GOVERNMENT COLLEGE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University)

Coimbatore - 641 013

Curriculum For

Post Graduate

M. E. Computer Science and Engineering

(Full Time)

2023

Regulations

OFFICE OF THE CONTROLLER OF EXAMINATIONS
GOVERNMENT COLLEGE OF TECHNOLOGY
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VISION AND MISSION OF THE DEPARTMENT

VISION

To be in the frontier of Computer Science and Engineering and to produce globally competent graduates with moral values committed to build a vibrant nation.

MISSION

- To strengthen the core competence in Computer Science and Engineering through analytical learning.
- To produce successful graduates with personal and professional responsibilities and commitment to lifelong learning.
- To uplift innovative research in Computer Science and Engineering to serve the needs of Industry, Government and Society.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The Programme Educational Objectives of M.E. Computer Science and Engineering programme are:

PEO 1: Graduates will be employed in computing profession as experts in providing solutions to complex design problems by their depth of knowledge in advanced computing.

PEO 2: Graduates with an aptitude in lifelong research will be either pursuing or completed doctoral programme and engaged in advanced research and development.

PEO 3: Graduates will be able to apply critical, lateral thinking and use reflective learning to analyze, conceptualize and evaluate the potential solutions for conducting theoretical and practical research by following ethical practices.

PROGRAMME OUTCOMES

Students of M.E. Computer Science and Engineering Programme at the time of graduation will be able to:

PO1: Independently carry out research / investigation and development work to solve practical problems.

PO2: Write and present a substantial technical report/document.

PO3: Demonstrate a higher degree of mastery over Computer Science and Engineering curriculum.

PO4: Practice code of ethics in professional accomplishments and research for sustainable societal development.

PO5: Identify feasible solutions by applying technical knowledge and ethical principles with engineering practices.

PO6: Engage in lifelong learning to improve knowledge and competence.

GOVERNMENT COLLEGE OF TECHNOLOGY, COIMBATORE – 641 013
M.E.COMPUTER SCIENCE AND ENGINEERING

FIRST SEMESTER

SI. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1	23CSFCZ1	Research Methodology and IPR (Common to All Branches)	FC	40	60	100	3	0	0	3
2	23CSFC02	Mathematical Foundations of Computer Science	FC	40	60	100	3	1	0	4
3	23CSPC01	Formal Languages, Machines and Computations	PC	40	60	100	3	1	0	4
4	23CSPC02	High Performance Computer Architecture	PC	40	60	100	3	0	0	3
5	23CSPC03	Algorithms and Complexity Analysis	PC	40	60	100	3	0	0	3
6	23CSPEXX	Professional Elective I	PE	40	60	100	3	0	0	3
7	23CSACXX	Audit Course I	AC	40	60	100	2	0	0	0
PRACTICAL										
8	23CSPC04	Advanced Algorithms and Elective Laboratory	PC	60	40	100	0	0	3	1.5
Total				**340**	**460**	**800**	**20**	**2**	**3**	**21.5**

SECOND SEMESTER

SI. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1	23CSPC05	Advanced Database Systems	PC	40	60	100	3	0	0	3
2	23CSPC06	Advanced Computer Networks	PC	40	60	100	3	0	0	3
3	23CSPC07	Advanced Operating System	PC	40	60	100	3	0	0	3
4	23CSPEXX	Professional Elective II	PE	40	60	100	3	0	0	3
5	23CSPEXX	Professional Elective III	PE	40	60	100	3	0	0	3
6	23CSACXX	Audit Course II	AC	40	60	100	2	0	0	0
PRACTICAL										
7	23CSPC08	Advanced Computer Networks and Electives Laboratory	PC	60	40	100	0	0	3	1.5
8	23CSEE01	Mini Project	EEC	40	60	100	0	0	4	2
Total				**340**	**460**	**800**	**17**	**0**	**7**	**18.5**

THIRD SEMESTER

SI. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1	23CSPC09	Data Science	PC	40	60	100	3	0	0	3
2	23CSPEXX	Professional Elective IV	PE	40	60	100	3	0	0	3
3	23$OEXX	Open Elective	OE	40	60	100	3	0	0	3
PRACTICAL										
4	23CSEE02	Project Phase I	EEC	100	100	200	0	0	12	6
Total				**220**	**280**	**500**	**9**	**0**	**12**	**15**

FOURTH SEMESTER

SI. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
PRACTICAL										
1	23CSEE03	Project Phase II	EEC	200	200	400	0	0	24	12
Total				**200**	**200**	**400**	**0**	**0**	**24**	**12**

Total Credits : 67

PROFESSIONAL ELECTIVES (PE)

PROFESSIONAL ELECTIVES – I

SI.No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	23CSPE01	Digital Image Processing	PE	40	60	100	3	0	0	3
2	23CSPE02	Embedded Systems	PE	40	60	100	3	0	0	3
3	23CSPE03	Fuzzy Logic and Neural Networks	PE	40	60	100	3	0	0	3
4	23CSPE04	Cloud Computing	PE	40	60	100	3	0	0	3
5	23CSPE05	Advanced Software Engineering	PE	40	60	100	3	0	0	3
6	23CSPE06	Pattern Recognition	PE	40	60	100	3	0	0	3

PROFESSIONAL ELECTIVES - II

SI.No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	23CSPE07	Computer Vision Engineering	PE	40	60	100	3	0	0	3
2	23CSPE08	Internet of Things	PE	40	60	100	3	0	0	3
3	23CSPE09	Network Science	PE	40	60	100	3	0	0	3
4	23CSPE10	Machine Learning	PE	40	60	100	3	0	0	3
5	23CSPE11	Multidimensional Data Structures	PE	40	60	100	3	0	0	3
6	23CSPE12	Cryptography and Network Security	PE	40	60	100	3	0	0	3

PROFESSIONAL ELECTIVES - III

SI.No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	23CSPE13	Social Networks	PE	40	60	100	3	0	0	3
2	23CSPE14	Information Retrieval	PE	40	60	100	3	0	0	3
3	23CSPE15	Natural Language Processing	PE	40	60	100	3	0	0	3
4	23CSPE16	Virtual Reality	PE	40	60	100	3	0	0	3
5	23CSPE17	Theory of Modern Compilers	PE	40	60	100	3	0	0	3

PROFESSIONAL ELECTIVES - IV

SI.No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	23CSPE18	Deep Learning	PE	40	60	100	3	0	0	3
2	23CSPE19	Ethical Hacking	PE	40	60	100	3	0	0	3
3	23CSPE20	Mining Massive Datasets	PE	40	60	100	3	0	0	3
4	23CSPE21	Data Center Networks	PE	40	60	100	3	0	0	3
5	23CSPE22	Data Visualization	PE	40	60	100	3	0	0	3
6	23CSPE23	Parallel Algorithms	PE	40	60	100	3	0	0	3

LIST OF OPEN ELECTIVES

SI. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	23SEOE01	Building Bye-Laws and Codes of Practice	OE	40	60	100	3	0	0	3
2	23SEOE02	Planning of Smart Cities	OE	40	60	100	3	0	0	3
3	23SEOE03	Green Building	OE	40	60	100	3	0	0	3
4	23EEOE04	Environment Health and Safety Management	OE	40	60	100	3	0	0	3
5	23EEOE05	Climate Change and Adaptation	OE	40	60	100	3	0	0	3
6	23EEOE06	Waste to Energy	OE	40	60	100	3	0	0	3
7	23GEOE07	Energy in Built Environment	OE	40	60	100	3	0	0	3
8	23GEOE08	Earth and Its Environment	OE	40	60	100	3	0	0	3
9	23GEOE09	Natural Hazard and Mitigation	OE	40	60	100	3	0	0	3
10	23EDOE10	Business Analytics	OE	40	60	100	3	0	0	3
11	23EDOE11	Introduction to Industrial safety	OE	40	60	100	3	0	0	3
12	23EDOE12	Operations Research	OE	40	60	100	3	0	0	3
13	23MFOE13	Occupational Health and Safety	OE	40	60	100	3	0	0	3
14	23MFOE14	Cost Management of Engineering Projects	OE	40	60	100	3	0	0	3
15	23MFOE15	Composite Materials	OE	40	60	100	3	0	0	3
16	23TEOE16	Global Warming Science	OE	40	60	100	3	0	0	3
17	23TEOE17	Introduction to Nano Electronics	OE	40	60	100	3	0	0	3

18	23TEOE18	Green Supply Chain Management	OE	40	60	100	3	0	0	3
19	23PSOE19	Distribution Automation System	OE	40	60	100	3	0	0	3
20	23PSOE20	Electricity Trading and Electricity Acts	OE	40	60	100	3	0	0	3
21	23PSOE21	Modern Automotive Systems	OE	40	60	100	3	0	0	3
22	23PEOE22	Virtual Instrumentation	OE	40	60	100	3	0	0	3
23	23PEOE23	Energy Management Systems	OE	40	60	100	3	0	0	3
24	23PEOE24	Advanced Energy Storage Technology	OE	40	60	100	3	0	0	3
25	23AEOE25	Design of Digital Systems	OE	40	60	100	3	0	0	3
26	23AEOE26	Basics of Nano Electronics	OE	40	60	100	3	0	0	3
27	23AEOE27	Advanced Processor	OE	40	60	100	3	0	0	3
28	23VLOE28	HDL Programming Languages	OE	40	60	100	3	0	0	3
29	23VLOE29	CMOS VLSI Design	OE	40	60	100	3	0	0	3
30	23VLOE30	High Level Synthesis	OE	40	60	100	3	0	0	3
31	23CSOE31	Artificial Intelligence	OE	40	60	100	3	0	0	3
32	23CSOE32	Computer Network Management	OE	40	60	100	3	0	0	3
33	23CSOE33	Blockchain Technologies	OE	40	60	100	3	0	0	3

LIST OF AUDIT COURSES

(Common to All Branches)

SI. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	23CSACZ1	English for Research Paper Writing	AC	40	60	100	2	0	0	0
2	23CSACZ2	Disaster Management	AC	40	60	100	2	0	0	0
3	23CSACZ3	Value Education	AC	40	60	100	2	0	0	0
4	23CSACZ4	Constitution of India	AC	40	60	100	2	0	0	0
5	23CSACZ5	Pedagogy Studies	AC	40	60	100	2	0	0	0
6	23CSACZ6	Stress Management by Yoga	AC	40	60	100	2	0	0	0
7	23CSACZ7	Personality Development Through Life Enlightenment Skills	AC	40	60	100	2	0	0	0
8	23CSACZ8	Sanskrit for Technical Knowledge	AC	40	60	100	2	0	0	0

SUMMARY OF CREDIT DISTRIBUTION

S.No	Course Work Subject Area	No of Credits					Percentage
		I	II	III	IV	Total	
1.	Foundation Course	7	0	0	0	07	10.44 %
2.	Professional Cores	11.5	10.5	3	0	25	37.31 %
3.	Professional Electives	3	6	3	0	12	17.91 %
4.	Employability Enhancement Courses	0	2	6	12	20	29.85 %
5.	Open Elective Courses	0	0	3	0	03	4.48 %
6.	Audit Courses	0	0	-	-	-	-
Total Credits		**21.5**	**18.5**	**15**	**12**	**67**	**100%**

23CSFCZ1	RESEARCH METHODOLOGY AND IPR *(Common to all Branches)*	SEMESTER I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	FC	3	0	0	3

Course Objectives	1. To impart knowledge on research methodology, Quantitative methods for problem solving, data interpretation and report writing 2. To know the importance of IPR and patent rights.

UNIT – I	**INTRODUCTION**	**L(9)**
Definition and objectives of Research – Types of research, Various Steps in Research process, Mathematical tools for analysis, Developing a research question-Choice of a problem Literature review, Surveying, synthesizing, critical analysis, reading materials, reviewing, rethinking, critical evaluation, interpretation, Research Purposes, Ethics in research – APA Ethics code.		
UNIT – II	**QUANTITATIVE METHODS FOR PROBLEM SOLVING**	**L(9)**
Statistical Modeling and Analysis, Time Series Analysis Probability Distributions, Fundamentals of Statistical Analysis and Inference, Multivariate methods, Concepts of Correlation and Regression, Fundamentals of Time Series Analysis and Spectral Analysis, Error Analysis, Applications of Spectral Analysis.		
UNIT – III	**DATA DESCRIPTION AND REPORT WRITING**	**L(9)**
Tabular and graphical description of data: Tables and graphs of frequency data of one variable, Tables and graphs that show the relationship between two variables , Relation between frequency distributions and other graphs, preparing data for analysis. Structure and Components of Research Report, Types of Report, Layout of Research Report, Mechanism of writing a research report, referencing in academic writing.		
UNIT – IV	**INTELLECTUAL PROPERTY**	**L(9)**
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	**PATENT RIGHTS**	**L(9)**
Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES

1	*Stuart Melville and Wayne Goddard,* ***"Research methodology: an introduction",*** *Juta Academic, 2nd edition, 2014.*
2	*Donald H.McBurney and Theresa White,* ***"Research Methods",*** *9th Edition, CengageLearning, 2013*
3	*RanjitKumar,* ***"Research Methodology: A Step by Step Guide for Beginners"****, 5th Edition, 2019*
4	*Dr. C. R. Kothari and GauravGarg,* ***"Research Methodology: Methods and Trends",*** *New age international publishers, 4th Edition, 2018*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Formulate research question for conducting research.	K3
CO2	Analyze qualitative and quantitative data.	K4
CO3	Interpret research findings and give appropriate conclusions.	K2
CO4	Develop a structured content to write technical report.	K3
CO5	Summarize the importance of IPR and protect their research work through intellectual property.	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	3	3	1	3
CO2	2	3	1	3	3	3
CO3	2	3	3	3	3	3
CO4	2	3	1	3	3	3
CO5	-	-	2	-	1	3
23CSFCZ1	**2**	**3**	**3**	**3**	**3**	**3**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20	-	-	-	100
CAT2	40	40	20	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	50	30	20	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	50	30	20	-	-	100
ESE	30	30	20	20	-	-	100

23CSFC02	MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE	SEMESTER I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	FC	3	1	0	4

Course Objectives	To enhance the fundamental knowledge in probability concepts and its applications relevant to various streams of Engineering and Technology. This is a foundation course which mainly deals with topic such as probability, standard statistical distributions, correlation and regression analysis, testing of hypothesis, linear programming problems, transportation and assignment problems and plays an important role in the understanding of Science, Engineering and Computer Science among other disciplines.	
UNIT – I	**RANDOM VARIABLES& DISTRIBUTIONS**	**L(9)+T(3)**
Random variables: Discrete and continuous random variables- Moments, Moment generating functions- Binomial, Geometric, Poisson, Uniform, Exponential and Normal distributions.		
UNIT – II	**CORRELATION AND REGRESSION ANALYSIS**	**L(9)+T(3)**
Correlation coefficients- Equation of the lines of regression, Regression coefficients, Regression plane- Multiple and Partial correlation, Partial regression.		
UNIT –III	**TESTING OF HYPOTHESIS**	**L(9)+T(3)**
Large samples: Tests for Mean and proportions, Small samples: Tests for Mean, Variance andAttributesusingt,F,Chi–Square distributions.		
UNIT – IV	**LINEARPROGRAMMING PROBLEMS**	**L(9)+T(3)**
Formulation of Linear Programming problem: Graphical Method - Simplex Method – Big M method -dual method..		
UNIT – V	**MARKOVIAN QUEUEING MODELS**	**L(9)+T(3)**
Markovian models- Birth and Death Queuing models- steady state results: Single and multiple server queuing models-queues with finite waiting rooms- Finite source models-Little's formula.		
Contact Periods: **Lecture: 45 Periods Tutorial: 15 Periods Practical: 0 Periods Total: 60 Periods**		

REFERENCES

1	*Veerarajan T,* ***"Probability, Statistics and Random Processes (with Queueing Theory and Queueing Networks)",*** *McGraw Hill Education(India)Pvt Ltd., New Delhi, Fourth Edition 2016.*
2	*Taha H.A.,* ***"Operations Research: An introduction", Ninth Edition, Pearson Education, Asia, New Delhi, 2012.***
3	*Gupta S.C and Kapoor V.K,* ***"Fundamentals of Mathematical Statistics",*** *Sultan Chand & Sons, New Delhi, 2015.*
4	*Gupta S.P,* ***"Statistical Methods",*** *Sultan Chand & Sons, New Delhi, 2015.*
5	*Veerarajan T,* ***"Higher Engineering Mathematics",*** *Yes Dee Publishing Pvt Ltd, Chennai,2016.*

6	*Kandasamy P, Thilagavathy K and Gunavathy K,* ***"Probability and Queueing Theory",*** *S. Chand & Co, Ramnagar, New Delhi, Reprint 2013.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Solve the engineering problems associated with random variables, moments and moment generating functions.	K4
CO2	Calculate the coefficient of correlation, regression coefficients, multiple and partial correlation.	K4
CO3	Test the significance of hypothesis connected to small and large samples using different parameters.	K4
CO4	Form the linear programming problems for a real time phenomena and find the solution for the same by using simplex, big M and dual methods.	K4
CO5	Analyse problems involving single and multi-server markovian models.	K4

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO1	3	-	2	-	2	1
CO2	3	-	2	-	2	1
CO3	3	-	2	-	2	1
CO4	3	-	2	-	2	1
CO5	3	-	2	-	2	1
23CSFC02	**3**	**-**	**2**	**-**	**2**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	40	20	10	-	-	100
CAT2	30	40	20	10	-	-	100
	30	40	20	10	-	-	
Individual Assessment 1/Case Study 1/Seminar 1/Project 1	30	40	20	10	-	-	100
Individual Assessment 2/Case Study 2/Seminar 2/Project 2	30	40	20	10	-	-	100
ESE	30	40	20	10	-	-	100

23CSPC01	FORMAL LANGUAGES, MACHINES AND COMPUTATIONS	SEMESTER I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	1	0	4

Course Objectives	The aims of this course are to understand basic theory of computation concepts that lies at the backbone of all state-of-the-art applications and program design. Students should understand the capabilities and limits of computation, particular applications and capabilities of deterministic and non-deterministic finite automata, context-free grammars, and finally Turing machines, as well as NP-completeness and complexity classes.	
UNIT – I	**REGULAR LANGUAGES AND APPLICATIONS**	**L(9)+T(3)**
Regular Expressions and applications – Regular languages, properties and applications – Finite Automata, variants and applications – Pumping lemma for RL.		
UNIT – II	**CONTEXT FREE LANGUAGES**	**L(9)+T(3)**
Grammars – Context Free Languages, properties and applications – Stack machines – Context free frontier – Stack machines applications – Pumping lemma for CFL.		
UNIT – III	**TURING MACHINES**	**L(9)+T(3)**
Turing machine basics – Simple TMs – Language define by TM – Variants of TMs and their equivalence – Universal TM – Recursive, Recursively Enumerable languages and properties		
UNIT – IV	**COMPUTABILITY AND UNCOMPUTABILITY**	**L(9)+T(3)**
Turing computable functions – Functions and languages – TM random access – Church-Turing thesis – Infinite models, finite machines – Halting problem – Reducibility – Rice's theorem – Grammars and Computability – Computable functions - Mathematical uncomputabilities		
UNIT – V	**COST MODELS AND ALTERNATE ALGORITHMS**	**L(9)+T(3)**
Asymptotic notations, properties and functions – TM cost model – Time complexity classes – Space complexity classes – Higher complexity classes – Verification methods – NP, NP hard and NP Complete problems – Approximation algorithms, probabilistic and parallel algorithms – Interactive proof system		
Contact Periods: **Lecture: 45 Periods Tutorial: 15 Periods Practical: 0 Periods Total: 60 Periods**		

REFERENCES :

1	*John E Hopcroft, Rajeev Motwani, Jeffrey D Ullman,* ***"Introduction to Automata Theory, Languages and Computation"****, Third Edition, Pearson, 2013*
2	*John C. Martin,* ***"Introduction to languages and the theory of computation"****, Third edition, McGrawHil, 2015*

3	*Michael Sipser,* ***"Introduction to Theory of Computation"****, Third Edition, Cengage learning, 2013.*
4	*H.R.Lewis and C.H.Papadimitriou,* ***"Elements of the theory of Computation****", Second Edition, Pearson, 2015*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Identify, use and apply Formal Languages	K3
CO2	Solve given problem by constructing appropriate Automata/Machines	K4
CO3	Provide solution model for computable functions	K5
CO4	Classify the problems based on the cost analysis	K6
CO5	Use alternate models of computation such as Approximation algorithms, probabilistic and parallel algorithms and Interactive proof system	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	3	3	3	-
CO2	3	-	2	3	3	-
CO3	3	-	3	3	3	-
CO4	2	-	3	3	2	1
CO5	1	-	1	1	1	2
23CSPC01	**3**	**-**	**3**	**3**	**3**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	50	30	20	-	-	-	100
CAT2	20	30	30	20	-	-	100
Individual Assessment 1/Case Study 1/Seminar 1/Project 1	-	-	-	40	40	20	100
Individual Assessment 2/Case Study 2/Seminar 2/Project 2	-	-	-	40	40	20	100
ESE	40	30	30	-	-	-	100

23CSPC02	HIGH PERFORMANCE COMPUTER ARCHITECTURE	SEMESTER I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	After the completion of the course, the students will be able to understand fundamentals of Computer Organization, performance laws and memory organization. Concepts and issues in instruction level parallelism with different types of data Level Parallelism and different types of thread level parallelism. extract the performance from software that is oblivious to architecture.	
UNIT – I	**FUNDAMENTALS OF QUANTITATIVE DESIGN AND ANALYSIS AND MEMORY HIERARCHY DESIGN**	**L(9)**
RISC processors - Characteristics of RISC processors, RISC vs CISC, Classification of Instruction Set Architectures - Review of performance measurements - Trends in Technology , Power and Energy in Integrated Circuits and Cost - Dependability - Measuring, Reporting, and Summarizing Performance - Quantitative Principles of Computer Design - Memory Hierarchy Design – Introduction - Memory Technology and Optimizations - Ten Advanced Optimizations of Cache Performance - Virtual Memory and Virtual Machines - Cross-Cutting Issues: The Design of Memory Hierarchies.		
UNIT – II	**INSTRUCTION-LEVEL PARALLELISM AND ITS EXPLOITATION**	**L(9)**
Instruction-Level Parallelism: Concepts and Challenges - Basic Compiler Techniques for Exposing ILP - Reducing Branch Costs With Advanced Branch Prediction - Overcoming Data Hazards With Dynamic Scheduling - Dynamic Scheduling: Examples and the Algorithm - Hardware-Based Speculation - Exploiting ILP Using Multiple Issue and Static Scheduling - Exploiting ILP Using Dynamic Scheduling, Multiple Issue, and Speculation - Advanced Techniques for Instruction Delivery and Speculation.		
UNIT – III	**DATA-LEVEL PARALLELISM IN VECTOR, SIMD, GPU ARCHITECTURES ANDWAREHOUSE-SCALE COMPUTERS**	**L(9)**
Introduction - Vector Architecture - SIMD Instruction Set Extensions for Multimedia - Graphics Processing Units - Detecting and Enhancing Loop-Level Parallelism - Programming Models and Workloads for Warehouse-Scale Computers - Computer Architecture of Warehouse-Scale Computers - The Efficiency and Cost of Warehouse-Scale Computers - Cloud Computing: The Return of Utility Computing.		
UNIT – IV	**THREAD-LEVEL PARALLELISM**	**L(9)**
Introduction - Centralized Shared-Memory Architectures - Performance of Symmetric Shared-Memory Multiprocessors - Distributed Shared-Memory and Directory-Based Coherence - Synchronization: The Basics - Models of Memory Consistency: An Introduction - Cross-Cutting Issues - Multicore Processors and Their Performance - The Future of Multicore Scaling.		
UNIT – V	**DOMAIN-SPECIFIC ARCHITECTURES**	**L(9)**
Introduction- Guidelines for DSAs - Example Domain: Deep Neural Networks - Google's Tensor Processing Unit, an Inference Data Center Accelerator - Microsoft Catapult, a Flexible Data Center Accelerator - Intel Crest, a Data Center Accelerator for Training - Pixel Visual Core, a Personal Mobile Device Image Processing Unit -A Vision of Computer Architecture Research over the Next 15 Years.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES :

1	*John L. Hennessey and David A. Patterson,* ***"Computer Architecture – A Quantitative Approach",*** *Morgan Kaufmann / Elsevier, Six edition, 2019.*
2	*William Stallings,* ***"Computer Organization and Architecture*** *Designing for Performance****",*** *Pearson Education, Tenth Edition, 2016.*
3	D. A. Patterson and J. L. Hennessy, **"*Computer Organization and Design RISC-V Edition: The Hardware Software Interface*,"** 1st Edition, Morgan Kaufmann Publishing Co., Menlo Park, CA., April 2017.
4	*Luis Ceze, Mark D. Hill, Thomas F. Wenisch ,* ***"Arch2030: A Vision of Computer Architecture Research over the Next 15 Years",*** *The Arch2030 Workshop at ISCA 2016.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the components and operation of a memory hierarchy and the range of performance issues influencing its design.	K2
CO2	Analyze and exploit instruction level parallelism.	K4
CO3	Evaluate performance of different architectures with respect to Data level Parallelism.	K5
CO4	Understand the organisation and operation of current generation multiprocessor and multicore systems.	K2
CO5	Describe and explain current and future trends in computer architecture	K4

