ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

M.E. COMPUTER SCIENCE AND ENGINEERING

(SPECIALIZATION IN OPERATIONS RESEARCH)

REGULATIONS – 2019

CHOICE BASED CREDIT SYSTEM

VISION AND MISSION

VISION OF THE DEPARTMENT

The Department of Computer Science and Engineering strives to create computing professionals, researchers, and entrepreneurs, with high technical knowledge, communication skills, values and ethics. It collaborates with academia, industry and community to set high standards in academic excellence and in fulfilling societal responsibilities.

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.

ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS
M.E. COMPUTER SCIENCE AND ENGINEERING
(SPECIALIZATION IN OPERATIONS RESEARCH)
REGULATIONS – 2019
CHOICE BASED CREDIT SYSTEM

PROGRAM EDUCATIONAL OBJECTIVES:

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

PROGRAM OUTCOMES:

Students will be able to:

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/development of solutions: Design solutions for complex computer science problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and computer science related tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
5. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one‘s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
6. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

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	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
1.	√	√	√			
2.	√	√	√	√	√	
3.	√	√	√	√	√	
4.	√		√	√	√	√
5.		√	√	√	√	√

YEAR	SEMESTER	COURSE TITLE	PO1	PO2	PO3	PO4	PO5	PO6
YEAR 1	SEMESTER1	Advanced Mathematics for Scientific Computing	√	√	√	√		
		Data Structures and Algorithms	√	√	√	√	√	
		Advanced Operating Systems	√	√	√	√	√	
		Linear Programming and Applications	√	√	√	√	√	
		Research Methodology and IPR					√	√
		Audit Course – I				√	√	√
		Data Structures and Algorithms Laboratory	√	√	√	√	√	√
		Linear Programming Laboratory	√	√	√	√	√	√
	SEMESTER 2	Advanced Databases	√	√	√	√	√	
		Networking Technologies	√	√	√	√	√	
		Non-Linear Programming	√	√	√	√	√	
		Program Elective I						
		Program Elective II						

		Audit Course –II						
		Advanced Databases Laboratory	√	√	√	√	√	
		Non-Linear Programming Laboratory	√	√	√	√	√	
		Professional Practices		√	√			√
YEAR 2	**SEMESTER 3**	Program Elective III						
		Program Elective IV						
		Program Elective V						
		Open Elective						
		Dissertation I	√	√	√	√	√	√
	SEMESTER 4	Dissertation II	√	√	√	√	√	√

ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS
M.E. COMPUTER SCIENCE AND ENGINEERING (SPECIALIZATION IN OPERATIONS RESEARCH)
REGULATIONS – 2019
CHOICE BASED CREDIT SYSTEM
I - IV SEMESTER CURRICULA AND SYLLABI
SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA5153	Advanced Mathematics for Scientific Computing	FC	3	1	0	4	4
2.	CP5151	Data Structures and Algorithms	PCC	3	0	0	3	3
3.	CP5251	Advanced Operating Systems	PCC	3	0	0	3	3
4.	OR5101	Linear Programming and Applications	PCC	3	0	0	3	3
5.	RM5151	Research Methodology and IPR	RMC	2	0	0	2	2
6.		Audit Course – I*	AC	2	0	0	2	0
PRACTICALS								
7.	CP5161	Data Structures and Algorithms Laboratory	PCC	0	0	4	4	2
8.	OR5111	Linear Programming Laboratory	PCC	0	0	4	4	2
			TOTAL	**16**	**1**	**8**	**25**	**19**

*Audit course is optional

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	OR5251	Advanced Databases	PCC	3	0	0	3	3
2.	CP5153	Networking Technologies	PCC	3	0	0	3	3
3.	OR5201	Non-Linear Programming	PCC	3	0	0	3	3
4.		Program Elective I	PEC	3	0	2	3	4
5.		Program Elective II	PEC	3	0	0	3	3
6.		Audit Course –II*	AC	2	0	0	2	
PRACTICALS								
7.	OR5261	Advanced Databases Laboratory	PCC	0	0	4	4	2
8.	OR5211	Non-Linear Programming Laboratory	PCC	0	0	4	4	2
9.	CP5262	Professional Practices	EEC	0	0	2	2	1
			TOTAL	**17**	**0**	**12**	**27**	**21**

*Audit course is optional

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Program Elective III	PEC	3	0	2	5	4
2.		Program Elective IV	PEC	3	0	0	3	3
3.		Program Elective V	PEC	3	0	0	3	3
4.		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
5.	OR5311	Dissertation 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.	OR5411	Dissertation II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL NO. OF CREDITS : 71

FOUNDATION COURSES (FC)

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	MA5153	Advanced Mathematics for Scientific Computing	FC	3	1	0	4	4

PROGRAM CORE COURSES (PCC)

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CP5151	Data Structures and Algorithms	PCC	3	0	0	3	3
2.	CP5251	Advanced Operating Systems	PCC	3	0	0	3	3
3.	OR5101	Linear Programming and Applications	PCC	3	0	0	3	3
4.	CP5161	Data Structures and Algorithms Laboratory	PCC	0	0	4	4	2
5.	OR5111	Linear Programming Laboratory	PCC	0	0	4	4	2
6.	CP5251	Advanced Databases	PCC	3	0	0	3	3
7.	CP5153	Networking Technologies	PCC	3	0	0	3	3
8.	OR5201	Non-Linear Programming	PCC	3	0	0	3	3
9.	OR5251	Advanced Databases Laboratory	PCC	0	0	4	4	2
10.	OR5211	Non-Linear Programming Laboratory	PCC	0	0	4	4	2

PROGRAM ELECTIVES COURSE (PEC)

SL. NO.	COURSE CODE	COURSE TITLE	CATEG ORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CP5086	Social Network Analysis	PEC	3	0	2	5	4
2.	SE5072	Fundamentals of Machine Learning	PEC	3	0	2	5	4
3.	CP5073	Cloud Computing Technologies	PEC	3	0	2	5	4
4.	CP5080	Ethical Hacking	PEC	3	0	2	5	4
5.	CP5079	Digital Image and Video Processing	PEC	3	0	2	5	4
6.	CP5083	Internet of Things	PEC	3	0	2	5	4
7.	CP5072	Advanced Software Engineering	PEC	3	0	2	5	4
8.	CP5252	Compiler Optimization Techniques	PEC	3	0	2	5	4
9.	CP5084	Parallel Algorithms	PEC	3	0	0	3	3
10.	CP5076	Cyber Security	PEC	3	0	0	3	3
11.	CP5081	Game Theory	PEC	3	0	0	3	3

12.	CP5071	Adhoc and Wireless Sensor Networks	PEC	3	0	0	3	3
13.	CP5078	Database Administration and Tuning	PEC	3	0	0	3	3
14.	CP5077	Data Warehousing and Data Mining Techniques	PEC	3	0	0	3	3
15.	BD5151	Big Data Mining and Analytics	PEC	3	0	0	3	3
OPERATIONS RESEARCH ELECTIVES								
16.	OR5001	Python Programming for Optimization Techniques	PEC	3	0	2	5	4
17.	OR5002	System Modeling and Simulation	PEC	3	0	2	5	4
18.	OR5003	Project Management with PERT/CPM	PEC	3	0	2	5	4
19.	OR5004	Dynamic Programming	PEC	3	0	0	3	3
20.	OR5005	Scheduling Algorithms	PEC	3	0	0	3	3
21.	OR5006	Network Optimization	PEC	3	0	0	3	3
22.	OR5007	Supply Chain Management	PEC	3	0	0	3	3
23.	OR5008	Convex Optimization Techniques	PEC	3	0	0	3	3
24.	OR5009	Numerical Optimization	PEC	3	0	0	3	3
25.	OR5010	Queuing Theory and Stochastic Modeling	PEC	3	0	0	3	3

OPEN ELECTIVE COURSES (OEC)

*(out of 6 courses one course must be selected)

SI. NO	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CONTACT PERIODS	CREDITS
				L	T	P		
1.	OE5091	Business Data Analytics	OEC	3	0	0	3	3
2.	OE5092	Industrial Safety	OEC	3	0	0	3	3
3.	OE5093	Operational Research	OEC	3	0	0	3	3
4.	OE5094	Cost Management of Engineering Projects	OEC	3	0	0	3	3
5.	OE5095	Composite Materials	OEC	3	0	0	3	3
6.	OE5096	Waste to Energy	OEC	3	0	0	3	3

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			Lecture	Tutorial	Practical	
1.	AX5091	English for Research Paper Writing	2	0	0	0
2.	AX5092	Disaster Management	2	0	0	0
3.	AX5093	Sanskrit for Technical Knowledge	2	0	0	0
4.	AX5094	Value Education	2	0	0	0
5.	AX5095	Constitution of India	2	0	0	0
6.	AX5096	Pedagogy Studies	2	0	0	0
7.	AX5097	Stress Management by Yoga	2	0	0	0
8.	AX5098	Personality Development Through Life Enlightenment Skills	2	0	0	0
9.	AX5099	Unnat Bharat Abhiyan	2	0	0	0
Total Credits						**0**

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CONTACT PERIODS	CREDITS
1.	CP5262	Professional Practices	EEC	0	0	2	2	1
2.	OR5311	Dissertation I	EEC	0	0	12	12	6
3.	OR5411	Dissertation II	EEC	0	0	24	24	12

MA5153 ADVANCED MATHEMATICS FOR SCIENTIFIC COMPUTING L T P C
3 1 0 4

OBJECTIVES:

- To apply mathematical linear programming techniques to solve constrained problems.
- To appreciate the use of simulation techniques.
- To enable them to estimate the value of the parameters involved in the specific distribution from a possible continuum of alternatives.
- To give an idea of testing the statistical hypothesis claimed based on a set of data points using standard sampling distributions.
- To impart knowledge of handling random vectors which represent random variables in multi dimensional space.

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

OUTCOMES:

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

- Formulate and find optimal solution in the real life optimizing/allocation/assignment problems involving conditions and resource constraints.
- Simulate appropriate application/distribution problems.
- Obtain the value of the point estimators using the method of moments and method of maximum likelihood.
- Apply the concept of various test statistics used in hypothesis testing for mean and variances of large and small samples.
- 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.

CP5151 DATA STRUCTURES AND ALGORITHMS L T P C
3 0 0 3

OBJECTIVES:

- To extend the students’ knowledge of algorithms and data structures.
- To enhance their expertise in algorithmic analysis and algorithm design techniques.
- To understand various types of search and heap structures.
- To study various types of geometric, randomized and approximation algorithms.
- To extrapolate from them in order to apply those algorithms and techniques to solve problems.

UNIT I FUNDAMENTALS 9

Properties of Big-oh Notation – Conditional Asymptotic Notation – Algorithm Analysis – Amortized Analysis – Introduction to NP – Completeness/NP-Hard – Recurrence Equations – Solving Recurrence Equations – Time-Space Tradeoff.

UNIT II SEARCH STRUCTURES 9

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

UNIT III HEAP STRUCTURES 9

Min/Max heaps – Deaps – Leftist Heaps – Binomial Heaps – Fibonacci Heaps – Skew Heaps – Lazy – Binomial Heaps

UNIT IV GEOMETRIC ALGORITHMS 9

Segment Trees – 1-Dimensional Range Searching – k-d Trees – Line Segment Intersection – Computing the Overlay of Two Subdivisions – Range Trees – Voronoi Diagram

UNIT V ADDITIONAL TOPICS 9

Approximation Algorithms: Vertex Cover & Euclidean Travelling Salesperson Problem – Randomized Algorithms: Closest Pair Problem & Minimum Spanning Trees – Online Algorithm: Euclidean Spanning Tree.

TOTAL : 45 PERIODS

OUTCOMES:

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

- Analyze algorithms.
- Determine algorithm correctness.
- Choose appropriate data structures for the problems to be solved.
- Design algorithms for problems from different domains.
- Identify various research strategies on algorithmic design.

REFERENCES:

1. Ellis Horowitz, SartajSahni, Susan Anderson-Freed, “Fundamentals of Data Structures in C”, Second Edition, University Press, 2008.
2. Gilles Brassard, Paul Bratley, “Algorithmics: Theory and Practice”, Prentice Hall, 1988.
3. Mark de Berg, Otfried Cheong, Marc van Kreveld, Mark Overmars, “Computational Geometry Algorithms and Applications”, Third Edition, Springer, 2008.
4. 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.
5. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, “Introduction to Algorithms”, MIT Press, 2009.

CO	PO						PSO		
	1	2	3	4	5	6	1	2	3
1.			√	√		√	√		
2.		√		√		√	√		
3.	√		√	√		√	√		
4.	√		√	√		√	√	√	√
5.	√		√	√		√	√	√	√

CP5251 ADVANCED OPERATING SYSTEMS L T P C
3 0 0 3

OBJECTIVES:

- To understand the concepts of distributed systems.
- To get an insight into the various issues and solutions in distributed operating systems.
- To learn about real-time operating systems.
- To gain knowledge on the design concepts of mobile operating systems.
- To understand cloud operating systems.

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 – Load Distributing Algorithms – Synchronous and Asynchronous Check Pointing and Recovery – Fault Tolerance – Two-Phase Commit Protocol – Non blocking 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

OUTCOMES:

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

- Identify the features of distributed operating systems.
- Demonstrate the various protocols of distributed operating systems.
- Identify the different features of real-time operating systems.
- Discuss the features of mobile operating systems.
- Discuss the features of cloud operating systems.

REFERENCES:

1. MukeshSinghal and Niranjan G. Shivaratri, "Advanced Concepts in Operating Systems – Distributed, Database and Multiprocessor Operating Systems", Tata McGraw-Hill, 2001.
2. Rajib Mall, "Real-Time Systems: Theory and Practice", Pearson Education India, 2006.
3. KarimYaghmour, "Embedded Android", O'Reilly, First Edition, 2013.
4. NikolayElenkov, "Android Security Internals: An In-Depth Guide to Android's Security Architecture", No Starch Press, 2014.

CO	PO						PSO		
	1	2	3	4	5	6	1	2	3
1.	√		√	√			√	√	
2.	√		√	√			√	√	
3.	√		√	√	√		√	√	√
4.	√		√	√			√	√	
5.	√		√	√			√	√	

OR5101 LINEAR PROGRAMMING AND APPLICATIONS L T P C
3 0 0 3

OBJECTIVES:

- To formulate optimization problem and solve using graphical and simplex methods.
- To learn the principles of complex linear programming problems and its solutions.
- To analyse the sensitivity of different attributes for optimal solutions.
- To apply the solutions to integer programming problems.
- To design and apply solutions to various use cases using software tools.

