement Specification – Formal system specification – Finite State Machines – Petrinets – Object modelling using UML – Use case Model –Scenario based methods–Class based methods– Behaviour, Patterns and Web/Mobile Apps

UNIT III ARCHITECTURE AND DESIGN CONCEPTS 9

Software design – Design process – Design concepts – Coupling – Cohesion – Functional independence – Design patterns – Model-view-controller – Publish-subscribe – Adapter – Command – Strategy – Observer – Proxy – Facade – Architectural styles – Layered - Client-server - Tiered - Pipe and filter.- User interface design

UNIT IV SOFTWARE QUALITY AND TESTING 9

Garvin's Quality dimensions–McCall's Quality factors– Review Techniques–Elements of Software Quality Assurance–SQA Processes and Product Characteristics–SQA Tasks, Goals, and Metrics–Statistical Software Quality Assurance–Software Reliability–The ISO 9000 Quality Standards–SQA Plan Software Testing Strategies - Testing Conventional Applications–Testing Object Oriented Applications–Testing Web applications–Testing Mobile Apps

UNIT V DEVOPS 9

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

TOTAL: 45 PERIODS

REFERENCES

1. Roger S. Pressman, "Software Engineering – A Practioner's Approach", MC Graw Hill, 8th edition.
2. Ian Sommerville, "Software Engineering", Addison-Wesley, 9th Edition, 2010

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3. Len Bass, Ingo Weber and Liming Zhu, “DevOps: A Software Architect‘s Perspective”, Pearson Education, 2016.
4. Bernd Bruegge, Allen H. Dutoit, “Object-Oriented Software Engineering”, Prentice Hall,Third Edition, 2009.
5. Robert E. Filman, Tzilla Elrad, Siobhán Clarke, Mehmet Aksit, “Aspect-Oriented Software Development”, Addison-Wesley Professional, 2004.
6. Renu Rajni, Pradeep Oak, “Software Testing: Effective Methods, Tools and Techniques”,Tata McGraw Hill, 2004.
7. Jonathan Bowen, “Formal Specification and Documentation using Z – A Case Study Approach”, Intl Thomson Computer Press, 1996.
8. Antoni Diller, “Z: An Introduction to Formal Methods”, Wiley, 1994.
9. James Shore, Shane Warden “The Art of Agile Development – Pragmatic guide to agile software development”, O’Reilly Media, October 2007.
10. Ken Schwaber, “Agile Project Management with SCRUM”, Microsoft Press, 2004.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Select Appropriate Process Model for Software Development.
CO2:Analyze user requirements and design S/W using object-oriented methodology in UML
CO3:Apply the various design patterns in software development
CO4:Incorporate appropriate quality factors and standards during Software Development
CO5:Apply software testing techniques in various software development stages
CO6:Understand the application of DevOps for software development

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	2	-	2
CO2	2	1	3	2	-	2
CO3	1	1	3	2	-	2
CO4	3	1	3	3	-	2
CO5	1	1	3	1	-	1
CO6	2	1	3	2	-	2

CP3060 DEEP LEARNING L T P C
3 0 2 4

UNIT I BASICS FOR DEEP LEARNING 9

Mathematical Preliminaries of Deep learning: Linear Algebra, Probability and Information Theory, Numerical Computations – Machine Learning Basics: Learning Algorithms, Overfitting Vs Under fitting, maximum likelihood estimation - MSE, Activation functions and Cost functions –Challenges motivating Deep Learning.

UNIT II INTRODUCTION TO DEEP LEARNING 9

Basic concept of Neurons – Perceptron Learning – Multilayer Perceptrons -Deep Feed Forward Networks - Back Propagation – Data representation for Neural Networks - Datasets for deep learning- cross validation - Bias-Variance Tradeoff- Gradient based optimization – Regularization

for Deep learning : Parameter norm Penalties, data set augmentation, Dropout, Multi task learning, Early stopping – Hyperparameters for deep learning.

UNIT III CONVOLUTIONAL NEURAL NETWORKS 9

CNN Architectures – Convolution – Pooling – Training a Convnet: weights initialization - batch normalization - hyper parameter optimization and batch normalization - Transfer Learning – Pretraining, fine-tuning – Pretrained CNN networks – Visualizing CNN Learning – Case Study : Image Classification using CNNs .

UNIT IV SEQUENCE MODELING USING RECURRENT NETS 9

Recurrent Neural Networks (RNN) - Bidirectional RNN - Long Short-Term Memory (LSTM) - GRU – Attention and Applications -GPT, BERTs and Variants -Encoder-decoder sequence to sequence architectures – Recursive Neural Networks - Performance metrics for text processing- Case Study – Text generation with LSTM, Speech Processing and Image Captioning using RNNs.

UNIT V UNSUPERVISED AND DEEP GENERATIVE MODELS 9

Types of Autoencoder - Variational Autoencoders - Generative Adversarial Networks : GAN framework , Generator training, Discriminator training, Convergence of GAN, KL-Divergence for GAN– Boltzmann Machines– Restricted Boltzmann Machine-Deep Boltzmann Machines- Deep Belief Networks-Boltzmann Machine for Real valued data Case Study: Text-to-Image Synthesis using GAN, Image generation with Generative Adversarial Networks.

PRACTICAL EXERCISES 30

Environment : TensorFlow/Keras

Processor : GPU or Cloud GPUs

1. Implement a perceptron to evaluate logical operations including XOR
2. Implement a Multi-Layer Perceptron and train the model using feed forward algorithm.
3. Build a MLP and train it using backpropagation algorithm with gradient decent optimization
4. Demonstrate the contexts of under fitting, Overfitting and good fit with MLP and generalize the model you built.
5. Build and evaluate a convolutional Neural Network model for image classification
6. Implement Transfer Learning concept for Sentence classification in Convolutional Neural Networks.
7. Build and evaluate variational autoencoder for image generation
8. Build and evaluate RNN structure (LSTM/GRU) to do PoS tagging, Sentence Classification, and Text Generation.
9. Build a GAN to generate image from text and evaluate the performance.
10. Implement Sentiment Analysis using Recursive Neural Networks
11. Build a Deep learning model for speech recognition
12. Implement Object Detection using Yolo V6
13. Build a Deep learning model to summarize a video with Attention Models
14. Build a Deep Learning model to evaluate energy efficiency in IoT devices.

TOTAL: 75 PERIODS

REFERENCES

1. Ian Good Fellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2017.
2. Francois Chollet, “Deep Learning with Python”, Manning Publications, 2018.
3. Josh Patterson, Adam Gibson, "Deep Learning: A Practitioner’s Approach”, O’Reilly Media, 2017.

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4. Ragav Venkatesan, Baoxin Li, “Convolutional Neural Networks in Visual Computing”, CRC Press, 2018.
5. Joshua F. Wiley, “R Deep Learning Essentials”, Packt Publications, 2016.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Understand the role of Applied Mathematics and the need of Deep learning.

CO2:To optimize and generalize deep neural networks for better performance.

CO3:To design and implement Convolutional and recurrent Neural Networks and Critically Analyse in Image and text Related Projects

CO4:To design and implement Deep Learning Applications.

CO5:To learn deep generative networks implications in unsupervised learning.

CO-PO Mapping

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

CP3082 WEB CONTENT DESIGN AND MANAGEMENT L T P C
3 0 2 4

UNIT I PRINCIPLES OF WEB DESIGN 9+6

User Centered Design, Web Medium, Information Architectures, Site types and Architectures, Page Structure, Site Maps, Navigation, Search, Web Design Process, Designing for multiple screen resolutions, creating a unified site design, Evaluating Web Sites.

UNIT II ELEMENTS OF PAGE DESIGN 9+6

Elements of Page Design, Adding styles with CSS, Pages and Layout, Typography, Color, Images, GUI Widgets and Forms, responsive web designs, User input forms, Working with data tables, Web standards and styles.

UNIT III WEB CONTENT DESIGN 9+6

Features – Automated templates – Template processor –Front Controller pattern – content modeling – content aggregation – plug-ins – Search Engine Optimization – recommended usageof tools — WORDPRESS

UNIT IV WEB CONTENT MANAGEMENT 9+6

Work flow management – document management – collaboration – versioning – recommended usage of tools — WORDPRESS

UNIT V WEB ANALYTICS 9+6

Web Analytics process – Data collection – qualitative analysis – log file analysis – Page Tagging – hybrid methods – click analytics – onsite and offsite analytics – web analytics methods

TOTAL: 75 PERIODS

REFERENCES

1. Patrich J. Lynch, Sarah Horton, "Web Style Guide-Foundations of User ExperienceDesign",Yale University Press, 4th Edition, 2016.
2. Thomas A. Powell, "The Complete Reference– Web Design", Tata McGraw Hill,Second Edition, 2003
3. Joel Sklar, —– Principles of Web Design, Cengage Learning –Web Warrior Series, 6thEdition,2015.
4. Deane Barker, "Web Content management-Systems, Features and Best Practices", O'reillyMedia, 1st Edition, 2016.
5. Brian Clifton, "Advanced web Metrics with Google Analytics", Third Edition, Sybex Publishers, 2012.
6. AvinashKaushik, Web Analytics 2.0: The Art of Online Accountability and Science of Customer Centricity, 1st edition, Sybex publishers, 2009.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Design web pages that follow standards and are usable.

CO2:Design web sites that are appealing.

CO3:Appreciate the usage of Content management System for designing webContent.

CO4:Take advantage of Content Management System tools for managing content for large web sites.

CO5:Use analytics tools for better management.

CO-PO Mapping

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

CP3075 SEMANTIC WEB L T P C
3 0 0 3

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.

Attested

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 TOOL 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

REFERENCES

1. Pascal Hitzler, Markus Krötzsch, Sebastian Rudolph, “Foundations of Semantic Web Technologies”, Chapman & Hall/CRC, 2009.
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, 2004.
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.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Create ontology for a given domain.
CO2:Develop an application using ontology languages and tools.
CO3:Understand the concepts of semantic Web.
CO4:Use ontology related tools and technologies for application creation.
CO5:Design and develop applications using semantic web.
CO6:Understand the standards related to semantic web.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	1	2	3
CO2	3	-	3	2	3	3
CO3	2	1	1	1	1	3
CO4	3	-	2	3	2	3
CO5	3	-	3	2	3	3
CO6	2	-	1	1	1	3

Attested

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CP3070 MOBILE APPLICATION DEVELOPMENT L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Mobile applications – Characteristics and Benefits – Application Model – Frameworks and Tools – Mobile OS: Android, iOS – versions with its features – Android architecture –ART(Android Runtime) – ADB(Android Debug Bridge) – Application framework basics

UNIT II USER INTERFACE DESIGN 9

Designing the right UI – GUI for Android – activity and its lifecycle – Material Design: new themes, new widgets, Cardlayouts – Backward compatibility – v7 appcompat library – Intent object, intent filters, adding categories – Menus – fragment and its lifecycle

UNIT III DATA PERSISTENCE 9

Different Data persistence schemes – content provider and resolver – shared preferences – saved instance – file read/write operations – SQLite database – Android in build content providers – user content provider

UNIT IV ANDROID SERVICE COMPONENT 9

Intent Service – Remote service – Service handlers – communication between service and Activity – Broadcast Receivers: Local Broad cast Manager, Dynamic Broad cast Receiver – System Broadcast – Pending Intent, Notifications – Packaging and deployment

UNIT V ANDROID APPLICATION DEVELOPMENT 9

Communication via the web – Telephony Manager: Sending SMS and making calls – Google maps service using API – Publishing Android Apps: Guidelines, policies and process of uploading Apps to Google Play

TOTAL: 45 PERIODS

REFERENCES

1. Reto Meier, “Professional Android 4 Application Development”, Wiley, 2012
2. Wei-Meng Lee, “Beginning Android Application Development”, Wiley Publishing, 2011
3. Zigurd Mednieks, Laird Dornin, G. Blake Meike, Masumi Nakamura, “Programming
4. Android”, O’Reilly, 2011
5. Rick Rogers, John Lombardo, Zigurd Mednieks, Blake Meike, “Android Application Development”, O’Reilly, 2010

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Acquire the knowledge on Android OS and its features.
CO2:Acquire knowledge on GUI design required for Android App development.
CO3:Apply the knowledge of persistence Data storage mechanism in Android Apps.
CO4:Develop web based mobile application that accesses internet and location data.
CO5:Apply the knowledge in App development using telephony and Google Map services
CO6:Design and apply the knowledge to publish Android applications into Market

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CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	1
CO2	3	3	3	3	3	3
CO3	3	3	3	1	3	1
CO4	3	3	3	3	1	1
CO5	3	3	3	1	3	3
CO6	3	3	3	3	3	3

CP3055 BLOCKCHAIN TECHNOLOGIES L T P C
3 0 2 4

UNIT I INTRODUCTION 9

Blockchain Overview-History and Origin of Blockchain - Technical Concepts of Blockchain Systems: - Physical Ledger Technology and Security - Digital Ledger Technology, Digital Security Technology: - Cryptographic Hash Functions - Digital Signatures

UNIT II FOUNDATIONS 9

Centralization vs. Decentralization of Blockchain - Distributed Ledger Technology (DLT) Technical Concepts: Mining - Distributed Consensus- Incentives - Proof of Work - Cryptosystems in practice- Distributed Networks – Attacks - Consensus Protocols

UNIT III WEB3 AND HYPERLEDGER 9

Web 3 Contract deployment – POST requests – Frontend – Development framework – Hyperledger Projects – Protocol – Reference architecture – Hyperledger Fabric – Corda.