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	3	2	3	3
CO2	3	2	3	2	3	3
CO3	3	2	3	2	3	3
CO4	3	2	3	2	3	3
CO5	3	2	3	2	3	3
23CSPC02	**3**	**2**	**3**	**2**	**3**	**3**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	40	30	20	-	-	100
CAT2	-	40	30	30	-	-	100
Individual Assessment 1/Case Study 1/Seminar 1/Project 1	-	50	30	20	-	-	100
Individual Assessment 2/Case Study 2/Seminar 2/Project 2	-	50	30	20	-	-	100
ESE	40	30	30	-	-	-	100

23CSPC03	ALGORITHMS AND COMPLEXITY ANALYSIS	SEMESTER I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	The objective of the course is to enable students with the ability to analyze the asymptotic performance of algorithms along the capability to understand and design algorithms using advanced design and analysis techniques.	
UNIT – I	**INTRODUCTION**	**L(9)**
Role of Algorithms in Computing – Characterizing Running Times - Divide and Conquer – Probabilistic analysis – Randomized algorithms – Sorting and Order Statistics		
UNIT – II	**ADVANCED DESIGN AND ANALYSIS TECHNIQUES**	**L(9)**
Dynamic programming: Rod cutting- Matrix-chain multiplication Elements of dynamic programming, Optimal binary search trees-Greedy Algorithms: An activity-selection problem, Elements of the greedy strategy, Huffman codes -offline caching – Amortized Analysis.		
UNIT – III	**GRAPH ALGORITHMS**	**L(9)**
Single source shortest paths – All pairs shortest paths : Floyd-Warshall algorithm - Johnson's algorithms for sparse graphs – Maximum Flow: Flow networks - The Ford-Fulkerson method-Maximum bipartite matching – Matching in Bipartite Graphs: The stable-marriage problem - The Hungarian algorithm for the assignment problem		
UNIT – IV	**ADVANCED ALGORITHMS I**	**L(9)**
Parallel Algorithms: Basics of fork-join parallelism – Parallel Matrix multiplication – Parallel merge sort – Online Algorithms – Waiting for a elevator – Maintaining a search List –Online Caching- Matrix Operation: Solving system & Linear equation -Matrix Inversion - Symmetric Positive definite Matrices and least Square Approximation- Linear Programming		
UNIT – V	**ADVANCED ALGORITHMS II**	**L(9)**
Polynomials and FFT – Number theoretic Algorithms-String matching – machine learning algorithms - NP Completeness – Approximation Algorithms		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

REFERENCES

1	*Thomas H. Cormen, Charles E. Leiseron, Ronald L.Rivest, Clifford Stein,* ***"Introduction to Algorithms"****, Fourth Edition, PH1 learning Pvt. Ltd., 2022.*
2	*Anany Levitin,* ***"The Design and analysis & algorithms"****, III Edition, Pearson, 2011.*
3	*Jeff Erickson,* ***"Algorithms"****, 1st edition, 2019.*
4	*Aho. A.V., Hopcroft. J.E. and Ullman .J.D.,* ***"The Design and Analysis of Algorithms"****, Addison-Wesley, 1974.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Design and analyze algorithms using divide and conquer, dynamic programming, greedy approaches.	**K6**
CO2	Perform probabilistic analysis and amortized analysis of algorithms.	**K1**
CO3	Use appropriate graph and matrix manipulation algorithms	**K3**
CO4	Solve problems using parallel algorithms and linear programming approach.	**K2**
CO5	Use algorithms on polynomials	**K2**
CO6	Identify problems that are NP Complete and generate near optimal solution	**K4**

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	2	-	-	2
CO2	3	-	2	-	-	2
CO3	2	-	2	-	3	2
CO4	2	-	2	-	3	2
CO5	2	-	2	-	1	2
CO6	2	-	2	-	-	2
23CSPC03	**2**	**-**	**2**	**-**	**1**	**2**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	30	30	-	20	-	100
CAT2	30	40	30	-	-	-	100
Individual Assessment 1/Case Study 1/Seminar 1/Project 1	30	30	30	-	10	-	100
Individual Assessment 2/Case Study 2/Seminar 2/Project 2	30	40	30	-	-	-	100
ESE	30	30	20	-	20	-	100

23CSPC04	ADVANCED ALGORITHMS AND ELECTIVE LABORATORY	SEMESTER I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	0	0	3	1.5

Course Objectives	Explain important algorithmic design paradigms and methods of analysisto design efficient algorithms in common engineering design solutions.
	PRACTICALS EXERCISESILLUSTRATINGTHEFOLLOWINGCONCEPTS:
1	Implement an algorithm that combines k sorted lists in time O(n log k)where n is the total number of elements.
2	Implement an algorithm to solve Matrix multiplication problem and Maximum value contiguous subsequence using dynamic programming approach.
3	Implement an algorithm based on greedy approach to solve knapsack problem and Activity selection problem.
4	Implement Merge sort algorithm using Divide and Conquer approach.
5	Implement stack operations and calculate the amortized cost.
6	Implement Graph Traversal algorithms.
7	Implement an algorithm to construct Minimum Spanning Trees.
8	Implement Shortest path and Maximum flow algorithms
9	Implement String matching algorithms
10	Implement Computational Geometry algorithms
Contact periods:	

Lecture: 0 Periods	**Tutorial: 0 Periods**	**Practical: 45 Periods**	**Total:45 Periods**

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Design and analyze algorithms using divide and conquer, dynamic programming, greedy algorithms	K6
CO2	Perform probabilistic analysis and amortized analysis of algorithms	K4
CO3	Implement Minimum spanning trees,shortest path and Maximum flow algorithms in graphs to solve problems	K6
CO4	Solve problems using String matching algorithms	K6
CO5	Solve problems using Computational geometry algorithms	K6

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	1	3	3
CO2	3	3	3	1	3	3
CO3	3	3	3	1	3	3
CO4	3	3	3	1	3	3
CO5	3	3	3	1	3	3
23CSPC04	**3**	**3**	**3**	**1**	**3**	**3**
1 – Slight, 2 – Moderate, 3 – Substantial						

23CSPC05	ADVANCED DATABASE SYSTEMS	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	The objective of the course is to explore emerging database technologies.	
UNIT – I	**DATABASE DESIGN THEORY , SQL , NOSQL**	**L(9)**

Database environment – Relational model and languages – Normal forms - Basic SQL- Complex Queries, Triggers, Views, and Schema Modification

NOSQL Databases and Big Data Storage Systems :Introduction to NOSQL Systems - The CAP Theorem -Document-Based NOSQL Systems and MongoDB - NOSQL Key-Value Stores - Column-Based or Wide Column NOSQL Systems - NOSQL Graph Databases and Neo4j

Case Study(not for Evaluation) : PostgreSQL , MongoDB

UNIT – II	INDEXING , QUERY PROCESSING AND OPTIMIZATION	L(9)

Indexing :Basic Concepts - Ordered Indices - B+ Tree Index File - B+ Tree Extensions - Hash Indices - Multiple-Key Access - Creation of Indices - Write-Optimized Index Structures - Bitmap Indices - Indexing of Spatial and Temporal Data

Query Processing : Overview - Measures of Query Cost - Selection Operation – Sorting - Join Operation - Other Operations - Evaluation of Expressions - Query Processing in Memory

Query Optimization: Overview - Transformation of Relational Expressions - Estimating Statistics of Expression Results - Choice of Evaluation Plans - Materialized Views - Advanced Topics in Query Optimization

UNIT – III	TRANSACTION PROCESSING, CONCURRENCY CONTROL, AND RECOVERY	L(9)

Introduction to Transaction Processing -Transaction and System Concepts -Desirable Properties of Transactions - Characterizing Schedules Based on Recoverability- Characterizing Schedules Based on Serializability -Transaction Support in SQL

Two-Phase Locking Techniques for Concurrency Control- Concurrency Control Based on Timestamp Ordering -Multiversion Concurrency Control Techniques - Validation (Optimistic) Techniques and Snapshot Isolation Concurrency Control - Granularity of Data Items and Multiple Granularity Locking - Using Locks for Concurrency Control in Indexes -Other Concurrency Control Issues

Recovery Concepts-NO-UNDO/REDO Recovery Based on Deferred Update- Recovery Techniques Based on Immediate Update- Shadow Paging -The ARIES Recovery Algorithm - Recovery in Multidatabase Systems - Database Backup and Recovery from Catastrophic Failures

UNIT – IV	PARALLEL AND DISTRIBUTED DATABASES	L(9)

Database system Architecture- Parallel Systems – Distributed Systems – Transaction processing in parallel and distributed system –cloud based services – Parallel and Distributed Storage : Data Partitioning –Dealing with Skew in Partitioning - Replication - Parallel Indexing -Distributed File Systems - Parallel Key-Value Stores.

Parallel and Distributed Query Processing : Parallel sort -parallel Join - Parallel Evaluation of Query Plans - Query Processing on Shared-Memory Architectures - Query Optimization for Parallel Execution - Parallel Processing of Streaming Data -Distributed Query Processing - Parallel and Distributed Transaction Processing.

UNIT – V	DATABASE SECURITY AND ENHANCED DATA MODELS	L(9)
Database Security: Issues, Access Control Mechanisms, SQL injection, Statistical Database security – Advanced Data models: Active Database, Temporal Database, Spatial Database Multimedia Database, Deductive Databases, Blockchain Databases **Case Study(not for Evaluation) :** Support of spatial , temporal and Multimedia in PostgreSQL and MongoDB, Hyperledger Fabric,corda		

Contact Periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

REFERENCES:

1	*Elmasri, Ramez.* ***"Fundamentals of database systems"*** *seventh edition, Pearson, 2021.*
2	*Silberschatz, Abraham, Henry F. Korth, and Shashank Sudarshan.* ***"Database system concepts."*** *Sixth edition , McGraw Hill ,2011.*
3	*Coronel, Carlos, and Steven Morris* ***"Database systems: design, implementation and management"*** *Cengage learning, sixth edition , Pearson 2019.*
4	*Diaz, Christopher.* ***Database Security: Problems and Solutions.*** *Stylus Publishing, LLC, 2022.*
5	*https://www.postgresql.org/*
6	*https://www.mongodb.com/*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Demonstrate SQL and NoSQL databases	K3
CO2	Explain different techniques used for indexing ,query processing and Query optimization	K2
CO3	Explore the principle and techniques behind Transaction Processing, Concurrency Control, and database recovery	K2
CO4	Apply Concurrency control and Query Optimization algorithms in Parallel and Distributed data model	K3
CO5	Elaborate on Database Security and Advanced Data Model	K2

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	3	3
CO2	3	2	3	2	3	3
CO3	3	2	3	2	3	3
CO4	3	2	3	2	3	3
CO5	3	2	3	2	3	3
23CSPC05	**3**	**2**	**3**	**2**	**3**	**3**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	40	50	-	-	-	100
CAT2	20	40	40	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	50	50	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	50	50	-	-	-	100
ESE	40	30	30	-	-	-	100

23CSPC06	ADVANCED COMPUTER NETWORKS	SEMESTER II

PREREQUISITES:	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	This course explores advanced topics in computer networks, focusing on both theoretical concepts and practical applications in the areas of advanced routing and switching, network security, emerging technologies, and protocols for efficient and reliable data communication.	
UNIT – I	**NETWORKING CONCEPTS**	**L(9)**
Peer To Peer Vs Client-Server Networks, Network Devices, OSI Model, Packets, Frames and Headers, Collision and Broadcast Domains, LAN Vs WAN, Network Adapter - Hub, Switch, Router, Firewall, IP, Wireless networking, IP addressing, TCP/IP, Internet, Troubleshooting, QoS and QoE.		
UNIT – II	**MOBILE NETWORKS**	**L(9)**
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, Concepts of 5G, channel access, air interface, Cognitive Radio, Spectrum management, C-RAN architecture, Introduction to 6G.		
UNIT – III	**SOFTWARE DEFINED NETWORKS**	**L(9)**
SDN Architecture and Characteristics, SDN- and NFV-Related Standards, SDN Data Plane, Data Plane Functions, OpenFlow Protocol, SDN Control Plane Architecture, ITU-T Model,OpenDaylight, SDN Application Plane Architecture, Network Services Abstraction Layer,Traffic Engineering, Measurement and Monitoring, Data center networking, Information centric networking		
UNIT – IV	**NETWORK FUNCTIONS VIRTUALIZATION**	**L(9)**
Motivation, Virtual Machines, NFV benefits and requirements, Reference architecture, NFV Infrastructure, Virtualized Network Functions, NFV Management and Orchestration, NFV Use Cases, NFV and SDN, Network virtualization – VLAN and VPN, Open Day Light's virtual tenant Network		
UNIT – V	**EMERGING NETWORKS AND SECURITY**	**L(9)**
Cloud Computing – Basic concepts, Cloud services, Deployment models, Architecture. Internet of Things – Scope and Components, Sensors, RFID, NFC, HIP, Architecture and Implementation, Fog and Edge Computing, Block chain in networking, Network Security – Threats and Vulnerabilities, Security polices, Security Requirements in SDN, NFV, IoT, Cloud.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*James Bernstein,* ***"Networking Made Easy: Get Yourself Connected"****, Computers Made Easy, 2018(Unit I)*
2	*Erik Dahlman, Stefan Parkvall, Johan Skold,* ***"4G: LTE/LTE-Advanced for Mobile Broadband"****, Academic Press, 2013 (Unit II)*
3	*Saad Z. Asif,* ***"5G Mobile Communications Concepts and Technologies"****, CRC press – 2019 (Unit II)*
4	*William Stallings,* ***"Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud"****, 1st Edition, Pearson Education, 2016 (Units III, IV, V)*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the components of modern network architectures considering scalability, performance, and various design constraints.	K2
CO2	Apply SDN principles in implementing virtualized network solutions	K3
CO3	Analyze and compare various mobile network architecture and protocols	K4
CO4	Evaluate virtualized network solutions, adapting to dynamic demands and optimizing resource utilization.	K5
CO5	Compare the network architectures of Cloud, Fog, Edge, IoT and analyze their security issues	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	1	3	-	2	-
CO2	1	1	3	-	2	-
CO3	1	1	3	-	2	-
CO4	1	1	3	-	2	-
CO5	1	1	3	-	2	-
23CSPC06	**1**	**1**	**3**	-	**2**	-
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	20	20	20	20	-	100
CAT2	10	30	30	20	10	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	20	20	20	20	20	100
Individual Assessmen t 2 /Case Study 2/ Seminar 2 / Project 2	-	10	30	30	20	10	100
ESE	20	40	40	-	-	-	100

23CSPC07	ADVANCED OPERATING SYSTEM	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	Gain knowledge on fundamentals of distributed systems and get an insight into the various issues and solutions in distributed operating systems, distributed mutual exclusion, deadlock detection and distributed resource management. Learn about real-time operating systems, concepts of mobile and cloud operating systems.	
UNIT – I	**INTRODUCTION**	**L(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**	**L(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**	**L(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 – Nonblocking Commit Protocol.		
UNIT – IV	**REAL TIME OPERATING SYSTEMS**	**L(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**	**L(9)**
Android – Overall Architecture – Linux Kernel – Hardware Support – Native User-Space –Dalvik and Android's Java – System Services – Introduction to Cloud Operating Systems.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

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

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the fundamental concepts in distributed OS.	K1
CO2	Demonstrate the Mutual exclusion, Deadlock detection and agreement protocols of Distributed operating systems.	K2
CO3	Identify the requirements of Distributed File System and Distributed Shared Memory.	K2
CO4	Identify the different features of real time operating systems.	K3
CO5	Discuss the role of operating systems in cloud and mobile environment.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	1	3	-	2	2
CO2	3	2	3	2	3	3
CO3	2	1	3	1	3	3
CO4	2	1	3	1	2	3
CO5	1	2	2	-	1	3
23CSPC07	**2**	**1**	**3**	**1**	**3**	**3**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20	-	-	-	100
CAT2	40	40	20	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	50	30	20	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	50	30	20	-	-	100
ESE	30	30	40	-	-	-	100

23CSPC08	ADVANCED COMPUTER NETWORKS AND ELECTIVES LABORATORY	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	0	0	3	1.5

Course Objectives	The objective of this course is to enable students gain practical, hands-on experience in applying advanced concepts and technologies in computer networks, preparing them for real-world scenarios and challenges in the field.
	EXERCISES
1	Implement basic routing and congestion control algorithms.
2	Implementation Point to Point network using duplex links between the nodes. Analyze the packet transfer by varying the queue size and bandwidth (NS3).
3	Implement the dynamic routing protocol by varying the CBR traffic for each node and use a flow monitor to monitor losses at nodes (NS3).
4	Create a wireless mobile ad-hoc network environment and implement the OLSR routing Protocol (NS3).
5	Choose and install hypervisor such as VirtualBox, VMware, or Hyper-V on your host machine. Create multiple virtual machines using hypervisor interface.
6	Configure different network settings for your virtual machine (NAT, Bridged, Host-Only) and Setup port forwarding to access services running inside the virtual machine.
7	Create topology in Mininet and configure OpenFlow switches with POX controller to communicate between nodes.
8	Install and configure an SDN controller (OpenDaylight or ONOS).
9	Network Packet Analysis- Select a TCP packet and follow the TCP stream to see the entire conversation between two hosts (Wireshark).
10	DNS analysis - Capture DNS traffic and analyze the DNS queries and responses (Wireshark).

Contact Periods:

Lecture: 0 Periods	Tutorial: 0 Periods	Practical: : 45 Periods	Total: 45 Periods

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		Bloom's Taxonomy Mapped
CO1	Analyze and optimize routing protocol parameters for enhanced network performance.	K4
CO2	Design and simulate voice and data traffic within mobile network	K5
CO3	Understand the concept of virtual routing and forwarding for network isolation	K2
CO4	Test and observe the impact of SDN on network behavior	K3
CO5	Capture and analyze real-time data on a network	K4

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	-	3	-
CO2	2	1	3	-	3	-
CO3	2	1	3	-	3	-
CO4	2	1	3	-	3	-
CO5	2	1	3	-	3	-
23CSPC08	**2**	**1**	**3**	**-**	**3**	**-**

1– Slight,2 –Moderate, 3–Substantial

23CSEE01	MINI PROJECT	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	0	0	4	2

Course Objectives	To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature and develop the methodology to solve the identified problem, prepare project reports.

Contact Periods:
Lecture: 0 Periods **Tutorial: 0 Periods** **Practical: 60 Periods** **Total: 60 Periods**

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature to get clear idea about the project work.	K2
CO2	Develop the methodology to solve the identified problem.	K3
CO3	Confidence to work on projects independently.	K2
CO4	Improve presentation and communication skills.	K3
CO5	Identify one's need for further knowledge and continuously develop one's own competencies, write clear, concise and accurate technical document for publication.	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	2	3	3	3
CO2	2	2	2	3	3	3
CO3	2	2	2	2	2	2
CO4	1	1	2	1	1	3
CO5	1	3	1	2	3	3
23CSEE01	**2**	**3**	**2**	**2**	**3**	**3**
1 – Slight, 2 – Moderate, 3 – Substantial						

23CSPC09	DATA SCIENCE	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	This course introduces he techniques and processes of data science, Descriptive data analytics Visualize data for various applications, Understand inferential data analytics, Analysis and build predictive models from data	
UNIT – I	**INTRODUCTION TO DATA SCIENCE**	**L(8)**
Need for data science – benefits and uses – facets of data – data science process – setting the research goal – retrieving data – cleansing, integrating, and transforming data – exploratory data analysis – build the models – presenting and building applications.		
UNIT – II	**DESCRIPTIVE ANALYTICS**	**L(10)**
Frequency distributions – Outliers –interpreting distributions – graphs – averages - describing variability – interquartile range – variability for qualitative and ranked data - Normal distributions – z scores –correlation – scatter plots – regression – regression line – least squares regression line – standard error of estimate – interpretation of r2 – multiple regression equations – regression toward the mean		
UNIT – III	**INFERENTIAL STATISTICS**	**L(9)**
Populations – samples – random sampling – Sampling distribution- standard error of the mean - Hypothesis testing – z-test – z-test procedure –decision rule – calculations – decisions – interpretations - one-tailed and two-tailed tests – Estimation – point estimate – confidence interval – level of confidence – effect of sample size.		
UNIT – IV	**ANALYSIS OF VARIANCE**	**L(9)**
t-test for one sample – sampling distribution of t – t-test procedure – t-test for two independent samples – p-value – statistical significance – t-test for two related samples. F-test – ANOVA – Two-factor experiments – three f-tests – two-factor ANOVA – Introduction to chi-square tests		
UNIT – V	**PREDICTIVE ANALYTICS**	**L(9)**
Linear least squares – implementation – goodness of fit – testing a linear model – weighted resampling. Regression using StatsModels – multiple regression – nonlinear relationships – logistic regression – estimating parameters – Time series analysis – moving averages – missing values – serial correlation – autocorrelation. Introduction to survival analysis		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Robert S. Witte and John S. Witte,* ***"Statistics",*** *Eleventh Edition, Wiley Publications, 2017.*
2	*David Cielen, Arno D. B. Meysman, and Mohamed Ali,* ***"Introducing Data Science",*** *Manning Publications, 2016*
3	*Sanjeev J. Wagh, Manisha S. Bhende, Anuradha D. Thakare,* ***"Fundamentals of Data Science",*** *CRC Press, 2022*
4	*Chirag Shah,* ***"A Hands-On Introduction to Data Science",*** *Cambridge University Press, 2020.*
5	*Vineet Raina, Srinath Krishnamurthy,* ***"Building an Effective Data Science Practice: A Framework to Bootstrap and Manage a Successful Data Science Practice",*** *Apress, 2021.*
6	*Tony Ojeda, Sean Patrick Murphy, Benjamin Bengfort, Abhijit Dasgupta,* ***"Practical Data Science Cookbook",*** *Packt Publishing Ltd., 2014*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the process of data science	K2
CO2	Describe and visualize data	K1
CO3	Perform statistical inferences from data	K3
CO4	Analyze the variance in the data	K3
CO5	Build models for predictive analytics	K4

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	-	2	-	-
CO2	3	1	2	3	1	-
CO3	3	-	2	3	2	-
CO4	2	1	2	3	3	1
CO5	3	3	3	3	3	3
23CSPC09	**3**	**1**	**2**	**3**	**3**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	50	30	20	-	-	-	100
CAT2	20	30	30	20	-	-	100
Individual Assessment 1 /Case Study 1 / Seminar 1 / Project 1	-	-	-	40	40	20	100
Individual Assessment 2 / Case Study 2/ Seminar 2/ Project 2	-	-	-	40	40	20	100
ESE	40	30	30	-	-	-	100

23CSEE02	PROJECT PHASE 1	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	0	0	12	6

Course Objectives	To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature and develop the methodology to solve the identified problem, prepare project reports.