UNIT I INTRODUCTION 9

Formulation and Graphical Solutions – Solution of Maximization Model – Solution of Minimization Model – Simplex method – Degeneracy – Unbounded Solution – Infeasible Solution – Alternative Optima.

UNIT II ADVANCED LINEAR PROGRAMMING 9

BIG-M method – Two–Phase method – Special cases in the Simplex method –Transportation and Assignment Problems – Revised Simplex Method – Duality in Linear Programming Problems –Dual Simplex method – Bounded variable technique.

UNIT III SENSITIVITY ANALYSIS 9

Sensitivity Analysis or Post Optimality Analysis – Changes in the Right-handside– Objective function – Changes affecting feasibility – Changes affecting optimality.

UNIT IV INTEGER PROGRAMMING 9

Knapsack Problem – Cutting plane algorithm – Branch and bound programming – Mixed integer Programming – travelling salesperson problem.

UNIT V CASE STUDIES AND TOOLS 9

Case Studies – Production Planning– Manpower planning– Solving LP problems using TORA / LINDO / LINGO / LP Solver using R

TOTAL:45 PERIODS

OUTCOMES:

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

- Mathematically formulate and solve minimization/maximization problems.
- Solve transportation and assignment problems.
- Analyse sensitivity, post optimality, changes affecting feasibility and optimality.
- Model and solve integer programming problems like travelling salesman problems.
- Solve linear programming problems using software tools.

REFERENCES:

1. HamdyA.Taha, “Operations Research-An Introduction”, Prentice Hall, TenthEdition,2017.
2. J.K.Sharma, “Operations Research Theory and applications”, Macmillan,6th Edition,2017.
3. Frederick S. Hiller, Gerald J Liberman, Bodhibrata Nag, PreetamBasu, “Introduction to Operations Research”,10th Edition,McGrawHill,,2017.
4. Ronald L.Rardin, “Optimization in Operations Research”, 2nd Edition PearsonEducation, Asia,2018.
5. DimitrisAlevras, Manfred W. Padberg, Linear Optimization and Extension: problems and Solutions, 1st Edition, Springa-Verlag Berlin and Heidelberg 2001.

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

RM5151 RESEARCH METHODOLOGY AND IPR LT P C
2 0 0 2

OBJECTIVES:

To impart knowledge and skills required for research and IPR:

- Problem formulation, analysis and solutions.
- Technical paper writing / presentation without violating professional ethics
- Patent drafting and filing patents.

UNIT I RESEARCH PROBLEM FORMULATION 6

Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations

UNIT II LITERATURE REVIEW 6

Effective literature studies approaches, analysis, plagiarism, and research ethics.

UNIT III TECHNICALWRITING /PRESENTATION 6

Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.

UNIT IV INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR) 6

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT V INTELLECTUAL PROPERTY RIGHTS (IPR) 6

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc.

Traditional knowledge Case Studies, IPR and IITs.

TOTAL: 30 PERIODS

OUTCOMES:

1. Ability to formulate research problem
2. Ability to carry out research analysis
3. Ability to follow research ethics
4. Ability to understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
5. Ability to understand about IPR and filing patents in R & D.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										
CO2	✓											
CO3	✓							✓				
CO4	✓				✓							
CO5	✓					✓						✓

REFERENCES:

1. Asimov, "Introduction to Design", Prentice Hall, 1962.
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
3. Mayall, "Industrial Design", McGraw Hill, 1992.
4. Niebel, "Product Design", McGraw Hill, 1974.
5. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners" 2010

CP5161 DATA STRUCTURES AND ALGORITHMS LABORATORY L T P C
0 0 4 2

OBJECTIVES:

- To familiarize various data structure implementations.
- To implement heap and various tree structures like AVL, Red-black, B- Tree and segment trees.
- To understand efficient implementation of line segment intersection
- To understand various search structures.
- To get understanding of problem to program mapping.

List of Experiments:

1. Binary Search Trees
2. Min/Max Heap
3. Leftist Heap
4. AVL Trees
5. Red-Black Trees
6. B-Trees
7. Segment Trees
8. Line segment intersection

TOTAL: 60 PERIODS

OUTCOMES:

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

- Achieve programming skill to convert a problem to a programming logic.
- Apply suitable data structure for the problem in hand.
- Implement heap and various tree structures like AVL, Red-black, B- Tree and segment trees.
- Understand the usage of data structures for geometric problems
- Understand the importance of height balancing in search structures.

CO	PO						PSO		
	1	2	3	4	5	6	1	2	3
1.	√		√	√		√	√	√	√
2.	√			√		√		√	√
3.			√			√		√	
4.			√	√		√		√	
5.			√			√		√	

OR5111 **LINEAR PROGRAMMING LABORATORY** **L T P C**
0 0 4 2

OBJECTIVES:

- To apply the knowledge of mathematics, engineering and linear programming to the design of solutions to complex engineering problems.
- To demonstrate knowledge and understanding of the linear programming principles in multidisciplinary environments.
- To create software programs, use modern tools and apply linear programming techniques.
- To conduct design of experiments for the specified needs with appropriate consideration.
- To demonstrate skill in interpretation of the data and synthesis of the information to provide valid inferences.

EXPERIMENTS:

1. Solving simplex maximization problems using R programming.
2. Solving simplex minimization problems using R programming.
3. Solving mixed constraints problems – Big M & Two phase method using TORA.
4. Solving transportation problems using R.
5. Solving assignment problems using R.
6. Solving optimization problems using LINGO.
7. Studying Primal-Dual relationships in LP using TORA.
8. Solving LP problems using dual simplex method using TORA.
9. Sensitivity & post optimality analysis using LINGO.

TOTAL: 60 PERIODS

OUTCOMES:

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

- Apply linear programming techniques to solve complex engineering problems.
- Use solvers like LINGO, TORA to solve real life linear optimization problems.
- Design algorithms, create programs in R, apply appropriate techniques and analyse the convergence time of different methods.
- Provide instant results through programming tools(solvers).
- Draw inferences from the results and provide information aiding planning and decision making.

OR5251 ADVANCED DATABASES L T P C
3 0 0 3

OBJECTIVES:

- To comprehend the underlying principles of Relational Database Management System.
- To develop database models using parallel and distributed databases.
- To understand the concepts of XML and Web databases.
- To apprehend the design and implementation of active temporal and deductive databases.
- To develop applications based on NOSQL database.

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 – Transaction Management-Recovery

UNIT II PARALLEL AND DISTRIBUTED DATABASES 9

Parallel Databases – I/O Parallelism – Inter-Query and Intra-Query Parallelism – Inter-Operation and Intra-operation Parallelism – Distributed Database Architecture – Distributed Data Storage – Distributed Transactions – Distributed Query Processing – Distributed Transaction Management.

UNIT III XML AND WEB DATABASES 9

XML Data Model – DTD – XML Schema – XML Querying – Web Databases – Open Database Connectivity – Java Database Connectivity – Accessing Relational database using PHP

UNIT IV ACTIVE TEMPORAL AND DEDUCTIVE DATABASES 9

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

UNIT V NO SQL DATABASES 9

NoSQL database vs traditional RDBMS database – Migrating from RDBMS to NOSQL – MongoDB – Database creation and Querying – Web Application development using MongoDB

TOTAL : 45 PERIODS

OUTCOMES:

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

- Design and implement relational databases.
- Design and implement parallel and distributed databases.
- Design and implement XML databases, Active, Temporal and Deductive databases.
- Implement the concept of database connectivity with the applications.
- Apply various data mining techniques.

REFERENCES:

1. R. Elmasri, S.B. Navathe, “Fundamentals of Database Systems”, Addison-Wesley, 2011.
2. Han, Jiawei, Jian Pei, and MichelineKamber. Data mining: concepts and Techniques. 2011.
3. Thomas Cannolly and Carolyn Begg, “Database Systems, A Practical Approach to Design, Implementation and Management”, Third Edition, Pearson Education, 2007.
4. Henry F Korth, Abraham Silberschatz, S. Sudharshan, “Database System Concepts”, Fifth Edition, McGraw Hill, 2006.
5. C.J.Date, A.Kannan andS.Swamynathan, “An Introduction to Database Systems”, Eighth Edition, Pearson Education, 2006.
6. V.S.Subramanian, “Principles of Multimedia Database Systems”, Harcourt India Pvt. Ltd.,2001.
7. ShashankTiwari, ”Professional NoSQL”, Wiley, 2011.

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

CP5153 NETWORKING TECHNOLOGIES L T P C
3 0 0 3

OBJECTIVES:

- To learn about integrated and differentiated services architectures.
- To understand the working of wireless network protocols.
- To study the developments in cellular networks.
- To get familiarized with next generation networks.
- To know the concepts behind software defined networks.

UNIT I NETWORK ARCHITECTURE AND QoS 9

Overview of TCP/IP Network Architecture – Integrated Services Architecture – Approach – Components– Services – Queuing Discipline – FQ – PS – BRFQ – GPS – WFQ – Random Early Detection – Differentiated Services.

UNIT II WIRELESS NETWORKS 9

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

UNIT III CELLULAR NETWORKS 9

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

UNIT IV 4G NETWORKS 9

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

UNIT V SOFTWARE DEFINED NETWORKS 9

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

TOTAL: 45 PERIODS

OUTCOMES:

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

- Identify the different features of integrated and differentiated services.
- Demonstrate various protocols of wireless networks.
- Analyze the use of next generation networks.
- Provide solutions using SDN.
- Design protocols for cellular networks.

REFERENCES:

1. William Stallings, “High Speed Networks and Internets: Performance and Quality of Service”, Prentice Hall, Second Edition, 2002.
2. Martin Sauter, “From GSM to LTE, An Introduction to Mobile Networks and Mobile Broadband”, Wiley, 2014.
3. Savo G Glisic, “Advanced Wireless Networks – 4G Technologies”, John Wiley & Sons, 2007.
4. Jonathan Rodriguez, “Fundamentals of 5G Mobile Networks”, Wiley, 2015.
5. Martin Sauter, “Beyond 3G – Bringing Networks, Terminals and the Web Together: LTE,
6. WiMAX, IMS, 4G Devices and the Mobile Web 2.0”, Wiley, 2009.
7. Naveen Chilamkurti, SheraliZeadally, HakimaChaouchi, “Next-Generation Wireless Technologies”, Springer, 2013.
8. Erik Dahlman, Stefan Parkvall, Johan Skold, “4G: LTE/LTE-Advanced for Mobile Broadband”, Academic Press, 2013.

CO	PO						PSO		
	1	2	3	4	5	6	1	2	3
1.	√		√	√		√	√	√	√
2.	√		√	√		√	√	√	√
3.	√		√	√		√	√	√	√
4.	√		√	√		√	√	√	√
5.	√		√	√		√	√	√	√

OR5201 NONLINEAR PROGRAMMING L T P C
3 0 0 3

OBJECTIVES:

- To learn the basic properties and solutions for nonlinear systems.
- To identify and apply solutions to unconstrained one dimensional nonlinear problems.
- To apply and solve unconstrained multi-dimensional nonlinear problems.
- To solve constrained nonlinear problems using various algorithms.
- To learn evolutionary programming approaches for optimisation.

UNIT I INTRODUCTION 9

Linear vs nonlinear programming – basic properties of solutions and algorithms – first order necessary conditions – examples of unconstrained problems – second order conditions – convex and concave functions – minimization and maximization of convex functions – saddle points – jacobian matrix

UNIT II ONE DIMENSIONAL OPTIMIZATION 9

Introduction to descent methods – global convergence of decent algorithms – speed convergence – Fibonacci method – golden section search method – steepest descent – newton's method – polynomial approximation method

UNIT III MULTI-DIMENSIONAL OPTIMIZATIONS 9

Unconstrained optimizations without derivatives – conjugate directions – descent properties of the conjugate direction method- conjugate gradient method – partial conjugate gradient method – Powell's method – variable metric algorithms without derivative – quasi newton method

UNIT IV UNCONSTRAINED OPTIMIZATION FOR CONSTRAINED PROBLEMS 9

Lagrange method – inequality constraints – KKT conditions – quadratic programming – geometric programming – separable linear programming – sequential linear programming – feasible direction method

UNIT V EVOLUTIONARY PROGRAMMING 9

Genetic engineering – genetic operators – reproduction – crossover – mutation – selection – genetic local search – simulated annealing – ant colony optimization – particle swarm optimization

TOTAL: 45 PERIODS

OUTCOMES:

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

- Formulate mathematically the optimization problem and solve minimization/ maximization problems.
- Mathematically formulate and solve 1-dimensional/multi-dimensional nonlinear problems.
- Identify methods to solve constrained and unconstrained optimization problems.
- Understand meta-heuristic and evolutionary approaches to obtain global optima and their application scenarios.
- Apply the concepts of nonlinear programming in complex multi-disciplinary fields of engineering.

REFERENCES:

1. Singiresu S Rao, “Engineering Optimization: Theory and Practice”, Wiley, 4th Edition, 2013.
2. David G.Luenberger, “Linear and Nonlinear Programming”, Springer Publications, 3rd Edition, 2008.
3. Hamdy A Taha, “Operations Research – An Introduction”, Pearson, 10th Edition, 2018.
4. Stephen Boyd, LievenVandenberghe, “Convex Optimization”, Cambridge India, 2016.
5. Bertsekas, Dimitri P. Nonlinear Programming. 3rd Edition. Athena Scientific Press, 2016.

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

OR5261 ADVANCED DATABASES LABORATORY L T P C
0 0 4 2

OBJECTIVES:

- To learn the DDL and DML operations.
- To understand the use of various Joins.
- To acquire knowledge on creation of views and nested queries.
- To write and use functions, triggers, and stored procedures.
- To use distributed databases, heterogeneous databases and XML databases.

LIST OF EXPERIMENTS:

1. Data Definition Language – Create – Alter – Drop – Enforcing Primary Key and Foreign Key Constraints – Data Manipulation Language – Insert – Delete – Update –Transaction Control Language – Commit – Rollback – Save Points
2. Cartesian Product – Equijoin – Left Outer Join – Right Outer Join – Full Outer Join
3. Set Operations – Creating Views – Creating Sequence – Indexing–Aggregate Functions – Analytic Functions – Nested Queries
4. Creating Triggers and Stored Procedures
5. Implementation of Distributed Databases
6. Connecting Heterogeneous Databases
7. XML Databases
8. Accessing and Updating a Relational Database using PHP
9. Accessing and Updating a Relational Database using JDBC
10. Accessing and Updating MongoDB using PHP

TOTAL: 60 PERIODS

OUTCOMES:

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

- Create and carry out all Data Manipulation operations.
- Create queries using various Joins appropriately.
- Create and use views and nested queries.
- Write and use functions, triggers, and stored procedures.
- Use distributed databases, heterogeneous databases and XML databases.