UNIT IV SMART CONTRACTS & ETHEREUM 9

Smart Contracts – Definition – Recardian contracts - Ethereum blockchain –Ethereum network – Components of Ethereum ecosystem –Programming languages - Ethereum development environment - Non-Fungible Token (NFT)

UNIT V ALTERNATIVE BLOCKCHAINS AND APPLICATIONS 9

Alternative blockchains – Applications, Internet of Things, Government, Health, Finance – Scalability – Privacy.

PRACTICAL EXERCISES 30

1. Implement cryptographic hash functions
2. Implement Decentralized Applications
3. Implement a simple program using Web3 Javascript API
4. Set up Go-Ethereum client
5. Set up Python Ethereum Client

TOTAL: 75 PERIODS

REFERENCES

1. Imran Bashir, “Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained”, Second Edition, Packt Publishing, 2018.

2. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, “Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction” Princeton University Press, 2016.
3. Alex Leverington, “Ethereum Programming” Packt Publishing Limited, 2017.
4. Andreas Antonopoulos, Satoshi Nakamoto, “Mastering Bitcoin”, O’Reilly Publishing, 2014.
5. Roger Wattenhofer, “The Science of the Blockchain” Create Space Independent Publishing Platform, 2016.
6. Arshdeep Bahga and Vijay Madisetti, “Blockchain Applications : A Hands-On Approach”, 2017.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Explain cryptocurrencies and their relationship with the blockchain technology.
CO2:Explain the different steps in the use of Bitcoins.
CO3:Relate Web 3 and Hyperledger to concepts in blockchain technologies.
CO4:Apply blockchains to different real-life problems
CO5:Implement a simple application using Ethereum.

CO-PO Mapping

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

CP3083 MULTIMEDIA SYSTEMS AND APPLICATIONS L T P C
3 0 0 3

UNIT I MULTIMEDIA ELEMENTS 9

Principles – Cognition, Learning, Interaction, Medium of Consumption: Elements - Text – characteristics, standards, formats; Graphics – representation, file formats, Image / Graphics – file formats, standards; Digital Audio – Characteristics, formats, standards, Speech, Video – characteristics, formats; Animation – characteristics, formats; , Multidimensional Data Structures, k-d trees, Quad Trees, R-trees.

UNIT II MULTIMEDIA TOOLS and AUTHORING 9

Hardware – Display Devices, wearables, Graphics cards, I/O devices, software – Editing tools forText, Image, Audio, Video and animation. Authoring tools, Authoring Multimedia presentations, Authoring Metaphors.

UNIT III MULTIMEDIA COMPRESSION 9

Symmetric and Asymmetric methods, Lossy and Lossless Compression,Text compression – RLE, Huffman,Arithmetic, Dictionary based; Document Image compression standards – CCITTand Color Image Compression – JPEG, Audio Compression – PCM, ADPCM, MPEG, AAC, AC3, speech compression; Video Compression-MPEG-4, H.265, DVI

Attested

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UNIT IV MULTIMEDIA COMMUNICATION SYSTEMS 9

Multimedia Communication Standards,Transport Protocols, streaming protocols, Internet Protocols Wireless multimedia communications, synchronization and QOS, security, Entertainment networks, Collaborative multimedia support, Real-time distributed multimedia networks, Hypertext, Hypermedia.

UNIT V MULTIMEDIA APPLICATIONS 9

Applications for WWW - Multimedia databases — Indexing and Retrieval, Visualization, Virtual, Augmented and Mixed Reality, Interactive E-learning, HCI and UX design,Games and Animation, Real-Time video conferencing.

TOTAL: 45 PERIODS

REFERENCES

1. Ze-Nian Li, Mark S. Drew, Jiangchuan Liu, “Fundamentals of Multimedia”, Second Edition, Springer Nature (Texts in Computer Science), 2014.
2. Prabhat K. Andleigh, Kiran Thakrar, “Multimedia Systems Design”, Pearson Education India, Ist Edition, 2015
3. Ralf Steinmetz and KlaraNahrstedt, “Multimedia computing, communications, and applications”, Pearson India, Pearson, 2002.
4. Fred Halsall, “Multimedia Communications: Applications, Networks, Protocols and Standards”, Pearson Education, 2002.
5. Khalid Sayood, “Introduction to Data Compression”, 4th Edition, Morgan Kauffman, 2012.
6. K.R. Rao, Zoran S. Bojkovic, Bojan M. Bakmaz, “ Wireless Multimedia Communication systems: Design, Analysis and Implementation”, CRC press, 2017.
7. V.S. Subrahmanian, “Principles of Multimedia Database Systems”, Elsevier / Morgan Kauffmann, 2008.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Handle the multimedia elements effectively

CO2:Use Multimedia Hardware and Software for Editing and Authoringmultimedia applications

CO3:Implement Compression algorithms for various multimedia applications

CO4:Develop effective strategies to deliver Quality-of-Experience in networked Multimedia applications

CO5:Design and develop multimedia applications in various domains

CO-PO Mapping

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

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CP3067 **INFORMATION RETRIEVAL TECHNIQUES** **L T P C**
3 0 0 3

UNIT I INTRODUCTION **9**

Basic Concepts – Practical Issues – Retrieval Process – Architecture – Boolean Retrieval – Retrieval Evaluation – Open Source IR Systems–History of Web Search – Web Characteristics– The impact of the web on IR –IR Versus Web Search–Components of a Search engine

UNIT II RETRIEVAL MODELING **9**

Taxonomy and Characterization of IR Models – Boolean Model – Vector Model – Term Weighting-Scoring and Ranking –Language Models – Set Theoretic Models – Probabilistic Models – Algebraic Models – Structured Text Retrieval Models – Models for Browsing

UNIT III INDEXING **9**

Static and Dynamic Inverted Indices – Index Construction and Index Compression. Searching – Sequential Searching and Pattern Matching. Query Operations –Query Languages – Query Processing – Relevance Feedback and Query Expansion – Automatic Local and Global Analysis – Measuring Effectiveness and Efficiency

UNIT IV EVALUATION AND PARALLEL INFORMATION RETRIEVAL **9**

Traditional Effectiveness Measures – Statistics in Evaluation – Minimizing Adjudication Effect – Nontraditional Effectiveness Measures – Measuring Efficiency – Efficiency Criteria –Queueing Theory – Query Scheduling – Parallel Information Retrieval – Parallel Query Processing – MapReduce

UNIT V SEARCHING THE WEB **9**

Searching the Web –Structure of the Web –IR and web search – Static and Dynamic Ranking – Web Crawling and Indexing – Link Analysis – XML Retrieval Multimedia IR: Models and Languages – Indexing and Searching Parallel and Distributed IR – Digital Libraries

TOTAL: 45 PERIODS

REFERENCES

1. Ricardo Baeza – Yates, Berthier Ribeiro – Neto, “Modern Information Retrieval: The Concepts and Technology behind Search”, (ACM Press Books), Second Edition, 2011.
2. Chrstopher D. Manning, Prabhakar Raghavan, Hinrich Schutze, “Introduction to Information Retrieval”, Cambridge University Press, First South Asian Edition, 2008.
3. Stefan Buttcher, Charles L. A. Clarke, Gordon V. Cormack, “Information RetrievalImplementingand Evaluating Search Engines”, The MIT Press, Cambridge, Massachusetts London, England, 2010.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Build an Information Retrieval system using the available tools.
CO2:Identify and design the various components of an Information Retrieval system.
CO3:Measure effectiveness and efficiency of information retrieval techniques.

CO4:Use parallel Information Retrieval approaches in real world problems.
CO5:Design an efficient search engine and analyze the Web content structure

CO-PO Mapping

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

CP3072 **PARALLEL ALGORITHMS** **L T P C**
3 0 0 3

UNIT I INTRODUCTION **10**

Introduction to Parallel Algorithms – Principles of Parallel Algorithm Design- Parallel Algorithm Models - Analyzing Parallel Algorithms- PRAM Algorithms: PRAM Model of Computation – Parallel Reduction – Prefix Sum-List ranking- Merging Sorted lists

UNIT II PROCESSOR ORGANISATION **8**

Mesh -Binary Tree Network-Hyper Tree Network- Pyramid – Butterfly- Hypercube –Shuffle-Exchange Networks – Multiprocessor- Multicomputer- Data Mapping

UNIT III SORTING & SEARCHING **9**

Sorting Networks – Sorting on a Linear Array – Sorting on CRCW, CREW, EREW – Searching a sorted sequence – Searching a random sequence – Bitonic Sort

UNIT IV ALGEBRAIC PROBLEMS **9**

Permutations and Combinations – Matrix Transpositions – Matrix by Matrix Multiplications – Matrix by Vector Multiplication.

UNIT V GRAPH ALGORITHMS **9**

Connectivity Matrix – Connected Components – All Pair Shortest Paths – Single Source Shortest Path - Minimum Spanning Trees – Sollin's Algorithm - Kruskal's Algorithm-Algorithms for Sparse Graphs

TOTAL: 45 PERIODS

REFERENCES

1. Michael J. Quinn, "Parallel Computing: Theory & Practice", Tata McGraw Hill Edition, 2003.
2. Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, "Introduction to Parallel Computing", Pearson, 2012
3. Selim G. Akl, "The Design and Analysis of Parallel Algorithms", Prentice Hall, New Jercy, 1989
4. Joseph JaJa, "Introduction to Parallel Algorithms", Addison-Wesley, 1992.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Understand the difference between sequential and parallel algorithms.

CO2:Design parallel algorithms in various models of parallel computation.
CO3:Understand various parallel processor organizations
CO4:Design parallel searching and sorting algorithms
CO5:Design parallel graph algorithms

CO-PO Mapping

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

CP3077 SOFT COMPUTING L T P C
3 0 0 3

UNIT I SOFT COMPUTING AND FUZZY COMPUTING 9

Introduction to Soft Computing and Fuzzy logic, Fuzzy membership functions, Operations on Fuzzy sets Fuzzy relations, Fuzzy propositions, Fuzzy implications, Fuzzy inferences, Defuzzyfication Techniques, Fuzzy logic controller, Industrial Applications.

UNIT II FUNDAMENTALS OF NEURAL NETWORKS 9

Neuron, Nerve Structure and Synapse – Artificial Neuron and its Model – Activation Functions – Neural Network Architecture: Single Layer and Multilayer Feed Forward Networks, Recurrent Networks – Various Learning Techniques: Perception and Convergence Rule, Auto-Associative and Hetero-Associative Memory.

UNIT III BACK PROPAGATION NETWORKS AND COMPETITIVE NEURAL NETWORKS 9

Back Propagation Networks Architecture: Perceptron Model- Single Layer Artificial Neural Network, Multilayer Perception Model – Back Propagation Learning Methods – Effect of Learning Rule Co-Efficient – Factors Affecting Back Propagation Training – Kohenen's Self Organizing Map – SOM Architecture, learning procedure – Application; Learning Vector Quantization, learning by LVQ – Adaptive Resonance Theory – Learning procedure – Applications.

UNIT IV GENETIC ALGORITHM 9

Basic Concepts – Working Principle – Procedures of GA – Flow Chart of GA – Genetic Representation: (Encoding) Initialization and Selection – Genetic Operators: Mutation, Generational Cycle – Applications. Multi-objective Optimization Problem Solving: Concept of multi-objective optimization problems (MOOPs) and issues of solving them -Multi-Objective Evolutionary Algorithm (MOEA) -Non-Pareto approaches to solve MOOPs - Pareto-based approaches to solve MOOPs -Some applications with MOEAs.