Contact Periods:
Lecture: 0 Periods **Tutorial: 0 Periods** **Practical: 180 Periods** **Total: 180 Periods**

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature to get clear idea about the project work.	K4
CO2	Develop clear outline and methodology to solve the identified problem.	K4
CO3	Confidence to work on projects independently.	K2
CO4	Improve presentation and communication skills.	K3
CO5	Identify one's need for further knowledge and continuously develop one's own competencies, write clear, concise and accurate technical document for publication.	K3

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	2	2	2	3
CO2	3	-	2	3	3	3
CO3	2	-	3	2	2	3
CO4	1	1	2	1	1	3
CO5	1	3	1	2	3	3
23CSEE02	**3**	**2**	**2**	**3**	**3**	**3**

1 – Slight, 2 – Moderate, 3 – Substantial

23CSEE03	PROJECT PHASE II	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	0	0	24	12

Course Objectives	To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature and develop the methodology to solve the identified problem, prepare project reports.
Contact Periods: **Lecture: 0 Periods Tutorial: 0 Periods Practical: 360 Periods Total: 360 Periods**	

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature to get clear idea about the project work.	K4
CO2	Develop a clear outline and methodology to solve the identified problem.	K4
CO3	Confidence to work on projects independently.	K2
CO4	Improve presentation and communication skills.	K5
CO5	Identify one's need for further knowledge and continuously develop one's own competencies, write clear, concise and accurate technical document for publication and publish the findings in the peer reviewed National/International journals	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	2	2	2	3
CO2	3	-	2	3	3	3
CO3	2	-	3	2	2	3
CO4	1	1	2	1	1	3
CO5	1	3	1	2	3	3
23CSEE03	**3**	**2**	**2**	**3**	**3**	**3**
1 – Slight, 2 – Moderate, 3 – Substantial						

23CSPE01	DIGITAL IMAGE PROCESSING	SEMESTER I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	1. Understand the basic concepts of image processing like pixel relations, transforms and Enhancement techniques, restoration and compression techniques, Segmentation methods, and Recognition. 2. Apply image processing concepts in real time applications	
UNIT – I	**FUNDAMENTALS**	**L(9)**
Digital Image Processing – Fundamental steps, Components – Elements of Visual Perception – Image Sensing and Acquisition– Sampling and Quantization – Relationship between Pixels – Color Image Fundamentals		
UNIT – II	**IMAGE TRANSFORMS AND ENHANCEMENT**	**L(9)**
Image Transforms and its properties: Unitary transform, Discrete Fourier Transform, Discrete Cosine Transform, Hadamard-Walsh transform, Haar Transform, Hoteling Transform – Image Enhancement in spatial Domain: Gray level transformations, Histogram processing, Spatial Filtering - Image Enhancement in spatial Domain: Sharpening and smoothing filters, Homomorphic filtering		
UNIT – III	**IMAGE RESTORATION AND COMPRESSION**	**L(9)**
Image Restoration: Degradation model – Noise models – Estimating Degradation - Algebraic approach to restoration – Inverse Filtering – Wiener Filtering – Blind deconvolution –Image reconstruction from projections. Image Compression: redundancy and compression models - Loss less compression: variable-length, Huffman, Arithmetic coding, bit-plane coding, Lossless predictive coding. Lossy compression: Transform based coding (DCT), JPEG standard		
UNIT – IV	**IMAGE SEGMENTATION, UNDERSTANDING AND RECOGNITION**	**L(9)**
Image Segmentation: Line, Edge Detection – Edge Linking and Boundary detection – Region based segmentation – Boundary representation – Region Descriptors. Image understanding and recognition: Pattern classes - Matching by templates, classifiers-statistical and neural network based model		
UNIT – V	**APPLICATIONS**	**L(9)**
Applications: Automatic fruit grading system in Precision agriculture – Automatic visual system – forensic and security system – Medical Investigation – Entertainment: Multimedia		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES

1	*Rafael C. Gonzalez and Richard E. Woods,* ***"Digital Image Processing",*** *Fourth Edition, Pearson Education, 2018*
2	*Anil K. Jain,* ***"Fundamental of Digital Image Processing",*** *Prentice Hall, 2015*
3	*Annadurai S, Shanmugalakshmi R,* ***"Fundamentals of Digital Image Processing",*** *Pearson Education Pvt. Ltd., 2007*
4	*S. Jayaraman, S.Esakkirajan, T.Veerakumar,* ***"Digital Image Processing",*** *Second Edition, Tata McGraw Hill Education Pvt. Ltd., 2020.*
5	*S. Sridhar,* ***"Digital Image Processing"****, Second Edition, OXFORD University press, 2016*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Describe the image processing steps and relationship between the pixels.	K2
CO2	Apply the image transforms and enhancement techniques on images.	K3
CO3	Analyze the different kinds of restoration and compression techniques of image processing.	K4
CO4	Perform edge detection and segmentation and Recognize image using matching by templates, statistical and neuralnetwork models.	K5
CO5	Apply suitable image processing techniques for various real time applications like medical and network security applications	K3

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	3	-	1	1
CO2	3	-	3	-	2	2
CO3	3	-	3	-	2	2
CO4	3	-	3	-	3	3
CO5	3	-	3	-	3	3
23CSPE01	**3**	**-**	**3**	**-**	**2**	**2**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Rememberin g (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	30	20	20	-	-	100
CAT2	20	30	20	30	-	-	100
Individual Assessment 1/Case Study 1/Seminar 1/Project 1	-	30	20	20	30	-	100
Individual Assessment 2/Case Study 2/Seminar 2/Project 2	-	30	20	-	20	30	100
ESE	10	30	20	20	10	10	100

23CSPE02	EMBEDDED SYSTEMS	SEMESTER I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	After the completion of the course, the students will be able to understand embedded concepts and embedded system architecture with programming of ARM Cortex Microcontroller. Selection of a proper Microcontroller for an application. The usage of the development and debugging tools. Memory systems and Peripherals.	
UNIT – I	**INTRODUCTION TO EMBEDDED CONCEPTS**	**L(9)**
Introduction to embedded systems, Application Areas, Categories of embedded systems, Overview of embedded system architecture, Specialties of embedded systems, recent trends in embedded systems, Architecture of embedded systems, Hardware architecture, Software architecture, Application Software, Communication Software.		
UNIT – II	**OVERVIEW OF ARM AND CORTEX-M3**	**L(9)**
Background of ARM Architecture, Architecture Versions, Processor Naming, Instruction Set Development, Thumb-2 and Instruction Set Architecture. Cortex-M3 Basics: Registers, General Purpose Registers, Stack Pointer, Link Register, Program Counter, Special Registers, Operation Mode, Exceptions and Interrupts, Vector Tables, Stack Memory Operations, Reset Sequence. CortexM3Instruction Sets: Assembly Basics, Instruction List, Instruction Descriptions.Cortex-M3 Implementation Overview: Pipeline, Block Diagram, Bus. Interfaces on Cortex-M3, I-Code Bus, D Code Bus, System Bus, External PPB and DAP Bus		
UNIT – III	**CORTEX EXCEPTION HANDLING AND INTERRUPTS**	**L(9)**
Exceptions: Exception Types, Priority, Vector Tables, Interrupt Inputs and Pending Behavior, Fault Exceptions, Supervisor Call and Pendable Service Call. NVIC: Nested Vectored Interrupt Controller Overview, Basic Interrupt Configuration, Software Interrupts and SYSTICK Timer. Interrupt Behavior: Interrupt/Exception Sequences, Exception Exits, Nested Interrupts, Tail-Chaining Interrupts, Late Arrivals and Interrupt Latency		
UNIT – IV	**CORTEX-M3/M4 PROGRAMMING**	**L(9)**
Cortex-M3/M4 Programming: Overview, Typical Development Flow, Using C, CMSIS (Cortex Microcontroller Software Interface Standard), Using Assembly. Exception Programming: Using Interrupts, Exception/Interrupt Handlers, Software Interrupts, Vector Table Relocation. Memory Protection Unit and other Cortex-M3 features: MPU Registers, Setting Up the MPU, Power Management, Multiprocessor Communication.		
UNIT – V	**CORTEX-M3/M4 DEVELOPMENT AND DEBUGGING TOOLS**	**L(9)**
STM32L15xxx ARM Cortex M3/M4 Microcontroller: Memory and Bus Architecture, Power Control, Reset and Clock Control. STM32L15xxx Peripherals: GPIOs, System Configuration Controller, NVIC, ADC, Comparators, GP Timers, USART. Development and Debugging Tools: Software and Hardware tools like Cross Assembler, Compiler, Debugger, Simulator, In-Circuit Emulator (ICE), Logic Analyzer etc.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES :

1	*Joseph Yiu,* ***" The Definitive Guide to the ARM Cortex-M3"****, Second Edition, Elsevier Inc. 2010.*
2	*Andrew N Sloss, Dominic Symes, Chris Wright,* ***"ARM System Developer'sGuide Designing and Optimizing System Software"****, Elsevier Publications,2006*
3	*Steve Furber,* ***"ARM System-on-Chip Architecture"****, 2nd Edition, Pearson Education, India ISBN: 9788131708408, 8131708403 , 2015*
4	***STM32L152xx ARM Cortex M3 Microcontroller*** *Reference Manual 5/97*
5	*ARM Company Ltd.* ***"ARM Architecture Reference Manual– ARM DDI 0100E"***

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the Embedded Concepts and Architecture of Embedded Systems.	K2
CO2	Describe the architectural features and instructions of ARM Cortex M3 Microcontroller.	K2
CO3	Use Interrupts, Exception/Interrupt Handlers, Software Interrupts, Vector Table Relocation.	K2
CO4	Use ARM Cortex M3/M4 with Embedded C Programming for Application Development.	K5
CO5	Design and implement software systems to provide an interface to ARM Cortex M3 based hardware systems.	K6

COURSE ARTICULATION MATRIX :

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	3	2	2	3
CO2	2	-	3	2	2	3
CO3	2	-	3	2	2	3
CO4	3	-	3	3	2	3
CO5	3	-	3	3	2	3
23CSPE02	**2**	**-**	**3**	**2**	**2**	**3**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	50	30	10	10	-	-	100
CAT2	40	25	20	10	-	5	100
Individual Assessment 1/Case Study 1/Seminar 1/Project 1	50	30	10	10	-	-	100
Individual Assessment 2/Case Study 2/Seminar 2/Project 2	5	5	20	20	15	35	100
ESE	50	25	15	10	-	-	100

23CSPE03	FUZZY LOGIC AND NEURAL NETWORKS	SEMESTER I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	1. Explain the basics of Fuzzy set, Fuzzy relations, and methods for Fuzzification and Fuzzy Logic Systems. 2. Understand the architecture and learning rules of simple neural networks, BPN, BAM and competitive resonance neural networks	
UNIT – I	**FUNDAMENTALS OF FUZZY LOGIC**	**L(9)**
Classical And Fuzzy Sets: Operations and Properties – Classical Relations and Fuzzy Relations: Properties and Operations, Composition, Tolerance and Equivalence Relations – Membership Functions: Features and Standard Forms – Fuzzification– Λ Cuts For Fuzzy Sets and Relations - Defuzzification		
UNIT – II	**FUZZY LOGIC SYSTEMS AND APPLICATIONS**	**L(9)**
Logic and Fuzzy Systems – Membership Value Assignments – Automated Methods for Fuzzy Systems: Least Squares Algorithm, Gradient and Clustering Method – Decision Making with Fuzzy Information – Applications: Fuzzy Classification, Fuzzy Pattern Recognition – Fuzzy Control Systems: Design Problems, Examples, Industrial Applications– Fuzzy Information Retrieval		
UNIT – III	**ARCHITECTURE OF NEURAL NETWORKS**	**L(9)**
Artificial Neural Networks - Biological Neural Networks - Typical Architecture - Setting Weights - Common Activations Functions- Basic Learning Rules - Mcculloch-Pitts Neuron - Simple Neural Nets For Pattern Classification: Architecture, Biases and Thresholds, Linear Separability, Hebb Net-Perceptron-Adaline.		
UNIT – IV	**BASIC NEURAL NETWORK TECHNIQUES**	**L(9)**
Back Propagation Neural Net: Standard Back Propagation – Architecture, Algorithm- Training Algorithm for Pattern Association-Hebb Rule and Delta Rule - Associative and other Neural Networks: Hetro Associative Memory Neural Net, Auto Associative Net- Bidirectional Associative Memory-Applications-Hopfield Nets-Boltzman Machine		
UNIT – V	**COMPETITIVE NEURAL NETWORKS**	**L(9)**
Neural Network Based on Competition: Fixed Weight Competitive Nets- KohonenselfOrganizing Maps and Applications-Learning Vector Quantization-Counter Propagation Nets and Applications - Adaptive Resonance Theory: Basic Architecture and Operation-Architecture, Algorithm, Application and Analysis of ART1 & ART2 - Cognitron and Neocognitron - Architecture, Training Algorithm and application		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES

1	*LaureneFausett,* ***"Fundamentals of Neural Networks",*** *Pearson Education India, 2008.*
2	*Timothy J.Ross,* ***"Fuzzy Logic with Engineering Applications",*** *John Wiley and sons Pvt.Ltd, Fourth Edition, 2016*
3	*J.A.Freeman and B.M.Skapura,* ***"Neural Networks, Algorithms applications and Programming Techniques",*** *Pearson, 2002*
4	*Zimmermann.H.J,* ***"Fuzzy Set Theory and its Applications"****, Kluwer Academic Publishers, Dordrecht, Germany, Fourth Edition,2013.*
5	*Zurada J.M.* ***"Introduction to Artificial Neural Systems",*** *Jaico Publishing House,1994*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Perform simple arithmetic, logical and geometric operations on classical and fuzzy sets.	K3
CO2	Apply Fuzzy Logic techniques for real time applications.	K3
CO3	Apply activation functions suitable for different neural networks and Solve linearly separable problems	K3
CO4	Choose and apply the suitable BPN algorithm for pattern classification, character recognization	K4
CO5	Describe the features, operations and applications of Competitive Networks and Adaptive resonance neural networks, and Neocognitron.	K2

COURSE ARTICULATION MATRIX :

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	3	2	2	2
CO2	3	1	3	3	2	2
CO3	2	1	3	2	2	2
CO4	3	1	3	3	2	2
CO5	2	1	3	2	1	2
23CSPE03	**2**	**1**	**3**	**2**	**2**	**2**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	30	20	20	-	-	100
CAT2	20	30	20	30	-	-	100
Individual Assessment 1/Case Study 1/Seminar 1/Project 1	-	30	20	20	30	-	100
Individual Assessment 2/Case Study 2/Seminar 2/Project 2	-	30	20	-	20	30	100
ESE	10	20	30	20	10	10	100

23CSPE04	CLOUD COMPUTING	SEMESTER I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	1. The objective of the course is to enable students to understand the basic underlying concepts, Characteristics, issues and challenges of cloud computing, architecture and virtualization. 2. Students will be familiar with Cloud application program and the ANEKA latform, security issues of cloud computing.

UNIT – I	INTRODUCTION TO CLOUD COMPUTING	L(9)

Overview of Computing Paradigm: Recent trends in Computing - Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing - Introduction to Cloud Computing - Cloud issues and challenges- Cloud Computing (NIST Model) - History of Cloud Computing, - Cloud service providers Properties, Characteristics & Disadvantages - Pros and Cons of Cloud Computing, Benefits of Cloud Computing - Role of Open Standards .

UNIT – II	CLOUD COMPUTING ARCHITECTURE AND VIRTUALIZATION	L(9)

Cloud computing stack - Comparison with traditional computing architecture (client/server), Services provided at various levels - Role of Networks in Cloud computing, protocols used, Role of Web services- Service Models (XaaS)- Infrastructure as a Service(IaaS) -Platform as a Service(PaaS) - Cloud Platform and Management – Software as a Service(SaaS)- Web services - Web 2.0 - Deployment Models -Public cloud -Private cloud -Hybrid cloud -Community cloud - Virtualization concepts - Introduction to virtualization - Types of Virtualization- Introduction to Various Hypervisors - High Availability (HA)/Disaster Recovery (DR) using Virtualization, Moving VMs

UNIT – III	CLOUD APPLICATION PROGRAMMING AND THE ANEKA PLATFORM	L(9)

Aneka - Framework overview - anatomy of the Aneka container - Building Aneka clouds - Cloud programming and management - Programming applications with threads - Multithreading with Aneka - Programming applications with Aneka threads - Task computing - Task-based application models - Aneka task-based programming - Data-Intensive Computing - Aneka MapReduce programming.

UNIT – IV	CLOUD SECURITY	L(9)

Infrastructure Security - Network level security, Host level security, Application level security - Data security and Storage - Data privacy and security Issues, Jurisdictional issues raised by Data location - Identity & Access Management -Access Control -Trust, Reputation, Risk , Authentication in cloud computing, Client access in cloud, Cloud contracting Model, Commercial and business considerations.- Cloud Reliability and fault-tolerance -privacy - policy and compliance -Cloud federation, interoperability and standards.

UNIT – V	CLOUD APPLICATIONS AND CASE STUDY	L(9)

Scientific applications : Healthcare – Biology – Geoscience - Business and consumer applications: CRM and ERP – Productivity - Social networking - Media applications - Multiplayer online gaming - Case Study on Open Source & Commercial Clouds – Eucalyptus - Microsoft Azure - Amazon EC2 - Google AppEngine.

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

REFERENCES

1	*Sosinsky, Barrie.* ***"Cloud computing bible"****, Vol. 762. John Wiley & Sons, 2010.*
2	*Kai Hwang, Geoffrey C. Fox, Jack, J. Dongarra* ***"Distributed and Cloud Computing from Parallel Processing to the Internet of Things",*** *Elsevier 2012.*
3	*RajkumarBuyya, Christian Vecchiola, S. ThamaraiSelvi* ***"Mastering Cloud Computing Foundations and Applications Programming",*** *2013.*
4	*RajkumarBuyya, James Broberg, Andrzej M. Goscinski,* ***"Cloud Computing: Principles and Paradigms",*** *Wiley,2011*
5	*Nikos Antonopoulos, Lee Gillam ,* ***"Cloud Computing: Principles, Systems and Applications"*** *Springer, 2012.*
6	*Ronald L. Krutz, Russell Dean Vines****, "Cloud Security: A Comprehensive Guide to Secure Cloud Computing",*** *Wiley-India, 2010.*
7	*John Ritting house & James Ransome,* ***"Cloud Computing, Implementation, Management and Strategy",*** *CRC Press, 2016.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Explain and discuss basic concepts, fundamental issues and challenges of Cloud Computing and paradigms of computing.	K1
CO2	Explain the basic architecture of cloud computing and virtualization techniques.	K2
CO3	Design and implement basic cloud application using Aneka framework.	K3
CO4	Explain the core issues of cloud computing such as security, privacy, and interoperability.	K4
CO5	Provide cloud computing solutions and recommendations and for applications.	K5

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	-	-	-	-
CO2	3	2	-	-	-	-
CO3	3	3	2	-	3	2
CO4	3	2	2	2	-	-
CO5	3	3	2	2	3	-
23CSPE04	**3**	**2**	**2**	**2**	**3**	**2**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20	-	-	-	100
CAT2	-	30	30	20	20	-	100
Individual Assessment 1/Case Study 1/Seminar 1/Project 1	40	40	20	-	-	-	100
Individual Assessment 2/Case Study 2/Seminar 2/Project 2	-	30	30	20	20	-	100
ESE	40	20	10	10	10	10	100

23CSPE05	ADVANCED SOFTWARE ENGINEERING	SEMESTER I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	The objective of the course is to familiarize students with software Design and estimation techniques, software quality, testing and maintenance strategies along with scrum development process	
UNIT – I	**INTRODUCTION AND REQUIREMENTS MODELING**	**L(9)**
Software Engineering- Process models-Agile development- Software engineering Knowledge-core Principles-Principles that guide each framework Activity - Requirements Engineering- Developing use cases-Building the requirements model-Negotiating, validating Requirements-Requirements Analysis-Requirements Modeling.		
UNIT – II	**SOFTWARE DESIGN AND ESTIMATION**	**L(9)**
Design Process - Design Concepts – Design Model - Architectural Design - Component level design –User interface design - pattern based design – Web App design – Case Study Software Project Estimation – Process and Project Metrics- Empirical Estimation model – Specialized Estimation Technique for Agile Development - Project Scheduling - Risk Management		
UNIT – III	**SOFTWARE QUALITY AND TESTING**	**L(9)**
Software Quality- Software - Quality Dilemma- Achieving Software Quality- Testing: Strategic Approach to software Testing- Strategic IssuesTesting: Strategies for Conventional Software, Object oriented software, Web Apps-Validating Testing- System Testing- Art of Debugging. -		
UNIT – IV	**SOFTWARE MAINTENANCE AND IMPROVEMENT**	**L(9)**
Software Maintenance-Software Supportability- Reengineering- Business Process Reengineering-Software Reengineering- Reverse Engineering-Restructuring- Forward Engineering.Software Process improvement: Process – CMMI – The people CMM – SPI return on investment – SPI Trends.		
UNIT – V	**INTRODUCTION TO SCRUM DEVELOPMENT PROCESS**	**L(9)**
Basics of Scrum – Running a Scum project – Steps for transition to scrum – Metrics for scrum –CaseStudy.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES

1	*Roger Pressman.S **"Software Engineering: A Practitioner's Approach"** Eighth Edition, McGraw Hill, 2014*
2	*Ian Sommerville **"Software Engineering"** Tenth Edition, Pearson Education Asia, 2017.*
3	*Shari Lawrence Pfleeger, Joanne M. Atlee, **"Software Engineering: Theory and Practice",** Fourth Edition, Pearson Education, 2011.*
4	*Alistair Cockburn, **"Agile Software Development",** First Edition, Pearson Education, 2002.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Apply different process models for different projects and Perform requirement gathering and model the requirements.	K3
CO2	Design the project and identify risks, construct RMMM plan and develop estimation models.	K4
CO3	Verify and validate the software applications using different types of testing and maintain the quality of software.	K4
CO4	Perform reverse and forward engineering process for maintenance and improvement required in the project	K5
CO5	Apply Scrum Development Process to develop software.	*K6*

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	1	2	3
CO2	3	3	3	1	2	3
CO3	3	3	3	1	2	3
CO4	3	3	3	1	2	3
CO5	3	3	3	1	2	3
23CSPE05	**3**	**3**	**3**	**1**	**2**	**3**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	30	40	-	-	-	100
CAT2	-	20	30	30	-	20	100
Individual Assessment 1/Case Study 1/Seminar 1/Project 1	-	-	50	50	-	-	100
Individual Assessment 2/Case Study 2/Seminar 2/Project 2	-	-	50	50	-	-	100
ESE	20	20	20	20	-	20	100

23CSPE06	PATTERN RECOGNITION	SEMESTER I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	Explain and compare a variety of pattern classification, structural pattern recognition and pattern classifier combination techniques	
UNIT – I	**INTRODUCTION TO PATTERN RECOGNITION**	**L(9)**
Introduction to Pattern Recognition- Data structures for pattern recognition –Review of Random Vectors, Expectation, Correlation, Covariance - Review of Linear Algebra- Linear Transformations -Feature Extraction– Training and Learning– Discriminant Functions.		
UNIT – II	**LINEAR CLASSIFIERS**	**L(9)**
Bayes Decision Theory - The Gaussian Probability Density Function - Minimum Distance classifiers – Mixture Models - Perceptron Algorithm – The Sum of Error Squares Classifier - Support Vector Machines: K-Nearest-Neighbor Classification		
UNIT – III	**UNSUPERVISED LEARNING AND CLUSTERING**	**L(9)**
Terminologies–Maximum likelihood estimation –Applications - Clustering - Sequential algorithms –Data descriptions - Criterion functions -Spectral Clustering - Hierarchical Clustering		
UNIT – IV	**SYNTACTICAL PATTERN RECOGNITION**	**L(9)**
Elements of formal grammars – String generation as pattern description – Case Studies - Recognition of syntactic description – Parsing – Stochastic grammars and applications – Graph based structural representation		
UNIT – V	**FEATURE SELECTION TECHNIQUES**	**L(9)**
Outlier Removal – Normalization – ROC Curve - Fishers Discriminant Ratio - Class Separability - Feature Subset Selection - Unsupervised learning in neural Pattern Recognition – Self-organizing networks		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45Periods**		

REFERENCES

1	*M. Narasimha Murthy and V. Susheela Devi,* ***"Pattern Recognition. An Algorithmic approach",*** *Springer, 2011.*
2	*Robert J.Schalkoff,* ***"Pattern Recognition Statistical, Structural and Neural Approaches",*** *Wiley, India, 2009.*
3	*SergiosTheodoridis, Konstantinos Koutroumbas,* ***"Introduction to Pattern Recognition: A Matlab Approach",*** *Elsevier Academic Press, 2010.*
4	*Andrew R. Webb, Keith D. Copsey,* ***"Statistical Pattern Recognition"****, Third Edition, Wiley, 2011.*
5	*Duda R.O., HarP.E.,and David G Stork,* ***"Pattern Classification",*** *Second edition, John Wiley & Sons, NewYork, 2012*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Describe the significance of pattern recognition	K2
CO2	Analyze the given patterns and apply suitable pattern classifiers for pattern classification	K4
CO3	Apply appropriate clustering techniques for high dimensional datasets.	K3
CO4	Summarize various syntactical pattern recognition models.	K4
CO5	Identify appropriate feature selection techniques.	K4

COURSE ARTICULATION MATRIX

COs/POs	**PO 1**	**PO2**	**PO 3**	**PO 4**	**PO5**	**PO6**
CO1	1	2	3	1	2	2
CO2	1	2	3	1	2	2
CO3	1	2	3	1	2	2
CO4	1	2	3	1	2	2
CO5	1	2	3	1	2	2
23CSPE06	**1**	**2**	**3**	**1**	**2**	**2**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	-	20	40	40	-	-	100
CAT2	-	20	40	40	-	-	100
Individual Assessment 1/Case Study 1/Seminar 1/Project 1	-	-	-	100	-	-	100
Individual Assessment 2/Case Study 2/Seminar 2/Project 2	-	-	-	100	-	-	100
ESE	-	30	40	30	-	-	100

23CSPE07	COMPUTER VISION ENGINEERING	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To enable correct identification of an object and take appropriate actions towards solving problems by making apt sense of images.	
UNIT – I	**IMAGE FORMATION AND PROCESSING**	**L(9)**
Geometric primitives and transformations, Photometric image formation, The digital camera, Point operators, Linear filtering, More neighborhood operators, Fourier transforms, Pyramids and wavelets, Geometric transformations, Global optimization		
UNIT – II	**SEGMENTATION**	**L(9)**
Feature detection and matching - Points and patches, Edges, Lines. Segmentation- Active contours, Split and merge, Mean shift and mode finding, Normalized cuts, Graph cuts and energy-based methods. Feature-based alignment-2D and 3D feature-based alignment, Pose estimation, Geometric intrinsic calibration.		
UNIT – III	**MOTION ESTIMATION**	**L(9)**
Structure from motion- Triangulation, Two-frame structure from motion, Factorization, Bundle adjustment, Constrained structure and motion. Dense motion estimation- Translational alignment, Parametric motion, Spline-based motion, Optical flow, Layered motion. Image stitching - Motion models.		
UNIT – IV	**COMPUTATIONAL PHOTOGRAPHY**	**L(9)**
Photometric calibration, High dynamic range imaging, Super-resolution and blur removal, Image matting and compositing, Texture analysis and synthesis. Stereo correspondence - Epipolar geometry, Sparse correspondence, Dense correspondence, Local methods, Global optimization, Multi-view stereo.		
UNIT – V	**IMAGE-BASED RENDERING**	**L(9)**
View interpolation, Layered depth images, Light fields and Lumigraphs, Environment mattes, Video-based rendering. Recognition - Object detection, Face recognition, Instance recognition, Category recognition, Context and scene understanding, Recognition databases and test sets		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES :

1	*Richard Szeliski,* ***"Computer Vision: Algorithms and Applications",*** *Springer, New York, 2010*
2	*David Forsyth and Jean Ponce****, "Computer Vision: A Modern Approach (Second Edition) ",*** *Prentice Hall, 2011*
3	*Richard Hartley and Andrew Zisserman,* **"Multiple View Geometry in Computer Vision (Second Edition)",** *Cambridge University Press, March 2004*
4	*S. Khan, H. Rahmani, S. Shah and M. Bennamoun,* ***"A Guide to Convolutional Neural Networks for Computer Vision",*** *Morgan & Claypool Publishers, 2018*
5	*E.R.Davies , "Computer Vision: Principles, Algorithms, Applications, Learning,", Elsevier Academic Press, 2017.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Describe image formation and processing techniques.	K2
CO2	Apply feature detection and segmentation algorithms on image datasets	K3
CO3	Analyze various motion estimation techniques	K4
CO4	Interpret computational photographical approaches to transform images.	K2
CO5	Apply image rendering and recognition techniques on real time images	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	2	-	2	2
CO2	2	-	3	-	2	2
CO3	2	-	3	3	2	2
CO4	2	-	3	3	2	3
CO5	2	-	3	3	2	3
23CSPE07	**2**	**-**	**3**	**3**	**2**	**2**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	-	40	40	20	-	-	100
CAT2	-	30	30	40	-	-	100
Individual Assessment 1/ Case study 1/ Seminar 1/ Project 1	-	-	-	100	-	-	100
Individual Assessment 2/ Case study 2/ Seminar 2/ Project 2	-	-	-	100	-	-	100
ESE	40	30	30	-	-	-	100

23CSPE08	INTERNET OF THINGS	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	After the completion of the course, the students will be able to understand the characteristics of IoT and its applications, standardization and Interoperability efforts for IoT, protocols for communication between things and data among IoT devices, design and deploy IoT applications in cloud, Security issues concerning IoT

UNIT – I	FUNDAMENTALS OF IoT	L(9)

Definition and Characteristics – Physical Design of IoT – Things in IoT – Logical Design of IoT- IoT Functional blocks, communication model and enabling technologies. Applications of domain specific IoT systems such as smart environment, smart energy, smart agriculture and smart health, IoT levels. IoT Vs M2M, SDN and NVF for IoT.