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

OR5211 NON-LINEAR PROGRAMMING LABORATORY L T P C
0 0 4 2

OBJECTIVES:

- To apply the knowledge of nonlinear programming techniques todesign solutions to complex engineering problems.
- To explore the applications of nonlinear programming algorithms and solvers.
- To create software programs and use modern tools or solvers.
- To conduct design of experiments for the specified needs with appropriate consideration. To demonstrate skill in synthesis of the solutions to provide valid inferences.

Experiments to solve optimization problems by implementing and analysing the efficiency of the following using a programming language making use of optimization libraries or solvers:

1. Develop a program to solve first order ordinary differential equations
2. Develop a program to determine minima and maxima when given a of convex function
3. Implement Golden section search for solving one dimensional optimization problems
4. Implement Steepest descent method for solving one dimensional optimization problems
5. Implement Newton's method for solving one dimensional optimization problems
6. Implement Conjugate directions method for solving multi-dimensional optimization problems
7. Implement Conjugate gradient method for solving multi-dimensional optimization problems
8. Implement Quasi-Newton method for solving multi-dimensional optimization problems
9. Implement Lagrange method for solving unconstrained optimization problems
10. Implement Parallel Steepest descent method for solving one dimensional optimization problems

TOTAL: 60 PERIODS

OUTCOMES:

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

- Apply nonlinear programming techniques to solve complex engineering problems.
- Use solvers like NOPT, GSL to solve nonlinear optimization problems.
- Design algorithms, create programs and apply appropriate techniques.
- Analyse the convergence time of different algorithms and their complexity issues.
- Provide instant results through programming tools or solvers.

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

CP5262 PROFESSIONAL PRACTICES L T P C

0 0 2 1

OBJECTIVES:

- To facilitate analysis, design and problem solving skills.
- To have a thorough domain knowledge.
- To understand the best Industry practices by reading case studies.
- To kindle innovative and professional thinking.
- To explore possible alternative solutions.
- To estimate feasibility, cost, risk and ROI.

SESSIONS BASED ON:

Identify an application/projects (may be of social relevance) – Understand customer requirements – Analyze and understand customers and stakeholders – value additions – innovations and research component – preparing plan / SRS document indicating feasibility, cost, risk, ROI and related design – suggest implementation methodology – perform risk assessment and management

TOTAL : 30 PERIODS

OUTCOMES:

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

- Identify and formulate the problem.
- Describe the background of the problem.
- Assess the needs of stakeholders.
- Make estimates like cost, risk, ROI etc., to justify the business opportunity.
- Describe the industry standards and procedures.
- Predict the business opportunity.
- Suggest system implications.

CP5086 SOCIAL NETWORK ANALYSIS L T P C
3 0 2 4

OBJECTIVES:

- To gain knowledge about the current web development and emergence of social web.
- To study about the modelling, aggregating and knowledge representation of semantic web.
- To appreciate the use of machine learning approaches for web content mining.
- To learn about the extraction and mining tools for social networks.
- To gain knowledge on web personalization and web visualization of social networks.

UNIT I CLUSTERING AND CLASSIFICATION 9+6

Supervised Learning – Decision tree – Naïve Bayesian Text Classification – Support Vector Machines – Ensemble of Classifiers – Unsupervised Learning – K-means Clustering – Hierarchical Clustering –Partially Supervised Learning – Markov Models – Probability-Based Clustering – Vector Space Model

UNIT II SOCIAL MEDIA MINING 9+6

Data Mining Essentials –Data Mining Algorithms – Web Content Mining –Latent semantic Indexing – Automatic Topic Extraction – Opinion Mining and Sentiment Analysis – Document Sentiment Classification

UNIT III EXTRACTION AND MINING COMMUNITIES IN WEB SOCIAL NETWORKS 9+6

Extracting evolution of Web Community from a Series of Web Archive – Detecting Communities in Social Networks – Definition of Community – Evaluating Communities – Methods for Community Detection & Mining – Applications of Community Mining Algorithms – Tools for Detecting Communities – Social Network Infrastructure and Communities – Decentralized Online Social Networks – Multi-Relational Characterization of Dynamic Social Network Communities

UNIT IV HUMAN BEHAVIOR ANALYSIS AND PRIVACY ISSUES 9+6

Understanding and Predicting Human Behavior for Social Communities – User Data Management, Inference and Distribution – Enabling New Human Experiences – Reality Mining – Context-Awareness – Privacyin Online Social Networks – Trust in Online Environment – Trust Models Based on Subjective Logic – Trust Network Analysis – Trust Transitivity Analysis – Combining Trust and Reputation – Trust Derivation Based on Trust Comparisons – Attack Spectrum and Countermeasures.

UNIT V VISUALIZATION AND APPLICATIONS OF SOCIAL NETWORKS 9+6

Graph Theory – Centrality – Clustering – Node-Edge Diagrams – Matrix representation – Visualizing Online Social Networks – Visualizing Social Networks with Matrix-Based Representations – Node-Link Diagrams – Hybrid Representations – Applications – Covert Networks – Community Welfare – Collaboration Networks – Co-Citation Networks – Recommendation in Social Media: Challenges – Classical Recommendation Algorithms –Recommendation Using Social Context – Evaluating Recommendations

TOTAL : 45+30 = 75 PERIODS

OUTCOMES:

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

- Apply knowledge of current web development in the era of social web.
- Model, aggregate and represent knowledge for semantic web.
- Use machine learning approaches for web content mining.
- Design extraction and mining tools for social networks.
- Develop personalized web sites and visualization for social networks.

REFERENCES:

1. Peter Mika, “Social networks and the Semantic Web”, Springer, 2007.
2. Borko Furht, “Handbook of Social Network Technologies and Applications”, Springer, 2010.
3. Bing Liu, “Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data (Data- Centric Systems and Applications)”, Springer; Second Edition, 2011.
4. Reza Zafarani, Mohammad Ali Abbasi, Huan Liu, ”Social Media Mining”, Cambridge University Press, 2014.
5. Guandong Xu, Yanchun Zhang and Lin Li, “Web Mining and Social Networking Techniques and applications”, Springer, 2011.
6. Dion Goh and Schubert Foo, “Social information retrieval systems: emerging technologies and Applications for searching the Web effectively”, Idea Group, 2007.

CO	PO						PSO		
	1	2	3	4	5	6	1	2	3
1.	√		√	√	√		√	√	√
2.	√		√	√			√	√	√
3.	√		√	√			√	√	√
4.	√		√	√	√		√	√	√
5.	√		√	√	√		√	√	√

SE5072 FUNDAMENTALS OF MACHINE LEARNING L T P C
3 0 2 4

OBJECTIVES:

- To understand the concepts of Machine Learning.
- To appreciate supervised learning and their applications.
- To appreciate the concepts and algorithms of unsupervised learning.
- To understand the theoretical and practical aspects of Probabilistic Graphical Models.
- To appreciate the concepts and algorithms of advanced learning.

UNIT I INTRODUCTION 8+6

Machine Learning– Machine Learning process- Preliminaries for Machine Learning algorithms Turning data into Probabilities and Statistics for Machine Learning- Probability theory – Probability Distributions – Decision Theory.

UNIT II SUPERVISED LEARNING 10+6

Linear Models for Regression – Linear Models for Classification- Discriminant Functions, Probabilistic Generative Models, Probabilistic Discriminative Models – Decision Tree Learning – Bayesian Learning, Naïve Bayes – Ensemble Methods, Bagging, Boosting, Neural Networks , Multi-layer Perceptron – Deriving Back Propagation - Support Vector Machines.

UNIT III UNSUPERVISED LEARNING 9+6

Clustering- K-means – EM Algorithm- Mixtures of Gaussians – Dimensionality Reduction – Linear Discriminant Analysis - Principal Components Analysis – Locally Linear Embedding – Isomap

UNIT IV PROBABILISTIC GRAPHICAL MODELS 9+6

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).

UNIT V ADVANCED LEARNING 9+6

Sampling-Basic Sampling methods, Monte Carlo, Gibbs Sampling – Computational Learning Theory – Mistake Bound Analysis – Reinforcement learning – Markov Decision processes, Deterministic and Non-deterministic Rewards and Actions, Temporal Difference Learning Exploration.

TOTAL : 45+30 PERIODS

OUTCOMES:

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

- Design a learning model appropriate to the application.
- Design a Neural Network for an application of your choice.
- Implement Probabilistic Discriminative and Generative algorithms for an application of your choice and analyze the results.
- Use a tool to implement typical Clustering algorithms for different types of applications.
- Design and implement an HMM for a Sequence Model type of application.
- Identify applications suitable for different types of Machine Learning with suitable justification.

REFERENCES:

1. Christopher Bishop, “Pattern Recognition and Machine Learning” Springer, 2007.
2. Stephen Marsland, “Machine Learning – An Algorithmic Perspective”, Chapman and Hall, CRC Press, Second Edition, 2014.
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.

CO	PO						PSO		
	1	2	3	4	5	6	1	2	3
1.	√		√	√			√		√
2.	√	√	√	√			√		√
3.			√				√		
4.			√	√					√
5.			√	√			√		√
6.	√		√	√		√	√		√

CP5073 CLOUD COMPUTING TECHNOLOGIES L T P C
3 0 2 4

OBJECTIVES:

- To understand the concept of cloud and utility computing.
- To understand the various issues in cloud computing.
- To familiarize themselves with the lead players in cloud.
- To appreciate the emergence of cloud as the next generation computing paradigm.
- To be able to set up a private cloud.

UNIT I INTRODUCTION 9+6

Introduction – Historical Development – Cloud Computing Architecture – The Cloud Reference Model – Cloud Characteristics – Cloud Deployment Models: Public, Private, Community, Hybrid Clouds – Cloud Delivery Models: IaaS, PaaS, SaaS – Open Source Private Cloud Software: Eucalyptus, Open Nebula, Open Stack.

UNIT II VIRTUALIZATION 9+6

Data Center Technology – Virtualization – Characteristics of Virtualized Environments - Taxonomy of Virtualization Techniques – Virtualization and Cloud Computing – Pros and Cons of Virtualization – Implementation Levels of Virtualization – Tools and Mechanisms: Xen, VMWare, Microsoft Hyper-V, KVM, Virtual Box

UNIT III CLOUD COMPUTING MECHANISM 9+6

Cloud Infrastructure Mechanism: Cloud Storage, Cloud Usage Monitor, Resource Replication – Specialized Cloud Mechanism: Load Balancer, SLA Monitor, Pay-per-use Monitor, Audit Monitor, Failover System, Hypervisor, Resource Cluster, Multi Device Broker, State Management Database – Cloud Management Mechanism: Remote Administration System, Resource Management System, SLA Management System, Billing Management System

UNIT IV HADOOP AND MAP REDUCE 9+6

Apache Hadoop – Hadoop Map Reduce – Hadoop Distributed File System – Hadoop I/O- Developing a Map Reduce Application – Map Reduce Types and Formats – Map Reduce Features – Hadoop Cluster Setup – Administering Hadoop.

UNIT V SECURITY IN THE CLOUD 9+6

Basic Terms and Concepts – Threat Agents – Cloud Security Threats – Cloud Security Mechanism: Encryption, Hashing, Digital Signature, Public Key Infrastructure, Identity and Access Management, Single Sign-on, Cloud Based Security Groups, Hardened Virtual Server Images.

TOTAL: 45 +30 = 75 PERIODS

OUTCOMES:

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

- Articulate the main concepts, key technologies, strengths and limitations of cloud computing.
- Identify the architecture, infrastructure and delivery models of cloud computing.
- Explain the core issues of cloud computing such as security, privacy and interoperability.
- Choose the appropriate technologies, algorithms and approaches for the related issues.
- Facilitate Service Level Agreements (SLA).

REFERENCES:

1. Thomas Erl, ZaighamMahood, Ricardo Puttini, “Cloud Computing, Concept, Technology & Architecture”, Prentice Hall, 2013.
2. RajkumarBuyya, Christian Vecchiola, S. ThamaraiSelvi, “Mastering Cloud Computing”, Tata McGraw-Hill,2013.
3. Toby Velte, Anthony Velte, Robert C. Elsenpeter, “Cloud Computing, A Practical Approach”,Tata McGraw-Hill Edition, 2010.
4. ArshdeepBahga, Vijay Madisetti, “Cloud Computing: A Hands-On Approach”, Universities Press(India) Private Limited, 2014.
5. Tom White, “Hadoop: The Definitive Guide”, O’Reilly Media, 4th Edition, 2015.
6. James E Smith and Ravi Nair, “Virtual Machines”, Elsevier, 2005.
7. John Rittinghouse& James Ransome, Cloud Computing, Implementation, Management and Strategy, CRC Press, 2010.

CO	PO						PSO		
	1	2	3	4	5	6	1	2	3
1.	√		√	√			√	√	
2.	√		√	√			√	√	
3.	√		√	√			√	√	
4.	√		√	√		√	√	√	
5.	√		√	√		√	√	√	√

CP5080 **ETHICAL HACKING** **L T P C**
3 0 2 4

OBJECTIVES:

- To learn about the importance of information security.
- To learn different scanning and enumeration methodologies and tools.
- To understand various hacking techniques and attacks.
- To be exposed to programming languages for security professionals.
- To understand the different phases in penetration testing.

UNIT I INTRODUCTION TO HACKING 9+6

Introduction to Hacking – Importance of Security – Elements of Security – Phases of an Attack – Types of Hacker Attacks – Hacktivism – Vulnerability Research – Introduction to Footprinting – Information Gathering Methodology – Footprinting Tools – WHOIS Tools – DNS Information Tools – Locating the Network Range – Meta Search Engines

UNIT II SCANNING AND ENUMERATION 9+6

Introduction to Scanning – Objectives – Scanning Methodology – Tools – Introduction to Enumeration – Enumeration Techniques – Enumeration Procedure – Tools

UNIT III SYSTEM HACKING 9+6

Introduction – Cracking Passwords – Password Cracking Websites – Password Guessing – Password Cracking Tools – Password Cracking Countermeasures – Escalating Privileges – Executing Applications – Keyloggers and Spyware

UNIT IV PROGRAMMING FOR SECURITY PROFESSIONALS 9+6

Programming Fundamentals – C language – HTML – Perl – Windows OS Vulnerabilities – Tools for Identifying Vulnerabilities – Countermeasures – Linux OS Vulnerabilities – Tools for Identifying Vulnerabilities – Countermeasures

UNIT V PENETRATION TESTING 9+6

Introduction – Security Assessments – Types of Penetration Testing- Phases of Penetration Testing – Tools – Choosing Different Types of Pen-Test Tools – Penetration Testing Tools

TOTAL: 45+30 =75 PERIODS

OUTCOMES:

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

- Identify threats to computers.
- Defend hacking attacks.
- Protect data assets.
- Defend a computer against a variety of security attacks using various tools.
- Practice and use safe techniques on the World Wide Web.