UNIT V APPLICATIONS 9

Control systems; Speech systems; Image processing; Natural language processing and decision making, Handwritten Script Recognition; Automotive Systems and Manufacturing; Decision Support System; Bioinformatics; Investment and trading.

TOTAL: 45 PERIODS

REFERENCES

1. S. Rajasekaran, G.A. Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications", Prentice Hall of India, 2010.
2. J.S.R. Jang, C.T. Sun, E. Mizutani, "Neuro-Fuzzy and Soft Computing", Pearson Education, 2004.
3. An Introduction to Genetic Algorithm Melanic Mitchell (MIT Press)
4. Evolutionary Algorithm for Solving Multi-objective, Optimization Problems (2nd Edition), Collelo, Lament, Veldhnizer (Springer)
5. S.N. Sivanandam, S.N. Deepa, "Principles of Soft Computing", Second Edition, Wiley-India, 2007
6. Siman Haykin, "Neural Networks", Prentice Hall of India, 1999.
7. Timothy Ross, "Fuzzy Logic with Engineering Applications", Wiley Publications, 2016.
8. David E. Goldberg, "Genetic Algorithms in Search, Optimization and Machine Learning", Pearson Education, 2008.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Describe human intelligence and AI Explain how intelligent system works.
CO2:Recognize the feasibility of applying a soft computing methodology for a particular problem.
CO3:Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems.
CO4:Apply genetic algorithms to optimization problems.
CO5:Design neural networks for pattern classification and regression problems
CO6:Develop some familiarity with current research problems and research methods in Soft Computing Techniques

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	-	2
CO2	2	3	2	3	2	2
CO3	2	2	2	2	-	2
CO4	3	3	2	2	2	2
CO5	3	2	2	2	2	2
CO6	2	3	2	3	3	1

CP3065 GAME THEORY L T P C
3 0 0 3

UNIT I INTRODUCTION 8

Introduction – Making rational choices: basics of Games – strategy – preferences – payoffs – Mathematical basics –Game theory –Rational Choice – Basic solution concepts-non-cooperative versus cooperative games – Basic computational issues – finding equilibria and learning in games- Typical application areas for game theory (e.g. Google's sponsored search, eBay auctions, electricity trading markets).

UNIT II GAMES WITH PERFECT INFORMATION 10

Games with Perfect Information – Strategic games – prisoner's dilemma, matching pennies- Nash equilibria- theory and illustrations – Cournot and Bertrand models of oligopoly- auctions- mixed strategy equilibrium- zero-sum games- Extensive Games with Perfect Information-repeated games (prisoner's dilemma)- subgame perfect Nash equilibrium; computational issues.

UNIT III GAMES WITH IMPERFECT INFORMATION 9

Games with Imperfect Information – Bayesian Games – Motivational Examples – General Definitions –Information aspects – Illustrations – Extensive Games with Imperfect –Information – Strategies- Nash Equilibrium – Beliefs and sequential equilibrium – Illustrations – Repeated Games – The Prisoner's Dilemma – Bargaining

UNIT IV NON-COOPERATIVE GAME THEORY 9

Non-cooperative Game Theory – Self-interested agents- Games in normal form – Analyzing games: from optimality to equilibrium – Computing Solution Concepts of Normal-Form Games – Computing Nash equilibria of two-player, zero-sum games –Computing Nash equilibria of two-player, general-sum games – Identifying dominated strategies

UNIT V MECHANISM DESIGN 9

Aggregating Preferences-Social Choice – Formal Model- Voting – Existence of social functions – Ranking systems – Protocols for Strategic Agents: Mechanism Design – Mechanism design with unrestricted preferences- Efficient mechanisms – Vickrey and VCG mechanisms (shortest paths) – Combinatorial auctions – profit maximization Computational applications of mechanism design – applications in Computer Science – Google's sponsored search – eBay auctions – K-armed bandits.

TOTAL: 45 PERIODS

REFERENCES

1. Thomas S. Ferguson, Game Theory, Web notes available at (*https://www.cs.cmu.edu/afs/cs/academic/class/15859s05/www/ferguson/comb.pdf*)
2. M. J. Osborne," An Introduction to Game Theory", Oxford University Press, 2012.
3. M. Machler, E. Solan, S. Zamir, "Game Theory", Cambridge University Press, 2013.
4. N. Nisan, T. Roughgarden, E. Tardos, and V. V. Vazirani (Editors), "Algorithmic Game Theory" Cambridge University Press, 2007.
5. A.Dixit and S. Skeath, "Games of Strategy", Second Edition, W W Norton & Co Inc, 2004.
6. Yoav Shoham, Kevin Leyton-Brown, "Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations", Cambridge University Press, 2008.
7. Zhu Han, Dusit Niyato, Walid Saad, Tamer Basar and Hjorungnes, "Game Theory in Wireless and Communication Networks", Cambridge University Press, 2012.
8. Y.Narahari, "Game Theory and Mechanism Design", IISC Press, World Scientific, 2015.
9. Anna R. Karlin and Yuval Peres, Game Theory, Alive, AMS, 2016 (E-book available online from the author at (https://homes.cs.washington.edu/~karlin/GameTheoryBook.pdf)
10. Ivan Pastine, Tuvana Pastine, Tom Humberstone, Introducing Game Theory: A Graphic Guide, Icon Books, 2017.
11. Steven Tadelis, Game Theory: An Introduction, Princeton University Press, 2013.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1: Discuss the notion of a strategic game and equilibria and identify the characteristics of main applications of these concepts.

CO2: Discuss the use of Nash Equilibrium for other problems.
CO3: Identify key strategic aspects and based on these be able to connect them to appropriate game theoretic concepts given a real world situation.
CO4: Identify some applications that need aspects of Bayesian Games.
CO5: Implement a typical Virtual Business scenario using Game theory.

CO-PO Mapping

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

CP3051 ADHOC AND WIRELESS SENSOR NETWORKS L T P C
3 0 0 3

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

In 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 MANAGEMENT AND PERFORMANCE 9

Greedy based Construction of Load Balancing Virtual Bones in WSN – Load Balanced CDS Construction in WSN- Reliable and Energy Efficient Target Coverage for WSN- Sensor networks role in IoT-Architecture-Algorithms.

UNIT V SECURITY IN ADHOC AND SENSOR NETWORKS 9

Security Attacks – Key Distribution and Management – Intrusion Detection – Software based Antitamper 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

REFERENCES

1. Subir Kumar Sarkar, “Wireless Sensor and Ad Hoc Networks Under Diversified Network Scenarios”, Auerbach Publications, 2012.
2. Jing (Selina) He, Mr. Shouling Ji, Yi Pan, Yingshu Li, ,”Wireless Ad Hoc and Sensor Networks Management, Performance, and Applications”, CRC Press, 2014
3. Holger Karl, Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks”, Wiley India Private Limited, 2011.
4. Erdal Çayirci, Chunming Rong, “Security in Wireless Ad Hoc and Sensor Networks”, John Wiley and Sons, 2009.
5. Carlos De Morais Cordeiro, Dharma Prakash Agrawal, “Ad Hoc and Sensor Networks: Theory and Applications”, World Scientific Publishing, Second Edition, 2011.
6. Waltenegus Dargie, Christian Poellabauer, “Fundamentals of Wireless Sensor Networks Theory and Practice”, Wiley India Private Limited, 2014
7. Adrian Perrig, J.D. Tygar, “Secure Broadcast Communication: In Wired and Wireless Networks”, Kluwer Academic Publishers, Springer, 2002.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Identifying suitable routing protocols for various scenarios of ad hoc networks.
CO2:To explore various mobility models for MANETs.
CO3:Identify different issues in wireless sensor networks.
CO4:Analyze various algorithms used in WSN
CO5:Identify and critique security issues in ad hoc and sensor networks

CO-PO Mapping

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

SE3053 SOFTWARE SECURITY L T P C
3 0 0 3

UNIT I LOW-LEVEL ATTACKS 9

Need for Software Security – Memory-Based Attacks – Low-Level Attacks Against Heap And Stack - Stack Smashing – Buffer Overflow – Code Injection - Format String Attacks – ROP (Return Oriented Programming) – Defense against Memory-Based Attacks – Stack Canaries – Non-Executable Data - Address Space Layout Randomization (ASLR)- Memory-Safety Enforcement - Control-Flow Integrity (CFI) – Randomization

UNIT II WEB SECURITY AND SECURE DESIGN 9

SQL Injection - Session Hijacking – Cross-Site Scripting (XSS), Cross-Site Forgery (CSRF) – Database Security – File Security - Secure Design - Threat Modeling and Security Design Principles - Good and Bad Software Design

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UNIT III SECURITY RISK MANAGEMENT 9

Risk Management Life Cycle – Risk Profiling – Risk Exposure Factors – Risk Evaluation And Mitigation – Risk Assessment Techniques – Threat and Vulnerability Management.

UNIT IV SECURITY TESTING 9

Traditional Software Testing – Comparison - Secure Software Development Life Cycle - Risk Based Security Testing – Prioritizing Security Testing with Threat Modeling – Shades of Analysis: White, Grey, and Black Box Testing..

UNIT V PENETRATION TESTING 9

Advanced Penetration Testing – Planning And Scoping – DNS Groper – DIG (Domain Information Graph) – Enumeration – Remote Exploitation – Web Application Exploitation - Exploits And Client Side Attacks – Post Exploitation – Bypassing Firewalls and Avoiding Detection - Tools for Penetration Testing

TOTAL: 45 PERIODS

REFERENCES

1. Robert C. Seacord, “Secure Coding in C and C++ (SEI Series in Software Engineering)”, Addison-Wesley Professional, 2005.
2. Jon Erickson , “Hacking: The Art of Exploitation”, 2nd Edition, No Starch Press, 2008.
3. Mike Shema, “Hacking Web Apps: Detecting and Preventing Web Application Security Problems”, First edition, Syngress Publishing, 2012
4. Bryan Sullivan and Vincent Liu, “Web Application Security, A Beginner's Guide”, Kindle Edition, McGraw Hill, 2012
5. Evan Wheeler, “Security Risk Management: Building an Information Security Risk Management Program from the Ground Up”, First edition, Syngress Publishing, 2011
6. Chris Wysopal, Lucas Nelson, Dino Dai Zovi, and Elfriede Dustin, “The Art of Software Security Testing: Identifying Software Security Flaws (Symantec Press)”, Addison-Wesley Professional, 2006
7. Lee Allen, “Advanced Penetration Testing for Highly-Secured Environments: The Ultimate Security Guide (Open Source: Community Experience Distilled)”, Kindle Edition, Packt Publishing, 2012.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Identify various vulnerabilities related to memory attacks.

CO2:Apply security principles in software development.

CO3:Evaluate the extent of security risks

CO4:Involve selection of testing techniques related to software security in the testing phase of software development.

CO5:Use tools for securing software.

CO-PO Mapping

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

CP3080 **VIRTUALIZATION TECHNIQUES** **L T P C**
3 0 0 3

UNIT I INTRODUCTION TO VIRTUALIZATION 9

Need for virtualization - Virtual machines and architectures – Hypervisors - Virtualization Technologies: Para Virtualization, Full Virtualization - Virtualization types: Server virtualization-Application virtualization-Storage virtualization- Process and System VMs - Taxonomy of VMs-Hardware Emulation, Full Virtualization with binary translation, Hardware assisted, Operating System Virtualization, OS assisted /Para virtualization- Comprehensive Analysis – Resource Pool – Testing Environment –Server Virtualization – Virtual Workloads – Provision Virtual Machines – Desktop Virtualization – Application Virtualization

UNIT II VIRTUAL MACHINES-IMPLEMENTATION AND EMULATION 9

Implementation levels of virtualization – virtualization structure – virtualization of CPU, Memory and I/O devices – virtual clusters and Resource Management – Virtualization for data center automation. Virtual Machine Implementation-Compatibility-State Mapping-Memory Architecture Emulation-Instruction Emulation- Staged Emulation – Exception Detection – Interrupt Handling – Exception Emulation-Operating System Emulation- same and Different OS Emulation – Code Cache Management-System Environment

UNIT III HIGH LEVEL LANGUAGE VIRTUAL MACHINE ARCHITECTURE AND IMPLEMENTATION 9

The Pascal P-Code Virtual Machine-Object-Oriented High-Level Language Virtual Machines-The Java Virtual Machine Architecture-Completing the Platform: APIs -The Microsoft Common Language Infrastructure: A Flexible High-Level Language-Virtual Machine- Virtual ISA Features-Dynamic Class Loading-Implementing Security- Garbage Collection-Java Native Interface-Basic Emulation-High-Performance Emulation-Case Study: The Jikes Research Virtual Machine

UNIT IV NETWORK AND STORAGE VIRTUALIZATION 9

Design of Scalable Enterprise Networks – Layer2 Virtualization – VLAN - VFI - Layer 3 Virtualization – VRF - Virtual Firewall Contexts - Network Device Virtualization - Data- Path Virtualization - Routing Protocols. Hardware Devices – SAN backup and recovery techniques – RAID – Classical Storage Model – SNIA Shared Storage Model – Virtual Storage: File System Level and Block Level- Introduction to Virtualized Datacentre architecture- Introduction to Storage Network Design- Architecture of storage, analysis and planning.