UNIT – II	IoT STANDARDIZATION AND INTEROPERABILITY	L(9)

Defining a common architecture, i-Core functional architecture, M2M service level standardizations, OGC sensor web for IoT, Data Interoperability, Semantics Interoperability, Organizational Interoperability and Eternal Interoperability, IoT testing methodologies, Semantics as an interoperability enabler.

UNIT – III	COMMUNICATION PROTOCOLS AND SYSTEM	L(9)

Protocols – HTTP, UPnP, CoAP, MQTT, XMPP. IoT systems logical design using python - python data types & data structures, control flow, functions or modules. Modules & package of python, python packages of interest for IoT-JSON, XML, HTTP & URL Lib, SMTP Lib. Exemplary Device: Raspberry Pi - Linux on Raspberry Pi – Programming Raspberry Pi with Python.

UNIT – IV	IoT CLOUD AND DATA ANALYTICS	L(9)

Introduction to Cloud storage Models – WAMP – Xively Cloud for IoT – Python Web Application Framework-Django – Designing a RESTful based Web API. Data Analytics for IoT – Apache Hadoop, Apache Oozie.

UNIT – V	SECURITY AND FUTURE RESEARCH	L(9)

IoT attacks - Phase attacks, Attacks as per architecture, Attacks based on components. Security Protocols - Time-Based Secure Key Generation and Renewal - Security access algorithms for unidirectional data transmissions, Security access algorithms for bidirectional data transmissions.platforms for Big data in IoT– issues of incorporating cloud in IoT - Fog computing. Case study – Smarter Classrooms.

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

REFERENCES

1	*ArshdeepBahga, Vijay Madisetti,* ***"Internet of Things - A hand on approach",*** *Universities Press (India) Private Limited, 2014*
2	*OvidivVermesan, Peter Friess,* ***"Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems",*** *River publications, 2013.*
3	*Charalamposdoucas,* ***"Building the Internet of Things with Arduino",*** *CreateSpace,2002*
4	*Pethuru Raj, Anupama C. Raman,* ***"The Internet of Things – Enabling Technologies, Platforms and Use cases",*** *CRC Press, Taylor & Francis Group, 2017.*
5	*Fei Hu,* ***"Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations,"*** *CRC Press, 2016.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Interpret the vision of IoT from a global context.	K2
CO2	Analyze the need for standardization and organizational interoperability to resolve heterogeneity Issues.	K4
CO3	Design a portable IoT using any Single Board Computer and relevant protocols	K3
CO4	Design applications of IoT in real time scenario and deploy an IoT application to the cloud.	K3
CO5	Analyze the security principles for IoT and future research	K4

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	3	2	-	2
CO2	3	-	3	2	-	2
CO3	3	-	3	2	-	2
CO4	3	-	3	2	-	2
CO5	3	-	3	2	-	2
23CSPE08	**3**	**-**	**3**	**2**	**-**	**2**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	30	20	20	-	-	100
CAT2	-	30	20	30	10	10	100
Individual Assessment 1 /Case Study 1 / Seminar 1 / Project 1	10	30	20	20	20	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2/ Project 2	-	20	20	20	20	20	100
ESE	20	40	40	-	-	-	100

23CSPE09	NETWORK SCIENCE	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	This course introduces the principles and concepts of network sciencecovering network structure, dynamics, models,analysis of complex systems and networks, applications in various domains such as social science, biology, and technology.	
UNIT – I	**INTRODUCTION**	**L(9)**
Overview of Network Science - Definition and scope, Historical development, Applications in different fields, Characteristics of Network Science, Societal and Scientific impact, Basic Concepts in Graph Theory - Graphs, nodes, and edges, Networks and graphs, Measures of centrality and connectivity, Prestige		
UNIT – II	**NETWORK STRUCTURE AND MODELS**	**L(9)**
Small world networks –Six degrees of separation, Watts-Strogatz model, Scale-Free Networks - Growth and Preferential attachment, Power-law degree distribution, Hubs and their role in network, Random Networks - Erdos-Renyi model, Barabasi-Albert model		
UNIT – III	**NETWORK DYNAMICS**	**L(9)**
Diffusion and Cascading Phenomena - Epidemic modeling and prediction, Information diffusion, Correlations in real networks, Cascading and modeling failures in networks, Percolation Theory - Building robustness, Percolation models, Molly Reed Criteria, Attack and Error Tolerance of Real Networks		
UNIT – IV	**COMMUNITY DETECTION AND CLUSTERING**	**L(9)**
Social Group and Subgroup- Subgroups Based on Complete Mutuality: Clique, Reachability and Diameter: n-cliques, n-clans and n-clubs, Subgroups Based on Nodal Degree: k-plexes, k-cores, Measures of Subgroup Cohesion, Community detection using Subgroups and Betweenness, Fast algorithms		
UNIT – V	**APPLICATIONS**	**L(9)**
Social Network Analysis - Centrality measures in social networks, Structural holes and brokerage, Online social networks, Biological and Technological Networks - Protein-protein interaction networks, Network science in technological systems, Smart cities and infrastructure		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Albert-László Barabási,* ***"Network Science"****, Cambridge University Press, 1st edition, 2016. Online edition available at http://networksciencebook.com/*
2	*Kayhan Erciyes,* ***"Complex Networks – An algorithmic perspective"****, CRC Press, Taylor and Francis Group, 2015*
3	*Wasserman Stanley, and Katherine Faust,* ***"Social Network Analysis: Methods and Applications, Structural Analysis in the Social Sciences"****,Cambridge University Press, 2012*
4	*John Scott,* ***"Social Network Analysis"****, Sage Publications Ltd., Fourth Edition, 2017.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the fundamental principles of network science, including graph theory, connectivity, and centrality measures.	K2
CO2	Apply various network models, such as random graphs, Watts-Strogatz, and Barabási-Albert models, to represent and simulate different types of networks.	K3
CO3	Evaluate dynamic processes on networks, including random walks, diffusion, and percolation, and their implications in real-world scenarios.	K5
CO4	Apply algorithms for community detection and understand the impact of community structure on network dynamics.	K3
CO5	Identify and analyze applications of network science in various domains, including social networks, biological networks, and technological networks.	K4

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	3	-	2	-
CO2	3	1	3	-	2	-
CO3	3	1	3	-	2	-
CO4	3	1	3	-	2	-
CO5	3	1	3	-	2	-
23CSPE09	**3**	**1**	**3**	**-**	**2**	**-**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	20	20	20	20	-	100
CAT2	10	30	30	20	10	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	20	20	20	20	20	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	10	30	30	20	10	100
ESE	20	40	40	-	-	-	100

23CSPE10	MACHINE LEARNING	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	This course explores the various concepts, algorithms and applications of machine leaning	
UNIT – I	**INTRODUCTION**	**L(9)**

Learning – Types of Machine Learning –Design a Learning System – Perspectives and Issues in Machine Learning – Concept Learning Task – Concept Learning as Search – Finding a Maximally Specific Hypothesis – Version Spaces and the Candidate Elimination Algorithm –Introduction to Machine learning tools

Case Study: Familiarity with R tool and Python programming language & libraries for Machine Learning algorithms

UNIT – II	SUPERVISED LEARNING	L(9)

Statistical decision theory: Regression and classification - Linear Separability – Linear Regression and Locally weighted regression – K Nearest Neighbour learning - Perceptron - Multi-layer Perceptron –Back-Propagation - Support Vector Machines – Decision Trees - Classification and Regression Trees – Random Forests - Different ways to Combine Classifiers – Ensemble Learning – Boosting – Bagging – Evaluation Measures – Multiclass classification

Case Study: Implementation of decision tree algorithm for problems in Retail Domain and Back propagation algorithm for problems in financial domain

UNIT – III	DIMENSIONALITY REDUCTION AND UNSUPERVISED LEARNING	L(9)

Dimensionality Reduction: Linear Discriminant Analysis – Principal Component Analysis – Factor Analysis – Independent Component Analysis – Locally Linear Embedding – Isomap – Least Squares Optimization – Unsupervised learning problems- Hierarchical Agglomerative Clustering (HAC)-Single-link, complete-link, group-average similarity- k-Means and Mixtures of Gaussians-Flat clustering, k-Means algorithms-Mixture of Gaussian model.

Case Study: Implementation of clustering algorithm for problems in financial/health care domain

UNIT – IV	GRAPHICAL MODELS	L(9)

Probability and Learning – Data into Probabilities –Bayes Theorem – Concept Learning – Maximum Likelihood – Minimum Description Length Principle – Bayes Optimal Classifier – Gibbs Algorithm – Naïve Bayes Classifier– Bayesian Belief Network – EM-algorithm - Markov Random Fields – Hidden Markov Models – Tracking Methods

Case Study: Naïve Bayes Classifier for problems in insurance domain

UNIT – V	REINFORCEMENT LEARNING	L(9)

Reinforcement Learning – Introduction -Elements of Reinforcement Learning – Learning Task – Q-learning – k-armed Bandit Elements – Model-Based learning – Value Iteration – Policy iteration – Temporal Difference Learning - Exploration Strategies – non-deterministic rewards and actions

Case Study: Implementation of Q learning algorithm/reinforcement learning for problems in automotive domain/games

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

REFERENCES :

1	*Ethem Alpaydin,* ***"Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series)",*** *Fourth Edition, MIT Press, 2020*
2	*Jason Bell,* ***"Machine learning – Hands on for Developers and Technical Professionals",*** *First Edition, Wiley, 2014*
3	*Peter Flach,* ***"Machine Learning: The Art and Science of Algorithms that Make Sense of Data",*** *First Edition, Cambridge University Press, 2012.*
4	*Stephen Marsland,* ***"Machine Learning – An Algorithmic Perspective",*** *Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.*
5	*Tom M Mitchell,* ***"Machine Learning",*** *First Edition, McGraw Hill Education, 2017*
6	*Trevor Hastie, Robert Tibshirani, Jerome Friedman,* ***"The Elements of Statistical Learning"****, Second Edition ,Springer, 2017*
7	*Kevin P. Murphy,* ***"Machine Learning: A Probabilistic Perspective",*** *MIT Press, 2012*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Differentiate between supervised, unsupervised, semi-supervised machine learning approaches	K2
CO2	Apply specific supervised or unsupervised machine learning algorithm for a particular problem	K3
CO3	Analyse and suggest the appropriate machine learning approach for the various types of problem	K4
CO4	Design and make modifications to existing machine learning algorithms to suit an individual application	K5
CO5	Provide useful case studies on the machine learning algorithms	K6

Course Articulation Matrix

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	-	2	-	-
CO2	3	1	2	3	1	-
CO3	3	-	2	3	2	-
CO4	2	1	2	3	3	1
CO5	3	3	3	3	3	3
23CSPE10	**3**	**1**	**2**	**3**	**3**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	50	30	20		-	-	100
CAT2	20	30	30	20	-	-	100
Individual Assessment 1 /Case Study 1 / Seminar 1 / Project 1	-	-	-	40	40	20	100
Individual Assessment 2 / Case Study 2/ Seminar 2/ Project 2	-	-	-	40	40	20	100
ESE	40	30	30	-	-	-	100

23CSPE11	MULTIDIMENSIONAL DATA STRUCTURES	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	This course explores the design and implementation of spatial data structures, indexing techniques, and algorithms for optimizing multidimensional queriestailored for efficient storage and retrieval of multidimensional data.	
UNIT – I	**DATA STRUCTURES – I**	**L(9)**
Overview of Multidimensional Data, Range Trees, Priority Search Trees, Quadtrees - Point Quadtrees, Trie-based Quadtree, Comparison of Point and Trie-based Quadtrees, K-d Trees - Point K-d Trees, Trie-based K-d Trees, Conjugation Tree, One-dimensional Orderings		
UNIT – II	**DATA STRUCTURES – II**	**L(9)**
Bucket Methods - Tree Directory Methods:K-d-B-tree, Hybrid Tree, LSD Tree, hB-tree, K-d-B-trie, BV-tree, Grid Directory Methods: Grid File, EXCELL, Linear Hashing, Spiral Hashing, Storage Utilization, PK-trees, Comparison with bucket methods		
UNIT – III	**IMAGE REPRESENTATIONS**	**L(9)**
Hierarchical Interior-based Representations - Pyramid, R-tree, Hilbert R-tree, R*-tree, R+-tree, Packed R-tree, R-tree, Cell Tree, Bulk Loading, Image-based Boundary Representations - PM Quadtree and Octree, Adaptively Sampled Distance Field, Object-based Boundary Representation -LOD, Strip Tree, Simplification Methods, Surface-based Boundary Representations - TIN		
UNIT – IV	**INTERVALS AND SMALL RECTANGLES**	**L(9)**
Plane-sweep Methods and the Rectangle Intersection Problem - Segment Tree, Interval Tree, Priority Search Tree, Point-based methods, Area based methods – MX-CIF Quadtree, HV/ VH tree, High-Dimensional Data - Best-first Incremental Nearest Neighbor Finding, Depth-first K-nearest Neighbor Algorithm		
UNIT – V	**INDEXING METHODS**	**L(9)**
Multi-dimensional indexing methods – X-tree, bounding sphere methods, Increasing the Fanout, Pyramid Technique, Sequential Scan Methods, Distance-based Indexing Methods - Ball Partitioning Methods, Generalized Hyperplane Partitioning Methods, M-tree, Sa-tree, kNN graph, Searching in the dimension-reduced space – Range queries, nearest neighbor queries		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Hanan Samet,* ***"Foundations of Multidimensional and Metric Data Structures"****, 1st Edition,Morgan Kaufmann Publishers, 2006*
2	*Dinesh P. Mehta, Sartaj Sahni,* ***"Handbook of Data Structures and Applications"****, 2nd Edition, CRC Press, 2018*
3	*Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein,* ***"Introduction to Algorithms"****, 4th Edition, MIT Press, 2022*
4	*Mark Berg , Otfried Cheong , Marc Kreveld , Mark Overmars,* ***"Computational Geometry Algorithms and Applications"****, 3rd Edition, Springer, 2008*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the principles and applications of spatial data structures, such asRange Trees, Priority Search Trees, Quadtrees, K-d trees, bucket methods, PK trees	K2
CO2	Evaluate the strengths and weaknesses of different multidimensional data structures in terms of efficiency, scalability, and suitability for real world applications.	K5
CO3	Understand object representations by their interiors and boundaries and apply them in computer vision applications	K3
CO4	Understand the representations of intervals and small rectangles and its applications in spatiotemporal data	K2
CO5	Analyze the performance and suitability of various multidimensional indexing techniques and nearest neighbor search algorithms	K4

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	3	-	2	-
CO2	3	1	3	-	2	-
CO3	3	1	3	-	2	-
CO4	3	1	3	-	2	-
CO5	3	1	3	-	2	-
23CSPE11	**3**	**1**	**3**	**-**	**2**	**-**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	20	20	20	20	-	100
CAT2	10	30	30	20	10	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	20	20	20	20	20	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	10	30	30	20	10	100
ESE	20	40	40	-	-	-	100

23CSPE12	CRYPTOGRAPHY AND NETWORK SECURITY	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	After the completion of the course, the students will be able to understand the concepts of classical and symmetric key encryption schemes, Public Key Cryptographic Algorithms, types of data integrity and authentication schemes, network layer and Web security protocols, Software attacks, wireless network security threats and practice systems.

UNIT – I	INTRODUCTION TO SECURITY	L(9)

Mathematics of Cryptography: Algebraic structures - Groups, Rings, Fields - Number Theory: Primality Testing - Euclidean Algorithm - Chinese Remainder Theorem - Fermat's and Euler's Theorem - Shannon's Theory

Classical Cryptography -Types of attack: Chosen Message Attack (CMA) – Chosen Plaintext Attack (CPA) – Chosen Cipher text Attack (CCA)- One Time Passwords (OTP) - Pseudo random Bit Generators - Stream ciphers and Block Ciphers: Block ciphers - Modes of operation - DES and its variants – AES - Linear and differential cryptanalysis - RC4.

UNIT – II	PUBLIC-KEY CRYPTOGRAPHY	L(10)

Introduction to Public-key Cryptography - RSA Cryptosystem -Implementing RSA- Attacks On RSA Rabin Cryptosystem - Factoring Algorithms - ElGamal Cryptosystem - Discrete Logarithm Problem - Elliptic Curve Systems - Key Distribution and Key Agreement : Blom's Scheme - Diffie Hellman Key Predistribution – Kerberos - Diffie-Hellman Key Agreement scheme.

UNIT – III	INTEGRITY AND AUTHENTICATION ALGORITHMS	L(9)

Authentication requirement – Authentication function – MAC – Hash function – Security of hash function: HMAC, CMAC – MD5 message Digest algorithm - Secure Hash Algorithm – Digital Signature Schemes - Digital Signature Standard – X.509 Certificate

UNIT – IV	NETWORK SECURITY AND WEB SECURITY PROTOCOLS	L(9)

Network Security, Security services, attacks, Security Issues in TCP/IP suite- Sniffing, spoofing, buffer overflow, ARP poisoning, ICMP Exploits, IP address spoofing, IP Fragment attack, routing exploits, UDP exploits, TCP exploits - Network Security Protocols:IP Security - AH and ESP - SSL/TLS - SSH. Web Security Protocols: HTTPS - DNS Security - Electronic Mail Security (PGP, S/MIME).

UNIT – V	SOFTWARE ATTACKS AND PRACTICES	L(8)

Intruders - Viruses - Worms - Trojan horses - Distributed Denial-Of-Service (DDoS) - Honey nets and Honey pots. Security Systems: Firewalls – IDS - Password Management - Wireless Security:Issues and threats in Wireless networks. Wireless LAN Security: WEP – WPA - Blockchains, Cloud Security and IoT security.

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

REFERENCES

1	*Douglas R. Stinson. "**Cryptography: Theory and Practice**", Fourth edition, Chapman & Hall/CRC, 2017.*
2	*William Stallings, "**Cryptography and Network Security - Principles and Practice**", Seventh Edition, Pearson Education, 2017*

3	*Behrouz A. Ferouzan, DebdeepMukhopadhyay, "**Cryptography and Network Security**", 3rd Edition, Tata Mc Graw Hill, 2015*
4	*J. Michael Stewart, "**Network Security, Firewalls And VPNs**", Jones& Bartlett Learning, 2013.*
5	*AtulKahate, "**Cryptography and Network Security**", Fourth Edition, Tata McGraw-Hill, 2019.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Demonstrate the various classical and symmetric encryption techniques and the adversary capabilities.	K3
CO2	Apply the different cryptographic operations of public key cryptography.	K3
CO3	Apply the various integrity and authentication schemes to simulate different applications.	K3
CO4	Understand the fundamentals and architecture used in Network security web security and Email Security protocols.	K1
CO5	Analyze a security solution for a given system or real-world applications.	K4

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	3	2	1	1
CO2	3	-	3	2	1	2
CO3	3	-	3	3	2	2
CO4	3	-	3	3	3	3
CO5	3	-	3	3	3	3
23CSPE12	**3**	**-**	**3**	**3**	**2**	**2**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	30	20	20	-	-	100
CAT2	-	30	20	30	10	10	100
Individual Assessment 1 /Case Study 1 / Seminar 1 / Project 1	10	30	20	20	20	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2/ Project 2	-	20	20	20	20	20	100
ESE	20	40	40	-	-	-	100

23CSPE13	SOCIAL NETWORKS	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	Demonstrate the analytical framework for understanding interactions among social communities.	
UNIT – I	**INTRODUCTION**	**L(9)**
Properties of social networks - Static and Dynamic properties - Random walks on graphs -Algorithms for Hitting and Commute Times - Algorithms for Computing Personalized Pagerank and Simrank - Algorithms for Computing Harmonic Functions- Applications in computer vision, text analysis, combating web spam.		
UNIT – II	**DISCOVERING COMMUNITIES**	**L(9)**
Communities in Context - Core methods - KL Algorithm-Agglomerative Algorithm -Spectral Algorithm - Multi-level Graph Partitioning –Markov Clustering - Community discovery in dynamic, heterogeneous and directed networks - Classification of nodes- Local classifiers - Classifiers for large scale networks.		
UNIT – III	**PRIVACY AND LINK PREDICTION**	**L(9)**
Privacy breaches in social networks - k-anonymity - l-diversity and *t*-closeness - Privacy preserving mechanisms - social networks and affiliation networks. Link Prediction - Feature Set Construction - Classification Models - Bayesian Probabilistic Models - Link Prediction by Local Probabilistic Models, Network Evolution based Probabilistic Model and Hierarchical Probabilistic Model.		
UNIT – IV	**SOCIAL NETWORK INFRASTRUCTURES**	**L(9)**
Decentralized Online Social Networks - Multi-Relational Characterization of Dynamic Social Network Communities - Accessibility Testing of Social Websites - Understanding and Predicting Human Behavior for Social Communities - Associating Human-Centered Concepts with Social Networks Using Fuzzy Sets.		
UNIT – V	**VISUALIZATION AND APPLICATIONS OF SOCIAL NETWORKS**	**L(9)**
Visualization of Social Networks - Novel Visualizations and Interactions for Social Networks Exploration - Applications of Social Network Analysis - Online Advertising in social networks - Social Bookmarking on a Company's Intranet: A Study of Technology Adoption and Diffusion.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Charu c. Aggarwal ,"**Social Network Data Analytics ",** Springer 2011*
2	*Borkofurht, **"Handbook of Social Network Technologies and Applications",** 2010*
3	*David Easley and Jon Kleinberg ,"**Networks ,Crowds, and Markets: Reasoning About a Highly Connected World",**Cambridge University Press,2010.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Compare Static and Dynamic properties of Social Networks and develop algorithms to perform random walks.	K4
CO2	Develop methods to discover communities in large scale online Social Networks.	K2
CO3	Use k-anonymity, l-diversity and other techniques to detect privacy threats and link selection, Bayesian Probabilistic Models to estimate efficiency of the links in graphs	K3
CO4	Explain decentralized large scale online Social Networks and Use fuzzy sets to understand human behavior in Social Network communities	K3
CO5	Visualize Social Networks using social network analysis tools and study Applications of Social Networks.	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	3	1	3	3
CO2	3	-	2	3	3	2
CO3	3	-	3	1	1	3
CO4	3	-	2	3	3	2
CO5	3	-	2	2	2	3
23CSPE13	**3**	**-**	**3**	**2**	**2**	**3**
1-Slight 2-Moderate 3-Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	-	40	40	20	-	-	100
CAT2	-	30	30	40	-	-	100
Individual Assessment 1/ Case study 1/ Seminar 1/ Project 1	-	-	-	100	-	-	100
Individual Assessment 2/ Case study 2/ Seminar 2/ Project 2	-	-	-	100	-	-	100
ESE	40	30	30	-	-	-	100

23CSPE14	INFORMATION RETRIEVAL	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	Understand the various aspects of an Information retrieval system and its evaluation and analyze the performance of information retrieval models.	
UNIT – I	**DICTIONARY AND POSTINGS**	**L(9)**
Information Retrieval process – indexing – Information Retrieval model – Boolean Retrieval model – Tokenization – Stemming – Inverted Index construction and compression – Skip Pointers – Phrase Queries - Wild card queries – Bigram Index – Jaccard Coefficient		
UNIT – II	**EVALUATION AND QUERY EXPANSION**	**L(9)**
Scoring – Term weighting – Vector Space model – Computing Scores in complete search systems – Relevance Feedback – Rocchio algorithm – Query expansion – types - Query drift		
UNIT – III	**XML, PROBABILISTIC AND CBIR**	**L(9)**
XML IR, Probabilistic IR, Probabilistic relevance feedback – Probability ranking principle-Language IR Crawling – Link Analysis, Content based Image Retrieval		
UNIT – IV	**PARALLEL INFORMATION RETRIEVAL**	**L(9)**
Effectiveness measures – Minimizing Adjudication effect – measuring efficiency – efficiency criteria- Query scheduling – Parallel information retrieval – Parallel query processing – MapReduce		
UNIT – V	**IR MODELS AND SCALABILITY**	**L(9)**
Support Vector Machines and Machine Learning on documents – Flat and hierarchical Clustering – IR as systems – Information Retrieval on graphs and audios.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	Christopher D Manning, Prabhakar Raghavan, Hinrich Schutze, " ***An Introduction to Information Retrieval***", Online Edition © 2009 Cambridge UP, April 2019
2	Carol Peters, Martin Braschler, Paul Clough, "***Multilingual Information Retrieval: From Research to Practice"*** Springer 2012
3	Andrew G Psaltis, " ***Streaming Data Understanding The Real Time Pipeline***", OReillyMedia Inc, May 2017
4	Stefan Butcher, "***Implementing and Evaluating Search Engines***", The MIT Press, 2016.