REFERENCES:

1. EC-Council, “Ethical Hacking and Countermeasures: Attack Phases”, Cengage Learning, 2010.
2. Jon Erickson, “Hacking, 2nd Edition: The Art of Exploitation”, No Starch Press Inc., 2008.
3. Michael T. Simpson, Kent Backman, James E. Corley, “Hands-On Ethical Hacking and Network Defense”, Cengage Learning, 2013.
4. Patrick Engebretson, “The Basics of Hacking and Penetration Testing – Ethical Hacking and Penetration Testing Made Easy”, Second Edition, Elsevier, 2013.
5. RafayBoloch, “Ethical Hacking and Penetration Testing Guide”, CRC Press, 2014.

CO	PO						PSO		
	1	2	3	4	5	6	1	2	3
1.	√		√	√			√	√	
2.	√		√	√			√	√	
3.	√		√	√			√	√	
4.	√		√	√		√	√	√	√
5.	√		√	√	√	√	√	√	√

CP5079 DIGITAL IMAGE AND VIDEO PROCESSING L T P C
3 0 2 4

OBJECTIVES:

- To understand broad range of image processing techniques and their applications.
- To learn about video processing techniques and understand the video content.
- To appreciate various techniques used for acquisition, preprocessing, enhancement and analysis of Image and Video data.
- To appreciate the use of image& video processing in current technologies.
- To expose the students to real-world applications and case studies of the image& video processing.

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.

TOTAL: 45+30 = 75 PERIODS

OUTCOMES:

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

- Have a clear impression of the breadth and practical scope of digital image processing and have arrived at a level of understanding that is the foundation for most of the work currently underway in this field.
- Critically 32odelli the role of video in modern technologies.
- Implement basic image and video processing algorithms.
- Design and develop various applications that incorporates different techniques of Image and Video processing.
- Apply and explore new techniques in the areas of Image and video Processing.

REFERENCES:

1. Rafael C.Gonzalez and Richard E.Woods, “Digital Image Processing”, Third Edition, Pearson Education, 2008, New Delhi.
2. S.Sridhar, “Digital Image Processing”, Oxford University Press, New Delhi, 2011.
3. The Essential Guide to Video Processing Al Bovik (Alan C Bovik), Academic Press, Second Edition, 2009.
4. Digital Video Processing – A. Murat Tekalp, Prentice Hall, 1995
5. Oges Marques, Practical Image and Video Processing Using MATLAB, Wiley-IEEE Press, 2011.

CO	PO						PSO		
	1	2	3	4	5	6	1	2	3
1.	√		√	√			√	√	
2.	√		√	√			√	√	
3.	√		√	√			√	√	
4.	√		√	√		√	√	√	√
5.	√		√	√		√	√	√	√

CP5083 INTERNET OF THINGS L T P C
3 0 2 4

OBJECTIVES:

- To understand the different architectures for IoT.
- To learn various protocols at the different layers for IoT.
- To develop prototype systems using Arduino / Rasberry Pi.
- To apply the use of data analytics in IoT.
- To develop applications of IoT in Industrial contexts.

UNIT I ARCHITECTURES AND MODELS 9+6

Introduction 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 – Sensors, Actuators, Smart Objects, Sensor networks.

UNIT II CONNECTIVITY 9+6

Communications Criteria – Access Technologies – IP as IoT Network Layer – Business case – Optimization – Profiles and compliances – Application Protocols – Transport Layer – Application Transport Methods.

UNIT III SYSTEM DEVELOPMENT 9+6

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

UNIT IV DATA ANALYTICS ANDIoT SECURITY 9+6

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

UNIT V IoT IN INDUSTRY 9+6

Manufacturing, Architecture, Protocols – Utilities, Grid Blocks - Smart Cities, Architecture, Use cases – Transportation, Architecture, Use cases.

TOTAL : 45+30 PERIODS

OUTCOMES:

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

- Explain the underlying architectures and models in IoT.
- Analyse different connectivity technologies for IoT.
- Develop simple applications using Arduino / Raspberry Pi.
- Apply data analytics techniques to IoT.
- Study the needs and suggest appropriate solutions for Industrial applications.

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 Elloumi , “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.

CO	PO						PSO		
	1	2	3	4	5	6	1	2	3
1.	√		√				√	√	
2.	√		√	√			√	√	
3.	√		√	√			√	√	
4.	√		√	√		√	√	√	√
5.	√		√	√		√	√	√	√

CP5072 ADVANCED SOFTWARE ENGINEERING L T P C
3 0 2 4

OBJECTIVES :

- Comprehend the different stages of Software Development Lifecycle.
- Comprehend the Process of developing Analysis models and map the Analysis models to Design Models.
- Comprehend the Design Issues related to Web applications and Mobile Apps.
- Comprehend the Quality Factors associated with Software Development.
- Comprehend the use of different Testing Strategies in Software Development.

UNIT I PROCESS MODELS 9+6

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 AND DESIGN CONCEPTS 9+6

Understanding Requirements – Scenario based methods – Class based methods – Behavior, Patterns and Web/Mobile Apps – Design process – Design concepts –Design model

UNIT III SOFTWARE DESIGN 9+6

Architectural design – Component level Design–User Interface Design – Pattern based design –Web App design – Mobile App design

UNIT IV SOFTWARE QUALITY 9+6

Garvin's Quality dimensions – McCall's Quality factors – ISO9126 Quality factors – The software Quality Dilemma – Achieving Software Quality – 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 – The SQA Plan

UNIT V SOFTWARE TESTING AND SOFTWARE CONFIGURATION MANAGEMENT **9+6**

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

TOTAL : 45+30 =75 PERIODS

OUTCOMES:

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

- Select Appropriate Process Model for Software Development .
- Develop Analysis Models and Map the Analysis Models to Design Models.
- Address the Design Issues related To Web Applications and Mobile Apps.
- Incorporate Appropriate Quality Factors and Standards during Software Development.
- Select Appropriate Testing Strategies For Software Testing.

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.
3. Bernd Bruegge, Allen H. Dutoit, "Object-Oriented Software Engineering", Prentice Hall, Third Edition, 2009.
4. Robert E. Filman, TzillaElrad, Siobhán Clarke, Mehmet Aksit, "Aspect-Oriented Software Development", Addison-Wesley Professional, 2004.
5. RenuRajni, Pradeep Oak, "Software Testing: Effective Methods, Tools and Techniques", Tata McGraw Hill, 2004.
6. Jonathan Bowen, "Formal Specification and Documentation using Z – A Case Study Approach", Intl Thomson Computer Pr, 1996.
7. Antoni Diller, "Z: An Introduction to Formal Methods", Wiley, 1994.
8. James Shore, Shane Warden "The Art of Agile Development – Pragmatic guide to agile software development", O'Reilly Media, October 2007.
9. Ken Schwaber, "Agile Project Management with SCRUM", Microsoft Press, 2004.

CO	PO						PSO		
	1	2	3	4	5	6	1	2	3
1.	√		√	√			√	√	
2.	√		√	√			√	√	
3.	√		√	√		√	√	√	√
4.	√		√	√			√	√	
5.	√		√	√			√	√	

CP5252 COMPILER OPTIMIZATION TECHNIQUES L T P C
3 0 2 4

OBJECTIVES:

- To understand different forms of intermediate languages and 36odelling programs.
- To understand optimizations techniques for single program blocks.
- To apply optimizations on procedures and low level code.
- To explore and enhance inter procedural optimizations.
- To enhance resource utilization.

UNIT I INTERMEDIATE REPRESENTATION OF PROGRAMS AND ANALYSIS 9+6

Structure of an Optimizing Compiler – Compiler Construction tools – LIR, MIR, HIR, DAG, SyntaxTree and Postfix. Analysis: Control Flow Analysis, Iterative Data Flow Analysis, Static Single Assignment – A Linear Time Algorithm for Placing φ-Nodes, Basic Block Dependence, Alias Analysis. Introduction to LLVM – Compiling a language.

UNIT II LOCAL AND LOOP OPTIMIZATIONS 9+6

Early Optimizations: Constant-Expression Evaluation – Scalar Replacement of Aggregates – Algebraic Simplifications and Re-association – Value Numbering – Copy Propagation – Sparse Conditional Constant Propagation. Redundancy Elimination: Common – Subexpression Elimination – Loop-Invariant Code Motion – Partial-Redundancy Elimination – Redundancy Elimination and Reassociation – Code Hoisting. Loop Optimizations: Induction Variable Optimizations – Unnecessary Bounds Checking Elimination. LLVM pass –LLVM Test Infrastructure.

UNIT III PROCEDURE OPTIMIZATION AND SCHEDULING 9+6

Procedure Optimizations: Tail-Call Optimization and Tail-Recursion Elimination – Procedure Integration – In-Line Expansion – Leaf-Routine Optimization and Shrink Wrapping. Code Scheduling: Instruction Scheduling – Speculative Loads and Boosting – Speculative Scheduling – Software Pipelining – Trace Scheduling – Percolation Scheduling. Control-Flow and Low-Level Optimizations: Unreachable-Code Elimination – Straightening – If Simplifications – Loop Simplifications – Loop Inversion Un-switching – Branch Optimizations – Tail Merging or Cross Jumping – Conditional Moves – Dead-Code Elimination – Branch Prediction – Machine Idioms and Instruction Combining. LLVM API procedure optimization.

UNIT IV INTER PROCEDURAL OPTIMIZATION 9+6

Symbol table Runtime Support – Interprocedural Analysis and Optimization: Interprocedural Control-Flow Analysis – The Call Graph – Interprocedural Data-Flow Analysis – Interprocedural Constant Propagation – Interprocedural Alias Analysis – Interprocedural Optimizations – Interprocedural Register Allocation – Aggregation of Global References. LLVM – Interprocedural Analyses.

UNIT V OPTIMIZING FOR MEMORY 9+6

Register Allocation: Register Allocation and Assignment – Local Methods – Graph Coloring Priority Based Graph Coloring. Computations on Iteration Spaces- Optimization for the Memory Hierarchy: Impact of Data and Instruction Caches – Instruction-Cache Optimization – Scalar Replacement of Array Elements – Data-Cache Optimization – Scalar vs. Memory-Oriented Optimizations. Software Prefetching – Parallelization – Instruction Level Parallelism – Automatic Parallelization.

TOTAL: 45+30 = 75 PERIODS

OUTCOMES:

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

- Identify the different optimization techniques that are possible for a sequence of code.
- Design performance enhancing optimization techniques.
- Manage procedures with optimal overheads.
- Understand modern programming language features and constructs.
- Learn to work on a larger software project.

REFERENCES:

1. Steven Muchnick, Advanced Compiler Design and Implementation, Morgan Kaufman Publishers, 1997.
2. Alfred V. Aho, Monica S. Lam Ravi Sethi, Jeffrey D. Ullman, “Compilers: Principles, Techniques, and Tools”, Addison Wesley, Second Edition, 2007.
3. Y.N.Srikant, Priti Shankar, “The Compiler Design Handbook – Optimizations and Machine Code Generation”, CRC Press, Second Edition, 2008.
4. Andrew W. Appel, Jens Palsberg, “Modern Compiler Implementation in Java”, Cambridge University Press, Second Edition, 2002.
5. Keith Cooper, Linda Torczon, “Engineering a Compiler”, Morgan Kaufmann, Second Edition, 2011.
6. Randy Allen and Ken Kennedy, Optimizing Compilers for Modern Architectures: A Dependence based Approach, Morgan Kaufman, 2001.

CO	PO						PSO		
	1	2	3	4	5	6	1	2	3
1.	√		√			√	√	√	√
2.	√	√	√	√			√	√	√
3.	√		√	√			√	√	√
4.	√		√	√				√	
5.	√		√	√		√	√	√	√

CP5084 PARALLEL ALGORITHMS L T P C
3 0 0 3

OBJECTIVES :

- To learn parallel algorithms development techniques for shared memory and DCM models.
- To study the main classes of fundamental parallel algorithms.
- Learn to design efficient parallel algorithms.
- To study the complexity and correctness models for parallel algorithms.
- To understand parallel solutions for bitwise computation.

UNIT I INTRODUCTION 9

Introduction to Parallel Algorithms – Models of computation – Selection – Merging on EREW and CREW – Median of two sorted sequence – Fast Merging on EREW – Analyzing Parallel Algorithms

UNIT II 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 III ALGEBRAIC PROBLEMS 9

Permutations and Combinations – Matrix Transpositions – Matrix by Matrix multiplications – Matrix by vector multiplication.

UNIT IV GRAPH & GEOMETRY 9

Connectivity Matrix – Connected Components – All Pair Shortest Paths – Minimum Spanning Trees – Point Inclusion – Intersection, Proximity and Construction Problems

UNIT V OPTIMIZATION & BIT COMPUTATIONS 9

Prefix Sums – Job Sequencing – Knapsack – Adding two integers – Adding n integers – Multiplying two integers – Selection

TOTAL : 45 PERIODS

OUTCOMES:

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

- Understand the difference between sequential and parallel algorithms.
- Design parallel algorithms in various models of parallel computation.
- Apply a suitable model for developing a parallel algorithm.
- Know the basic issues associated with implementing parallel algorithms.
- Understand the differences among several algorithms used for solving the same problem and recognize which one is better under different conditions.

REFERENCES:

1. Selim G. Akl, “The Design and Analysis of Parallel Algorithms”, Prentice Hall, New Jercy, 1989.
2. Michael J. Quinn, “Parallel Computing: Theory & Practice”, Tata McGraw Hill Edition, 2003.
3. Joseph JaJa, “Introduction to Parallel Algorithms”, Addison-Wesley, 1992.