UNIT V CLOUD AND VM APPLICATIONS 9

Service creation environments to develop cloud based applications- Service creation environments to deploy cloud based applications- Development environments for service development; Amazon, Azure and Google App- Introduction to Cloud IT Model- VMWare Server – VMWare ESXi – Citrix Xen Server – Microsoft Virtual PC – Microsoft Hyper-V – Virtual Box, Server Virtualization: Configuring Servers with Virtualization – Adjusting and Tuning Virtual servers – VM Backup – VM Migration, Desktop Virtualization: Terminal services – Hosted Desktop – Web-based Solutions – Localized Virtual Desktops, Network and Storage Virtualization: Virtual Private Networks – Virtual LAN – SAN and VSAN – NAS

TOTAL: 45 PERIODS

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REFERENCES

1. James E. Smith, Ravi Nair, “Virtual Machines: Versatile Platforms for Systems and Processes”, Elsevier/Morgan Kaufmann, 2005
2. David Marshall, Wade A. Reynolds, “Advanced Server Virtualization: VMware and Microsoft Platform in the Virtual Data Center”, Auerbach Publications, 2006
3. Kumar Reddy, Victor Moreno, “Network virtualization”, Cisco Press, July, 2006.
4. Chris Wolf, Erick M. Halter, “Virtualization: From the Desktop to the Enterprise”, A Press 2005
5. Kenneth Hess , Amy Newman, “Practical Virtualization Solutions: Virtualization from the Trenches”, Prentice Hall, 2010
6. Lee Badger , Tim Grance , Robert Patt -Corner , Jeff Voas Cloud Computing Synopsis and Recommendations NIST, May 2011
7. Tom White -Hadoop: The Definitive Guide Storage and Analysis at Internet Scale O'Reilly Media Press May 2012

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Understand the virtualization technologies.

CO2:Explore virtual clusters and resource management in virtualized environments.

CO3:Apply various virtual machine programming languages.

CO4:Differentiate between network and storage virtualization.

CO5:Understand the concept of service creation environments for developing cloud-based applications.

CO-PO Mapping

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

CP3059 DATABASE ADMINISTRATION AND TUNING L T P C
3 0 0 3

UNIT I FUNDAMENTALS OF DATABASE ADMINISTRATION 9

The Management Discipline of Database Administration- Database, Data, and System Administration- Database Design- OODBMS-Persistence-DBA Tasks- Types of DBAs- Working as a DBA- Multiplatform DBA Issues- Test and Production- DBMS Release Migration - Creating the Database Environment - Choosing a DBMS - DBMS Architectures - DBMS Clustering - DBMS Proliferation - Hardware Issues - Installing the DBMS -Storage and Memory Requirements- Configuring the DBMS

UNIT II DATABASE SECURITY, BACKUP AND RECOVERY 9

Different Security Issues- Security Models- threats to databases- Database Users – Grant and Revoke - Types of Privileges - Privileges - Security Reporting - Authorization Roles and Groups - Using Views for Security - Using Stored Procedures for Security Auditing - SQL Injection

Prevention - External Security - Job Scheduling and Security – Types of Failures- Image Copy Backups - Full vs. Incremental Backups - Database Objects and Backups-Concurrent Access Issues - Backup Consistency - Log Archiving and Backup.

UNIT III PERFORMANCE MANAGEMENT 7

Designing the DBMS Environment for Recovery - Types of Recovery - DBA Tools- Monitoring Vs Management- Service level management-Performance parameters- Performance Tuning Tools-Techniques for Optimizing Databases-Database reorganization- Files and datasets- space management- Loading and unloading data-bulk data movement- Client server computing

UNIT IV DATABASES AND INDEX TUNING 10

Introduction to Tuning- Tuning and Relational Databases – Relational Algebra – Concurrency control goals- Locking and Concurrency Control – Correctness Consideration – Lock Tuning – Logging and the Recovery Subsystem – Principles of Recovery – Tuning the Recovery Subsystem – Operating Systems Considerations – Hardware Tuning- Types of Queries – B tree – B+ Tree - Bit Map Indexes – Clustering Indexes – Non Clustering Indexes – Composite Indexes – Hot Tables – Comparison of Indexing and Hashing Techniques.

UNIT V OPTIMIZATION AND TROUBLESHOOTING 10

Optimization Techniques -- Normalization – Tuning Denormalization – Clustering Two Tables – Aggregate Maintenance – Record Layout – Query Cache – Parameter Cache - Query Tuning – Transaction chopping -Triggers - Query Plan Explainers – Performance Monitors – Event Monitors. Finding 'Suspicious' Queries – Analysing Query's Access Plan – Profiling Query Execution. Tuning DBMS Subsystems - Disk Subsystem - Buffer Manager - Logging Subsystem - Locking Subsystem. Troubleshooting CPU, Disks and Controllers, Memory, and Networks

TOTAL: 45 PERIODS

REFERENCES

1. Craig S. Mullins, "Database Administration: The Complete Guide to Practices and Procedures", Addison-Wesley Professional, 2nd edition, 2013.
2. Dennis Shasha and Philippe Bonnet, "Database Tuning, Principles, Experiments and Troubleshooting Techniques", Elsevier Reprint, 2005.
3. C.J.Date, A.Kannan, S.Swamynathan, —An Introduction to Database Systems‖, Eighth Edition, Pearson Education, 2006.
4. R. Elmasri, S.B. Navathe, —Fundamentals of Database Systems‖, Sixth Edition, Pearson Education/Addison Wesley, 2010.
5. Craig S. Mullins. “DB2 Developer's Guide A Solutions-Oriented Approach to Learning the Foundation and Capabilities of DB2 for Z/OS”, IBM Press, 6th edition, 2012.
6. Henry F Korth, Abraham Silberschatz, S. Sudharshan, —Database System Concepts, Seventh Edition, McGraw Hill, 2019
7. Thomas Connoly and Carlolyn Begg, "Database Systems, A Practical Approach to Design, Implementation and Management", Fourth Edition, Pearson Education, 2008

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:An ability to understand various DBA roles, tasks and tools

CO2:Apply various Database recovery, backup and security privileges and

CO3:Differentiate between monitoring and management in the context of database administration and explain their respective roles in ensuring database performance and availability.

CO4:Effectively tune and optimize relational databases, including query optimization, concurrency control, recovery subsystem tuning, index selection, and hardware considerations.

CO5:Possess the skills to effectively optimize and tune database systems by employing techniques such as normalization, denormalization, clustering, query tuning, performance monitoring, and troubleshooting various subsystems.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	2	1	0	1
CO2	1	1	2	3	2	1
CO3	2	1	3	3	1	1
CO4	3	2	3	3	1	1
CO5	2	3	3	2	1	1

CP3058 DATA WAREHOUSING AND DATA MINING TECHNIQUES L T P C
3 0 0 3

UNIT I INTRODUCTION TO DATA WAREHOUSING 9

Data Warehouse: Basic Concepts - Differences between Operational Database Systems and Data Warehouses- Data warehousing Components – Data Warehousing: A Multi-tiered Architecture – Data Warehouse Models: Enterprise Warehouse, Data Mart, distributed and virtual data warehouses - Building a Data warehouse - Data Warehouse and DBMS, - Data Extraction, Cleanup, and Transformation Tools - Data marts, Metadata, Multidimensional data model, Data Warehouse Modeling: Data Cube and OLAP , OLAP operations, Schemas for Multidimensional Database –Metadata.

UNIT II DATA WAREHOUSE PROCESS AND ARCHITECTURE 9

A Business Analysis Framework for Data Warehouse Design - Data Warehouse Design Process - Data Warehouse Usage for Information Processing - Data Warehouse Implementation: Efficient Data Cube Computation: Efficient Processing of OLAP, OLAP Server Architectures: ROLAP versus MOLAP versus HOLAP - tuning and testing of data warehouse - data warehouse visualization, Data Warehouse Deployment, Maintenance. Data Warehousing and Business Intelligence Trends.

UNIT III INTRODUCTION TO DATA MINING 9

Data Objects and Attribute Types - Basic Statistical Descriptions of Data - Measuring Data Similarity and Dissimilarity - KDD versus data mining, Stages of the Data Mining Process-task primitives, Data Mining Techniques - Data preprocessing – Data cleaning, Data Integration, Data Transformation and Data Discretization, Data reduction - Association Rule Mining: Frequent Item set Mining Methods – Pattern Evaluation Methods – Association Mining to Correlation Analysis.

UNIT IV CLASSIFICATION AND CLUSTERING 9

Decision Tree Induction - Bayesian Classification – Rule Based Classification – Classification by Back propagation – Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods(Genetic Algorithms, Rough Set Approach, Fuzzy Set Approaches) – Semi-Supervised Classification - Clustering techniques – Partitioning methods : k-means- Hierarchical

Methods : distance based agglomerative and divisible clustering, Probabilistic hierarchical Clustering Density-Based Methods : DBSCAN, DENCLUE – Expectation Maximization -Grid Based Methods – Clustering High-Dimensional Data - Clustering Graph and Network Data - Outlier Analysis.

UNIT V TRENDS IN DATA MINING 9

Big Data - Mining complex data objects – Spatial databases – Temporal databases – Visual and Audio Data Mining – Time series and sequence data – Text mining – Web mining – Data mining Applications.

TOTAL: 45 PERIODS

REFERENCES

1. Jiawei Han, Micheline Kamber and Jian Pei"Data Mining Concepts and Techniques", Third Edition, Elsevier, 2011.
2. Alex Berson, Stephen J. Smith, "Data Warehousing, Data Mining & OLAP", Tata McGraw Hill, Tenth Reprint, 2007.
3. G. K. Gupta, "Introduction to Data Mining with Case Studies", Eastern Economy Edition, Prentice Hall of India, Third Edition, 2014.
4. Ian.H.Witten, Eibe Frank and Mark.A.Hall, "Data Mining: Practical Machine Learning Tools and Techniques", Morgan Kaufmann, Third edition, 2011.
5. Bruce Ratner, "Statistical and Machine - Learning Data Mining: Techniques for Better Predictive Modeling and Analysis of Big Data", CRC Press, Second Edition, 2012.
6. Mehmed kantardzic, "Data mining: Concepts, Models, Methods, and Algorithms", WileyBlackwell, Second Edition, 2011.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Evolve multidimensional intelligent model from typical system.
CO2:Design and implement data warehouse and to do Business Analytics.
CO3:Acquire knowledge on data and to prepare data for mining
CO4:Design and deploy classification and clustering techniques.
CO5:Evaluate various mining techniques on complex data objects.

CO-PO Mapping

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

CP3076 SOCIAL NETWORK ANALYSIS L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Introduction to Semantic Web: Limitations of current Web - Development of Semantic Web - Emergence of the Social Web - Social Network analysis: Development of Social Network Analysis - Key concepts and measures in network analysis - Applications of Social Network Analysis-

Graph Essentials –Graph Basics – Graph Representation- Types of Graphs – Connectivity in Graphs – Special Graphs – Graph Algorithms.

UNIT II MODELLING, AGGREGATING AND KNOWLEDGE REPRESENTATION 9

Ontology and their role in the Semantic Web: Ontology-based knowledge Representation - Ontology languages for the Semantic Web: Resource Description Framework - Web Ontology Language - Modelling and aggregating social network data: State-of-the-art in network data representation - Ontological representation of social individuals - Ontological representation of social relationships - Aggregating and reasoning with social network data - Advanced representations.