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Describe retrieval models and index constructions.	K2
CO2	Evaluate a simple retrieval model.	K5
CO3	Analyze XML, Probabilistic and Content based image retrieval techniques.	K4
CO4	Summarize parallel retrieval techniques.	K2
CO5	Handle scalable Information Retrieval models.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	2	-	3	3
CO2	2	-	2	-	3	3
CO3	2	-	3	-	3	3
CO4	2	-	3	-	3	3
CO5	2	-	3	-	3	3
23CSPE14	**2**	**-**	**3**	**-**	**3**	**3**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2)%**	**Applying (K3)%**	**Analyzing (K4) %**	**Evaluating (K5)%**	**Creating (K6)%**	**Total %**
CAT1	-	40	40	20	-	-	100
CAT2	-	30	30	40	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	-	-	-	100	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	-	-	-	100	-	100
ESE	20	40	40	-	-	-	100

23CSPE15	NATURAL LANGUAGE PROCESSING	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	The objective of the course is to get familiar with the foundational algorithms used in Natural Language Processing (NLP) and their practical applications	
UNIT – I	**INTRODUCTION**	**L(9)**
Classical Approaches to Natural Language Processing - Text Preprocessing – Lexical Analysis - Syntactic Parsing- Semantic Analysis- Natural Language Generation		
UNIT – II	**STATISTICAL NLP AND SEQUENCE LABELING**	**L(9)**
N-grams Language models –- Naive Bayes, Text Classification, and Sentiment – Vector Semantics and Embeddings - Neural Networks and Neural Language Models - Sequence Labeling for Parts of Speech and Named Entities - Transformers and Pretrained Language Models - Fine-Tuning and Masked Language Models		
UNIT – III	**ANNOTATING LINGUISTIC STRUCTURE**	**L(9)**
Constituency –Context Free Grammar – Treebanks - CKY Parsing: A Dynamic Programming Approach – Span-Based Neural Constituency Parsing - Evaluating Parsers - Dependency Relations- Dependency Parsing -Transition Based - Graph Based - Logical Representations of Sentence Meaning		
UNIT – IV	**COMPUTATIONAL SEMANTICS AND SEMANTIC PARSING**	**L(9)**
Relation and Event Extraction - Time and Temporal Reasoning - Word Senses and WordNet – Semantic Role Labeling - Lexicons for Sentiment, Affect, and Connotation .		
UNIT – V	**NLP APLLICATIONS**	**L(9)**
Machine Translation - Question Answering and Information Retrieval - Chatbots & Dialogue Systems - Automatic Speech Recognition and Text-to-Speech		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Daniel Jurafsky and James H.Martin,* ***"Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition"*** *Third edition , Prentice Hall Series, 2023*
2	*Nitin Indurkhya,Fred J. Damerau,* ***"Handbook of Natural Language Processing",*** *Second edition, CRC,2010*
3	*Jacob Eisenstein. "****Natural Language Processing*** *", MIT Press, 2019*
4	*NPTEL course :* ***Natural Language Processing*** *https://archive.nptel.ac.in/noc/courses/noc19/SEM2/noc19-cs56/*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Comprehend text preprocessing techniques, including lexical analysis, syntactic parsing and semantic analysis to enhance the quality of textual data.	K2
CO2	Summarize key algorithms for statistical NLP and sequence labeling	K2
CO3	Apply annotation skills to real-world linguistic data, contributing to the broader field of linguistics and language technology	K3
CO4	Utilize word senses and WordNet for disambiguation and lexicons for Sentiment, Affect, and Connotation	K3
CO5	Design and implement practical NLP applications, such as machine translation, question answering system ,chatbots, automatic speech and text to speech recognition systems.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	-	2	-	-	3
CO2	1	-	2	-	1	3
CO3	2	2	3	2	2	3
CO4	2	2	3	2	2	3
CO5	3	3	3	2	2	3
23CSPE15	**2**	**2**	**2**	**2**	**2**	**3**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1)%**	**Understanding (K2) %**	**Applying (K3)%**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	50	20	-	-	-	100
CAT2	-	30	70	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	50	50	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	-	100	-	-	-	100
ESE	10	50	40	-	-	-	100

23CSPE16	VIRTUAL REALITY	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	The objective of the course is to provide fundamentals of sensation, perception, technical and engineering aspects of virtual reality systems	
UNIT – I	**INTRODUCTION TO VIRTUAL REALITY**	**L(9)**
Virtual Reality - History of VR - The Basics: Design Guidelines - Benefits of VR –VR hardware –VR software - Two Pillars of VR: Presence and 3D Multimodal Interaction -Building a Virtual Reality System - Object Modeling - Scene Construction- Object Placement -Multiple Frames of Reference -Re-Expressing Coordinates -Function and Behavior Modeling -Performance Estimation and System Tuning		
UNIT – II	**REPRESENTING THE VIRTUAL WORLD**	**L(9)**
Representation of the Virtual World, Visual Representation in VR, Aural Representation in VR and Haptic Representation in VR - Geometric Models - Changing Position and Orientation - Axis-Angle Representations of Rotation- Viewing Transformations - Chaining the Transformations		
UNIT – III	**3D MULTIMODAL DESIGN**	**L(9)**
Why 3D Multimodal - Structured Approach to the Interaction / Interface Design – Metaphors - Interface Design – Multimodality. Case Study : Handling Collision		
UNIT – IV	**INTERACTION AND ITERATIVE DESIGN**	**L(9)**
Human-Centered Interaction - Norman's Principles of Interaction Design - VR Interaction Concepts - Interaction Patterns and Techniques - Interaction: Design Guidelines Philosophy of Iterative Design - Define Stage - Make Stage - Learn Stage - iterative Design: Design Guidelines - The Present and Future State of VR		
UNIT – V	**EVALUATING VR SYSTEMS AND APLLICATIONS**	**L(9)**
Perceptual Training - Recommendations for Developers -Comfort and VR Sickness -Experiments on Human Subjects VR in Education – Medical - Entertainment - Military - Manufacturing - Robotics		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Steven M. LaValle.* ***"VIRTUAL REALITY"*** *Cambridge University Press, 2023. http://www.lavalle.pl/vr/*
2	*Gerard Jounghyun Kim* ***"Designing Virtual Reality Systems The Structured Approach"*** *,Springer 2005*
3	*Vince, John* ***"Introduction to virtual reality"****, Springer, 2004.*
4	*Jason Jerald* ***,"The VR Book: Human-Centered Design for Virtual Reality",****ACM books , 2016*
5	*Grigore C. Burdea, Philippe Coiffet* ***," Virtual Reality Technology"****2 edition ,wiley, 2003*
6	*NPTEL Course :* ***Virtual Reality https://archive.nptel.ac.in/courses/106/106/106106138/***

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Comprehend the basics of virtual reality	K2
CO2	Demonstrate their ability to represent the real world scenarios in virtual reality	K3
CO3	Comprehend the techniques behind 3D Multimodal design	K2
CO4	Narrate Norman's principles of interaction design and the philosophy of iterative design in VR	K2
CO5	Demonstrate their understanding related to the assessment of VR systems and use them for empowering the enhancement of VR applications.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	-	2	1	-	1
CO2	1	-	2	3	2	1
CO3	1	-	2	2	-	1
CO4	1	-	2	2	-	1
CO5	1	-	2	3	2	1
23CSPE16	**1**	**-**	**2**	**2**	**2**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1)%**	**Understanding (K2) %**	**Applying (K3)%**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	40	30	-	-	-	100
CAT2	20	50	30	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	50	50	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	40	60	-	-	-	100
ESE	10	50	40	-	-	-	100

23CSPE17	THEORY OF MODERN COMPILERS	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	This course introduces the theory of modern compilers	
UNIT – I	**INTERMEDIATE REPRESENTATIONS**	**L(9)**
Introduction to compiler technologies - Review of compiler Structure -Intermediate Representations - Run Time Support: Data representations and Instructions, Register Usage, The local stack frame, Run time Stack, Parameter Passing, Procedure Prologues, Epilogues, Call and returns, Code sharing and position independent code-Producing Code Generators Automatically		
UNIT – II	**FLOW ANALYSIS**	**L(9)**
Control Flow Analysis -Data Flow Analysis: Iterative data flow analysis, Lattices of flow functions, Control tree based data flow analysis, Structural analysis, Interval analysis - Dependence Analysis and Dependence Graph-Alias Analysis.		
UNIT – III	**EARLY OPTIMIZATIONS AND LOOP OPTIMIZATIONS**	**L(9)**
Introduction to optimization, Importance of Individual optimizations, Order and repetition of optimizations - Early Optimization: Constant folding, Scalar replacement of aggregates, Algebraic simplifications and Reassociation, Value Numbering, Copy and Constant Propagation-Redundancy Elimination-Loop Optimizations		
UNIT – IV	**PROCEDURE OPTIMIZATION AND SCHEDULING**	**L(9)**
Procedure Optimizations-Register Allocation - Code Scheduling –Control-Flow and Low-Level Optimizations: Unreachable code elimination, Straightening, If and Loop simplification, Loop inversion, Unswitching, Branch Optimizations, Tail merging, Conditional moves, dead code elimination, Branch prediction		
UNIT – V	**INTERPROCEDURAL ANALYSIS AND MEMORY HIERARCHY OPTIMIZATION**	**L(9)**
Inter procedural Analysis and Optimizations: Control flow, Dataflow and Alias analysis, Constant Propagation, Optimization and Register allocation – Optimization for the Memory Hierarchy: Impact of data and Instruction caches and Optimizations		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*A V Aho, Monical Lam, R Sethi, J D Ullman ,"**Compilers: Principles, Techniques, and Tools"**, Second Edition ,2013*
2	*Steven Muchnick.,"**Advanced Compiler Design and Implementation",** Morgan Kaufmann Publishers, Elsevier,2008.*
3	*Keith Cooper, Linda Torczon, **"Engineering a Compiler", Morgan Kaufmann, Second Edition, 2011.***
4	*Andrew W. Appel, Jens Palsberg, **"Modern Compiler Implementation in Java",** Second Edition, Cambridge University Press, 2002*

5	*Randy Allen and Ken Kennedy,* ***"Optimizing Compilers for Modern Architectures: A Dependence based Approach‖",*** *Morgan Kaufman, 2001*
6	*Robert Morgan,* ***"Building an Optimizing Compiler",*** *Digital Press, 1998*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Generate Intermediate representations	K3
CO2	Perform control and data flow analysis	K4
CO3	Eliminate redundancy from IR and Target Code	K3
CO4	Optimize loops, Procedures and Memory Hierarchy	K4
CO5	Generate target code	K5

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	3	3	2	-
CO2	2	-	2	1	1	-
CO3	2	-	2	1	1	-
CO4	2	-	3	3	2	-
CO5	2	-	3	3	2	-
23CSPE17	**2**	**-**	**3**	**3**	**2**	**-**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	50	30	20	-	-	-	100
CAT2	20	30	30	20	-	-	100
Individual Assessment 1 /Case Study 1 / Seminar 1 / Project 1	-	-	-	40	40	20	100
Individual Assessment 2 / Case Study 2/ Seminar 2/ Project 2	-	-	-	40	40	20	100
ESE	40	30	30	-	-	-	100

23CSPE18	DEEP LEARNING	SEMESTER III

PREREQUISITE	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	The students will be introduced with Perceptron Learning Algorithms, Feedforward Neural Networks, Deep Neural Networks, Convolution Neural Networks and Recurrent Neural Networks	
UNIT – I	**INTRODUCTON TO DEEP LEARNING**	**L(9)**
Basics: Biological Neuron, Biological Neuron, Idea of computational units, McCulloch–Pitts unit and Thresholding logic, Linear Perceptron, Perceptron Learning Algorithm, Linear separability. Convergence theorem for Perceptron Learning Algorithm.		
UNIT – II	**FEEDFORWARD NETWORKS**	**L(9)**
Representation Power of Feedforward Neural Networks, Backpropagation, Empirical Risk Minimization, Regularization, Autoencoders.		
UNIT – III	**DEEP NEURAL NETWORKS**	**L(9)**
Difficulty of training deep neural networks, Greedy layerwise training. Gradient Descent (GD), Stochastic Gradient Descent (GD), Better Training of Neural Networks: Newer optimization methods for neural networks (Adagrad, adadelta, rmsprop, adam, NAG), Regularization methods (dropout, drop connect, batch normalization).		
UNIT – IV	**CONVOLUTIONAL NEURAL NETWORKS**	**L(9)**
Convolutional Networks: The Convolution Operation - Variants of the Basic Convolution Function - Structured Outputs - Data Types - Efficient Convolution Algorithms - Random or Unsupervised Features- LeNet, AlexNet		
UNIT – V	**RECURRENT NEURAL NETWORKS**	**L(9)**
Recurrent Neural Networks: Bidirectional RNNs - Deep Recurrent Networks Recursive Neural Networks - The Long Short-Term Memory and Other Gated RNNs		
Contact Periods: **Lecture: 45 Periods Tutorial:0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Ian Goodfellow and Yoshua Bengio and Aaron Courville.,* ***" Deep Learning ",****MIT Press, 2016*
2	*Raúl Rojas,* ***" Neural Networks: A Systematic Introduction ",*** *Springer-Verlag, Berlin, 1996.*
3	*Yegnanarayana, B.,* ***" Artificial Neural Networks ",*** *PHI Learning Pvt. Ltd, 2009*
4	*Christopher Bishop.,* ***" Pattern Recognition and Machine Learning ",*** *Springer,2016*
5	*Nikhil Buduma,* ***"Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms",*** *O'Reilly publications, 2017*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Summarize the basics of neural network and deep learning	K2
CO2	Implement basic neural network model with hidden layers	K3
CO3	Analyze optimization and generalization in deep learning	K4
CO4	Criticize convolutional neural network and how it is applied to analyzing visual imagery	K5
CO5	Appraise Recurrent Neural Network (RNN) and its temporal dynamic behavior which helps us to remembers some information about a sequence to predict the next information	K5

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	-	2	-	-
CO2	3	1	2	3	1	-
CO3	3	-	2	3	2	-
CO4	2	1	2	3	3	1
CO5	3	3	3	3	3	3
23CSPE18	**3**	**1**	**2**	**3**	**3**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	50	30	20	-	-	-	100
CAT2	20	30	30	20	-	-	100
Individual Assessment 1 /Case Study 1 / Seminar 1 / Project 1	-	-	-	40	40	20	100
Individual Assessment 2 / Case Study 2/ Seminar 2/ Project 2	-	-	-	40	40	20	100
ESE	40	30	30	-	-	-	100

23CSPE19	ETHICAL HACKING	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	The objective of the course is to get familiar with techniques of ethical hacking	
UNIT – I	**PRINCIPLE OF HACKING**	**L(9)**
Hacking - Types - ethical Hacking Terminology–different phases involved in Ethical Hacking - Hacktivism - Categories of Penetration Test – Penetration Testing Methodologies-Cracking the Hacker Mindset - Hacking Methodology - Ethical Hacking Tools		
UNIT – II	**INFORMATION GATHERING AND SCANNING**	**L(9)**
Information Gathering Techniques - Target Enumeration and Port Scanning Techniques – Advanced Firewall/IDS Evading Techniques - Network Sniffing - Remote Exploitation.		
UNIT – III	**SYSTEM HACKING AND MALWARE ANALYSIS**	**L(9)**
Understanding Password-Cracking Techniques - Understanding Different Types of Passwords - Understanding Keyloggers and Other Spyware Technologies - Understanding How to Hide Files - Understanding How to Cover Your Tracks and Erase Evidence - Collecting Malware and Initial Analysis - Static Analysis - Live Analysis - Norman SandBox Technology - Hacking Malware : Trends in Malware - De-obfuscating Malware - Reverse-Engineering Malware		
UNIT – IV	**VULNERABILITY ANALYSIS**	**L(9)**
Passive Analysis -Client-Side browser exploits - Exploiting the Windows Access Control Model - Intelligent Fuzzing with Sulley -From Vulnerability to Exploit -Mitigation alternatives - Patching		
UNIT – V	**WIRELESS AND WEB HACKING**	**L(9)**
Wireless Hacking – Introducing Aircrack –ng – Cracking the WEP – Cracking a WPA/WPA2 Wireless Network Using Aircrack-ng – Evil Twin Attack – Causing Denial of Service on the Original AP – Web Hacking – Attacking the Authentication – Brute Force and Dictionary Attacks – Log-In Protection Mechanisms – Handling Captcha – Manipulating User-Agents to bypass Captcha and Other Protection Authentication Bypass Attacks – Session Attacks – SQL Injection Attacks.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Kimberly Graves,* ***"Certified Ethical Hacker STUDY GUIDE",*** *Wiley publication, 2010*
2	*Allen Harper, Shon Harris, Jonathan Ness, Chris Eagle, Gideon Lenkey, and Terron Williams* ***,"Gray Hat Hacking The Ethical Hacker's Handbook"*** *Third Edition, Mc Graw Hill,2011*
3	*RafayBaloch****, "Ethical Hacking and Penetration Testing Guide",*** *CRC Press, 2014*
4	*Kevin Beaver****, "Ethical Hacking for Dummies",*** *Sixth Edition, Wiley, 2018*
5	*Daniel G. Graham ,* ***"ETHICAL HACKING A Hands-on Introduction to Breaking In "*** *no starch press, 2021*
6	*NPTEL Course :****Ethical Hacking https://archive.nptel.ac.in/courses/106/105/106105217/***

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Comprehend the distinct phases in ethical hacking ,its methodology and tools	K2
CO2	Enumerate information gathering , scanning and sniffing techniques for ethical hacking	K2
CO3	Comprehend defend against various cyber security threats, particularly related to password security, spyware, file hiding, digital forensics, and malware.	K2
CO4	Analyze and exploit vulnerability and implement effective mitigation strategies.	K3
CO5	Demonstrate the ability to crack WEP and WPA/WPA2 wireless networks using Aircrack-ng and an understanding of encryption weaknesses and vulnerabilities	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	-	2	2	3	2
CO2	2	-	2	3	3	2
CO3	2	-	2	2	3	2
CO4	2	2	2	3	3	2
CO5	2	-	2	3	3	2
23CSPE19	**2**	**2**	**2**	**3**	**3**	**2**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1)%**	**Understanding (K2) %**	**Applying (K3)%**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	70	-	-	-	-	100
CAT2	20	50	30	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	100		-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	40	60	-	-	-	100
ESE	10	60	30	-	-	-	100

23CSPE20	MINING MASSIVE DATASETS	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	This course explores advanced methods for mining patterns, knowledge, and insights from massive datasets and its applications in various domains like retail industry, healthcare and social media analytics.	
UNIT – I	**INTRODUCTION**	**L(9)**
Overview of Massive Data Mining, Challenges in scalable data mining methods and Traditional algorithms, Applications in retail industry.Distributed Computing Frameworks - Introduction to Hadoop ecosystem, Algorithms using MapReduce programming model, Apache Spark, MLlib		
UNIT – II	**FINDING SIMILAR ITEMS AND MINING DATA STREAMS**	**L(9)**
Applications of Near-Neighbor Search, Locality-Sensitive Hashing for Documents, LSH Families for Distance Measures, Applications of LSH. Mining Data Streams - Sampling Data, Filtering Streams, counting distinct elements, estimating moments, Counting ones in a window.		
UNIT – III	**MINING SOCIAL-NETWORK GRAPHS**	**L(9)**
Social networks as graphs, Clustering of social-network graphs, Direct discovery of communities, partitioning of graphs, Finding overlapping communities, Simrank, Counting triangles, Neighborhood properties of graphs.		
UNIT – IV	**CLUSTERING**	**L(9)**
Introduction to Clustering Techniques – Curse of dimensionality, Hierarchical Clustering – Euclidean and Non-Euclidean spaces, K-means Algorithms, CURE algorithm, GRGPF algorithm, Clustering for Streams and Parallelism		
UNIT – V	**APPLICATIONS**	**L(9)**
Advertising on the Web- Issues in Online Advertising, Online Algorithms, Matching Problem, Adwords Problem and its implementation, Recommendation System - Content-Based Recommendations, Collaborative Filtering, Dimensionality reduction, Netflix challenge, Parallel Implementation of Perceptrons and SVMs.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Jure Leskovec, Anand Rajaraman, Jeff Ullman,* ***"Mining of Massive datasets"****, 3rd Edition, Cambridge University Press, 2020. http://www.mmds.org (Video lectures, Slides)*
2	*https://www.edx.org/learn/mining/stanford-university-mining-massive-datasets*
3	*Tomasz Wiktorski,* ***"Data-intensive Systems: Principles and Fundamentals using Hadoop and Spark"****, Springer, 2019*
4	*https://www.udemy.com/course/the-ultimate-hands-on-hadoop-tame-your-big-data/*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the fundamental concepts and challenges of mining massive datasets and demonstrate proficiency in Hadoop MapReduce and Apache Spark	K2
CO2	Apply LSH algorithm for finding similarities among documents and mining algorithms for streams	K3
CO3	Analyze and mine graph structures in massive datasets using various algorithms and apply them in the area of social network analysis.	K4
CO4	Understand several methods for discovering clusters in high-dimensional data in both Euclidean and Non-Euclidean spaces	K2
CO5	Apply mining massive datasets algorithms to solve real-world problems in diverse domains	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	3	-	2	-
CO2	3	1	3	-	2	-
CO3	3	1	3	-	2	-
CO4	3	1	3	-	2	-
CO5	3	1	3	-	2	-
23CSPE20	**3**	**1**	**3**	**-**	**2**	**-**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	20	20	20	20	-	100
CAT2	10	30	30	20	10	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	20	20	20	20	20	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	10	30	30	20	10	100
ESE	20	40	40	-	-	-	100

23CSPE21	DATA CENTER NETWORKS	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	After the completion of the course, the students will be able to understand the architecture of data center, Server Management and troubleshooting, network maintenance and system Resource Management, data center security and administration.