CO	PO						PSO		
	1	2	3	4	5	6	1	2	3
1.	√		√				√	√	
2.	√		√	√			√	√	
3.	√		√	√			√	√	√
4.	√		√	√			√	√	√
5.	√		√	√			√	√	√

CP5076 **CYBER SECURITY** **L T P C**
3 0 0 3

OBJECTIVES:

- To understand the nature of threats and cyber security management goals and technology
- To understand the landscape of hacking and perimeter defense mechanisms
- To develop strategies for cyber security and protecting critical infrastructure
- To understand policies to mitigate cyber risks
- To understand the IT Act, scheme, amendments and emerging cyber law and desired cyber ecosystem capabilities

UNIT I OVERVIEW OF CYBER SECURITY 9

Introduction – Cyberspace – Cyber Crime – Nature of Threat – Cyber security – Policy, Mission and Vision of Cyber security Program. Cyber security management system – goals, technology categories – perimeter defense and encryption. Cyber security management 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 – webapplication attack – Countermeasures– Types of Network Security Devices –Firewalls, Intrusion Detection Systems, Content Filtering, Virtual Private Networks – Encryption

UNIT III STRATEGIES FOR CYBER SECURITY 9

Creating a Secure Cyber, Types of Attacks, Comparison of Attacks, Creating an Assurance Framework, Encouraging Open Standards, Strengthening the Regulatory framework, Creating Mechanisms for IT Security, Securing E-Governance Services, and Protecting Critical Information Infrastructure. Areas forIntervention – Legal Responses – Harmonization of Legislation – Criminalization of Cyber Offences – National Security and issues related to Privacy and Freedom of Expression – Investigation Procedures – International Cooperation – Electronic Evidence –Liability of ISPs–Recommendations

UNIT IV POLICIES TO MITIGATE CYBER RISK 8

Promotion of R&D in Cyber security – Reducing Supply Chain Risks – Mitigate Risks through Human Resource Development – Creating Cyber security Awareness– Information sharing – Implementing a Cyber security Framework. Signatures– Digital Signature, Electronic Signature

UNIT V CRITICAL INFORMATION INFRASTRUCTURE PROTECTION 10

National Security – InformationSharing And Coordination – Innovation In Regulatory Approach – Innovation In Security Programmes– Proactive Threat and Vulnerability Management – Promoting Best Practices In Critical Infrastructure Sectors – Assessing and Monitoring Security Preparedness of Sectors (Security Index) – Security in Information Technology Supply Chain – Taking Leadership And Participating In International Efforts – Capacity Building in Security Skills and training and Awareness. The Indian Cyberspace– Cyber Threats – Need for a Comprehensive Cyber Security Policy – Need for a Nodal Authority – Need for an International Convention on Cyberspace – Cyber War – Fifth Domain of Warfare – Meeting the Cyber Warfare Challenges.

TOTAL: 45 PERIODS

OUTCOMES:

- Gain knowledge on the nature of threats and cyber security management goals and framework
- Knowledge on the landscape of hacking and perimeter defense mechanisms
- Ability to differentiate and integrate strategies for cyber security and protecting critical infrastructure
- Able to understand policies to mitigate cyber risks
- Knowledge on IT Act, and amendments, copy rights, IPR and cyber law to deal with offenses.

REFERENCES:

1. David Kim and Michael G. Solomon, Fundamentals of Information Systems Security, Third Edition Transition Guide, Jones &BartlettLearning, 2018.
2. Peter Trim and Yang – Im Lee, —Cyber Security Management- A Governance, Risk and Compliance Framework, Gower Publishing, England 2014.
3. Institute for Defence Studies and Analysis Report, India's Cyber Security Challenge, 2012 https://idsa.in/system/files/book/book_indiacybersecurity.pdf
4. John G. Voeller, Cyber Security, John Wiley & Sons, England, 2014.
5. Carol C. Woody, Nancy R. Mead, Cyber Security Engineering: A Practical Approach for Systems and Software Assurance, Addison-Wesley, 2016.
6. Edward Griffor, Handbook of System Safety and Security, Syngress an Elsevier Publications, 2017.
7. Thomas A. Johnson Cyber Security- Protecting Critical Infrastructures from Cyber Attack and Cyber Warfare, CRC Press, 2015.
8. NIST Cyber security Framework, Version 1.0, 2014.
9. CGI, —Cyber security in Modern Critical Infrastructure Environments, 2014.
10. Stuart Broderick J, Cyber Security Program, Cisco Security Solutions, June 2016.

CO	PO						PSO		
	1	2	3	4	5	6	1	2	3
1.	√		√					√	
2.	√		√				√	√	
3.	√		√	√		√	√	√	√
4.	√		√	√	√			√	√
5.	√		√	√	√			√	√

CP5081 **GAME THEORY** **L T P C**
3 0 0 3

OBJECTIVES:

- To introduce the student to the notion of a game, its solutions concepts, and other basic notions and tools of game theory, and the main applications for which they are appropriate, including electronic trading markets.
- To formalize the notion of strategic thinking and rational choice by using the tools of game theory, and to provide insights into using game theory in 41odelling applications.
- To draw the connections between game theory, computer science, and economics, especially emphasizing the computational issues.
- To introduce contemporary topics in the intersection of game theory, computer science, and economics.
- To apply game theory in searching, auctioning and trading.

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's and Bertrand's 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

OUTCOMES:

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

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

REFERENCES:

1. M. J. Osborne, An Introduction to Game Theory. Oxford University Press, 2004.
2. M. Machler, E. Solan, S. Zamir, Game Theory, Cambridge University Press, 2013.
3. N. Nisan, T. Roughgarden, E. Tardos, and V. V. Vazirani (Editors), Algorithmic Game Theory. Cambridge University Press, 2007.
4. A.Dixit and S. Skeath, Games of Strategy, Second Edition. W W Norton & Co Inc, 2004.
5. YoavShoham, Kevin Leyton-Brown, Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations, Cambridge University Press 2008.
6. Zhu Han, DusitNiyato, WalidSaad, TamerBasar and Are Hjorungnes, “Game Theory in Wireless and Communication Networks”, Cambridge University Press, 2012.
7. Y.Narahari, “Game Theory and Mechanism Design”, IISC Press, World Scientific.

CO	PO						PSO		
	1	2	3	4	5	6	1	2	3
1.	√		√				√	√	
2.	√		√	√			√	√	√
3.	√		√	√			√	√	√
4.	√		√	√			√	√	√
5.	√		√	√			√	√	√

CP5071 ADHOC AND WIRELESS SENSOR NETWORKS L T P C

3 0 0 3

OBJECTIVES:

- To learn about the issues in the design of wireless ad hoc networks.
- To understand the working of protocols in different layers of mobile ad hoc and sensor networks.
- To expose the students to different aspects in sensor networks.
- To understand various traffic generators and models for sensor networks.
- To understand various security issues in ad hoc and sensor networks and solutions to the issues.

UNIT I FUNDAMENTALS AND ROUTING PROTOCOLS OF WIRELESS ADHOC NETWORKS 9

Introduction – Applications of Mobile Ad Hoc Networks (MANETs) – Medium Access Control Layer – Topology Control – Routing Protocols – Broadcasting – Multicasting – Internet Connectivity for MANETs – Security in MANETs - Scenario Based Performance Analysis of Various Routing Protocols in MANETs

UNIT II MOBILITY MODELS AND OVERHEAD CONTROL MECHANISMS IN MANETS 9

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

UNIT III WIRELESS SENSOR NETWORKS (WSN) 9

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

UNIT IV PERFORMANCE ANALYSIS AND EVALUATION 9

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

UNIT V SECURITY IN ADHOC AND SENSOR NETWORKS 9

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

TOTAL: 45 PERIODS

OUTCOMES:

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

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

REFERENCES:

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

CO	PO						PSO		
	1	2	3	4	5	6	1	2	3
1.	√		√				√	√	
2.	√		√				√	√	
3.	√		√	√			√	√	√
4.	√		√				√	√	
5.	√		√	√			√	√	√

CP5078 DATABASE ADMINISTRATION AND TUNING L T P C
3 0 0 3

OBJECTIVES:

- To understand the tasks in database administration.
- To learn the methods to secure the database and to recover from failures.
- To understand the fundamentals of database tuning.
- To apply indexing techniques and query optimization for database tuning.
- To understand and measure performance monitors to troubleshoot the database system.

UNIT I INTRODUCTION TO DATABASE ADMINISTRATION 10

Database Administration – DBA Tasks- Database Design –Performance Monitoring and Tuning – Availability – Database Security and Authorization – Backup and Recovery – Data Integrity- DBMS Release Migration – Types of DBAs – Creating the Database Environment – Choosing a DBMS – DBMS Architectures – DBMS Clustering –DBMS Proliferation – Hardware Issues –Installing the DBMS – DBMS Installation Basics Hardware Requirements –Storage Requirements Memory Requirements Configuring the DBMS – Connecting the DBMS to Supporting Infrastructure Software –Installation Verification – DBMS Environments – Upgrading DBMS Versions and Releases – Fallback Planning – Migration Verification

UNIT II DATABASE SECURITY, BACKUP AND RECOVERY 10

Database Users – Granting and Revoking Authority – Types of Privileges – Granting to PUBLIC- Revoking 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 – Image Copy Backups – Full vs. Incremental Backups – Database Objects and Backups – DBMS Control – Concurrent Access Issues - Backup Consistency – Log Archiving and Backup – DBMS Instance Backup – Designing the DBMS Environment for Recovery – Types of Recovery – Alternatives to Backup and Recovery– DBA Tools – DBA Rules of Thumb.

UNIT III FUNDAMENTALS OF TUNING 8

Review of Relational Databases – Relational Algebra – 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.

UNIT IV INDEX TUNING AND QUERY OPTIMIZATION 9

Types of Queries – Data Structures – B tree – B+Tree – Hash Structures – Bit Map Indexes – Clustering Indexes – Non Clustering Indexes – Composite Indexes – Hot Tables – Comparison of Indexing and Hashing Techniques. Optimization Techniques – Tuning Relational Systems –- Normalization – Tuning Denormalization – Clustering Two Tables – Aggregate Maintenance – Record Layout – Query Cache – Parameter Cache – Query Tuning – Triggers – Client Server Mechanisms – Objects, Application Tools and Performance –Tuning the Application Interface – Bulk Loading Data – Accessing Multiple Databases.

UNIT V TROUBLESHOOTING 8

Query Plan Explainers – Performance Monitors – Event Monitors – Finding "Suspicious" Queries – Analyzing a Query"s Access Plan – Profiling a Query Execution – DBMS Subsystems.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Describe the principle functions in database administration and security.
- Discuss the need for performance tuning in databases.
- Write optimized code for accessing multiple databases.
- Reconstruct indexes and optimize queries for better database performance.
- Carry out troubleshooting in database systems.

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. Silberschatz, Korth, Database System Concepts, McGraw Hill, 6th edition, 2010.
4. Thomas Connoly and Carlolyn Begg, Database Systems, A Practical Approach to Design, Implementation and Management, Fourth Edition, Pearson Education, 2008.

CO	PO						PSO		
	1	2	3	4	5	6	1	2	3
1.	√		√				√	√	
2.	√		√				√	√	
3.	√		√	√			√	√	√
4.	√		√	√			√	√	
5.	√		√	√			√	√	√

CP5077 DATA WAREHOUSING AND DATA MINING TECHNIQUES L T P C
3 0 0 3

OBJECTIVES:

- To understand data mining principles and techniques and Introduce DM as a cutting edge business intelligence.
- To expose the students to the concepts of data warehousing architecture and implementation.
- To learn various Data Mining techniques such as classification, clustering & Association rule mining
- To establish and house a centralized compilation of linked data.
- To study the overview of developing areas – web mining, text mining and ethical aspects of data mining.
- To identify business applications and trends of data mining.

UNIT I INTRODUCTION TO DATA WAREHOUSING 9

Evolution of Decision Support Systems – Data warehousing Components – Building a Data warehouse, Data Warehouse and DBMS, Data marts, Metadata, Multidimensional data model, OLAP vs OLTP, OLAP operations, Data cubes, Schemas for Multidimensional Database: Stars, Snowflakes and Fact constellations

UNIT II DATA WAREHOUSE PROCESS AND ARCHITECTURE 9

Types of OLAP servers, 3–Tier data warehouse architecture, distributed and virtual data warehouses. Data warehouse implementation, tuning and testing of data warehouse. Data Staging (ETL) Design and Development, data warehouse visualization, Data Warehouse Deployment, Maintenance, Growth, Business Intelligence Overview – Data Warehousing and Business Intelligence Trends – Business Applications – tools-SAS

UNIT III INTRODUCTION TO DATA MINING 9

Data mining-KDD versus data mining, Stages of the Data Mining Process-task primitives, Data Mining Techniques – Data mining knowledge representation – Data mining query languages, Integration of a Data Mining System with a Data Warehouse – Issues, Data preprocessing – Data cleaning, Data transformation, Feature selection, Dimensionality reduction, Discretization and generating concept hierarchies – Mining frequent patterns – association-correlation

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 – Clustering techniques – Partitioning methods – k-means- Hierarchical Methods – distance based agglomerative and divisible clustering, Density – Based Methods – expectation maximization – Grid Based Methods – Model-Based Clustering Methods – Constraint – Based Cluster Analysis – Outlier Analysis

UNIT V PREDICTIVE MODELING OF BIG DATA AND TRENDS IN DATA MINING 9

Statistics and Data Analysis – EDA – Small and Big Data –Logistic Regression Model – Ordinary Regression Model-Mining complex data objects – Spatial databases – Temporal databases – Multimedia databases – Time series and sequence data – Text mining – Web mining – Applications in Data mining

TOTAL : 45 PERIODS

OUTCOMES:

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

- Evolve multidimensional intelligent model from typical system.
- Discover the knowledge imbibed in the high dimensional system and gain knowledge on datawarehouse process.
- Acquire knowledge of data processing and data quality.
- Design and deploy classification and clustering techniques.
- Evaluate various mining techniques on complex data objects.

REFERENCES:

1. Jiawei Han, MichelineKamber, “Data Mining: Concepts and Techniques”, Morgan Kaufmann, Third edition, 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. Mehmedkantardzic, “Data mining: Concepts, Models, Methods, and Algorithms”, Wiley-Blackwell, Second Edition, 2011.
7. Ian Witten, Eibe Frank, “Data Mining: Practical Machine Learning Tools and Techniques”, Third Edition, Morgan Kaufmann, 2011.
8. George M Marakas, “Modern Data Warehousing, Mining and Visualization: Core Concepts”,Prentice Hall, 2002.

CO	PO						PSO		
	1	2	3	4	5	6	1	2	3
1.	√		√				√	√	
2.	√		√	√			√	√	
3.	√		√				√	√	
4.	√		√	√			√	√	√
5.	√		√	√		√	√	√	√

BD5151 **BIG DATA MINING AND ANALYTICS** **L T P C**
3 0 0 3

OBJECTIVES:

- To understand the computational approaches to Modeling, Feature Extraction.
- To understand the need and application of Map Reduce.
- To understand the various search algorithms applicable to Big Data.
- To analyze and interpret streaming data.
- To learn how to handle large data sets in main memory.
- To learn the various clustering techniques applicable to Big Data.

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 – 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 – Market Basket Model – Apriori algorithm – Handling Larger Datasets in Main Memory – Limited Pass Algorithm – Counting Frequent Item sets.

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

OUTCOMES:

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

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

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.