UNIT III DETECTING AND MINING COMMUNITIES 9

Detecting communities in social networks - Definition of community - Evaluating communities - Methods for community detection and mining - Applications of community mining algorithms - Tools for detecting communities social network infrastructures and communities- Strategic network formation: game theoretic models for network creation/ user behaviour in social networks - Information diffusion in Social Media- Herd Behaviour -Information Cascades-Diffusion of Innovations-Epidemics

UNIT IV VISUALIZATION OF SOCIAL NETWORKS 9

Social Networks as Graphs- Random graph models/ graph generators- Graph theory - Centrality - Clustering - Node-Edge Diagrams - Matrix representation - Visualizing online social networks, Visualizing social networks with matrix-based representations - Matrix and Node-Link Diagrams - Hybrid representations - Applications - Cover networks - Community welfare - Collaboration networks - Co-Citation networks.

UNIT V APPLICATIONS 9

Classical Recommendation Algorithms- Recommendation Using Social Context-Evaluating Recommendations Behavior Analytics: Individual Behavior- Collective Behavior- Hacking on Twitter Data-Twitter: Friends, Followers, and Set wise Operations-Analyzing Tweets-Visualizing tons of tweets.

TOTAL: 45 PERIODS

REFERENCES

1. R. Zafarani, M. Abbasi, and H. Liu,“Social Media Mining: An Introduction”, Cambridge University Press, 2014.
2. Peter Mika, “Social Networks and the Semantic Web”, First Edition, Springer 2007.
3. Borko Furht, “Handbook of Social Network Technologies and Applications”, 1st Edition, Springer, 2010.
4. Guandong Xu ,Yanchun Zhang and Lin Li, “Web Mining and Social Networking – Techniques and applications”, First Edition, Springer, 2011.
5. Dion Goh and Schubert Foo, “Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively”, IGI Global Snippet, 2008.
6. Matthew A. Russell, “Mining the Social Web”, O‟Reilly Media,2nd edition, 2013.
7. Colleen McCue, “Data Mining and Predictive Analysis: Intelligence Gathering and Crime Analysis”, Elsevier,2nd edition, 2015.

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COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Develop semantic web related applications.

CO2:Represent knowledge using ontology.

CO3:Predict human behaviour in social web and related communities.

CO4:Visualize social networks

CO5:Apply social network analysis techniques in real-life applications

CO-PO Mapping

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

SE3054 SOFTWARE TESTING AND QUALITY ASSURANCE L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Introduction to Software Quality - Challenges – Quality Factors – Testing Activities – Test Case Selection – Power of Test – Components of SQA – SQA Components in Project Life Cycle – Test Groups – Software Quality Assurance Group – Reviews

UNIT II TESTING METHODOLOGIES 9

Basics of Software Testing – Test Generation from Requirements – Finite State Models – Combinatorial Designs - Test Selection, Minimization and Prioritization for Regression Testing – Test Adequacy, Assessment and Enhancement.

UNIT III TEST STRATEGIES 9

Testing Strategies – White Box and Black Box Approach – Integration Testing – System and Acceptance Testing – Performance Testing – Regression Testing - Internationalization Testing – Ad-hoc Testing – Website Testing – Usability Testing – Accessibility Testing.

UNIT IV TEST AUTOMATION AND MANAGEMENT 9

Test plan – Management – Execution and Reporting – Software Test Automation – Automated Testing tools - Hierarchical Models of Software Quality – Configuration Management – Documentation Control.

UNIT V SOFTWARE QUALITY ASSURANCE 9

Project progress control – costs – quality management standards – project process standards – management and its role in SQA – SQA unit.

TOTAL: 45 PERIODS

REFERENCES

1. Yogesh Singh, “Software Testing”, Cambridge University Press, 2012
2. Daniel Galin, “Software Quality Assurance – from Theory to Implementation” Pearson Education, 2009
3. Aditya Mathur, “Foundations of Software Testing”, Pearson Education, 2008

4. Srinivasan Desikan, Gopalaswamy Ramesh, “Software Testing – Principles and Practices”, Pearson Education, 2006
5. Ron Patton, ”Software Testing” , Second Edition, Pearson Education, 2007

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Develop Quality plans and use SQA components in project life cycle.
CO2:Analyze the product Quality.
CO3:Judge the use of infrastructure components and use configuration items for Quality control.
CO4:Use various testing methods and verify.
CO5:Assess Quality standards of various software products.

CO-PO Mapping

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

CP3079 USER INTERFACE DESIGN L T P C
3 0 0 3

UNIT I INTRODUCTION 9

process of Design thinking, Human factors in Interaction Design, Understanding Users- cognition and cognitive frameworks, User Centred approaches - modeling users personas and goals, Usability, accessibility standards and Universal Usability. HCI and software Engineering, User Centric Computing, Computational User models.

UNIT II INTERACTION DESIGN 9

Interaction Design, Principles, heuristics, Design Patterns, Design Frameworks, interface metaphors, Design Methods, Prototyping, Understanding Interaction Styles, Direct Manipulation and Immersive Environments, Fluid Navigation, Expressive Human and Command Languages, Communication and Collaboration.

UNIT III ADVANCED INTERACTION DESIGN 9

Social Media interaction design, Digital Products, Information architecture design, Designing for web, Mobile, web and Mobile usability, Touch Screens, Interaction design for the XR, Best Practices, Ubiquitous computing, IOT and wearable computing, Human-Robot interaction.

UNIT IV EVALUATION 9

Evaluation Techniques- Expert Reviews and Heuristics - Assessing User Experience- Usability Testing – Acceptance tests, Heuristic Evaluation and Walkthroughs, Analytics Predictive Models.

UNIT V FORMAL MODELS, TOOLS, CASE STUDIES 9

Task analysis, Dialog Notations and Design, Tools - proto.io, mural, material; Case Studies - studying usability of web and mobile apps, touch screens, chatbots.

TOTAL: 45 PERIODS

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REFERENCES

1. Ben Shneiderman, Catherine Plaisant, Maxine Cohen, Steven Jacobs, NiklasElmqvist, “Designing the User Interface: Strategies for Effective Human-Computer Interaction”, Sixth Edition, Pearson Education, 2018.
2. Jenny Preece, Helen Sharp, Yvonne Rogers, “Interaction Design: Beyond Human Computer Interaction”, Wiley Student Edition, 5th Edition, Wiley, 2019.
3. Jenifer Tidwell, Charles Brewer & Aynne Valencia, “Designing Interfaces: Patterns for Effective Interaction Design”, Third Edition,O'reilly, 2020.
4. Alan Cooper, Robert Reimann, David Cronin, Christopher Noessel, “About Face: The Essentials of Interaction Design”, 4th Edition, Wiley, 2014.
5. Samit Bhattacharya, “Human-Computer Interaction: User-Centric Computing for Design”, McGrawHill, 1st Edition, 2019.
6. Donald A. Norman, “Design of Everyday Things”, MIT Press, 2013.
7. Steve Krug, “Don't Make Me Think, Revisited: A Common Sense Approach to Web and Mobile Usability”, Third Edition, New Riders, 2014.
8. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, “Human Computer Interaction”, Third Edition, Pearson Education, 2004.
9. Alan Dix, Devina Ramduny-Ellis, Jo Hare, Steve Gil,l TouchIT: Understanding Design in a Physical-Digital World, Oxford University Press, 1st Edition, 2022.
10. https://www.nngroup.com
11. https://www.interaction-design.org/
12. www.mural.co
13. https://m3.material.io/

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Apply usability principles and user/cognitive modeling for various design tasks.
CO2:Use the different design methods, interaction styles, metaphors, basic design paradigms
CO3:Create advanced interaction designs for a variety of use cases in complex environments.
CO4:Evaluate interaction designs and implementations.
CO5:Use formal models and notation to design interactions for new systems.
CO6:Explore use cases from real world examples and suggest usable designs.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	3	2	2	1
CO2	2	2	3	2	2	1
CO3	2	2	3	2	2	1
CO4	2	2	3	2	2	1
CO5	2	2	3	2	2	1
CO6	2	2	3	2	2	1

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SE3052 **SOFTWARE RELIABILITY METRICS AND MODELS** **L T P C**
3 0 0 3

UNIT I INTRODUCTION TO SOFTWARE TESTING 09

Background on Software Testing – Manual Testing –Automated Testing–Automated Test Life Cycle Methodology (ATLM) – Test Maturity Model – Test Automation Development – Overcoming False Expectations of Automated Testing – benefits – Test tool proposal.

UNIT II SOFTWARE RELIABILITY CONCEPTS 10

Basic Ideas of Software Reliability, Hardware reliability vs. Software reliability, Reliability metrics, Failure and Faults – Prevention, Removal, Tolerance, Forecast, Dependability Concept – Failure Behaviour, Characteristics, Maintenance Policy, Reliability and Availability Modeling, Reliability Evaluation Testing methods, Limits, Starvation, Coverage, Filtering, Microscopic Model of Software Risk.

UNIT III COMPUTATIONAL SOFTWARE RELIABILITY 08

Computation of software reliability, Functional and Operational Profile, Operational Profiles – Difficulties, Customer Type, User Type, System Mode, Test Selection - Selecting Operations, Regression Test.

UNIT IV RELIABILITY MODELING 09

Classes of software reliability Models, Time Dependent Software Reliability Models: Time between failure reliability Models, Fault Counting Reliability Models. Time Independent Software Reliability Models: Fault injection model of Software Reliability, Input Domain Reliability Model, Orthogonal defect classification, Software availability Models. Software Reliability Modeling: A general procedure for reliability modeling.

UNIT V RELIABILITY METRICS 09

Short and Long Term Prediction, Model Accuracy, Analysing Predictive Accuracy – Outcomes, PLR, U and Y Plot, Errors and Inaccuracy, Recalibration – Detecting Bias, Different Techniques, Power of Recalibration, Limitations in Present Techniques, Improvements.

TOTAL: 45 PERIODS

REFERENCES

1. John D. Musa, Software Reliability Engineering: More Reliable Software and Cheaper, AuthorHouse, 2nd Edition, 2004.
2. Hoang Pham, Software Reliability, Springer Verlag, New York , 2000.
3. Michael R. Lyu,Software Reliability Engineering, IEEE Computer Society Press (Digital Version), 2011.
4. Michael R. Lyu, Software Fault Tolerance, Wiley (Digital Version), 2007.
5. Patric D. T.O Connor, Andre Kleyner: Practical Reliability Engineering, 5th Edition, John Wesley & Sons , 2012
6. D. Reled, Software Reliability Methods, Springer Verlag, New York , 2001

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Identify and apply various software metrics, which determine the quality level of software.

CO2:Identify and evaluate the reliability of any given software product.

CO3:Understand the fault handling and failure forecasting techniques in software systems.

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CO4:Understand and Comprehend different time-dependent and time-independent software reliability models.

CO5:Design reliability models for evaluating the quality level of software systems based on the requirement.

CO-PO Mapping

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

CP3081 VISUALIZATION TECHNIQUES L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Introduction – Visualization Stages – Computational Support – Issues – Different Types of Tasks – Data representation – Limitation: Display Space, Rendering Time, Navigation Link.

UNIT II DATA REPRESENTATION - I 9

Human Factors – Foundation for Science of Data Visualization – Environment- Optics – Optimal Display – Overview about Lightness, Brightness, Contrast, Constancy, Color –Visual attention that Pops Out – Types of Data – Data Complexity – The Encoding of Values –Encoding of Relation – Relation and Connection – Alternative Canvass.

UNIT III DATA REPRESENTATION - II 9

Human Vision – Space Limitation – Time Limitations – Design – Exploration of Complex Information Space – Figure Caption in Visual Interface – Visual Objects and Data Objects – Space Perception and Data in Space – Images, Narrative and Gestures for Explanation.

UNIT IV INTERACTION AND DESIGN 9

Norman's Action Cycle – Interacting with Visualization – Interaction for Information Visualization – Interaction for Navigation – Interaction with Models – Interacting with Visualization – Interactive 3D Illustrations with Images and Text– Personal View – Attitude – user perspective – Convergence – Sketching – Evaluation.

UNIT V CURRENT TRENDS 9

Design – Virtual Reality: Interactive Medical Application – Tactile Maps for Visually Challenged People – Animation Design for Simulation – Integrating Spatial and Nonspatial Data – Innovating the Interaction- Small Interactive Calendars – Selecting One from Many – Web Browsing Through a Key Hole – Communication Analysis – Archival Galaxies.