UNIT – I	DATA CENTER ARCHITECTURE	L(9)

Data center Architecture, Data center prerequisites Data center Requirements Physical Area for Equipment and Unoccupied Space - power to run all the devices - cooling and HVAC - Network bandwidth - Budget Constraints-Power Distribution in a Data Center: Estimating Your Power Needs – UPS – Generators - Power Distribution Units (PDUs) - Electrostatic Discharge (ESD) - Data Center HVAC: Strict Environmental Requirements - Air-Conditioning Systems - Placement of Hardware Racks

UNIT – II	DATA CENTER DESIGN	L(9)

Characteristics of an Outstanding Design, Guidelines for Planning a Data Center Data Center structures, Raised Floor Design and Deployment, Design and Plan against Vandalism, Data center design case study, Modular Cabling Design, Points of Distribution, Data center servers, Server Performance Metrics - Sever Capacity Planning

UNIT – III	DATA CENTER NETWORK MAINTENANCE	L(9)

Data Center Maintenance, Network Operations Center, Network Monitoring, Datacenter physical security, Data center Logical security, Cleaning, Data center Consolidation, Reasons for data center Consolidation, Consolidation opportunity, Server consolidation, Storage Consolidation, Network Consolidation, Service Consolidation, Process Consolidation, Staff Consolidation, Data Consolidation phases - Best Practices in IT: System Management Best Practices - Server Cluster Best Practices - Data Storage Best Practices - Network Management Best Practices - Documentation Best Practices

UNIT – IV	DATA CENTER CLUSTER AND DISASTER RECOVERY	L(9)

Cluster Architecture: Asymmetric Two-Node Clusters - Symmetric Two-Node Clusters - Complex Cluster Configurations - Failover Policies - Cluster Requirements: Required Hardware Cluster Components - Cluster Software Requirements – What Happens During Service Failover - Designing Cluster-Friendly Applications - Disaster Recovery - High Availability (HA) and Disaster Recovery (DR) - Five Phases of DR – Designing a Disaster-Tolerant Architecture - Online Replication Techniques - DR Architectures

UNIT – V	DATA CENTER SECURITY AND ADMINISTRATION	L(9)

Security Guidelines Internet security, Source Security Issues, Best Practices for System Administration, System Administration Work Automation, Device Naming, Naming Practices, NIS, DNS, LDAP, Load balancing, Terminology, Advantages, Types of load balancing, Implementing a Network with Load-Balancing Switches – Fault Tolerance - Designing Fault-Tolerant Networks - Network Security

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

REFERENCES :

1	*Kailash Jayaswal , **"Administering Data Centers: Servers, Storage and Voice over IP",** John Wiley & Sons, 2005*
2	*Mauricio Arregoces, Maurizio Portol, **"Data center fundamentals",** Cisco Press, 2003*
3	*Dinesh G Dutt, **"Cloud Native Data Center Networking: Architecture, Protocols, and Tools",** O'Reilly Media, 2019*
4	*Luiz André Barroso, UrsHölzle, ParthasarathyRanganathan, **"The Datacenter as a Computer: Designing Warehouse-Scale Machines",** Third Edition, Morgan & Claypool Publishers, 2018*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Manage Server Systems and Data Centers Infrastructure Management	K2
CO2	Analyze the Storage, Bandwidth, Efficiency of systems and other resources for build Data center.	K4
CO3	Monitor the data center networks and resources	K3
CO4	Illustrate configuration of data center cluster and significance of disaster recovery	K1
CO5	Describe various security threats and fault tolerance of data center architecture.	K4

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	3	-	2	3
CO2	3	-	3	-	2	3
CO3	3	-	3	-	2	3
CO4	3	-	3	-	3	3
CO5	3	-	3	-	3	3
23CSPE21	**3**	**-**	**3**	**-**	**2**	**3**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	30	20	20	-	-	100
CAT2	10	30	20	40	-	-	100
Individual Assessment 1 /Case Study 1 / Seminar 1 / Project 1	10	30	20	20	20	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2/ Project 2	-	20	20	20	20	20	100
ESE	20	40	40	-	-	-	100

23CSPE22	DATA VISUALIZATION	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	Explore, monitor and curate data into a form easier to understand, highlighting the trends and outliers.	
UNIT – I	**INTRODUCTION TO DATA VISUALIZATION**	**L(9)**
Basic principles for data visualization - Seven stages of visualizing data –Static Graphics – Complete plots, customization, extensibility, Data Visualization through Graph Representations, Graph Layout Techniques - Graph-theoretic Graphics - Graph Drawing, Geometric Graphs, Graph-theoretic Analytics.		
UNIT – II	**HIGH-DIMENSIONAL DATA VISUALIZATION**	**L(9)**
Mosaic Plots - Trellis Displays- Parallel Coordinate Plots- Projection Pursuit and the Grand Tour - Geometric Approach to the Statistical Analysis- Factorial Analysis- Distance Visualization- Principal Axis Methods and Classification: a Unified View- Computational Issues		
UNIT – III	**SMOOTHING TECHNIQUES**	**L(9)**
Nonparametric Regression- Structural Adaptation- Smoothing in One Dimension - Smoothing in Two Dimensions - Additive Models - Data Visualization via Kernel Machines - Hierarchical Cluster Analysis- Partitioning Cluster Analysis- Model-Based Clustering. Visualizing Contingency Tables.		
UNIT – IV	**EXPLORATION AND ANALYSIS OF HIGH-DIMENSIONAL DATA**	**L(9)**
Exploratory Data Analysis - Visual and Computational Models- Matrix Visualization- Generalization and Flexibility, Matrix Visualization of Binary Data - Visualization in Bayesian Data Analysis - Web-Based Statistical Graphics		
UNIT – V	**APPLICATIONS**	**L(9)**
Reconstruction, Visualization and Analysis of Medical Images - Exploratory Graphics of a Financial Dataset - Graphical Data Representation in Bankruptcy Analysis - Visualizing Functional Data with an Application to eBay's Online Auctions - Visualization Tools for Insurance Risk Processes		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES :

1	*Kristen Sosulski,* ***"Data Visualization Made Simple",*** *Taylor and Francis, 2019.*
2	*Evan Stubbs,* ***"The value of business analytics: Identifying the path to profitability",*** *Wiley, 2011.*
3	*Stephen Few,* ***"Information dashboard design: Displaying data for at-a-glance monitoring",*** *second edition, Analytics Press, 2013.*
4	*Tamara Munzner,* ***"Visualization Analysis and Design",*** *CRC Press, Nov. 2014*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Discuss basic principles of data visualization using graphs	K2
CO2	Illustrate visualization techniques for huge dimensional datasets	K3
CO3	Summarize trends, pattern in data using smoothing techniques.	K2
CO4	Categorize visual cues effectively and explore the metadata	K4
CO5	Choose appropriate visualization techniques based on the application environment.	K5

COURSE ARTICULATION MATRIX						
COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	2	-	3	3
CO2	3	-	2	-	3	3
CO3	3	-	3	-	3	3
CO4	3	-	3	-	3	3
CO5	3	-	3	-	3	3
23CSPE22	**3**	**-**	**3**	**-**	**3**	**3**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	-	40	40	20	-	-	100
CAT2	-	30	30	40	-	-	100
Individual Assessment 1/ Case study 1/ Seminar 1/ Project 1	-	-	-	-	100	-	100
Individual Assessment 2/ Case study 2/ Seminar 2/ Project 2	-	-	-	-	100	-	100
ESE	40	30	30	-	-	-	100

23CSPE23	PARALLEL ALGORITHMS	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	After the completion of the course, the students will be able to understand the different types of multiprocessors, techniques for implementing parallel algorithms, model the programming using message passing and shared memory, and apply the parallelization techniques for sorting, graph, Fast Fourier Transform.	
UNIT – I	**PARALLEL COMPUTING ARCHITECTURE**	**L(9)**
Introduction to parallel computers: Parallel Computing, Shared memory multiprocessors, Distributed Memory Multiprocessors, SIMD, Systolic processor, Cluster, Grid Computing, Multicore systems, SM, Communication between parallel processors – Shared memory multi processors: Cache coherence and Memory Consistency – Interconnection Networks: Classification and Interconnection.		
UNIT – II	**FUNDAMENTALS OF PARALLEL ALGORITHMS**	**L(9)**
Concurrency platforms: Cilk++, OpenMP, CUDA – Adhoc techniques for parallel algorithms: Independent loop scheduling, dependent loops, loop spreading, loop unrolling, problem partitioning, Divide and Conquer strategies, pipelining – Non serial Parallel algorithms.		
UNIT – III	**ALGORITHM ANALYSIS**	**L(9)**
Z-Transform analysis: Definition, DFA, Software and Hardware implementations of zTransform and various designs – Dependence Graph analysis: DFA, Deriving dependence graph of an algorithm, Scheduling function, Node projection operation, Nonlinear projection operation, Software and hardware implementations – Computational Geometry analysis.		
UNIT – IV	**PROGRAMMING USING MESSAGE PASSING AND SHARED MEMORY PARADIGM**	**L(9)**
Programming Using Message Passing:Principles of Message-Passing Programming, The Building Blocks: Send and Receive Operations, MPI: the Message Passing Interface, Topologies and Embedding, Overlapping Communication with Computation, Collective Communication and Computation Operations, Groups and Communicators. Programming Shared Address Space Platforms: Thread Basics - The POSIX Thread API - Thread Basics: Creation and Termination - Synchronization Primitives in Pthreads - Controlling Thread and Synchronization Attributes - Composite Synchronization Constructs		
UNIT – V	**PARALLEL ALGORITHMS AND APPLICATIONS**	**L(9)**
Dense Matrix Algorithms: Matrix Multiplication, Solving Linear Equations – Sorting: Issues in sorting, Sorting Networks, Quick sort, Bucket sort- Graph Algorithms- Discrete Optimization Problems: Sequential Search Algorithms, Search overhead Factor, Parallel DFS and BFS -Dynamic Programming - Fast Fourier Transform		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES :

1	*Fayez Gebali,* ***"Algorithms and Parallel Computing",*** *Wiley publications, 2011*
2	*A.Grama, A.Gupta, G.Karypis and V.Kumar,* ***"Introduction to Parallel Computing",*** *Second Edition, Addison-Wesley, 2003*
3	*Joseph JaJa,* ***"An introduction to Parallel Algorithms",*** *Addison-wesley publications, 1992*
4	*Michael J Quinn,* ***"Parallel Programming in C with MPI and OpenMP",*** *first edition, McGraw Hill, 2004*
5	*Barry Wilkinson and Michael Allen,* ***"Parallel programming: techniques and applications using networked workstations and parallel computers",*** *Second Edition, Pearson Education, 2005.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Describe the architecture of different multiprocessors	K2
CO2	Implement the techniques using OpenMP, CUDA	K3
CO3	Analyze the implementation techniques for parallel algorithms	K4
CO4	Implement the MPI and Posix Threads for Message passing and Shared memory	K3
CO5	apply the parallelization techniques for sorting, graph, Fast Fourier Transform	K5

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	3	-	1	1
CO2	2	-	3	-	2	2
CO3	3	-	3	-	2	2
CO4	2	-	3	-	2	2
CO5	2	-	3	-	2	2
23CSPE23	**2**	**-**	**3**	**-**	**2**	**2**

1 – Slight, 2 – Moderate, 3 – Substantial

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	30	20	20	-	-	100
CAT2	-	30	20	30	10	10	100
Individual Assessment 1/ Case study 1/ Seminar 1/ Project 1	10	30	20	20	20	-	100
Individual Assessment 2/ Case study 2/ Seminar 2/ Project 2	-	20	20	20	20	20	100
ESE	20	40	40	-	-	-	100

23SEOE01	BUILDING BYE-LAWS AND CODES OF PRACTICE *(Common to all Branches)*					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objectives	To impart knowledge on the building bye –laws and to emphasize the significance of codes of practice in construction sector.					
UNIT – I	**INTRODUCTION TO BUILDING BYE-LAWS**					**L(9)**
Introduction to Building Bye Laws and regulation, their need and relevance, General definitions such as building height, building line, FAR, Ground Coverage, set back line. Introduction to Master Plan and understanding various land uses like institutional, residential etc. - Terminologies of Building bye-laws.						
UNIT – II	**ROLE OF STATUTORY BODIES**					**L(9)**
Role of various statutory bodies governing building works like development authorities, municipal corporations etc. Local Planning Authority, Town and Country planning organisation, Ministry of urban development.						
UNIT – III	**APPLICATION OF BUILDING BYE-LAWS**					**L(9)**
Interpretation of information given in bye laws including ongoing changes as shown in various annexure and appendices. Application of Bye-laws like structural safety, fire safety, earthquake safety, basement, electricity, water, and communication lines in various building types.						
UNIT – IV	**INTRODUCTION TO CODES OF PRACTICE**					**L(9)**
Introduction to various building codes in professional practice - Codes, regulations to protect public health, safety and welfare - Codes, regulations to ensure compliance with the local authority.						
UNIT – V	**APPLICATION OF CODES OF PRACTICE**					**L(9)**
Applications of various codes as per various building types. Bureau of Indian Standards, Eurocode – Introduction to other international codes.						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

REFERENCES :

1	***"National Building Code of India 2016 – SP 7",*** *NBC 2016, Bureau of Indian Standards.*
2	***"Model Building Bye-Laws (MBBL) – 2016",*** *Town and Country Planning Organization, Ministry of Housing and Urban Affairs, Government of India.*
3	***"Unified Building Bye-laws for Delhi 2016",*** *Nabhi Publications, 2017.*
4	Mukesh *Mittal,* ***"Building Bye Laws",*** *Graphicart publishers, Jaipur, 2013.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the building bye-laws in planning, design and construction works.	K3
CO2	Familiarize with the role of various statutory bodies.	K2
CO3	Execute safety related work practices in the construction sector.	K3
CO4	Ensure compliance with the rules and regulations in design and construction practices.	K3
CO5	Perform design and construction practices based on national and international codal provisions.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	3	1	1	2	3
CO2	1	3	1	1	2	3
CO3	1	3	1	1	2	3
CO4	2	3	1	1	2	3
CO5	2	3	1	1	2	3
23SEOE01	**2**	**3**	**1**	**1**	**2**	**3**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20	-	-	-	100
CAT2	40	40	20	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	40	40	20	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	40	40	20	-	-	-	100
ESE	40	40	20	-	-	-	100

23SEOE02	**PLANNING OF SMART CITIES** *(Common to all Branches)*				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	To have an exposure on planning of smart cities with consideration of the recent challenges and to address the importance of sustainable development of urban area.	
UNIT – I	**SMART CITIES DEVELOPMENT POTENTIALS AND CHALLENGES**	**L(9)**
Perspectives of Smart Cities: Introduction and Overview - Implementation Challenges - Methodological issues - Spatial distribution of startup cities – Re imagining postindustrial cities - Implementation Challenges for Establishing Smart Urban Information and Knowledge Management System.		
UNIT – II	**SUSTAINABLE URBAN PLANNING**	**L(9)**
Optimising Green Spaces for Sustainable Urban Planning - 3D City Models for Extracting Urban Environmental Quality Indicators - Assessing the Rainwater Harvesting Potential - The Strategic Role of Green Spaces - Monitoring Urban Expansion.		
UNIT – III	**ENERGY MANAGEMENT AND SUSTAINABLE DEVELOPMENT**	**L(9)**
Alternatives for Energy Stressed Cities - Social Acceptability of Energy - Efficient Lighting - Energy Management - Urban Dynamics and Resource Consumption - Issues and Challenges of Sustainable Tourism - Green Buildings: Eco-friendly Technique for Modern Cities.		
UNIT – IV	**MULTIFARIOUS MANAGEMENT FOR SMART CITIES**	**L(9)**
Assessment of Domestic Water Use Practices - Issue of Governance in Urban Water Supply - Assessment of Water Consumption at Urban Household Level - Water Sustainability - Socio-economic Determinants and Reproductive Healthcare System - Problems and Development of Slums.		
UNIT – V	**INTELLIGENT TRANSPORT SYSTEM**	**L(9)**
Introduction to Intelligent Transport Systems (ITS) - The Range of ITS Applications -Network Optimization - Sensing Traffic using Virtual Detectors - Vehicle Routing and Personal route information - The Smart Car - Commercial Routing and Delivery - Electronic Toll Collection - The Smart Card - Dynamic Assignment - Traffic Enforcement. Urban Mobility and Economic Development.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

REFERENCES

1	*Poonam Sharma, Swati Rajput,* ***"Sustainable Smart Cities In India Challenges And Future Perspectives"****, Springer 2017 Co.(P) Ltd. 2013.*
2	*Ivan Nunes Da Silva,* ***"Rogerio Andrade Flauzino-Smart Cities Technologies-Exli4eva"****, 2016.*
3	*Stan McClellan, Jesus A. Jimenez, George Koutitas* ***"Smart Cities_ Applications, Technologies, Standards"****, and Driving Factors-Springer International Publishing, 2018.*
4	*Stan Geertman, Joseph Ferreira, Jr., Robert Goodspeed, John Stillwell,* ***"Planning Support Systems And Smart Cities"****, Springer, 2015.*
5	*Pradip Kumar Sarkar and Amit Kumar Jain* ***"Intelligent Transport Systems"****, PHI Learning, 2018.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Indicate the potential challenges in smart city development.	K2
CO2	Select the different tools for sustainable urban planning.	K3
CO3	Choose appropriate energy conservation system for smart cities.	K3
CO4	Identify the proper method of water management system.	K3
CO5	Apply Intelligent Transport System concepts in planning of smart city.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	-	2	3	1	1
CO2	1	1	1	3	2	1
CO3	1	1	-	2	2	1
CO4	1	-	1	2	1	1
CO5	1	-	1	3	1	-
23SEOE02	**1**	**1**	**2**	**3**	**2**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	45	30	-	-	-	100
CAT2	25	45	30	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	15	40	45	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	10	45	45	-	-	-	100
ESE	20	40	40	-	-	-	100

23SEOE03	GREEN BUILDING *(Common to all Branches)*				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	To introduce the different concepts of energy efficient buildings, indoor environmental quality management, green buildings and its design.	
UNIT – I	**INTRODUCTION**	**L(9)**
Life cycle impacts of materials and products – sustainable design concepts – strategies of design for the Environment -The sun-earth relationship and the energy balance on the earth's surface, climate, wind – Solar radiation and solar temperature – Sun shading and solar radiation on surfaces – Energy impact on the shape and orientation of buildings – Thermal properties of building materials.		
UNIT – II	**ENERGY EFFICIENT BUILDINGS**	**L(9)**
Passive cooling and day lighting – Active solar and photovoltaic- Building energy analysis methods- Building energy simulation- Building energy efficiency standards-Lighting system design- Lighting economics and aesthetics- Impacts of lighting efficiency – Energy audit and energy targeting- Technological options for energy management.		
UNIT – III	**INDOOR ENVIRONMENTAL QUALITY MANAGEMENT**	**L(9)**
Psychrometry- Comfort conditions- Thermal comfort- Ventilation and air quality-Air conditioning requirement- Visual perception- Illumination requirement- Auditory requirement- Energy management options- Air conditioning systems- Energy conservation in pumps- Fans and blowers- Refrigerating machines- Heat rejection equipment- Energy efficient motors- Insulation.		
UNIT – IV	**GREEN BUILDING CONCEPTS**	**L(9)**
Green building concept- Green building rating tools- Leeds and IGBC codes. – Material selection Embodied energy- Operating energy- Façade systems- Ventilation systems-Transportation- Water treatment systems- Water efficiency- Building economics		
UNIT – V	**GREEN BUILDING DESIGN - CASE STUDY**	**L(9)**
Case studies - Building form, orientation and site considerations; conservation measures; energy modeling; heating system and fuel choices; renewable energy systems; material choices - construction budget		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES :

1	*Sam Kubba* ***"Handbook of Green Building Design and Construction: LEED, BREEAM, and Green Globes",*** *Elsevier Science, 2012.*
2	*Yudelson, Jerry, McGraw-Hill,* ***"Greening existing buildings",*** *New York, 2010*
3	*Charles J. Kibert, John Wiley & Sons,* ***"Sustainable Construction: Green Building Design and Delivery****", 3rd Edition, 2012*
4	*R.S. Means, John Wiley & Sons,* ***"Green Building: Project Planning & Cost Estimating",*** *2010.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the concepts of sustainable design in building construction.	K3
CO2	Execute green building techniques including energy efficiency management in the building design.	K3
CO3	Establish indoor environmental quality in green building.	K3
CO4	Perform the green building rating using various tools.	K3
CO5	Create drawings and models of green buildings.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	2	3	3	3
CO2	3	3	2	3	3	3
CO3	2	2	2	2	3	3
CO4	2	3	1	3	3	3
CO5	3	3	1	3	3	3
23SEOE03	**3**	**3**	**2**	**3**	**3**	**3**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20	-	-	-	100
CAT2	40	40	20	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	40	40	20	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	40	40	20	-	-	-	100
ESE	40	40	20	-	-	-	100

23EEOE04	**ENVIRONMENT HEALTH AND SAFETY MANAGEMENT** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To impart knowledge on occupational health hazards, safety measures at work place, accident prevention, safety management and safety measures in industries.	
UNIT – I	**OCCUPATIONAL HEALTH HAZARDS**	**L(9)**
Occupation, Health and Hazards - Safety Health and Management: Occupational Health Hazards - Ergonomics - Importance of Industrial Safety - Radiation and Industrial Hazards: Types and effects - Vibration - Industrial Hygiene - Different air pollutants in industries and their effects - Electrical, fire and Other Hazards.		
UNIT – II	**SAFETY AT WORKPLACE**	**L(9)**
Safety at Workplace - Safe use of Machines and Tools: Safety in use of different types of unit operations - Ergonomics of Machine guarding - working in different workplaces - Operation, Inspection and maintenance - Housekeeping, Industrial lighting, Vibration and Noise.		
UNIT – III	**ACCIDENT PREVENTION**	**L(9)**
Accident Prevention Techniques - Principles of accident prevention - Hazard identification and analysis, Event tree analysis, Hazop studies, Job safety analysis - Theories and Principles of Accident causation - First Aid: Body structure and functions - Fracture and Dislocation, Injuries to various body parts.		
UNIT – IV	**SAFETY MANAGEMENT**	**L(9)**
Safety Management System and Law - Legislative measures in Industrial Safety - Occupational safety, Health and Environment Management, Bureau of Indian Standards on Health and Safety, IS 14489 standards - OSHA, Process safety management (PSM) and its principles - EPA standards		
UNIT – V	**GENERAL SAFETY MEASURES**	**L(9)**
Plant Layout for Safety - design and location, distance between hazardous units, lighting, colour coding, pilot plant studies, Housekeeping - Accidents Related with Maintenance of Machines - Work Permit System - Significance of Documentation - Case studies involving implementation of health and safety measures in Industries.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

REFERENCES:

1	***"Physical Hazards of the Workplace"****, Barry Spurlock, CRC Press, 2017.*
2	***"Handbook of Occupational Safety and Health",*** *S. Z. Mansdorf, Wiley Publications,2019*
3	***"Safety, Health, and Environment"****, NAPTA, 2nd Edition, Pearson Publications, 2019.*
4	*"**Occupational Health and Hygiene in Industries**", Raja Sekhar Mamillapalli, Visweswara Rao PharmaMed Press, 1st edition, 2021.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Identify the occupational health hazards.	K3
CO2	Execute various safety measures at workplace.	K3
CO3	Analyze and execute accident prevention techniques.	K3
CO4	Implement safety management as per various standards.	K3
CO5	Develop awareness on safety measures in Industries.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	2	2	2	3	2
CO2	2	2	2	1	2	2
CO3	2	3	2	1	2	2
CO4	1	1	1	2	2	2
CO5	1	1	1	1	1	2
23EEOE04	1	2	2	1	2	2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	35	20	10	5	5	100
CAT2	25	35	20	10	5	5	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	20	40	30	10	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20	40	30	10	-	-	100
ESE	25	35	20	10	5	5	100

23EEOE05	**CLIMATE CHANGE AND ADAPTATION** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To understand the Earth's climate system, changes and their effects on the earth, identifying the impacts, adaptation, mitigation of climate change and for gaining knowledge on clean technology, carbon trading and alternate energy sources.	
UNIT – I	**EARTH'S CLIMATE SYSTEM**	**L(9)**
Introduction-Climate in the spotlight - The Earth's Climate Machine – Climate Classification- Global Wind Systems – Trade Winds and the Hadley Cell – The Westerlies – Cloud Formation and Monsoon Rains – Storms and Hurricanes - The Hydrological Cycle – Global Ocean Circulation – El Nino and its Effect - Solar Radiation – The Earth's Natural Green House Effect – Green House Gases and Global Warming – Carbon Cycle.		
UNIT – II	**OBSERVED CHANGES AND ITS CAUSES**	**L(9)**
Observation of Climate Change – Changes in patterns of temperature, precipitation and sea level rise – Observed effects of Climate Changes – Patterns of Large-Scale Variability –Drivers of Climate Change – Climate Sensitivity and Feedbacks – The Montreal Protocol –UNFCCC – IPCC – Evidences of Changes in Climate and Environment – on a Global Scale and in India – climate change modeling.		
UNIT – III	**IMPACTS OF CLIMATE CHANGE**	**L(9)**
Impacts of Climate Change on various sectors – Agriculture, Forestry and Ecosystem – Water Resources – Human Health – Industry, Settlement and Society – Methods and Scenarios –Projected Impacts for Different Regions – Uncertainties in the Projected Impacts of Climate Change – Risk of Irreversible Changes.		
UNIT – IV	**CLIMATE CHANGE ADAPTATION AND MITIGATION MEASURES**	**L(9)**
Adaptation Strategy/Options in various sectors – Water – Agriculture –- Infrastructure and Settlement including coastal zones – Human Health – Tourism – Transport – Energy – Key Mitigation Technologies and Practices – Energy Supply – Transport – Buildings – Industry –Agriculture – Forestry - Carbon sequestration – Carbon capture and storage (CCS) – Waste (MSW & Bio waste, Biomedical, Industrial waste – International and Regional cooperation.		
UNIT – V	**CLEAN TECHNOLOGY AND ENERGY**	**L(9)**
Clean Development Mechanism – Carbon Trading - examples of future Clean Technology –Biodiesel – Natural Compost – Eco- Friendly Plastic – Alternate Energy – Hydrogen – Biofuels– Solar Energy – Wind – Hydroelectric Power – Mitigation Efforts in India and Adaptation funding.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0Periods** **Practical: 0 Periods** **Total:45 Periods**		