CO	PO						PSO		
	1	2	3	4	5	6	1	2	3
1.	√		√	√			√	√	√
2.			√	√		√	√		
3.	√		√	√			√	√	√
4.	√		√	√			√	√	√
5.	√		√	√			√	√	√

OR5001 PYTHON PROGRAMMING FOR OPTIMIZATION TECHNIQUES L T P C
3 0 2 4

OBJECTIVES:

- To develop solutions using python programming language.
- To familiarise with the organization and functions of python program.
- To design solutions using classes and objects in python.
- To acclimatize modern python optimization tools.
- To model optimization problems and develop efficient programs.

UNIT I INTRODUCTION TO PYTHON 9+6

Introduction to Python language – Using the interpreter – Python datatypes and functions – Working with Data – List, Dictionary and Set – Processing Primitives – List comprehensions – File Handling – Object model including Variables, Reference counting, Copying, and Type checking – Error handling – Control structures.

UNIT II PROGRAM ORGANIZATION AND FUNCTIONS 9+6

Organize Large programs into functions – Python functions including scoping rules and Documentation strings – Modules and Libraries – Organize programs into modules – Installing third - party libraries. System administration, Text processing, Subprocesses, Binary data handling, XML parsing and Database Access.

UNIT III CLASSES AND OBJECTS 9+6

Introduction to Object - oriented programming – Basic principles of Object - oriented programming in Python – Class definition, Inheritance, Composition, Operator overloading and Object creation – Solving problems in calculus, linear algebra and differentiation using libraries like scipy, numpy, sympy – Plotting using matplotlib

UNIT IV SOLVING OPTIMIZATION PROBLEMS USING SCIPY.OPTIMIZE 9+6

Solving optimization problems using SciPy.optimize : Unconstrained and constrained minimization of multivariate scalar functions– Global optimization routines – Least-square minimization and curve fitting algorithms – Scalar univariate functions minimizers and root finders – Multivariate equation system solvers - Multidimensional general nonlinear solvers – General linear programming solver

UNIT V MATHEMATICAL MODELING AND SOLVING USING PYOMO 9+6

Mathematical modeling – Overview of modeling components and processes – Abstract vs Concrete models – Simple abstract pyomo model – simple concrete pyomo model – Solving simple examples

TOTAL : 45+30 = 75 PERIODS

OUTCOMES:

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

- Design solutions using python classes and objects.
- Mathematically model real time problems and solve using python packages.
- Identify and apply suitable python functions for a given problem.
- Apply the knowledge of optimization techniques and create solutions to complex engineering problems using python.
- Demonstrate skill in development of optimization solvers and synthesis of the information to provide valid inferences.

REFERENCES:

1. Mark Lutz, "Learning Python, Powerful OOPs,O'reilly,2011.
2. Guttag, John. Introduction to Computation and Programming Using Python. MIT Press, 2013.
3. Zelle, John M. Python Programming: An Introduction to Computer Science. 1st ed. Franklin Beedle& Associates, 2003.
4. Budd, Timothy. Exploring Python. McGraw- Hill Science, 2009.
5. W.E. Hart, C. Laird, J.-P. Watson, and D.L. Woodruff, Pyomo - Optimization Modeling in Python, Springer, 2012.

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

OR5002 SYSTEMS MODELLING AND SIMULATION L T P C
3 0 2 4

OBJECTIVES:

- To introduce the characteristics of system modelling and the importance of simulation.
- To study the various approaches of modelling.
- To model the solutions using queueing theory.
- To teach the generation of data for simulation.
- To study the various system models and familiarize the simulation tools.

UNIT I INTRODUCTION 9+6

System definition - Types and characteristics - Need for modelling and simulation -Types of Simulation - Introduction to discrete event simulation - Single server - Multiserver Exercises - System modelling - Simple Petrinets

UNIT II MODELLING APPROACHES 9+6

Modelling concurrent systems - Analysis of Petrinets - Finite state Automata and Regular Expressions - Relationship - FSA with silent transitions - Pumping lemma for regular sets - Analysis using DFS and model checking.

UNIT III QUEUING MODELS 9+6

Characteristics of queuing systems - Notations - Types of Queues - Markovian model - Non-Markovianmodel - Queuing Networks - Applications of queuing systems.

UNIT IV SIMULATION DATA 9+6

Methods for generating random numbers - Testing of random numbers - Methods of generating random variants - Problem formulation - input modelling -Verification and Validation - Output1ZX Analysis.

UNIT V CASE STUDY 9+6

NS2 - Simulation of Computer Systems - Simulation of Computer Networks - Simulation of Mobile Networks -Simulation of Manufacturing and Material Handling Systems

TOTAL: 45+30 = 75 PERIODS

OUTCOMES:

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

- Understand the characteristics of system modelling and the importance of simulation.
- Design system model using various approaches.
- Apply queueing theory to various systems.
- Generate data for simulation.
- Model and analyse a given system using simulation tools.

REFERENCES:

1. Jerry Banks “Discrete-event system simulation”, Pearson Education, 2009.
2. Fitzgerald, John, Larsen, PeterGorm, “Modeling Systems; Practical Tools and Techniques in software development”, Cambridge University Press, 2009.
3. Hopcroft, John E, Motwani, Rajeev, Ullman, Seffrey D, “Introduction to automata theory, languages and computation”, Pearson/Addison Wesley, 3rd Edition, 2007.
4. Donald Gross and Carl M. Harris, “Fundamentals of Queuing theory”, 2nd Edition, John Wiley and Sons, New York (1985).
5. Hamdy A Taha, “Operations Research an Introduction”, Prentice Hall, Eighth Edition, 2007.
6. Jeofrey Gordon “System Simulation”, Prentice Hall of India, 2009.

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

OR5003 **PROJECT MANAGEMENT WITH PERT/CPM** **L T P C**
3 0 2 4

OBJECTIVES:

- To understand the concept of project planning and scheduling.
- To explore the different alternative schedules to complete a project.
- To study the effect of uncertainty in project completion.
- To find out the optimum cost effective project completion plan.
- To solve the limited resources network scheduling problems using Heuristic methods

UNIT I INTRODUCTION **9+6**

PERT and CPM come of age – planning scheduling and control planning - scheduling networks – The activity – Node Diagram – Building a house – Network scheduling

UNIT II ALGORITHMS FOR CRITICAL PATH **9+6**

Finding the critical path – Multiple critical paths – Job slack – Algorithm for finding the critical path – Late start and Late finish times – Total slack – Free slack – project due dates that differ from earliest completion time – A digression on stack – Back to the contractor

UNIT III PERT MODEL **9+6**

The PERT model – The problem of uncertainty – Expected times for activities – variability of activity times – The expected length of a critical path – Probability of completing a project by a given date – Effects of a near critical path - other methods for calculating project length and variance – Simulation of a network-criticality index - PERT's Event orientation - The PERT assumptions – The CPM model - Schedule-Related project Costs - The lowest cost schedule - stretching jobs - The problem of large projects - solutions by computers - cost optimization-L.P.Models - Non linear cost-time trade-off curves - non convex and discontinuous cost-time trade off curves.

UNIT IV COST ANALYSIS **9+6**

PERT/ cost : A network cost accounting system - Basic concepts of Network Cost Systems - cost accounting by work packages - forecast of project costs - Analysis and control of project costs - Graphic displays of cost and time data - cost curve for activities and departments - possible accounting problems with PERT/cost

UNIT V HEURISTIC APPROACHES **9+6**

Network scheduling with limited resources-The complexity of project scheduling with limited resources - Heuristic programs - Heuristic methods for resource leveling of project schedules - Example of a resource leveling programs - Heuristic methods for resource allocation in project scheduling- A simple heuristic program - The SPAR-1 resource allocation model - Conceptual problems of critical path analysis when resources are limited - Slack in a limited resource schedule-projects with uncertain activity estimates - planning versus scheduling - conclusion.

TOTAL: 45+30 = 75PERIODS

OUTCOMES:

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

- Conceptually understand the project elements, activities and its effect on project planning.
- Identify the critical activities.
- Identify parallel activities.
- Create a project scheduling incorporating all critical values.
- Optimize effectively through complementary tools.

REFERENCES:

1. Chandra, P., “Projects”, Tata McGraw-Hill Education, 2009.
2. Levy, F. K. and Wiest, J. D., “A Management Guide to PERT/CPM”, Prentice Hall, 1969.
3. Lewis, R., “Project Management”, McGraw-Hill, 2006.
4. Moder, J. J. and Phillips, “C. R., Project Management With CPM, PERT and Precedence Diagramming”, Van Nostrand Reinhold,1983.
5. Morris, P. W. G., and Pinto, J. K., “The Wiley Guide to Managing Projects”, JohnWiley& Sons, 2004.
6. Phillips, J., “PMP Project Management Professional Study Guide”, McGraw-Hill, 2003.
7. Pritsker, A. A. B., “Modeling and analysis using Q-GERT networks”, John Wiley & Sons Inc, 1979.

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

OR5004 DYNAMIC PROGRAMMING L T P C
3 0 0 3

OBJECTIVES:

- To analyse systems and devise methods for optimal and efficient results.
- To formulate dynamic programming problems and analyse its characteristics.
- To apply principle of optimality with deterministic approaches like recursion.
- To apply the markov chaining models in dynamic programming.
- To solve risk and uncertainty problems using dynamic programming.

UNITI INTRODUCTION AND APPLICATIONS OF DYNAMIC PROGRAMMING 9

Characteristics of Dynamic Programming Problems – Formulation – Examples – Disadvantages of Dynamic Programming – Bellman’s Principal of Optimality of Dynamic Programming – Applications of Dynamic Programming – Capital Budgeting Problem – Reliability Improvement Problem (Shortest path Problem) – Minimizing Scheduling problem – Optimal Subdividing Problem solution of LPP through Dynamic Programming.

UNITII DETERMINISTIC DYNAMIC PROGRAMMING 9

Introduction – Mathematical description – Principal of Optimality – Recursive computation – Multistage Forward and Backward Recursion – Selected Dynamic Programming Applications – Cargo loading model – workforce size model – equipment replacement model – investment model – inventory models – Problem of Dimensionality.

UNITIII PROBABILISTIC DYNAMIC PROGRAMMING 9

Introduction – Distribution of effort example – New product introduction – Elementary inventory model – optimal Batch size model – Stochastic regeneration Model – Equipment Replacement – Sales Forecasting problem – Applicability and Computational feasibility.

UNITIV DYNAMIC PROGRAMMING IN MARKOV CHAINS 9

Introduction – Stochastic Shortest – Route Model – Unbounded horizon with discounting equivalent Average Return – Linear Programming Approach – Computational considerations – Markov chain version of the equipment replacement model.

UNITV RISK AND UNCERTAINTY 9

Terminology and Classification – Decision making under risk – Multistage Optimization under Risk Markovian Decision Processes – A variable stage Stochastic Problem – Uncertainty and Adaptive Optimization – Gambling with unknown Probabilities – Two-Person – Zero-Sum Games – Games in Extensive

TOTAL:45 PERIODS

OUTCOMES:

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

- Identify and formulate dynamic programming problems and also comprehend characteristics of dynamic programming problems.
- Analyse and solve deterministic dynamic programming problems.
- Analyse the computational feasibility and solve multi-stage stochastic dynamic programming problems using known efficient methods.
- Understand and apply HMM models.
- Design and solve decision making problems under risk.

REFERENCES:

1. HamdyA.Taha, “Operations Research – An Introduction”, Prentice Hall, HI Learning Private Limited, Tenth Edition, 2017.
2. Harvey M.Wagner, “Principles of Operations Research with applications to Managerial Decisions”, PHI Learning Private Limited, 2nd Edition, 2009.
3. RonaldL.Rardin, “Optimization in Operations Research”, 2ndEdition Pearson Education, Asia 2018.

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

OR5005 **SCHEDULING ALGORITHMS** **L T P C**
3 0 0 3

OBJECTIVES:

- To study the basics of scheduling theory in real time.
- To model solution to single machine scheduling problems.
- To formulate solution to parallel machine scheduling.
- To solve flow shop scheduling using various algorithms.
- To study the various tools and algorithms for job shop scheduling.

UNIT I SCHEDULING THEORY 9

Scheduling background – Scheduling function – Sequencing – Ready time – Flow time – Tardiness - Weighted flow time – Inventory – Regular measures of performance – Dominant schedules – SPT, EDD, WSPT sequences – Scheduling Theorems

UNIT II SINGLE MACHINE SCHEDULING 9

Pure sequencing model – Hodgson's algorithm – Smith's rule – Wilkerson Irwin algorithm – Neighborhood search – Dynamic programming technique – Branch and Bound algorithm – Non simultaneous arrivals – Minimizing T and F for dependent jobs – Sequence dependent set up times.

UNIT III PARALLEL MACHINE SCHEDULING 9

Preemptive jobs: McNaughton's algorithm – Non preemptive jobs – Heuristic procedures – Minimizing Fw : H1 &Hm heuristics – Dependent jobs: Hu's algorithm – Muntz Coffman algorithm

UNIT IV FLOW SHOP SCHEDULING 9

Characteristics – Johnson's algorithm – Extension of Johnson's rule – Campbell Dudek Smith algorithm – Palmer's method – Start lag, stop lag – Mitten's algorithm – Ignall Schrage algorithm - Despatch index heuristic.

UNIT V JOB SHOP SCHEDULING 9

Characteristics –Graphical tools – Jackson's algorithm – Feasible, Semi-active and Active schedules – Single pass approach – Non delay schedule – Priority dispatching rules – Heuristic schedule generation – Open shop scheduling.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Understand the basics of scheduling theory in real time.
- Model solution to single machine scheduling problems.
- Formulate solution to parallel machine scheduling.
- Solve flow shop scheduling using various algorithms.
- Study the various tools and algorithms for job shop scheduling.

REFERENCES:

1. Kenneth R. Baker, "Introduction to sequencing and scheduling", John Wiley & Sons, New York, 2000.
2. Richard W. Conway, William L. Maxwell and Louis W. Miller, "Theory of Scheduling", Dover Publications, 2003.

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

OR5006 **NETWORK OPTIMIZATION** **L T P C**
3 0 0 3

OBJECTIVES:

- To analyse network characteristics and identify optimization parameters.
- To apply optimization techniques to solve shortest path problems.
- To formulate network optimization problem as nonlinear optimization problem and solve using convex optimization solution methods.
- To apply integer constrained optimization methods to network problem.
- To study the various network flow models and network simulation tools.

UNIT I INTRODUCTION **9**

Classification of optimization problems - Queuing theory - Stochastic process - Birth and death model - Kendall's notation for representing queuing model - Stochastic analysis - Little's theorem - Jackson queuing networks.

UNIT II SHORTEST PATH PROBLEMS **9**

Shortest path problems - max-flow problem - min-cost flow problem - Simplex methods for min-cost flow - Dual ascent methods for min-cost flow.