TOTAL: 45 PERIODS

REFERENCES

1. Robert Spence, "Information Visualization An Introduction", Third Edition, Pearson Education, 2014.

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2. Colin Ware, “Information Visualization Perception for Design”, Third edition, Margon Kaufmann Publishers, 2012.
3. Robert Spence, “Information Visualization Design for Interaction”, Second Edition, Pearson Education, 2006.
4. Benjamin B. Bederson and Ben shneiderman, “The Craft of Information Visualization”, Morgan Kaufmann Publishers, 2003.
5. Thomas strothotte, “Computational Visualization: Graphics, Abstraction and Interactivity”, Springer, 1998.
6. Matthew O. Ward, George Grinstein, Daniel Keim, “Interactive Data Visualization: Foundation, Techniques and Applications”, Second Edition, A. K. Peters/CRC Press, 2015.
7. Joerg Osarek, “Virtual Reality Analytics”, Gordon’s Arcade, 2016.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Apply mathematics and basic science knowledge for designing information visualizing System.

CO2:Collect data ethically and solve engineering problem in visualizing the information.

CO3:Implement algorithms and techniques for interactive information visualization.

CO4:Conduct experiments by applying various modern visualization tool and solve the space layout problem.

CO5:Analyze and design system to visualize multidisciplinary multivariate Data individually or in teams.

CO6:Develop a cost effective and a scalable information visualization system.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	1	1	1
CO2	1	1	2	2	2	1
CO3	2	1	3	3	3	1
CO4	3	2	2	1	1	1
CO5	1	1	1	1	1	1
CO6	1	1	2	2	1	1

BD3051 FOUNDATIONS OF DATA SCIENCE L T P C

3 0 0 3

UNIT I INTRODUCTION 9

Data Science: Benefits and uses – facets of data – Data Science Process: Overview – Defining research goals – Retrieving data – Data preparation – Exploratory Data analysis – build the model– presenting findings and building applications – Data Mining – Data Warehousing – Basic Statistical descriptions of Data

UNIT II DESCRIBING DATA 9

Types of Data – Types of Variables -Describing Data with Tables and Graphs –Describing Data with Averages – Describing Variability – Normal Distributions and Standard (z) Scores

UNIT III DESCRIBING RELATIONSHIPS 9

Correlation –Scatter plots –correlation coefficient for quantitative data –computational formula for correlation coefficient – Regression –regression line –least squares regression line – Standard

error of estimate – interpretation of r2 –multiple regression equations –regression towards the mean

UNIT IV PYTHON LIBRARIES FOR DATA WRANGLING 9

Basics of Numpy arrays –aggregations –computations on arrays –comparisons, masks, boolean logic – fancy indexing – structured arrays – Data manipulation with Pandas – data indexing and selection – operating on data – missing data – Hierarchical indexing – combining datasets – aggregation and grouping – pivot tables

UNIT V DATA VISUALIZATION 9

Foundation for a Science of Data Visualization – Environment- Optics –Optimal Display – Overview about Lightness, Brightness, Contrast, Constancy, Color –Visual attention that Pops Out - Importing Matplotlib – Line plots – Scatter plots – three dimensional plotting – Geographic Data with Basemap – Visualization with Seaborn.

TOTAL: 45 PERIODS

REFERENCES

1. David Cielen, Arno D. B, Meysman and Mohamed Ali, “Introducing Data Science”, Manning Publications, 2016.
2. Robert S. Witte and John S. Witte, “Statistics”, Eleventh Edition, Wiley Publications, 2017.
3. Jake Vander Plas, “Python Data Science Handbook”, O’Reilly, 2016.
4. Matthew O. Ward, George Grinstein, Daniel Keim, “Interactive Data Visualization: Foundation, Techniques and Applications”, Second Edition, A. K. Peters/CRC Press, 2015.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1: Define the data science process

CO2:Understand different types of data description for data science process

CO3:Gain knowledge on relationships between data

CO4:Use the python libraries for data wrangling

CO5:Apply visualization libraries in python to interpret and explore data

CO-PO Mapping

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

CP3071 WIRELESS COMMUNICATIONS L T P C

3 0 0 3

UNIT I INTRODUCTION TO WIRELESS COMMUNICATION 9

Introduction to Wireless Communications - Wireless Vision - Technical Issues - Current Wireless Systems - The Wireless Spectrum - Transmission Fundamentals – Communication Networks – Protocols and TCP/IP Suite - Frequency Reuse – Channel Assignment Strategies – Hand off

Strategies – Interference and system capacity- Co-Channel Interference- Adjacent Channel Interference – Trunking and Grade of service – Improving coverage & capacity in cellular systems- Cell Splitting- Sectoring-Repeaters for Range Extension-Microcell Zone Concept.

UNIT II WIRELESS CHANNELS AND CODING 9

Physical Modeling - Input/Output Model - Capacity - Capacity of Flat Fading Channels - Frequency-Selective Fading Channels. Digital Modulation and Detection - Signal Space Analysis - Coding for Wireless Channels: Overview of Code Design-Linear Block Codes - Convolutional Codes - Concatenated Codes - Turbo Codes - Low-Density Parity-Check Codes - Coded Modulation - Coding with Interleaving for Fading Channels - Unequal Error Protection Codes- Joint Source and Channel Coding

UNIT III DIVERSITY AND EQUALISATION 9

Realization of independent fading paths, Receiver Diversity: selection combining, Threshold Combining, Maximum-ratio Combining, Equal gain Combining. Transmitter Diversity- Moment Generating Functions in Diversity Analysis- Equalisation – Equalizer Noise Enhancement Equalizer Types Folded Spectrum and ISI-Free Transmission Adaptive equalization, Linear and Non-Linear equalization, Zero forcing and LMS Algorithms - MIMO Systems

UNIT IV MULTICARRIER MODULATION 9

Data Transmission using Multiple Carriers – Multicarrier Modulation with Overlapping Sub channels – Mitigation of Subcarrier Fading – Discrete Implementation of Multicarrier Modulation – Peak to average Power Ratio- Frequency and Timing offset.

UNIT V 5G AND 6G IN WIRELESS COMMUNICATION 9

5G Concepts – 5G Standardisation – 5G Spectrum – LTE- An Overview- NR Overview - Radio Interface Architecture – Overall Transmission Structure – Channel Sounding. Introduction to 6G – Overview of 6G Technologies

TOTAL: 45 PERIODS

REFERENCES

1. Erik Dahlman, Stefan Parkvall, Johan Skold, 5G NR: The Next Generation Wireless Access Technology, First Edition, 2018
2. David Tse and Pramod Viswanath, Fundamentals of Wireless Communication, Cambridge University Press, 2005.
3. Andrea Goldsmith, Wireless Communications, Cambridge University Press, 2007.
4. William Stallings, Wireless Communication and Networks, Global Edition, Pearson, 2016.
5. Simon Haykin& Michael Moher, “Modern Wireless Communications”, Pearson Education, 2007.
6. Keith Q. T. Zhang, “Wireless Communications: Principles, Theory and Methodology” 1st edition, John Wiley & Sons, 2016.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Understand concepts of wireless communication.
CO2:Analyse the different types of wireless channels and coding
CO3:Understand about transmitter and receiver diversity and equalisation.
CO4:Learn about performance of the digital modulation.
CO5:Explore 5G, 6G technology concepts.

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CO-PO Mapping

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

CP3053 AGILE METHODOLOGIES L T P C
3 0 0 3

UNIT I AGILE METHODOLOGY 9

Theories for Agile Management – Agile Software Development – Traditional Model vs. Agile Model - Classification of Agile Methods – Agile Manifesto and Principles – Agile Project Management – Agile Team Interactions – Ethics in Agile Teams - Agility in Design, Testing – Agile Documentations – Agile Drivers, Capabilities and Value

UNIT II AGILE PROCESSES 9

Lean Production - SCRUM, Crystal, Feature Driven Development- Adaptive Software Development - Extreme Programming: Method Overview – Lifecycle – Work Products, Roles and Practices.

UNIT III AGILITY AND KNOWLEDGE MANAGEMENT 9

Agile Information Systems – Agile Decision Making - Earl_S Schools of KM – Institutional Knowledge Evolution Cycle – Development, Acquisition, Refinement, Distribution, Deployment , Leveraging – KM in Software Engineering – Managing Software Knowledge – Challenges of Migrating to Agile Methodologies – Agile Knowledge Sharing – Role of Story-Cards – Story-Card Maturity Model (SMM)

UNIT IV AGILITY AND REQUIREMENTS ENGINEERING 9

Impact of Agile Processes in RE–Current Agile Practices – Variance – Overview of RE Using Agile – Managing Unstable Requirements – Requirements Elicitation – Agile Requirements Abstraction Model – Requirements Management in Agile Environment, Agile Requirements Prioritization – Agile Requirements Modeling and Generation – Concurrency in Agile Requirements Generation

UNIT V AGILITY AND QUALITY ASSURANCE 9

Agile Product Development – Agile Metrics – Feature Driven Development (FDD) – Financial and Production Metrics in FDD – Agile Approach to Quality Assurance - Test Driven Development – Agile Approach in Global Software Development.

TOTAL: 45 PERIODS

REFERENCES

1. Craig Larman, “Agile and Iterative Development: A Manager’s Guide”, Addison-Wesley, 2004.
2. David J. Anderson and Eli Schragenheim, “Agile Management for Software Engineering: Applying the Theory of Constraints for Business Results”, Prentice Hall, 2003.
3. Kevin C. Desouza, “Agile Information Systems: Conceptualization, Construction and Management”, Butterworth-Heinemann, 2007

4. Hazza and Dubinsky, “Agile Software Engineering, Series: Undergraduate Topics in Computer Science”, Springer, 2009.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Analyze existing problems with the team, development process and wider organization

CO2:Apply a thorough understanding of Agile principles and specific practices

CO3:Select the most appropriate way to improve results for a specific circumstance or need

CO4:Judge and craft appropriate adaptations to existing practices or processes depending upon **analysis** of typical problems

CO5:Evaluate likely successes and formulate plans to manage likely risks or problems

CO-PO Mapping

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

CP3078 STATISTICAL NATURAL LANGUAGE PROCESSING L T P C
3 0 0 3

UNIT I MORPHOLOGY AND PART-OF SPEECH PROCESSING 9

Introduction –Regular Expressions and Automata- Non-Deterministic FSAs. Transducers – English Morphology – Finite-State Morphological Parsing - Porter Stemmer – Tokenization-Detection and Correction of Spelling Errors. N-grams – Perplexity - Smoothing - Interpolation - Backoff Part-of-Speech Tagging – English Word Classes - Tagsets - Rule-Based - HMM - Transformation-Based Tagging - Evaluation and Error Analysis. Hidden Markov and Maximum Entropy Models.

UNIT II SPEECH PROCESSING 9

Phonetics – Articulatory Phonetics - Phonological Categories - Acoustic Phonetics and Signals - Speech Synthesis – Text Normalization – Phonetic and Acoustic Analysis – Diphone Waveform synthesis – Evaluation- Automatic Speech Recognition –Architecture – Hidden Markov Model to Speech - MFCC vectors - Acoustic Likelihood Computation - Evaluation. Triphones – Discriminative Training - Modeling Variation. Computational Phonology-Finite-State Phonology – Computational Optimality Theory - Syllabification - Learning Phonology and Morphology.

UNIT III SYNTAX ANALYSIS 9

Formal Grammars of English – Constituency - Context-Free Grammars –Grammar Rules – Treebanks - Finite-State and Context-Free Grammars - Dependency Grammars. Syntactic Parsing – Parsing as Search - Ambiguity - Dynamic Programming Parsing Methods –CKY-Earley and Chart Parsing- Partial Parsing-Evaluation. Statistical Parsing – Probabilistic Context-Free Grammars – Probabilistic CKY Parsing of PCFGs –Probabilistic Lexicalized CFGs – Collins Parser Language and Complexity -The Chomsky Hierarchy -The Pumping Lemma.

Attested

UNIT IV SEMANTIC AND PRAGMATIC INTERPRETATION 9

Representation of Meaning – Desirable Properties - Computational Semantics -Word Senses - Relations Between Senses – WorldNet - Event Participants- Proposition Bank - Frame Net – Metaphor. Computational Lexical Semantics – Word Sense Disambiguation- Supervised Word Sense Disambiguation - Dictionary and Thesaurus Methods- Word Similarity – Minimally Supervised WSD - Hyponymy and Other Word Relations - Semantic Role Labeling – Unsupervised Sense Disambiguation. Computational Discourse - Discourse Segmentation – Unsupervised Discourse - Segmentation - Text Coherence - Reference Resolution –Phenomena– Features and algorithms - Pronominal Anaphora Resolution.