REFERENCES

1	***"Impacts of Climate Change and Climate Variability on Hydrological Regimes",*** *Jan C. Van Dam, Cambridge University Press, 2003.*
2	*IPCC fourth assessment report - The AR4 synthesis report, 2007*
3	*IPCC fourth assessment report –Working Group I Report****, "The physical sciencebasis",****2007*
4	*IPCC fourth assessment report - Working Group II Report,* ***"Impacts, Adaptation and Vulnerability"****, 2007*
5	*IPCC fourth assessment report – Working Group III Report"* ***Mitigation of Climate Change",*** *2007*
6	***"Climate Change and Water". Technical Paper of the Intergovernmental Panel on Climate Change,*** *Bates, B.C., Z.W. Kundzewicz, S. Wu and J.P. Palutikof, Eds., IPCC Secretariat, Geneva, 2008.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Classify the Earths climatic system and factors causing climate change and global warming.	K2
CO2	Relate the Changes in patterns of temperature, precipitation and sea level rise and Observed effects of Climate Changes	K2
CO3	Illustrate the uncertainty and impact of climate change and risk of reversible changes.	K3
CO4	Articulate the strategies for adaptation and mitigation of climatic changes.	K3
CO5	Discover clean technologies and alternate energy source for sustainable growth.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	3	2	3	1
CO2	3	2	2	2	3	2
CO3	2	2	2	2	3	2
CO4	3	2	2	2	2	2
CO5	3	3	2	3	3	3
23EEOE05	**3**	**3**	**3**	**3**	**3**	**3**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	30	35	10	-	-	100
CAT2	25	30	35	10	-	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	20	30	40	10	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20	30	40	10	-	-	100
ESE	25	30	35	10	-	-	100

23EEOE06	**WASTE TO ENERGY** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To classify waste as fuel, introduce conversion devices, gain knowledge about Biomass Pyrolysis, demonstrate methods, factors for biomass gasification, and acquire knowledge about biogas and its development in India.	
UNIT – I	**INTRODUCTION**	**L(9)**
Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, Gasifiers, Digestors.		
UNIT – II	**BIOMASS PYROLYSIS**	**L(9)**
Biomass Pyrolysis: Pyrolysis -Types, Slow Pyrolysis, Fast Pyrolysis – Manufacture of charcoal – Methods – Yields and Applications – Manufacture of Pyrolytic oils and gases, Yields and Applications.		
UNIT – III	**BIOMASS GASIFICATION**	**L(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 Considerations in gasifier operation.		
UNIT – IV	**BIOMASS COMBUSTION**	**L(9)**
Biomass Combustion – Biomass Stoves – Improved Chullahs, types, some exotic designs, Fixed bed combustors, types – Inclined grate combustors – Fluidized bed combustors, design, construction and operation of all the above biomass combustors.		
UNIT – V	**BIOENERGY SYSTEM**	**L(9)**
Biogas: 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.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

REFERENCES

1	***"Energy Recovery from Municipal Solid Waste by Thermal Conversion Technologies",*** *P Jayaram Reddy, Taylor and Francis Publications, 2016.*
2	***"Waste – to – Energy: Technologies and project Implementations",*** *Marc J Rogoff, Francois Screve,ELSEVIER Publications, Third Edition, 2019.*
3	***"Biogas Technology and Principles"****, Brad Hill, NY RESEARCH PRESS Publications, Illustrated Edition, 2015.*
4	***"Biomass Gasification and Pyrolysis Practical Design and Theory",*** Prabir*ELSEVIER Publications, 2010*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Investigate solid waste management techniques.	K2
CO2	Get knowledge about biomass pyrolysis.	K3
CO3	Demonstrate methods and factors considered for biomass gasification.	K3
CO4	Identify the features of different facilities available for biomass combustion.	K4
CO5	Analyze the potential of different Bioenergy systems with respect to Indian condition.	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	3	3	2	3	1
CO2	3	2	2	2	3	1
CO3	3	3	2	3	2	1
CO4	3	2	2	3	3	1
CO5	2	3	3	3	2	1
23EEOE06	**3**	**3**	**3**	**3**	**3**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	20	25	15	10	100
CAT2	10	25	20	10	25	10	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	-	15	35	50	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	-	10	40	50	-	-	100
ESE	10	25	25	20	10	10	100

23GEOE07	ENERGY IN BUILT ENVIRONMENT *(Common to all Branches)*					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objective	To understand constructional energy requirements of buildings, energy audit methods and conservation of energy.					
UNIT–I	**INTRODUCTION**					**L(9)**
Indoor activities and environmental control - Internal and external factors on energy use –Characteristics of energy use and its management -Macro aspect of energy use in dwellings and its implications – Thermal comfort-Ventilation and air quality-Air-conditioning requirement-Visual perception-Illumination requirement-Auditory requirement.						
UNIT–II	**LIGHTING REQUIREMENTS IN BUILDING**					**L(9)**
The sun-earth relationship - Climate, wind, solar radiation and temperature - Sun shading and solar radiation on surfaces-Energy impact on the shape and orientation of buildings–Lighting and day lighting: Characteristics and estimation, methods of day-lighting–Architectural considerations for day-lighting.						
UNIT–III	**ENERGY REQUIREMENTS IN BUILDING**					**L(9)**
Steady and unsteady heat transfer through wall and glazed window-Standards for thermal performance of building envelope- Evaluation of the overall thermal transfer- Thermal gain and net heat gain-End-Use energy requirements-Status of energy use in buildings-Estimation of energy use in a building.						
UNIT–IV	**ENERGY AUDIT**					**L(9)**
Energy audit and energy targeting-Technological options for energy management-Natural and forced ventilation–Indoor environment and air quality-Air flow and air pressure on buildings-Flow due to Stack effect.						
UNIT–V	**COOLING IN BUILT ENVIRONMENT**					**L(9)**
Passive building architecture–Radiative cooling-Solar cooling techniques-Solar desiccant dehumidification for ventilation-Natural and active cooling with adaptive comfort–Evaporative cooling – Zero energy building concept.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES

1	*J.Krieder and A.Rabl**, "Heating and Cooling of Buildings**: **Design for Efficiency"**, McGraw-Hill, 2000.*
2	*S.M.Guinnes and Reynolds, "**Mechanical and Electrical Equipment for Buildings"**, Wiley, 1989.*
3	*A.Shaw, "**Energy Design for Architects"**, AEE Energy Books, 1991.*
4	*ASHRAE, "**Hand book of Fundamentals"**,ASHRAE,Atlanta,GA.,2001.*
5	*Reference Manuals of DOE-2 (1990), Orlando Lawrence-Berkeley Laboratory, University of California, and Blast, University of Illinois, USA.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Understand energy and its usage	K2
CO2	Know lighting to be given to a building	K1
CO3	Analyse the energy requirements in a building	K3
CO4	Apply the energy audit concepts.	K3
CO5	Study architectural specifications of a building	K1

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	3	1	2	1
CO2	2	-	3	1	2	1
CO3	2	-	3	1	2	1
CO4	2	-	3	1	2	1
CO5	2	-	3	1	2	1
23GEOE07	**2**	**-**	**3**	**1**	**2**	**1**
1–Slight, 2–Moderate, 3–Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT 1	40	40	20	-	-	-	100
CAT 2	40	40	20	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	50	50	-	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	50	50	-	-	-	-	100
ESE	40	40	20	-	-	-	100

23GEOE08	EARTH AND ITS ENVIRONMENT *(Common to all Branches)*					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objective	To know about the planet earth, the geosystems and the resources like ground water and air and to learn about the Environmental Assessment and sustainability.					
UNIT–I	**EVOLUTION OF EARTH**					**L(9)**
Evolution of earth as habitable planet-Evolution of continents-oceans and landforms-evolution of life through geological times - Exploring the earth's interior - thermal and chemical structure - origin of gravitational and magnetic fields.						
UNIT–II	**GEOSYSTEMS**					**L(9)**
Plate tectonics - working and shaping the earth - Internal geosystems – earthquakes – volcanoes -climatic excursions through time - Basic Geological processes - igneous, sedimentation – metamorphic processes.						
UNIT–III	**GROUND WATER GEOLOGY**					**L(9)**
Geology of ground water occurrence –recharge process-Ground water movement-Ground water discharge and catchment hydrology – Ground water as a resource - Natural ground water quality and contamination-Modelling and managing ground water systems.						
UNIT–IV	**ENVIRONMENTAL ASSESMENT AND SUSTAINABILITY**					**L(9)**
Engineering and sustainable development - population and urbanization - toxic chemicals and finite resources - water scarcity and conflict - Environmental risk - risk assessment and characterization –hazard assessment-exposure assessment.						
UNIT–V	**AIR AND SOLIDWASTE**					**L(9)**
Air resources engineering-introduction to atmospheric composition–behaviour-atmospheric photo chemistry-Solid waste management–characterization-management concepts.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Period Practical: 0 Period Total: 45 Periods**						

REFERENCES

1	*John Grotzinger and Thomas H.Jordan, "**Understanding Earth",** Sixth Edition, W.H.Freeman, 2010.*
2	*Younger,P.L., "**Ground water in the Environment: An introduction"**, Blackwell Publishing,2007.*
3	*Mihelcic, J. R., Zimmerman, J. B., "**Environmental Engineering:Fundamentals, Sustainability and Design"**,Wiley,NJ, 2010.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	To know about evolution of earth and the structure of the earth.	K2
CO2	To understand the internal geosystems like earthquakes and volcanoes and the Various geological processes.	K2
CO3	To able to find the geological process of occurrence and movement of Ground water and the modeling systems.	K3
CO4	To assess the Environmental risks and the sustainability developments.	K3
CO5	To learn about the photochemistry of atmosphere and the solid waste Management concepts.	K1

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	-	-	2	2	-
CO2	3	-	3	3	-	3
CO3	2	-	-	-	-	-
CO4	-	2	-	-	1	-
CO5	2	2	-	1	-	-
23GEOE08	**2**	**2**	**3**	**3**	**2**	**3**
1–Slight, 2–Moderate, 3–Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT 1	40	40	20	-	-	-	100
CAT 2	40	40	20	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	-	50	50	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	-	50	50	-	-	-	100
ESE	40	40	20	-	-	-	100

23GEOE09	NATURAL HAZARDS AND MITIGATION *(Common to all Branches)*					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objective	To get idea on the causes, effects and mitigation measures of different types of hazards with case studies.					
UNIT–I	**EARTH QUAKES**					**L(9)**
Definitions and basic concepts-different kinds of hazards–causes-Geologic Hazards–Earthquakes-causes of earthquakes–effects-plate tectonics-seismic waves-measures of size of earthquakes-earthquake resistant design concepts.						
UNIT–II	**SLOPE STABILITY**					**L(9)**
Slope stability and landslides-causes of landslides–principles of stability analysis-remedial and corrective measures for slope stabilization.						
UNIT–III	**FLOODS**					**L(9)**
Climatic Hazards–Floods-causes of flooding-regional flood frequency analysis–flood control measures-flood routing-flood forecasting-warning systems.						
UNIT–IV	**DROUGHTS**					**L(9)**
Droughts –causes - types of droughts –effects of drought -hazard assessment – decision making-Use of GIS in natural hazard assessment–mitigation-management.						
UNIT–V	**TSUNAMI**					**L(9)**
Tsunami–causes–effects–under sea earthquakes–landslides–volcanic eruptions–impact of sea meteorite–remedial measures–precautions–case studies.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Period Practical: 0 Period Total: 45 Periods**						

REFERENCES

1	*Donald Hyndman and David Hyndman,* ***"Natural Hazards and Disasters",*** *Brooks/Cole Cengage Learning, 2008.*
2	*Edward Bryant,* ***"Natural Hazards"****, Cambridge University Press, 2005.*
3	*J Michael Duncan and Stephan G Wright,* ***"Soil Strength and Slope Stability"****, John Wiley & Sons, Inc, 2005.*
4	*AmrS.Elnashai and Luigi Di Sarno,* ***"Fundamentals of Earthquake Engineering"****, John Wiley & Sons,Inc,2008*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Learn the basic concepts of earthquakes and the design concepts of earthquake Resistant buildings.	K2
CO2	Acquire knowledge on the causes and remedial measures of slope stabilization.	K3
CO3	As certain the causes and control measures of flood.	K3
CO4	Know the types, causes and mitigation of droughts.	K2
CO5	Study the causes, effects and precautionary measures of Tsunami.	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	-	3	2	3
CO2	3	1	2	3	3	3
CO3	3	2	3	-	-	3
CO4	3	-	-	3	2	3
CO5	3	-	2	2	-	3
23GEOE09	**3**	**1**	**2**	**3**	**2**	**3**
1–Slight, 2–Moderate, 3–Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT 1	40	40	20	-	-	-	100
CAT 2	40	40	20	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	-	50	50	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	-	50	50	-	-	-	100
ESE	40	40	20	-	-	-	100

23EDOE10	**BUSINESS ANALYTICS** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	1. To apprehend the fundamentals of business analytics and its life cycle. 2. To gain knowledge about fundamental business analytics. 3. To study modeling for uncertainty and statistical inference. 4. To apprehend analytics the usage of Hadoop and Map Reduce frameworks. 5. To acquire insight on other analytical frameworks.	
UNIT – I	**BUSINESS ANALYTICS AND PROCESS**	**L(9)**
Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling andestimation methods overview.		
UNIT – II	**REGRESSION ANALYSIS**	**L(9)**
Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.		
UNIT – III	**STRUCTURE OF BUSINESS ANALYTICS**	**L(9)**
Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.		
UNIT – IV	**FORECASTING TECHNIQUES**	**L(9)**
Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.		
UNIT – V	**DECISION ANALYSIS AND RECENT TRENDS IN BUSINESS ANALYTICS**	**L(9)**
Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.Recent Trends: Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES

1	*VigneshPrajapati,* ***"Big Data Analytics with R and Hadoop",****Packt Publishing, 2013.*
2	*Umesh R Hodeghatta, UmeshaNayak,* ***"Business Analytics Using R – A Practical Approach",*** *Apress, 2017.*
3	*AnandRajaraman, 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: TheScience of Data-Driven Decision Making",*** *Wiley, 2017.*
6	*Rui Miguel Forte,* ***"Mastering Predictive Analytics with R",*** *Packt Publication, 2015.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Identify the real world business problems and model with analytical solutions.	K4
CO2	Solve analytical problem with relevant mathematics background knowledge.	K4
CO3	Convert any real world decision making problem to hypothesis and apply suitable statistical testing.	K4
CO4	Write and Demonstrate simple applications involving analytics using Hadoop and Map Reduce	K4
CO5	Use open source frameworks for modeling and storing data.	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	2	1	2	1
CO2	1	1	1	2	1
CO3	2	2	1	1	-
CO4	2	2	1	-	-
CO5	1	2	-	-	-
23EDOE10	**1**	**2**	**1**	**2**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT 1	25	25	25	25	-	-	100
CAT 2	20	25	25	30	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	25	30	25	20	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	30	20	30	20	-	-	100
ESE	20	30	20	30	-	-	100

23EDOE11	**INTRODUCTION TO INDUSTRIAL SAFETY** *(Common to all Branches)*

PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	1. Summarize basics of industrial safety. 2. Describe fundamentals of maintenance engineering. 3. Explain wear and corrosion. 4. Illustrate fault tracing. 5. Identify preventive and periodic maintenance.	
UNIT – I	**INTRODUCTION**	**L(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**	**L(9)**
Definition and aim of maintenance engineering, Primary and secondary functions andresponsibility 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**	**L(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**	**L(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**	**L(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		

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

REFERENCES

1	*Hans F. Winterkorn,* ***"Foundation Engineering Handbook",*** *Chapman & Hall London, 2013.*
2	***"Maintenance Engineering"*** *by Dr. Siddhartha Ray, New Age International (P) Ltd., Publishers, 2017*
3	***"Industrial Safety Management",****McGraw Hill Education; New edition (1 July 2017)*
4	***"Industrial Engineering And Production Management",*** *S. Chand Publishing; Third edition ,2018*
5	***"Industrial Safety and Maintenance Engineering",****Parth B. Shah, 2021.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Ability to summarize basics of industrial safety	K4
CO2	Ability to describe fundamentals of maintenance engineering	K4
CO3	Ability to explain wear and corrosion	K4
CO4	Ability to illustrate fault tracing	K4
CO5	Ability to identify preventive and periodic maintenance	K4

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	2	1	1	-	-
CO2	2	2	1	-	1
CO3	1	2	1	1	1
CO4	2	1	1	1	1
CO5	2	1	2	1	1
23EDOE11	**2**	**1**	**1**	**1**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT 1	25	25	25	25	-	-	100
CAT 2	20	25	25	30	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	25	30	25	20	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	30	20	30	20	-	-	100
ESE	20	30	20	30	-	-	100

23EDOE12	**OPERATIONS RESEARCH** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	1. Solve linear programming problem and solve using graphical method. 2. Solve LPP using simplex method. 3. Solve transportation, assignment problems. 4. Solve project management problems. 5. Solve scheduling problems.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models		
UNIT – II	**LINEAR PROGRAMMING PROBLEM**	**9 Periods**
Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming		
UNIT – III	**NON-LINEAR PROGRAMMING PROBLEM**	**9 Periods**
Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT		
UNIT – IV	**SEQUENCING AND INVENTORY MODEL**	**9 Periods**
Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.		
UNIT – V	**GAME THEORY**	**9 Periods**
Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical:0Periods Total: 45 Periods**		

REFERENCES

1	*H.A. Taha* ***"Operations Research, An Introduction",*** *PHI, 2017.*
2	***"Industrial Engineering and Management",*** *O. P. Khanna, 2017.*
3	***"Operations Research",*** *S.K. Patel, 2017.*
4	***"Operation Research",****AnupGoel, RuchiAgarwal, Technical Publications, Jan 2021.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Formulate linear programming problem and solve using graphical method.	K4
CO2	Solve LPP using simplex method.	K4
CO3	Formulate and solve transportation, assignment problems.	K4
CO4	Solve project management problems.	K4
CO5	Solve scheduling problems	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	1	1	-	-
CO2	2	2	1	-	-
CO3	1	1	2	1	1
CO4	1	1	-	-	-
CO5	2	1	-	-	-
23EDOE12	**2**	**1**	**1**	**1**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT 1	25	25	25	25	-	-	100
CAT 2	20	25	25	30	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	25	30	25	20	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	30	20	30	20	-	-	100
ESE	20	30	20	30	-	-	100

23MFOE13	**OCCUPATIONAL HEALTH AND SAFETY** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	1. To gain knowledge about occupational health hazard and safety measures at work place. 2. To learn about accident prevention and safety management. 3. To learn about general safety measures in industries.	
UNIT – I	**OCCUPATIONAL HEALTH AND HAZARDS**	**9 Periods**
Safety- History and development, National Safety Policy- Occupational Health Hazards - Ergonomics - Importance of Industrial Safety Radiation and Industrial Hazards- Machine Guards and its types, Automation.		
UNIT – II	**SAFETY AT WORKPLACE**	**9 Periods**
Safety at Workplace - Safe use of Machines and Tools: Safety in use of different types of unit operations - Ergonomics of Machine guarding - working in different workplaces - Operation, Inspection and maintenance, Plant Design and Housekeeping, Industrial lighting, Vibration and Noise Case studies.		
UNIT – III	**ACCIDENT PREVENTION**	**9 Periods**
Accident Prevention Techniques - Principles of accident prevention - Definitions, Theories, Principles – Hazard identification and analysis, Event tree analysis, Hazop studies, Job safety analysis - Theories and Principles of Accident causation - First Aid : Body structure and functions - Fracture and Dislocation, Injuries to various body parts.		
UNIT – IV	**SAFETY MANAGEMENT**	**9 Periods**
Safety Management System and Law - Legislative measures in Industrial Safety: Various acts involved in Detail- Occupational safety, Health and Environment Management: Bureau of Indian Standards on Health and Safety, 14489, 15001 - OSHA, Process safety management (PSM) and its principles - EPA standards- Safety Management: Organisational & Safety Committee - its structure and functions.		
UNIT – V	**GENERAL SAFETY MEASURES**	**9 Periods**
Plant Layout for Safety -design and location, distance between hazardous units, lighting, colour coding, pilot plant studies, Housekeeping - Accidents Related with Maintenance of Machines - Work Permit System: Significance of Documentation Directing Safety, Leadership -Case studies involving implementation of health and safety measures in Industries.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

REFERENCES:

1	*Benjamin O.Alli,* ***Fundamental Principles of Occupational Health and Safety*** *ILO 2008.*
2	*Danuta Koradecka,* ***Handbook of Occupational Health and Safety****, CRC, 2010.*
3	*Dr. Siddhartha Ray,* ***Maintenance Engineering,*** *New Age International (P) Ltd., Publishers, 2017*
4	*Deshmukh. L.M.,* ***Industrial Safety Management****, 3rd Edition, Tata McGraw Hill, New Delhi, 2008.*
5	*https://nptel.ac.in/courses/110105094*
6	*https://archive.nptel.ac.in/courses/110/105/110105094/*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Gain the knowledge about occupational health hazard and safety measures at work place.	K3
CO2	Learn about accident prevention and safety management.	K2
CO3	Understand occupational health hazards and general safety measures in industries.	K3
CO4	Know various laws, standards and legislations.	K2
CO5	Implement safety and proper management of industries.	K4

COURSE ARTICULATION MATRIX:					
Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	1	1	1	1
CO2	2	2	1	1	1
CO3	1	2	1	1	1
CO4	2	1	1	1	1
CO5	2	1	2	1	1
23MFOE13	**2**	**1**	**1**	**1**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	-	50	50	-	-	-	100
CAT2	-	50	30	20	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	50	50	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	50	30	20	-	-	100
ESE	-	40	40	20	-	-	100

23MFOE14	COST MANAGEMENT OF ENGINEERING PROJECTS *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	1. To understand the costing concepts and their role in decision making. 2. To acquire the project management concepts and their various aspects in selection. 3. To gain the knowledge in costing concepts with project execution. 4. To develop knowledge of costing techniques in service sector and various budgetary control techniques. 5. To familiarize with quantitative techniques in cost management.	
UNIT – I	**INTRODUCTION TO COSTING CONCEPTS**	**9 Periods**
Introduction and Overview of the Strategic Cost Management Process, Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision - Making.		
UNIT – II	**PROJECT PLANNING ACTIVITIES**	**9 Periods**
Project: meaning, Different types, why to manage, cost overruns centers, 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. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process.		
UNIT – III	**COST ANALYSIS**	**9 Periods**
Cost Behaviour and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis.		
UNIT – IV	**PRICING STRATEGIES AND BUDGETORY CONTROL**	**9 Periods**
Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing, Costing of service sector, Just-in - time approach, Material Requirement Planning, Enterprise Resource Planning. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.		
UNIT – V	**TQM AND OPERATIONS REASEARCH TOOLS**	**9 Periods**
Total Quality Management and Theory of constraints, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Charles T. Horngren and George Foster,* ***Advanced Management Accounting****, 2018.*
2	*John M. Nicholas,****Project Management for Engineering, Business and Technology****, Taylor &Francis, 2016*
3	*Nigel J,* ***Engineering Project Management****, John Wiley and Sons Ltd, Smith 2015.*
4	*Charles T. Horngren and George Foster* ***Cost Accounting a Managerial Emphasis****, Prentice Hall of India, New Delhi, 2011.*
5	*https://archive.nptel.ac.in/courses/110/104/110104073/*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the costing concepts and their role in decision making.	K3
CO2	Apply the project management concepts and analyze their various aspects in selection.	K4
CO3	Interpret costing concepts with project execution.	K4
CO4	Gain knowledge of costing techniques in service sector and various budgetary control techniques.	K2
CO5	Become familiar with quantitative techniques in cost management.	K3

COURSE ARTICULATION MATRIX					
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	1	2	1	1
CO2	2	1	1	1	-
CO3	2	2	2	-	-
CO4	1	1	1	1	1
CO5	1	2	1	1	-
23MFOE14	**1**	**1**	**1**	**1**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	-	-	40	60	-	-	100
CAT2	-	30	30	40	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	-	40	60	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	30	30	40	-	-	100
ESE	-	20	40	40	-	-	100

23MFOE15	**COMPOSITE MATERIALS** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	1. To summarize the characteristics of composite materials and effect of reinforcement in composite materials. 2. To identify the various reinforcements used in composite materials. 3. To compare the manufacturing process of metal matrix composites. 4. To understand the manufacturing processes of polymer matrix composites. 5. To analyze the strength of composite materials.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement on overall composite performance.		
UNIT – II	**REINFORCEMENT**	**9 Periods**
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 Isosteresconditions.		
UNIT – III	**MANUFACTURING OF METAL MATRIX COMPOSITES**	**9 Periods**
Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing- 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 COMPOSITE**	**9 Periods**
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 ANALYSIS OF COMPOSITES**	**9 Periods**
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.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

REFERENCES:

1	*Chawla K.K., **Composite Materials**, Springer, 2013.*
2	*Lubin.G, **Hand Book of Composite Materials**, Springer New York, 2013.*
3	*Deborah D.L. Chung, **Composite Materials Science and Applications**, Springer, 2011.*
4	*uLektz, **Composite Materials and Mechanics**, uLektz Learning Solutions Private Limited, Lektz, 2013.*
5	*https://nptel.ac.in/courses/112104168*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Know the characteristics of composite materials and effect of reinforcement in composite materials.	K2
CO2	Know the various reinforcements used in composite materials.	K2
CO3	Understand and apply the manufacturing processes of metal matrix composites	K3
CO4	Understand and apply the manufacturing processes of polymer matrix composites.	K3
CO5	Analyze the strength of composite materials.	K4