UNIT III NON-LINEAR NETWORK OPTIMIZATION **9**

Nonlinear network optimization - Convex separable network problems - Algorithms for differentiable dual problems.

UNIT IV INTEGER CONTRAINTS NETWORK PROBLEMS **9**

Network problems with integer constraints - Formulation of integer - constrained problems - Branch-and-bound - Lagrangian relaxation - Rollout algorithms.

UNIT V CASE STUDIES **9**

Nature inspired algorithms - Optimization as markov chains - TCP modeling - solving optimization problems using NS3/OPNET/QUALNET.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Apply the knowledge of optimization techniques in computer networks.
- Design solutions to flow problems in real time networks.
- Formulate network problems as optimization problems and obtain optimal solutions.
- Apply linear, nonlinear and integer programming techniques to network problems.
- Develop and test algorithms using simulation tools.

REFERENCES:

1. Dimitri P. Bertsekas, “Network Optimization: Continuous and Discrete Models”, 1998.
2. “Operations Research – An Introduction”, Hamdy A. Taha, 10th Edition, Pearson Education Inc., 2017.
3. K.S. Trivedi, "Probability and Statistics with Reliability, Queueing and Computer Science Applications", Wiley Publications, 2016.
4. Anurag Kumar, D.Manjunath, Joy Kuri, “Communication Networking: An analytical approach”, Morgan Kaufmann Publishers, 2011.
5. Mahbub Hassan, Raj Jain, “High Performance TCP/IP Networking: Concepts, Issues and Solutions”, 1st Edition, Pearson Education Inc., 2015.
6. Xin-She Yang, “Nature-Inspired Optimization Algorithms”, Elsevier Inc., First edition 2014.

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

OR5007 SUPPLY CHAIN MANAGEMENT L T P C
3 0 0 3

OBJECTIVES:

- To familiarize the management of supply chain assembly.
- To forecast supply and demand.
- To learn about the capability of Inventory management, planning and decision making.
- To devise network planning and procurement strategy.
- To study the role of IT in Supply chain management.

UNIT I INTRODUCTION 9

Introduction to SCM – Development chain – Global Optimization – Managing uncertainty and risk – Evolution of SCM – Issues in SCM – Decision phase – Supply chain drivers and obstacles – SCM complexity.

UNIT II FORECASTING 9

Demand forecasting – Role of forecasting-Characteristics – Basic Approach – Time series method – Measures of forecast error – Aggregate planning in SCM – Aggregate planning using Linear Programming – Excel – Supply and demand planning in supply chain – Managing supply – Demand – Implementing solution.

UNIT III INVENTORY MANAGEMENT AND RISK POOLING 9

Introduction to inventory – Forms of inventory – Single stage control – Economic Order Quantity (EOQ)– Lot size model – Demand uncertainty – Single period model – Review Policies – Risk Pooling – Centralized v/s Decentralized systems – Practical issues – Approaches for future demand.

UNIT IV NETWORK PLANNING AND PROCUREMENT STRATEGY 9

Network design – Inventory positioning and logistics and logistics co-ordination – Resource allocation – Transportation in a supply chain – Outsourcing benefits and risks – Buy/make Decisions – Procurement strategy – E-Procurement.

UNIT V INFORMATION TECHNOLOGY IN SUPPLY CHAIN MANAGEMENT 9

Enabling supply chain through IT –ERP vendor platforms – Service oriented architecture (SOA) – RFID

TOTAL: 45 PERIODS

OUTCOMES:

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

- Understand the management of supply chain assembly.
- Forecast the demand and plan for supply.
- Manage large inventory system with various system approaches.
- Acquire knowledge in planning and procurement strategies.
- Apply IT solutions like ERP & SOA to manage supply chain.

REFERENCES:

1. Sunil Chopra, Peter Mendil, “Supply chain Management – Strategy, Planning and Operation”, Pearson, 5th Edition, 2012.
2. HartmatStadtler, ChristoperKilger, “Supply Chain Management and Advanced Planning Concepts, Models, Software and Case Studies”, 5th edition, Springer, 2015.
3. Simchi-Levi David, Kaminsky Philip, Simchi-Levi Edith, “Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies”, McGraw Hill, 3rd edition, 2008.
4. Handfield R.B, Nicholas E.L, “Introduction to Supply Chain Management”, PHI, 1999.
5. Shapiro, J.F, “Modelling the Supply Chain”, Dubury, 2nd Edition 2006.

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

OR5008 **CONVEX OPTIMIZATION TECHNIQUES** **L T P C**
3 0 0 3

OBJECTIVES:

- To identify and formulate convex and concave optimization problems.
- To conceptualize the real life applications in terms of convex problems and identify appropriate algorithm to solve them.
- To analyse duality, sensitivity and optimality conditions.
- To solve unconstrained convex optimization problems.
- To appreciate duality and interior point methods in solving convex optimization problems.

UNIT I INTRODUCTION **9**

Convex sets: affine sets – operations that preserve convexity – generalized inequalities – separating and supporting hyper planes – dual cones and generalized inequalities. Convex functions: basic properties and examples – operations that preserve convexity – conjugate functions – log concave and log convex functions – convexity with respect to generalized inequalities

UNIT II CONVEX OPTIMIZATION PROBLEMS **9**

Optimization problems – convex optimization – linear optimization problems -quadratic optimization problems – geometric programming – generalized inequality constraints – vector optimization

UNIT III DUALITY **9**

Lagrange dual function – Lagrange dual problem – geometric interpretation – saddle point interpretation – optimality conditions – perturbation and sensitivity analysis – generalized inequalities

UNIT IV UNCONSTRAINED AND EQUALITY CONSTRAINED MINIMIZATION **9**

Unconstrained minimization problems – descent methods- gradient descent method - steepest descent method – newton's method – self concordance – Equality constrained minimization problems – newton's method with equality constraints – infeasible start newton method

UNIT V INTERIOR POINT METHODS **9**

Inequality constrained minimization problems – logarithmic barrier function and central path – barrier method – feasibility and phase I methods – complexity analysis via self-concordance – problems with generalized inequalities – primal dual interior point methods

TOTAL: 45 PERIODS

OUTCOMES:

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

- Identify and mathematically formulate convex optimization problems.
- Solve constrained and unconstrained optimization problems by identifying and using various algorithms.
- Understand duality and interior point methods in solving convex optimization problems.
- Apply the concepts of convex optimization in real life scenarios.
- Provide inferences from the obtained solutions to aid planning and decision making.

REFERENCES:

1. Singiresu S Rao, "Engineering Optimization: Theory and Practice", Wiley, 4th Edition, 2013.
2. David G.Luenberger, "Linear and Nonlinear Programming", Springer Publications, 3rd Edition, 2008.
3. Hamdy A Taha, "Operations Research - An Introduction", Pearson, 10th Edition, 2018.
4. Stephen Boyd, LievenVandenberghe, "Convex Optimization", Cambridge India, 2016.
5. Bertsekas, Dimitri P. *Nonlinear Programming*. 3rd Edition. Athena Scientific Press, 2016.

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

OR5009 **NUMERICAL OPTIMIZATION** **L T P C**
3 0 0 3

OBJECTIVES:

- To create mathematical formulations and apply solutions using level and convex sets.
- To analyse the performance and complexity issues of various algorithms for finding optimal solutions.
- To solve unconstrained optimization problems using basic descent methods.
- To understand the characteristics of constrained optimization problems and methods to solve them.
- To identify appropriate numerical optimization technique to solve real time complex engineering problems.

UNIT I INTRODUCTION **9**

Mathematical Formulation – Categories of optimizations – Local and Global Optimality - Existence of an Optimal Solution - Level Sets – Gradients - Convex Sets.

UNIT II COMPLEXITY ISSUES **9**

Algorithms and Complexity – Average Running Time - Randomized Algorithms - Basics of Computational Complexity Theory - Complexity of Local Optimization - Optimal Methods for Nonlinear Optimization – To teach the solution to unconstrained optimal problems.

UNIT III UNCONSTRAINED OPTIMIZATION **9**

Fundamentals – Search directions – Rates of convergence – Linear search method – Conjugate gradient method – Quasi newton methods – Non-linear equations.

UNIT IV CONSTRAINED OPTIMIZATION **9**

Local and Global Solutions – Smoothness - First-Order Optimality Conditions - Derivation of the First-Order Conditions - Second-Order Conditions - Other Constraint Qualifications – Quadratic Programming - Active set methods, Gradient Projection and sequential quadratic programming.

UNIT V CASE STUDIES **9**

Case Studies – Transportation problem - Network flow problem - Portfolio Optimization – Optimal trajectory problem – Chemical process optimization.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Formulate and analyse the existence of solutions to optimization problems.
- Understand the basics of linear programming, unconstrained and constrained optimization.
- Analyse the stability, order of convergence and conditions of application of techniques.
- Solve unconstrained and constrained optimization problems.
- Apply the knowledge of numerical optimization techniques to complex engineering problems and provide inferences from the obtained solutions to aid planning and decision making.

REFERENCES:

1. Jorge Nocedal, Stephen J Wright, “Numerical Optimization”, Springer Series in Operations Research, Springer, 1999.
2. M. S. Bazaraa, J. J. Jarvis, and H. D. Sherali, “Linear Programming and Network Flows”, John Wiley & Sons, 4th edition, 2010.
3. D. Bertsimas and J. N. Tsitsiklis, “Introduction to Linear Optimization”, Athena Scientific,Belmont, MA, 1997.
4. S. Boyd and L. Vandenberghe, “Convex Optimization”, Cambridge University Press, 2004.

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

OR5010 QUEUEING THEORY AND STOCHASTIC PROCESS L T P C
3 0 0 3

OBJECTIVES:

- To review the basics of probability distributions.
- To review the stochastic processes and its applications.
- To appreciate the classification and application of random process.
- To formulate and model systems using queueing models.
- To model, simulate and solve systems to improve performance.

UNIT I RANDOM VARIABLES 9

Discrete And Continuous Random Variables – Moments – Moment Generating Functions – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma And Normal Distributions.

UNIT II INTRODUCTION TO STOCHASTIC PROCESSES (SP) 9

Definition and examples of SPs, classification of random processes according to state space and parameter space, types of SPs, elementary problems

UNIT III RANDOM PROCESSES 9

Classification – Stationary Process – Markov Process – Poisson Process – Discrete Parameter Markov Chain – Chapman Kolmogorov Equations – Limiting Distributions.

UNIT IV QUEUEING MODELS 9

Markovian Queues – Birth And Death Processes – Single And Multiple Server Queuing Models – Little‟S Formula – Queues With Finite Waiting Rooms – Queues With Impatient Customers: Balking And Reneging.

UNIT V ADVANCED QUEUEING MODELS 9

Finite Source Models – M/G/1 Queue – PollaczekKhinchin Formula – M/D/1 And M/EK/1 As Special Cases – Series Queues – Open Jackson Networks.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Demonstrate a fundamental knowledge of queuing theory based modelling.
- Appreciate the application of stochastic processes.
- Understand various stationary and random processes.
- Analyse and solve engineering problems using queuing models.
- Design and formulate advance queuing models like series queues and Jackson networks.

REFERENCES:

1. Gross. D. And Harris. C.M., “Fundamentals Of Queuing Theory”, Wiley Student Edition, 2013.
2. Ibe. O.C., “Fundamentals Of Applied Probability And Random Processes”, Elsevier, 1st Indian Reprint, 2005.
3. J. Medhi, “Stochastic Processes”, 3rd Edition, New Age International, 2009.
4. S.M. Ross, “Stochastic Processes”, 2nd Edition, Wiley, 1996 (WSE Edition).
5. Robertazzi, “Computer Networks And Systems: Queuing Theory And Performance Evaluation”, 3rd Edition, Springer, 2006.
6. Taha. H.A., “Operations Research”, 10th Edition, Pearson Education, Asia, 2017.
7. Trivedi.K.S., “Probability And Statistics With Reliability, Queuing And Computer Science Applications”, 2nd Edition, John Wiley And Sons, 2002.
8. Yates. R.D. And Goodman. D. J., “Probability And Stochastic Processes”, 2nd Edition, Wiley India Pvt. Ltd., Bangalore, 2012.

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

OE5091 **BUSINESS DATA ANALYTICS** **L T P C**
3 0 0 3

OBJECTIVES:

- To understand the basics of business analytics and its life cycle.
- To gain knowledge about fundamental business analytics.
- To learn modeling for uncertainty and statistical inference.
- To understand analytics using Hadoop and Map Reduce frameworks.
- To acquire insight on other analytical frameworks.

UNIT I OVERVIEW OF BUSINESS ANALYTICS 9

Introduction – Drivers for Business Analytics – Applications of Business Analytics: Marketing and Sales, Human Resource, Healthcare, Product Design, Service Design, Customer Service and Support – Skills Required for a Business Analyst – Framework for Business Analytics Life Cycle for Business Analytics Process.

Suggested Activities:

- Case studies on applications involving business analytics.
- Converting real time decision making problems into hypothesis.
- Group discussion on entrepreneurial opportunities in Business Analytics.

Suggested Evaluation Methods:

- Assignment on business scenario and business analytical life cycle process.
- Group presentation on big data applications with societal need.
- Quiz on case studies.

UNIT II ESSENTIALS OF BUSINESS ANALYTICS 9

Descriptive Statistics – Using Data – Types of Data – Data Distribution Metrics: Frequency, Mean, Median, Mode, Range, Variance, Standard Deviation, Percentile, Quartile, z-Score, Covariance, Correlation – Data Visualization: Tables, Charts, Line Charts, Bar and Column Chart, Bubble Chart, Heat Map – Data Dashboards.

Suggested Activities:

- Solve numerical problems on basic statistics.
- Explore chart wizard in MS Excel Case using sample real time data for data visualization.
- Use R tool for data visualization.

Suggested Evaluation Methods:

- Assignment on descriptive analytics using benchmark data.
- Quiz on data visualization for univariate, bivariate data.

UNIT III MODELING UNCERTAINTY AND STATISTICAL INFERENCE 9

Modeling Uncertainty: Events and Probabilities – Conditional Probability – Random Variables – Discrete Probability Distributions – Continuous Probability Distribution – Statistical Inference: Data Sampling – Selecting a Sample – Point Estimation – Sampling Distributions – Interval Estimation – Hypothesis Testing.

Suggested Activities:

- Solving numerical problems in sampling, probability, probability distributions and hypothesis testing.
- Converting real time decision making problems into hypothesis.

Suggested Evaluation Methods:

- Assignments on hypothesis testing.
- Group presentation on real time applications involving data sampling and hypothesis testing.
- Quizzes on topics like sampling and probability.