UNIT V APPLICATIONS 9

Information Extraction – Named Entity Recognition - Relation Detection and Classification – Temporal and Event Processing - Template-Filling - Biomedical Information Extraction. Question Answering and Summarization -Information Retrieval -Factoid Question Answering - Summarization - Single and Multi-Document Summarization - Focused Summarization - Evaluation. Dialog and Conversational Agents – Properties of Human Conversations – Basic Dialogue Systems - VoiceXML - Information- State and Dialogue Acts - Markov Decision Process Architecture. Machine Translation –Issues in Machine Translation - Classical MT and the Vauquois Triangle -Statistical MT - Phrase-Based Translation Model - Alignment in MT –IBM Models – Evaluation.

TOTAL: 45 PERIODS

REFERENCES

1. Jurafsky and Martin, “Speech and Language Processing”, Pearson Prentice Hall, Second Edition, 2008.
2. Christopher D. Manning and HinrichSchütze, “Foundations of Statistical Natural Language Processing”, MIT Press, 1999.
3. Stevan Bird, “Natural Language Processing with Python”, Shroff, 2009
4. James Allen, “Natural Language Understanding”, Addison Wesley, Second Edition, 2007.
5. NitinIndurkhya, Fred J. Damerau, “Handbook of Natural Language Processing”, (Chapman& Hall/CRC Machine Learning & Pattern Recognition), Second Edition, 2010.
6. Alexander Clark, Chris Fox, Shalom Lappin, “The Handbook of Computational Linguistics and Natural Language Processing”, Wiley-Blackwell, 2012.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Identify the different linguistic components of given sentences.

CO2:Design a morphological analyser for a language of your choice using finite state automata concepts.

CO3:Implement the Earley algorithm for a language of your choice by providing suitable grammar and words.

CO4:Use a machine learning algorithm for word sense disambiguation.

CO5:Build a tagger to semantically tag words using WordNet.

CO6:Design a business application that uses different aspects of language processing.

CO-PO Mapping

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

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CO3	2	-	3	3	-	2
CO4	2	-	2	2	-	2
CO5	2	-	2	2	-	3
CO6	2	-	2	2	-	3

CP3074 **QUANTUM COMPUTING** **L T P C**
3 0 0 3

UNIT I QUANTUM MECHANICS AND QUANTUM COMPUTATION 9

The postulates of quantum mechanics, The density operator, The Schmidt decomposition and purifications, EPR and the Bell inequality, Quantum circuits : Quantum algorithms, Single qubit operations, Controlled operations. Measurement, Universal quantum gates, Summary of the quantum circuit model of computation, Simulation of quantum systems.

UNIT II QUANTUM COMPUTERS AND ALGORITHMS 9

Guiding principles, Conditions for quantum computation, Harmonic oscillator quantum computer, Optical photon quantum computer, Optical cavity quantum electrodynamics, Ion traps, Nuclear magnetic resonance, Other implementation schemes, The quantum Fourier transform and its applications, Quantum search algorithms

UNIT III QUANTUM INFORMATION 9

Quantum noise and quantum operations : Classical noise and Markov processes, Quantum operations, Examples of quantum noise and quantum operations, Applications of quantum operations, Limitations of the quantum operations formalism, Distance measures for quantum information : Distance measures for classical information, How close are two quantum states?, How well does a quantum channel preserve information?

UNIT IV QUANTUM ERROR-CORRECTION 9

Introduction, The Shor code, Theory of quantum error-correction, Constructing quantum codes, Stabilizer codes, Fault-tolerant quantum computation.

UNIT V ENTROPY AND INFORMATION THEORY 9

Entropy : Shannon Entropy, Basic properties of entropy, Von Neumann entropy, Strong sub additivity, Quantum information theory : Distinguishing quantum states and the accessible information, Data compression, Classical information over noisy quantum channels, Quantum information over noisy quantum channels, Entanglement as a physical resource, Quantum cryptography

TOTAL: 45 PERIODS

REFERENCES

1. Michael A. Nielsen, Issac L. Chuang, Quantum Computation and Quantum Information, Cambridge University Press, Tenth Edition 2010.
2. Parag K Lala, Quantum Computing, A Beginners Introduction, Mc Graw Hill Education, First edition 2020.
3. Chris Bernhardt, Quantum Computing for Everyone, The MIT Press, Reprint edition 2020.
4. Jack D. Hidary's Quantum Computing: An applied approach, Springer, 2019.

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5. Eric Johnston, Nic Harrigan, and Mercedes Gimeno Segovia, Programming Quantum Computers: Essential Algorithms and Code, O'reilly, 2019.
6. Pierpaolo Marturano, Quantum Computing, De Gruyter Oldenbourg Publishing, 2023.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Understand the basics of quantum computing.
CO2:Understand the background of Quantum Mechanics.
CO3:Analyse the computation models.
CO4:Model the circuits using quantum computation. Environments and frameworks.
CO5:Understand the quantum operations such as noise and error-correction.

CO-PO Mapping

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

SE3051 FORMAL METHODS IN SOFTWARE SYSTEMS L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Need for Formal methods – Problems in Natural Language Specifications, Formal Versus Informal Programming – Advantages of Formal Methods – Requirements of Formal System – Types – Prepositional Logic – Predicate Logic – Relationships and Functions.

UNIT II FORMAL SPECIFICATION STYLE 9

Model-Oriented – Specifications – Concurrency-Based Specifications –Example Specification Languages.

UNIT III VDM 9

Introduction to VDM – Basic Types – Quote Types – Compound Types – Optional Types – Functions – Operations – Additional Constructs – Modules.

UNIT IV THE Z NOTATION 9

The Interchange Language – User-Defined Identifiers – Data Types – Basic Types – Compound Types – Schemas – Additional Constructs.

UNIT V FORMAL SEMANTICS AND TOOLS 9

Operational Semantics – Denotational Semantics – Axiomatic Semantics Proof Editors – Proof Analyser – Symbolic Simulators –Translators – Test Generation Tools.

TOTAL: 45 PERIODS

REFERENCES

1. Alexander Kossiakoff, William N. Sweet, Samuel J. Seymour, Steven M. Biemer, "Systems Engineering Principles and Practice", John Wiley & Sons, Inc., 2011.

2. Andrew Harry, " Formal Methods: Fact File VDM and Z", John Wiley and Sons, 1996.
3. Severance, Frank L. An Introduction to System Modeling and Simulation. New York: Wiley, 2001
4. Jim Woodcock, Jim Davies, "Using Z Specification, Refinement and Proof", Prentice Hall International, 1996.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:To model various classes of software systems within appropriate formalisms
CO2:To model various classes of software systems within appropriate formalisms;
CO3:To interpret and apply the formal languages of the formalisms for modeling software systems
CO4:To apply specific techniques for the analysis and verification of software systems;
CO5:To formulate and prove properties of software systems within studied formalisms

CO-PO Mapping

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

CP3066 **GPU COMPUTING** **L T P C**
3 0 0 3

UNIT I GPU ARCHITECTURE **9**

Evolution of GPU Architectures – Understanding Parallelism with GPU – Typical GPU Architecture – CUDA Hardware Overview – Threads, Blocks, Grids, Warps, Scheduling – Memory Handling with CUDA: Shared Memory, Global Memory, Constant Memory and Texture Memory.

UNIT II CUDA PROGRAMMING **9**

CUDA Basics – Multi GPU – Multi GPU Solutions – Optimizing CUDA Applications: Problem Decomposition, Memory Considerations, Transfers, Thread Usage, Resource Contentions.

UNIT III PROGRAMMING ISSUES **9**

Common Problems: CUDA Error Handling, Parallel Programming Issues, Synchronization, Algorithmic Issues, Finding and Avoiding Errors.

UNIT IV OPENCL BASICS **9**

OpenCL Standard – Kernels – Host Device Interaction – Execution Environment – Memory Model – Basic OpenCL Examples.

UNIT V ALGORITHMS ON GPU ALGORITHMS ON GPU **9**

Parallel Patterns: Convolution, Prefix Sum, Sparse Matrix – Matrix Multiplication – Programming Heterogeneous Cluster.

TOTAL: 45 PERIODS

REFERENCES

1. Shane Cook, “CUDA Programming: A Developer’s Guide to Parallel Computing with GPUs”, Morgan Kaufmann, 2013.
2. David R. Kaeli, Perhaad Mistry, Dana Schaa, Dong Ping Zhang, “Heterogeneous Computing with OpenCL 2.0”, Morgan Kauffman, 2015.
3. David B. Kirk, Wen-mei W. Hwu, “Programming Massively Parallel Processors – A Hands-on Approach”, Third Edition, Morgan Kaufmann, 2016.
4. Nicholas Wilt, “CUDA Handbook: A Comprehensive Guide to GPU Programming”, Addison Wesley, 2013.
5. Jason Sanders, Edward Kandrot, “CUDA by Example: An Introduction to General Purpose GPU Programming”, Addison Wesley, 2011.
6. https://developer.nvidia.com/language-solutions
7. https://www.khronos.org/opencl/

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Describe GPU Architecture.

CO2:Write programs using CUDA, identify issues and debug them.

CO3:Implement efficient algorithms in GPUs for common application kernels, such as matrix multiplication.

CO4:Write simple programs using OpenCL.

CO5:Given a problem, identify efficient parallel programming patterns to solve it.

CO6:Compare different GPU programming paradigms.

CO-PO Mapping

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

CP3061 DEVOPS AND MICROSERVICES L T P C
3 0 0 3

UNIT I INTRODUCTION TO DEVOPS 9

DevOp Preliminaries – What is DevOp – Basic DevOp Tools – Deployment Pipeline - Design Options.

UNIT II SECURITY IN DEVOPS 9

Virtualization – Container Orchestration – Secure Development – Disaster Recovery.

UNIT III INTRODUCTION TO MICROSERVICES 9

Microservices – Reasons for using Micro services – Challenges – Microservices and SOA

UNIT IV IMPLEMENTATION OF MICROSERVICES 11

Architecture of Microservices based systems – Integration and Communication – Architecture of Individual Microservices - Testing Microservices and Microservice-Based Systems - Operations and Continuous Delivery of Microservices - Organizational Effects of a Microservices-Based Architecture.

UNIT V BUILDING WEBAPPS, WEB SERVICES And MICROSERVICES With SPRING BOOT 7

Example of a Microservices Based Architecture - Technologies for Nanoservices.

TOTAL: 45 PERIODS

REFERENCES

1. Len Bass and John Klein, Deployment and Operations for Software Engineers, Len Bass Publishing, 2022
2. Eberhard Wolff, Microservices: Flexible Software Architecture, Addison-Wesley Professional, 2016
3. Michael Hüttermann, DevOps for Developers, Apress, 2012.
4. Moshe Zadka, DevOps in Python, Apress, 2019
5. Irakli Nadareishvili, Ronnie Mitra, Matt McLarty & Mike Amundsen, Microservice Architecture Aligning Principles Practices and Culture, O'Reilly 2016.
6. CHakradhar Rao Jonagam, Microservices with Kubernetes: Build a continous delivery pipeline for microservices using Kubernetes, Packt.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Explain basic DevOps practices
CO2:Be familiar with a Deployment Pipeline and associated tools
CO3:Understand Microservice Architecture
CO4:Be familiar with incident response and disaster recovery
CO5:Develop services using different technologies

CO-PO Mapping

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

CP3064 FULL STACK WEB APPLICATION DEVELOPMENT L T P C
3 0 2 4

UNIT I OVERVIEW OF FULL STACK 9+6

Understanding the Basic Web Development Framework - Browser – JavaScript – functions, arrays, objects, strings, Web Server –- Backend Services – MVC Architecture – Full stack with JAVA Spring Boot, React, MongoDB.

***Lab Exercises**:*

- Implement JavaScript functions, arrays, objects, strings

UNIT II FRONT-END DEVELOPMENT 9+6

REACT - Virtual DOM, components, props, JSX, Events, conditionals, lists, forms, Routing, Hooks, Redux, Client-server communication, material-UI.

Lab Exercises:

- installing Node.js, Using createRoot() and render() methods,
- Using React Class and function components, properties, events, conditionals, forms
- Implementing simple UI like menus

UNIT III JAVA SPRING BOOT 9+6

Spring Boot core features, architecture - auto configuration, dependency management, application, component scan, starters-starter web, data JPA, actuators, annotation, POM file.