UNIT IV ANALYTICS USING HADOOP AND MAPREDUCE FRAMEWORK 9

Introducing Hadoop – RDBMS versus Hadoop – Hadoop Overview – HDFS (Hadoop Distributed File System) – Processing Data with Hadoop – Introduction to MapReduce – Features of MapReduce – Algorithms Using Map-Reduce: Matrix-Vector Multiplication, Relational Algebra Operations, Grouping and Aggregation – Extensions to MapReduce.

Suggested Activities:

- Practical – Install and configure Hadoop.
- Practical – Use web based tools to monitor Hadoop setup.
- Practical – Design and develop MapReduce tasks for word count, searching involving text corpus etc.

Suggested Evaluation Methods:

- Evaluation of the practical implementations.
- Quizzes on topics like HDFS and extensions to MapReduce.

UNIT V OTHER DATA ANALYTICAL FRAMEWORKS 9

Overview of Application development Languages for Hadoop – PigLatin – Hive – Hive Query Language (HQL) – Introduction to Pentaho, JAQL – Introduction to Apache: Sqoop, Drill and Spark, Cloudera Impala – Introduction to NoSQL Databases – Hbase and MongoDB.

Suggested Activities:

- Practical – Installation of NoSQL database like MongoDB.
- Practical – Demonstration on Sharding in MongoDB.
- Practical – Install and run Pig
- Practical – Write PigLatin scripts to sort, group, join, project, and filter data.
- Design and develop algorithms to be executed in MapReduce involving numerical methods for analytics.

Suggested Evaluation Methods:

- Mini Project (Group) – Real time data collection, saving in NoSQL, implement analytical techniques using Map-Reduce Tasks and Result Projection.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Identify the real world business problems and model with analytical solutions.
- Solve analytical problem with relevant mathematics background knowledge.
- Convert any real world decision making problem to hypothesis and apply suitable statistical testing.
- Write and Demonstrate simple applications involving analytics using Hadoop and MapReduce
- Use open source frameworks for modeling and storing data.
- Apply suitable visualization technique using R for visualizing voluminous data.

REFERENCES:

1. Vignesh Prajapati, “Big Data Analytics with R and Hadoop”, Packt Publishing, 2013.
2. Umesh R Hodeghatta, Umesha Nayak, “Business Analytics Using R – A Practical Approach”, Apress, 2017.

3. Anand Rajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 2012.
4. Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, David R. Anderson, “Essentials of Business Analytics”, Cengage Learning, second Edition, 2016.
5. U. Dinesh Kumar, “Business Analytics: The Science of Data-Driven Decision Making”, Wiley, 2017.
6. A. Ohri, “R for Business Analytics”, Springer, 2012
7. Rui Miguel Forte, “Mastering Predictive Analytics with R”, Packt Publication, 2015.

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

OE5092 INDUSTRIAL SAFETY LT P C
3 0 0 3

OBJECTIVES:

- Summarize basics of industrial safety
- Describe fundamentals of maintenance engineering
- Explain wear and corrosion
- Illustrate fault tracing
- Identify preventive and periodic maintenance

UNIT I INTRODUCTION 9

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT II FUNDAMENTALS OF MAINTENANCE ENGINEERING 9

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT III WEAR AND CORROSION AND THEIR PREVENTION 9

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT IV FAULT TRACING **9**

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT V PERIODIC AND PREVENTIVE MAINTENANCE **9**

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to:

CO1: Ability to summarize basics of industrial safety
CO2: Ability to describe fundamentals of maintenance engineering
CO3: Ability to explain wear and corrosion
CO4: Ability to illustrate fault tracing
CO5: Ability to identify preventive and periodic maintenance

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES:

1. Audels, Pump-hydraulic Compressors, Mcgrew Hill Publication, 1978.
2. Garg H P,Maintenance Engineering, S. Chand and Company,1987.
3. Hans F. Winterkorn, Foundation Engineering Handbook, Chapman & Hall London, 2013.
4. Higgins & Morrow, Maintenance Engineering Handbook, Eighth Edition,2008

OE5093 OPERATIONS RESEARCH **L T P C**
3 0 0 3

OBJECTIVES:

- Solve linear programming problem and solve using graphical method.
- Solve LPP using simplex method
- Solve transportation, assignment problems
- Solve project management problems
- Solve scheduling problems

UNIT I LINEAR PROGRAMMING **9**

Introduction to Operations Research – assumptions of linear programming problems - Formulations of linear programming problem – Graphical method

UNIT II ADVANCES IN LINEAR PROGRAMMING 9

Solutions to LPP using simplex algorithm- Revised simplex method - primal dual relationships – Dual simplex algorithm - Sensitivity analysis

UNIT III NETWORK ANALYSIS – I 9

Transportation problems -Northwest corner rule, least cost method, Voges's approximation method - Assignment problem -Hungarian algorithm

UNIT IV NETWORK ANALYSIS – II 9

Shortest path problem: Dijkstra's algorithms, Floyds algorithm, systematic method -CPM/PERT

UNIT V NETWORK ANALYSIS – III 9

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to:

CO1: To formulate linear programming problem and solve using graphical method.
CO2: To solve LPP using simplex method
CO3: To formulate and solve transportation, assignment problems
CO4: To solve project management problems
CO5: To solve scheduling problems

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES:

1. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010
2. Hitler Libermann, Operations Research: McGraw Hill Pub. 2009
3. Pant J C, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Pannerselvam, Operations Research: Prentice Hall of India 2010
5. Taha H A, Operations Research, An Introduction, PHI, 2008

OE5094 COST MANAGEMENT OF ENGINEERING PROJECTS L T P C
3 0 0 3

OBJECTIVES:

- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

UNIT I INTRODUCTION TO COSTING CONCEPTS 9

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.

UNIT II INTRODUCTION TO PROJECT MANAGEMENT 9

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts.

UNIT III PROJECT EXECUTION AND COSTING CONCEPTS 9

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing.

UNIT IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL 9

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT 9

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to:

CO1 – Understand the costing concepts and their role in decision making

CO2–Understand the project management concepts and their various aspects in selection

CO3–Interpret costing concepts with project execution

CO4–Gain knowledge of costing techniques in service sector and various budgetary control techniques

CO5 - Become familiar with quantitative techniques in cost management

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓			✓	✓		✓	✓
CO2	✓	✓	✓		✓				✓		✓	✓
CO3	✓	✓	✓		✓	✓					✓	✓
CO4	✓	✓	✓		✓		✓				✓	✓
CO5	✓	✓	✓		✓	✓	✓				✓	✓

REFERENCES:

1.Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991

2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988

3. Charles T. Horngren et al Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi, 2011

4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003

5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007

OE5095 **COMPOSITE MATERIALS** **L T P C**
3 0 0 3

OBJECTIVES:

- Summarize the characteristics of composite materials and effect of reinforcement in composite materials.
- Identify the various reinforcements used in composite materials.
- Compare the manufacturing process of metal matrix composites.
- Understand the manufacturing processes of polymer matrix composites.
- Analyze the strength of composite materials.

UNIT I INTRODUCTION 9

Definition – Classification and characteristics of Composite materials - Advantages and application of composites - Functional requirements of reinforcement and matrix - Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT II REINFORCEMENTS 9

Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers - Properties and applications of whiskers, particle reinforcements - Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures - Isostrain and Isostress conditions.

UNIT III MANUFACTURING OF METAL MATRIX COMPOSITES 9

Casting – Solid State diffusion technique - Cladding – Hot isostatic pressing - Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving - Properties and applications.

UNIT IV MANUFACTURING OF POLYMER MATRIX COMPOSITES 9

Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding - Properties and applications.

UNIT V STRENGTH 9

Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to:

- CO1 - Know the characteristics of composite materials and effect of reinforcement in composite materials.
- CO2 – Know the various reinforcements used in composite materials.
- CO3 – Understand the manufacturing processes of metal matrix composites.
- CO4 – Understand the manufacturing processes of polymer matrix composites.
- CO5 – Analyze the strength of composite materials.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓	✓								
CO2		✓	✓	✓	✓						✓	
CO3			✓	✓	✓		✓				✓	
CO4			✓	✓	✓		✓				✓	
CO5			✓	✓	✓		✓					

REFERENCES:

1. Cahn R.W. - Material Science and Technology – Vol 13 – Composites, VCH, West Germany.
2. Callister, W.D Jr., Adapted by Balasubramaniam R, Materials Science and Engineering, An introduction, John Wiley & Sons, NY, Indian edition, 2007.
3. Chawla K.K., Composite Materials, 2013.
4. Lubin.G, Hand Book of Composite Materials, 2013.

OE5096 WASTE TO ENERGY L T P C
3 0 0 3

OBJECTIVES:

- Interpret the various types of wastes from which energy can be generated
- Develop knowledge on biomass pyrolysis process and its applications
- Develop knowledge on various types of biomass gasifiers and their operations
- Invent knowledge on biomass combustors and its applications on generating energy
- Summarize the principles of bio-energy systems and their features

UNIT I INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE 9

Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNIT II BIOMASS PYROLYSIS 9

Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT III BIOMASS GASIFICATION 9

Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT IV BIOMASS COMBUSTION 9

Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT V BIO ENERGY 9

Properties of biogas (Calorific value and composition), Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production -Urban waste to energy conversion - Biomass energy programme in India.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to:

CO1 – Understand the various types of wastes from which energy can be generated
CO2 – Gain knowledge on biomass pyrolysis process and its applications
CO3 – Develop knowledge on various types of biomass gasifiers and their operations
CO4 – Gain knowledge on biomass combustors and its applications on generating energy
CO5 – Understand the principles of bio-energy systems and their features

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓									✓
CO2	✓		✓									✓
CO3	✓	✓	✓		✓							✓
CO4	✓	✓	✓		✓		✓					✓
CO5	✓	✓	✓		✓							✓

REFERENCES:

1. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.

AUDIT COURSES (AC)

AX5091 ENGLISH FOR RESEARCH PAPER WRITING L T P C
2 0 0 0

OBJECTIVES

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS 6

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS 6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS 6

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first-time submission

TOTAL: 30 PERIODS

OUTCOMES

CO1 –Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										✓		✓
CO2										✓		✓
CO3										✓		✓
CO4										✓		✓
CO5										✓		✓

REFERENCES

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

AX5092 DISASTER MANAGEMENT L T P C
2 0 0 0

OBJECTIVES

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION 6

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA 6

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT 6

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

OUTCOMES

CO1: Ability to summarize basics of disaster
CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES

1. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company,2007.
3. Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi,2001.

AX5093 SANSKRIT FOR TECHNICAL KNOWLEDGE L T P C
2 0 0 0

OBJECTIVES

- Illustrate the basic sanskrit language.
- Recognize sanskrit, the scientific language in the world.
- Appraise learning of sanskrit to improve brain functioning.
- Relate sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
- Extract huge knowledge from ancient literature.

UNIT I ALPHABETS 6

Alphabets in Sanskrit

UNIT II TENSES AND SENTENCES 6

Past/Present/Future Tense - Simple Sentences

UNIT III ORDER AND ROOTS 6

Order - Introduction of roots

UNIT IV SANSKRIT LITERATURE 6

Technical information about Sanskrit Literature

UNIT V TECHNICAL CONCEPTS OF ENGINEERING 6

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

TOTAL: 30 PERIODS

OUTCOMES

- CO1 - Understanding basic Sanskrit language.
- CO2 - Write sentences.
- CO3 - Know the order and roots of Sanskrit.
- CO4 - Know about technical information about Sanskrit literature.
- CO5 - Understand the technical concepts of Engineering.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										✓		✓
CO2										✓		✓
CO3												✓
CO4												✓
CO5												✓

REFERENCES

1. "Abhyaspustakam" – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi, 2017.

AX5094 VALUE EDUCATION L T P C

2 0 0 0

OBJECTIVES

Students will be able to

- Understand value of education and self-development
- Imbibe good values in students
- Let the should know about the importance of character

UNIT I

Values and self-development–Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements

UNIT II

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline

UNIT III

Personality and Behavior Development-Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brother hood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT IV

Character and Competence–Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to

- Knowledge of self-development.
- Learn the importance of Human values.
- Developing the overall personality.

SUGGESTED READING

1. Chakroborty, S.K."Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi

AX5095 CONSTITUTION OF INDIA L T P C
2 0 0 0

OBJECTIVES

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION:

History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION:

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES:

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE:

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION:

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION:

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization
- of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING

1. The Constitution of India,1950(Bare Act),Government Publication.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

AX5096 PEDAGOGY STUDIES L T P C
2 0 0 0

OBJECTIVES

Students will be able to:

- Review existing evidence on there view topic to inform programme design and policy
- Making under taken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

UNIT I INTRODUCTION AND METHODOLOGY:

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions **-** Overview of methodology and Searching.

UNIT II THEMATIC OVERVIEW

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT III EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES

Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT IV PROFESSIONAL DEVELOPMENT

Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes

UNIT V RESEARCH GAPS AND FUTURE DIRECTIONS

Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to understand:

- What pedagogical practices are being used by teachers informal and informal classrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

SUGGESTED READING

1. Ackers J, HardmanF (2001) Classroom interaction in Kenyan primary schools, Compare, 31(2): 245-261.
2. Agrawal M (2004)Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36(3):361-379.
3. Akyeampong K (2003) Teacher training in Ghana-does it count? Multi-site teacher education research project (MUSTER) country report 1.London:DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33(3): 272–282.
5. Alexander RJ(2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M(2003) Read India: Amass scale, rapid, ‘learning to read’ campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf

AX5097 STRESS MANAGEMENT BY YOGA L T P C
2 0 0 0

OBJECTIVES

- To achieve overall health of body and mind
- To overcome stress

UNIT I

Definitions of Eight parts of yoga.(Ashtanga)

UNIT II

Yam and Niyam - Do`s and Don’t’s in life - i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.

UNIT III

Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayam

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to:

- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

SUGGESTED READING

1. 'Yogic Asanas for Group Tarining-Part-I":Janardan Swami Yoga bhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

AX5098	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	L T P C 2 0 0 0

OBJECTIVES

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

UNIT I

Neetisatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses- 29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont's) - Verses- 71,73,75,78 (do's)

UNIT II

Approach to day to day work and duties - Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.

UNIT III

Statements of basic knowledge - Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 Chapter 12 - Verses 13, 14, 15, 16,17, 18 - Personality of role model - shrimad bhagwad geeta - Chapter2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to

- Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and mankind to peace and prosperity
- Study of Neet is hatakam will help in developing versatile personality of students.

SUGGESTED READING

1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari's Three Satakam, Niti-sringar-vairagya, New Delhi,2010
2. Swami Swarupananda , Srimad Bhagavad Gita, Advaita Ashram, Publication Department, Kolkata, 2016.