Lab Exercises:

- Implement simple Client-server communication using TOMCAT from REACT client
- installing any IDE like STS (Spring Tool Suite) and configuring for spring application
- Creating Spring Boot project with Spring Initializr
- implementing a simple hello world web application

UNIT IV MONGODB 9+6

Understanding NoSQL and MongoDB – Building MongoDB Environment – User accounts – Access control – Administering databases – Managing collections – Connecting to MongoDB from Spring Boot Spring Data MongoDB, CRUD operations.

Lab Exercises:

- Install MongoDB Atlas Cluster, use Dependencies, Spring Web and Spring Data MongoDB, Docker, Container
- Create a CRUD application with MongoDB and Spring Boot.

UNIT V BUILDING WEBAPPS, WEB SERVICES AND MICROSERVICES WITH SPRING BOOT 9+6

using Spring Boot for Building simple web applications, creating RESTful web service, Microservices architecture, Principles of Microservices and its advantages, Service register & API Gateway, Admin Server & Client, Interservice communication, External API communication, Distributed logging.

Lab Exercises:

- Building RESTful web services with annotations: Rest controller, Request mapping, Request Body, Path Variable.
- Building Microservice: using the dependencies on the Spring Initializr - Spring Web, Spring Boot DevTools, Spring Boot Actuator, Config Client.

TOTAL: 75 PERIODS

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REFERENCES

1. John Carnell, Illary Huaylupo Sánchez, “Spring Microservices in Action”, 2nd Edition, Manning Publications, 2021.
2. Greg L. Turnquist, Learning Spring Boot 3.0, 3rd Edition, Packt Publishing, 2022.
3. David Herron, Node.js Web Development, Packt Publishing Limited, 5th edition, 2020.
4. David Flanagan, Javascript The Definitive Guide, Oreilly, 7th Edition, 2020.
5. K. Siva Prasad Reddy, Sai Upadhyayula, Beginning Spring Boot 3: Build Dynamic Cloud-Native Java Applications and Microservices, A Press, 2022.
6. Craig Walls, Spring Boot in Action, Manning Publications, 2016.
7. https://spring.io
8. https://react.dev
9. https://www.mongodb.com/compatibility/spring-boot
10. https://nodejs.org/en

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Use Javascript and its libraries for building front-end applications
CO2:Use React.js to build client-side applications
CO3:Develop Spring Boot based web applications
CO4:Integrate web applications with MongoDB
CO5:Develop Web applications, RESTful web services and MicroServices using full stack

CO-PO Mapping

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

CP3054 BIO INFORMATICS L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Bioinformatics- Need for Bioinformatics technologies – Overview of Bioinformatics technologies - Structural bioinformatics – Data format and processing – Secondary resources and applications – Role of Structural bioinformatics – Biological Data Integration System.

UNIT II DATAWAREHOUSING AND DATAMINING IN BIOINFORMATICS 9

Bioinformatics data – Data warehousing architecture – data quality – Biomedical data analysis – DNA data analysis – Protein data analysis – Machine learning – Neural network architecture and applications in bioinformatics- Case Study on Artificial Neural Networks Applications in Protein secondary structure prediction.

UNIT III GRAPHS **9**

Hidden Markov modeling for biological data analysis and protein, gene families Sequence identification –Sequence classification – multiple alignment generation – Comparative modeling –Protein modeling – genomic modeling – Probabilistic modeling – Bayesian networks – Boolean networks – Molecular modeling – Computer programs for molecular modeling.

UNIT IV PHYLOGENETICS AND MODELS OF EVLOUTION **9**

Introduction to Phylogenetics, Jukes Cantor and Kimura Models of Evolution, Distance and Character based methods for phylogenetic tree construction: Unweighted Pair Group Method of Arithmetic Averages, Neighbour joining Trees, Maximum Likelihood Trees, Ultra metric and Min ultra metric trees, Parsimonous trees, Additive trees, Assessing there liability of phylogenetic trees-Bootstrapping.

UNIT V MICROARRAY ANALYSIS **9**

Microarray technology for genome expression study – image analysis for data extraction – preprocessing – segmentation – gridding – spot extraction – normalization, filtering – cluster analysis – gene network analysis – Compared Evaluation of Scientific Data Management Systems – Cost Matrix – Evaluation model – Benchmark – Tradeoffs.

TOTAL: 45 PERIODS

REFERENCES

1. David W. Mount Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, 2nd ed., 2004
2. Arthur M .Lesk, Introduction to Bioinformatics, Oxford University Press, 2014
3. Big Data Analysis for Bioinformatics and Biomedical Discoveries Edited by Shui Qing Ye, CRC Press, Taylor and Francis Group, 2015
4. Bolón-Canedo, V., & Alonso-Betanzos, A. (Eds.). Microarray Bioinformatics. Methods in Molecular Biology, 2019
5. Andrew R.Leach, Molecular Modeling Principles And Applications, Prentice Hall,2009.
6. Baldi,P.,Brunak, S.Bioinformatics: The Machine Learning Approach, East West Press, 2nd 2001
7. Orpita Bosu, Bioinformatics – Databases, Tools and Algorithms, Oxford University Press, 2007.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Gather knowledge of basic bioinformatics and computational biology concepts

CO2:Perform analysis of biological data including proteomic, genomic and transcriptomic data and provide meaningful interpretation of the results

CO3:Understand machine learning techniques, microarray data analysis and interpretation of results

CO4:Understand the concepts of modelling for bioinformatics

CO5:Perform analysis of various methods of phylogenetic tree construction and its evolutions

CO-PO Mapping

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

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

CP3069 **MIXED REALITY** **L T P C**
3 0 0 3

UNIT I INTRODUCTION **9**

Introduction to Virtual Reality – Definition – Three I's of Virtual Reality – Virtual Reality Vs 3D Computer Graphics – Benefits of Virtual Reality – Components of VR System – Introduction to AR – System Structure of Augmented Reality – Key Technology in AR – 3D Vision – Approaches to Augmented Reality – Alternative Interface Paradigms – Spatial AR – Input Devices – 3D Position Trackers – Performance Parameters – Types Of Trackers – Interaction-Modelling and annotation-Navigation and Manipulation Interfaces – Gesture Interfaces – Types of Gesture Input Devices – Output Devices – Graphics Display – Human Visual System – Personal Graphics Displays – Large Volume Displays – Sound Displays – Human Auditory System.

UNIT II MR COMPUTING ARCHITECTURE **9**

Computing Architectures of VR – Rendering Principle – Graphics and Haptics Rendering – PC Graphics Architecture – Graphics Accelerators – Graphics Benchmarks – Workstation Based Architectures – SGI Infinite Reality Architecture – Distributed VR Architectures – Multi-pipeline Synchronization – Collocated Rendering Pipelines – Distributed Virtual Environments – AR Architecture

UNIT III MR MODELING **9**

Modeling – Geometric Modeling – Virtual Object Shape – Object Visual Appearance – Kinematics Modeling – Transformation Matrices – Object Position – Transformation Invariants – Object Hierarchies – Viewing The 3D World – Physical Modeling – Collision Detection – Surface Deformation – Force Computation – Force Smoothing And Mapping – Behavior Modeling – Model Management

UNIT IV MR PROGRAMMING **9**

VR Programming – Toolkits and Scene Graphs – World Toolkit – Java 3D – Comparison of World Toolkit and Java 3D – GHOST – People Shop – Human Factors in VR – Methodology And Terminology – VR Health and Safety Issues – VR and Society –Mixed Reality Coding – Trajectories through Mixed Reality Performance – Mobile Interface Design – Quantitative Evaluation – Qualitative Evaluation

UNIT V APPLICATIONS **9**

Emerging MR Applications in Medical, Military & Manufacturing– Education, Arts and Entertainment– Applications of MR in Robotics-Application of AI in AR & VR: virtual assistant, Digital avatars and characters, user engagement, Interactive training, digital art creation – Information Visualization –Wearable Computing – Games

TOTAL: 45 PERIODS

REFERENCES

1. Grigore C. Burdea, Philip Coiffet, "Virtual Reality Technology", Second Edition, Wiley India, 2006.
2. Benford, S., Giannachi G., "Performing Mixed Reality", MIT Press, 2011

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3. Dieter Schmalstieg, Tobias Hollerer, “Augmented Reality: Principles & Practice”, Addison Wesley, 2016.
4. Charles Palmer, John Williamson, “Virtual Reality Blueprints: Create Compelling VR Experiences for Mobile”, Packt Publisher, 2018.
5. John Vince, “Introduction to Virtual Reality”, Springer-Verlag, 2004.
6. William R. Sherman, Alan B.Craig: Understanding Virtual Reality – Interface,Application, Design”, Morgan Kaufmann, 2003.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Discuss the basic concepts of Mixed Reality.

CO2:Design and develop the Mixed Reality applications in different domains.

CO3:Design various models using modelling techniques.

CO4:Perform Mixed Reality Programming with toolkits.

CO5:Understand the working principles of input output devices used in mixed reality applications.

CO6:Evaluate mixed reality-based applications.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	1	1	1
CO2	2	1	1	2	3	2
CO3	2	3	3	3	3	2
CO4	3	3	3	3	3	1
CO5	2	3	1	1	2	2
CO6	3	3	2	3	3	2

CP3057 CYBER PHYSICAL SYSTEMS L T P C
3 0 0 3

UNIT I CYBER-PHYSICAL SYSTEMS 9

Cyber-Physical Systems (CPS) in the real world - Characteristics of CPS - Architecture of CPS - Distinctive features of CPS systems - CPS for Industry 4.0 - IIOT implications - Logical Foundations of Cyber-Physical Systems - CPS HW platforms : Processors, Sensors, Actuators - CPS Network - Scheduling Real Time CPS tasks.

UNIT II CPS - FEEDBACK SYSTEMS 9

Modeling of system : Continuous Dynamics, Discrete Dynamic, Hybrid Systems, Composition of State Machine, Concurrent Models of Computation - CPU Dynamics - Relation between physical and software models - Principles of Dynamical Systems : Dynamical Systems and Stability - Controller Design Techniques - Meta Model of CPS - Control systems: Human-in or on the loop - Economics in the loop - Environment in the loop.

UNIT III CPS - HITL 9

Taxonomies for HiTL CPS - Data Acquisition : Humans as Sets of Sensors, Humans as Communication Nodes - State Inference: Humans as Processing Nodes - Actuation - HiTL Technologies and Applications - Requirements and Challenges for HiTL Applications - Future of

Human-In-the-Loop Cyber-Physical Systems - Human-in-the-Loop Constraints.

UNIT IV HUMAN CENTRIC COMPUTING 9

Aim of Human Centric Computing - Context-aware service technology - Multi-device Collaboration technology - Human Interaction technology - Human Centric Computing in a Data-Driven Society.

UNIT V CPS IMPLEMENTATION ISSUES 9

From features to automotive software components - Mapping software components to ECUs - CPS Performance Analysis - effect of scheduling, bus latency, sense and actuation faults on control performance, network congestion - Building real-time networks for CPS.

TOTAL: 45 PERIODS

REFERENCES

1. E. A. Lee and S. A. Seshia, “Introduction to Embedded Systems: A Cyber-Physical Systems Approach”, 2011.
2. R. Alur, “Principles of Cyber-Physical Systems,” MIT Press, 2015.
3. R. Alur, “Principles of Cyber-Physical Systems,” MIT Press, 2015.
4. T. D. Lewis “Network Science: Theory and Applications”, Wiley, 2009.
5. P. Tabuada, “Verification and control of hybrid systems: a symbolic approach”, Springer-Verlag 2009.
6. C. Cassandras, S. Lafortune, “Introduction to Discrete Event Systems”, Springer 2007.
7. Constance Heitmeyer and Dino Mandrioli, “Formal methods for real-time computing”, Wiley publisher, 1996.
8. Platzer, Andre, " Logical Foundation of Cyber-Physical Systems", Theorectical Computer Science, Springer-2018.
9. Rajkamal, " Enbedded Systems, Architecture, Programming and Design", Second Edition, Tata McGraw-Hill Publisher, 2008.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:Explain and analyze the major concepts, philosophical and theoretical perspectives, empirical findings,and historical trends in Cyber-Physical Systems.

CO2:Use Computational knowledge base to create their own methods for answering novel questions of either a theoretical or applied nature, and to critically evaluate the work of others in the same domain.

CO3:Articulate the main concepts, key technologies, strengths and limitations of Human Centered Cyber Physical Systems.

CO4:Point out the challenges in HiTL and able to explain the future of HiTL CPS.

CO5:Be proficient with basic feedback and control research methods, including both theory-driven and applied research design.

CO-PO Mapping

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