COURSE ARTICULATION MATRIX					
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	2	1	1	1
CO2	2	2	1	1	2
CO3	2	1	2	1	1
CO4	1	2	2	2	1
CO5	1	2	1	1	1
23MFOE15	**1**	**2**	**2**	**1**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	-	60	40	-	-	-	100
CAT2	-	-	60	40	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	60	40	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	-	60	40	-	-	100
ESE	-	40	40	20	-	-	100

23TEOE16	GLOBAL WARMING SCIENCE *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To make the students learn about the material consequences of climate change, sea level change due to increase in the emission of greenhouse gases and to examine the science behind mitigation and adaptation proposals.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Terminology relating to atmospheric particles – Aerosols - Types, characteristics, measurements – Particle mass spectrometry - Anthropogenic-sources, effects on humans.		
UNIT – II	**CLIMATE MODELS**	**9 Periods**
General climate modeling- Atmospheric general circulation model - Oceanic general circulation model, sea ice model, land model concept, paleo-climate - Weather prediction by numerical process. Impacts of climate change - Climate Sensitivity - Forcing and feedback.		
UNIT – III	**EARTH CARBON CYCLE AND FORECAST**	**9 Periods**
Carbon cycle-process, importance, advantages - Carbon on earth - Global carbon reservoirs - Interactions between human activities and carbon cycle - Geologic time scales - Fossil fuels and energy - Perturbed carbon cycle.		
UNIT – IV	**GREENHOUSE GASES**	**9 Periods**
Blackbody radiation - Layer model - Earth's atmospheric composition and Green house gases effects on weather and climate - Radioactive equilibrium - Earth's energy balance.		
UNIT – V	**GEO ENGINEERING**	**9 Periods**
Solar mitigation - Strategies – Carbon dioxide removal - Solar radiation management - Recent observed trends in global warming for sea level rise, drought, glacier extent.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0Periods** **Practical: 0 Periods** **Total: 45 Periods**		

REFERENCES:

1	*Eli Tziperman,* ***"Global Warming Science: A Quantitative Introduction to Climate Change and Its Consequences"****, Princeton University Press, 1st Edition, 2022.*
2	*John Houghton,* ***"Global warming: The Complete Briefing"****, Cambridge University Press, 5th Edition, 2015.*
3	*David Archer,* ***"Global warming: Understanding the Forecast"****, Wiley, 2nd Edition, 2011.*
4	*David S.K. Ting, Jacqueline A Stagner,* ***"Climate Change Science: Causes, Effects and Solutions for Global Warming"****, Elsevier, 1st Edition, 2021.*
5	*Frances Drake,* ***"Global Warming: The Science of Climate Change"****,Routledge, 1st edition, 2000.*
6	*Dickinson,* ***"Climate Engineering-A review of aerosol approaches to changing the global energybalance"****, Springer, 1996.*
7	*Andreas Schmittner,* ***"Introduction to Climate Science"****, Oregon State University, 2018.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the global warming in relation to climate changes throughout the earth.	K2
CO2	Assess the best predictions of current climate models.	K4
CO3	Understand the importance of carbon cycle and its implication on fossil fuels.	K2
CO4	Know about current issues, including impact from society, environment, economy as well as ecology related to greenhouse gases.	K4
CO5	Know the safety measures and precautions regarding global warming.	K5

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	2	1	1	2
CO2	1	1	2	1	1	1
CO3	1	2	1	1	1	2
CO4	1	1	1	1	1	2
CO5	2	1	2	1	1	2
23TEOE16	**1**	**1**	**1**	**1**	**1**	**2**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	35	35	10	-	-	100
CAT2	15	25	25	20	15	-	100
Individual Assessment 1 / Case Study 1 / Seminar 1 / Project 1	25	20	20	35	-	-	100
Individual Assessment 2 / Case Study 2 / Seminar 2 / Project 2	20	20	35	15	10	-	100
ESE	25	20	25	20	10	-	100

23TEOE17	**INTRODUCTION TO NANO ELECTRONICS** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To make the students provide strong, essential, important methods and foundations of quantum mechanics and apply quantum mechanics on engineering fields.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Particles and Waves - Operators in quantum mechanics - The Postulates of quantum mechanics - The Schrodinger equation values and wave packet Solutions - Ehrenfest's Theorem.		
UNIT – II	**ELECTRONIC STRUCTURE AND MOTION**	**9 Periods**
Atoms- The Hydrogen Atom - Many-Electron Atoms – Pseudopotentials, Nuclear Structure, Molecules, Crystals - Translational motion – Penetration through barriers – Particle in a box - Two terminal quantum dot devices - Two terminal quantum wire devices.		
UNIT – III	**SCATTERING THEORY**	**9 Periods**
The formulation of scattering events - Scattering cross section - Stationary scattering state - Partial wave stationary scattering events - multi-channel scattering - Solution for Schrodinger equation-Radial and wave equation - Greens' function.		
UNIT – IV	**CLASSICAL STATISTICS**	**9 Periods**
Probabilities and microscopic behaviours - Kinetic theory and transport processes in gases - Magnetic properties of materials - The partition function.		
UNIT – V	**QUANTUM STATISTICS**	**9 Periods**
Statistical mechanics - Basic Concepts - Statistical models applied to metals and semiconductors - The thermal properties of solids- The electrical properties of materials - Black body radiation - Low temperatures and degenerate systems.		
Contact Periods: **Lecture:45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total:45 Periods**		

REFERENCES:

1	*Vladimi V.Mitin, Viatcheslav A. Kochelap and Michael A.Stroscio,* ***"Introduction to Nanoelectronics: Science, Nanotechnology, Engineering, and Applications"****, Cambridge University Press, 1st Edition, 2007.*
2	*Vinod Kumar Khanna,* ***"Introductory Nanoelectronics: Physical Theory and Device Analysis"****, Routledge, 1st Edition, 2020.*
3	*George W. Hanson,* ***"Fundamentals of Nanoelectronics"****, Pearson Publishers, United States Edition, 2007.*
4	*Marc Baldo,* ***"Introduction to Nanoelectronics"****, MIT Open Courseware Publication, 2011.*
5	*Vladimi V.Mitin,* ***"Introduction to Nanoelectronics"****, Cambridge University Press, South Asian Edition, 2009.*
6	*Peter L. Hagelstein, Stephen D. Senturia and Terry P. Orlando, "****Introductory Applied Quantum Statistical Mechanics"****, Wiley, 2004.*
7	*A. F. J. Levi,* ***"Applied Quantum Mechanics"****, 2nd Edition, Cambridge, 2012.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the postulates of quantum mechanics.	K2
CO2	Know about nano electronic systems and building blocks.	K2
CO3	Solve the Schrodinger equation in 1D, 2D and 3Ddifferent applications.	K4
CO4	Learn the concepts involved in kinetic theory of gases.	K2
CO5	Know about statistical models applies to metals and semiconductor.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	1	1	1	1	1
CO2	2	2	1	1	1	1
CO3	2	2	2	1	1	1
CO4	1	1	1	1	1	1
CO5	1	1	1	1	1	1
23TEOE17	**1**	**1**	**1**	**1**	**1**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	30	20	20	-	-	100
CAT2	30	30	20	20	-	-	100
Individual Assessment 1 / Case Study 1 / Seminar 1 / Project 1	35	25	20	20	-	-	100
Individual Assessment 2 / Case Study 2 / Seminar 2 / Project 2	30	25	20	25	-	-	100
ESE	20	30	30	20	-	-	100

23TEOE18	GREEN SUPPLY CHAIN MANAGEMENT *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To make the students learn and focus on the fundamental strategies, tools and techniques required to analyze and design environmentally sustainable supply chain systems.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Intro to SCM – complexity in SCM, Facility location - Logistics – Aim, activities, importance, progress, current trends - Integrating logistics with an organization.		
UNIT – II	**ESSENTIALS OF SUPPLY CHAIN MANAGEMENT**	**9 Periods**
Basic concepts of supply chain management - Supply chain operations – Planning and sourcing - Making and delivering - Supply chain coordination and use of technology - Developing supply chain systems.		
UNIT – III	**PLANNING THE SUPPLY CHAIN**	**9 Periods**
Types of decisions – strategic, tactical, operational - Logistics strategies, implementing the strategy - Planning resources – types, capacity, schedule, controlling material flow, measuring and improving performance.		
UNIT – IV	**ACTIVITIES IN THE SUPPLY CHAIN**	**9 Periods**
Procurement – cycle, types of purchase – Framework of e-procurement - Inventory management – EOQ, uncertain demand and safety stock, stock control - Material handling – Purpose of warehouse and ownership, layout, packaging - Transport – mode, ownership, vehicle routing and scheduling models- Travelling salesman problems - Exact and heuristic methods.		
UNIT – V	**SUPPLY CHAIN MANAGEMENT STRATEGIES**	**9 Periods**
Five key configuration components - Four criteria of good supply chain strategies - Next generation strategies- New roles for end-to-end supply chain management - Evolution of supply chain organization – International issues in SCM – Regional differences in logistics.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Charisios Achillas, Dionysis D. Bochtis, Dimitrios Aidonis and Dimitris Folinas,* ***"Green Supply Chain Management"****, Routledge, 1st Edition, 2019.*
2	*Hsiao-Fan Wang and Surendra M.Gupta,* ***"Green Supply Chain Management: Product Life Cycle Approach"****,McGraw-Hill Education, 1st Edition, 2011.*
1	*Joseph Sarkis and Yijie Dou,* ***"Green Supply Chain Management"****, Routledge, 1st Edition, 2017.*
2	*Arunachalam Rajagopal,* ***"Green Supply Chain Management: A Practical Approach"****, Replica, 2021.*
3	*Mehmood Khan, Matloub Hussain and Mian M. Ajmal,* ***"Green Supply Chain Management for Sustainable Business Practice"****, IGI Global, 1st Edition, 2016.*
4	*S Emmett,* ***"Green Supply Chains: An Action Manifesto"****, John Wiley & Sons Inc, 2010.*
5	*Joseph Sarkis and Yijie Dou,* ***"Green Supply Chain Management: A Concise Introduction"****, Routledge, 1st Edition, 2017.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Integrate logistics with an organization.	K2
CO2	Evaluate complex qualitative and quantitative data to support strategic and operational decisions.	K5
CO3	Develop self-leadership strategies to enhance personal and professional effectiveness.	K3
CO4	Analyze inventory management models and dynamics of supply chain.	K4
CO5	Identify issues in international supply chain management and outsources strategies.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	1	1	1	1	3
CO2	2	2	1	1	1	1
CO3	2	1	2	1	1	1
CO4	2	2	1	1	2	2
CO5	1	1	2	1	1	3
23TEOE18	**2**	**1**	**1**	**1**	**1**	**2**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	30	10	10	-	100
CAT2	30	40	20	10	-	-	100
Individual Assessment 1 / Case Study 1 / Seminar 1 / Project 1	30	20	25	15	10	-	100
Individual Assessment 2 / Case Study 2 / Seminar 2 / Project 2	35	30	25	10	-	-	100
ESE	30	30	20	10	10	-	100

23PSOE19	**DISTRIBUTION AUTOMATION SYSTEM** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To study about the distributed automation and economic evaluation schemes of power network	
UNIT – I	**INTRODUCTION**	**9 Periods**
Introduction to Distribution Automation (DA) - Control system interfaces- Control and data requirements- Centralized (vs) decentralized control- DA system-DA hardware-DAS software.		
UNIT – II	**DISTRIBUTION AUTOMATION FUNCTIONS**	**9 Periods**
DA capabilities - Automation system computer facilities- Management processes- Information management- System reliability management- System efficiency management- Voltage management- Load management.		
UNIT – III	**COMMUNICATION SYSTEMS**	**9 Periods**
Communication requirements - reliability- Cost effectiveness- Data requirements- Two way capability- Communication during outages and faults - Ease of operation and maintenance- Conforming to the architecture of flow. Distribution line carrier- Ripple control-Zero crossing technique- Telephone, cableTV, radio, AM broadcast, FM SCA,VHF radio, microwave satellite, fiber optics-Hybrid communication systems used in field tests.		
UNIT – IV	**ECONOMIC EVALUATION METHODS**	**9 Periods**
Development and evaluation of alternate plans- select study area – Select study period- Project load growth- Develop alternatives- Calculate operating and maintenance costs-Evaluate alternatives.		
UNIT – V	**ECONOMIC COMPARISON**	**9 Periods**
Economic comparison of alternate plans-Classification of expenses - capital expenditures-Comparison of revenue requirements of alternative plans-Book life and continuing plant analysis- Year by year revenue requirement analysis, Short term analysis- End of study adjustment-Break even analysis, sensitivity analysis - Computational aids.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES

1	*M.K. Khedkar, G.M. Dhole,* ***"A Textbook of Electric Power Distribution Automation"****, Laxmi Publications, Ltd., 2010.*
2	*Maurizio Di Paolo Emilio,* ***"Data Acquisition Systems: From Fundamentals to Applied Design"****, Springer Science & Business Media, 21-Mar-2013*
3	*IEEE Tutorial course* ***"Distribution Automation"****, IEEE Working Group on Distribution Automation, IEEE Power Engineering Society. Power Engineering Education Committee, IEEE Power Engineering Society. Transmission and Distribution Committee, Institute of Electrical and Electronics Engineers, 1988*
4	*Taub,* ***"Principles Of Communication Systems",*** *Tata McGraw-Hill Education, 07-Sep-2008*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Analyse the requirements of distributed automation	K1
CO2	Know the functions of distributed automation	K2
CO3	Perform detailed analysis of communication systems for distributed automation.	K3
CO4	Study the economic evaluation method	K4
CO5	Understand the comparison of alternate plans	K5

COURSE ARTICULATION MATRIX				
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**
CO1	2	-	1	3
CO2	3	-	3	2
CO3	3	-	3	2
CO4	3	-	3	1
CO5	2	-	1	2
23PSOE19	**3**	**-**	**3**	**2**
1 – Slight, 2 – Moderate, 3 – Substantial				

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	30	20	10	20	-	100
CAT2	20	20	20	20	20	-	100
Individual Assessment1/ Case study1/ Seminar 1/Project1	20	10	30	20	20	-	100
Individual Assessment2/ Case study2/ Seminar 2 /Project2	20	30	10	20	20	-	100
ESE	30	20	20	20	10	-	100

23PSOE20	ELECTRICITY TRADING AND ELECTRICITY ACTS *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To acquire expertise on Electric supply and demand of Indian Grid, gain exposure on energy trading in the Indian market and infer the electricity acts and regulatory authorities.	
UNIT – I	**ENERGY DEMAND**	**9 Periods**
Basic concepts in Economics - Descriptive Analysis of Energy Demand - Decomposition Analysis and Parametric Approach - Demand Side Management - Load Management - Demand Side Management - Energy Efficiency - Rebound Effect		
UNIT – II	**ENERGY SUPPLY**	**9 Periods**
Supply Behavior of a Producer - Energy Investment - Economics of Non-renewable Resources - Economics of Renewable Energy Supply Setting the context - Economics of Renewable Energy Supply - Economics of Electricity Supply		
UNIT – III	**ENERGY MARKET**	**9 Periods**
Perfect Competition as a Market Form - Why is the Energy Market not Perfectly Competitive? - Market Failure and Monopoly - Oil Market: Pre OPEC Era I - Oil Market: Pre OPEC Era II - Oil Market: OPEC		
UNIT – IV	**LAW ON ELECTRICITY**	**9 Periods**
Introduction of the Electricity Law; Constitutional Design - Evolution of Laws on Electricity Salient Features of Electricity Act, 2003 - Evolution of Laws on Electricity - Salient Features of the Electricity Act 2003		
UNIT – V	**REGULATORY COMMISSIONS FOR ELECTRICITY ACT**	**9 Periods**
Regulatory Commissions - Appellate Tribunal - Other Institutions under the Act - Electricity (Amendment) Bill 2020/2021. A Critical Comment - Renewable Energy - Role of Civil Society; Comments on Draft Renewable Energy Act, 2015		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES

1	*Bhattacharyya, Subhes. C. (2011).* ***"Energy Economics: Concepts, Issues, Markets and Governance"****. Springer.London, UK*
2	*Stevens, P. (2000).* ***"An Introduction to Energy Economics. In Stevens, P.(ed.) The Economics of Energy"****, Vol.1, Edward Elgar, Cheltenham, UK.*
3	*Nausir Bharucha,* ***"Guide to the Electricity Laws"****, LexisNexis, 2018*
4	*Mohammad Naseem,* ***"Energy Laws in India"****, Kluwer Law International, 3rd Edn, The Netherlands, 2017.*
5	*Alok Kumar & Sushanta K Chaterjee,* ***"Electricity Sector in India: Policy and Regulation"****, OUP, 2012.*
6	*Benjamin K Sovacool & Michael H Dowrkin,* ***"Global Energy Justice: Problems, Principles and Practices"****, Cambridge Univesity Press, 2014.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Describe electric supply and demand of power grid	K1
CO2	Summarize various energy trading strategies	K2
CO3	Relate the electricity acts practically	K3
CO4	Cite the electricity regulatory authorities	K2
CO5	Analyze/check the existing power grid for its technical and economical sustainability	K4

COURSE ARTICULATION MATRIX				
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**
CO1	3	-	3	3
CO2	3	-	1	1
CO3	3	-	2	2
CO4	3	-	1	2
CO5	3	-	3	3
23PSOE20	**3**	**-**	**2**	**2**
1 – Slight, 2 – Moderate, 3 – Substantial				

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	30	20	30	-	-	100
CAT2	20	20	20	20	20	-	100
Individual Assessment1/ Case study1/ Seminar 1/Project1	20	30	30	20	-	-	100
Individual Assessment2/ Case study2/ Seminar 2 /Project2	20	30	-	20	-	40	100
ESE	30	30	-	20	20	-	100

23PSOE21	MODERN AUTOMOTIVE SYSTEMS *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To expose the students with theory and applications of Automotive Electrical and Electronic Systems.	
UNIT – I	**INTRODUCTION TO MODERN AUTOMOTIVE ELECTRONICS**	**9 Periods**
Introduction to modern automotive systems and need for electronics in automobiles- Role of electronics and microcontrollers- Sensors and actuators- Possibilities and challenges in automotive industry- Enabling technologies and industry trends.		
UNIT – II	**SENSORS AND ACTUATORS**	**9 Periods**
Introduction- basic sensor arrangement- Types of sensors- Oxygen sensor, engine crankshaft angular position sensor – Engine cooling water temperature sensor- Engine oil pressure sensor- Fuel metering- vehicle speed sensor and detonation sensor- Pressure Sensor- Linear and angle sensors- Flow sensor- Temperature and humidity sensors- Gas sensor- Speed and Acceleration sensors- Knock sensor- Torque sensor- Yaw rate sensor- Tyre Pressure sensor- Actuators - Stepper motors – Relays.		
UNIT – III	**POWERTRAIN CONTROL SYSTEMS IN AUTOMOBILE**	**9 Periods**
Electronic Transmission Control - Digital engine control system: Open loop and close loop control systems- Engine cooling and warm up control- Acceleration- Detonation and idle speed control - Exhaust emission control engineering- Onboard diagnostics- Future automotive powertrain systems.		
UNIT – IV	**SAFETY, COMFORT AND CONVENIENCE SYSTEMS**	**9 Periods**
Cruise Control- Anti-lock Braking Control- Traction and Stability control- Airbag control system- Suspension control- Steering control- HVAC Control.		
UNIT – V	**ELECTRONIC CONTROL UNITS (ECU)**	**9 Periods**
Introduction to Energy Sources for ECU, Need for ECUs- Advances in ECUs for automotives - Design complexities of ECUs- V-Model for Automotive ECU's- Architecture of an advanced microcontroller (XC166 Family, 32-bit Tricore) used in the design of automobile ECUs- On chip peripherals, protocol interfaces, analog and digital interfaces.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES

1	*Enrique Acha, Manuel Madrigal**, "Power System Harmonics: Computer Modeling and Analysis**", John Wiley and Sons, 2001.*
2	*M. H. J. Bollen, **"Understanding Power Quality Problems, Voltage Sag and Interruptions",** IEEE Press, series on Power Engineering, 2000.*
3	*Roger C. Dugan, Mark F. McGranaghan, Surya Santoso and Wayne Beaty H., **"Electrical Power SystemQuality"**, Second Edition, McGraw Hill Publication Co., 2008.*
4	*G.T.Heydt, **"Electric Power Quality",** Stars in a Circle Publications, 1994(2nd edition).*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Acquire knowledge about conventional automotive control units and devices.	K1
CO2	Recognize the practical issues in the automotive control systems	K2
CO3	Analyze the impact of modern automotive techniques in various Engineering applications	K4
CO4	Develop modern automotive control system for electrical and electronics systems	K6
CO5	Understand the function of sensors and actuators	K2

COURSE ARTICULATION MATRIX				
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**
CO1	3	-	1	3
CO2	3	-	3	2
CO3	3	-	3	2
CO4	2	-	3	1
CO5	2	-	1	2
23PSOE21	**3**	**-**	**2**	**2**
1 – Slight, 2 – Moderate, 3 – Substantial				

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	30	20	30	-	-	100
CAT2	20	20	20	20	20	-	100
Individual Assessment1/ Case study1/ Seminar 1/Project1	20	30	-	20	-	30	100
Individual Assessment2/ Case study2/ Seminar 2 /Project2	20	30	-	20	-	40	100
ESE	30	30	20	20	-	-	100

23PEOE22	VIRTUAL INSTRUMENTATION *(Common to all Branches)*				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	To comprehend the Virtual instrumentation programming concepts towards measurements and control and to instill knowledge on DAQ, signal conditioning and its associated software tools	
UNIT – I	**INTRODUCTION**	**7 Periods**
Introduction - advantages - Block diagram and architecture of a virtual instrument - Conventional Instruments versus Traditional Instruments - Data-flow techniques, graphical programming in data flow, comparison with conventional programming.		
UNIT – II	**GRAPHICAL PROGRAMMING AND LabVIEW**	**9 Periods**
Concepts of graphical programming - LabVIEW software - Concept of VIs and sub VI - Display types - Digital - Analog - Chart and Graphs. Loops - structures - Arrays – Clusters- Local and global variables – String - Timers and dialog controls.		
UNIT – III	**MANAGING FILES & DESIGN PATTERNS**	**11 Periods**
High-level and low-level file I/O functions available in LabVIEW – Implementing File I/O functions to read and write data to files – Binary Files – TDMS – sequential programming – State machine programming – Communication between parallel loops –Race conditions – Notifiers & Queues – Producer Consumer design patterns		
UNIT – IV	**PC BASED DATA ACQUISITION**	**9 Periods**
Introduction to data acquisition on PC, Sampling fundamentals, ADCs, DACs, Calibration, Resolution, - analog inputs and outputs - Single-ended and differential inputs - Digital I/O, counters and timers, DMA, Data acquisition interface requirements - Issues involved in selection of Data acquisition cards - Use of timer-counter and analog outputs on the universal DAQ card.		
UNIT – V	**DATA ACQUISITION AND SIGNAL CONDITIONING**	**9 Periods**
Components of a DAQ system, Bus, Signal and accuracy consideration when choosing DAQ hardware – Measurement of analog signal with Finite and continuous buffered acquisition- analog output generation – Signal conditioning systems – Synchronizing measurements in single & multiple devices – Power quality analysis using Electrical Power Measurement tool kit.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES :

1	*Jeffrey Travis, Jim Kring,* ***"LabVIEW for Everyone: Graphical Programming Made Easy and Fun" (3rd Edition),*** *Prentice Hall, 2006***.**
2	*Jovitha Jerome,* ***"Virtual Instrumentation using LabVIEW",*** *PHI, 2010*
3	*Gary W. Johnson, Richard Jennings,* ***"LabVIEW Graphical Programming"****, McGraw Hill Professional Publishing, 2019*
4	*Robert H. Bishop,* ***"Learning with LabVIEW"****, Prentice Hall, 2013.*
5	*Kevin James, "****PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control"****, Newness, 2000*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Describe the graphical programming techniques using LabVIEW software.	K2
CO2	Explore the basics of programming and interfacing using related hardware.	K4
CO3	Analyse the aspects and utilization of PC based data acquisition and Instrument interfaces.	K4
CO4	Create programs and Select proper instrument interface for a specific application.	K6
CO5	Familiarize and experiment with DAQ and Signal Conditioning	K3

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	-	3	2	1
CO2	3	-	3	2	1
CO3	3	-	2	2	2
CO4	3	1	3	3	1
CO5	3	1	3	3	2
23PEOE22	**3**	**1**	**3**	**2**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	40	15	15	-	-	100
CAT2	15	10	25	30	20	-	100
Individual Assessment1/ Case study1/ Seminar 1/Project1	10	10	20	30	20	10	100
Individual Assessment2/ Case study2/ Seminar 2 /Project2	25	40	20	15	-	-	100
ESE	30	25	15	20	5	5	100

23PEOE23	ENERGY MANAGEMENT SYSTEMS *(Common to all Branches)*				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	To Comprehend energy management schemes, perform energy audit and execute economic analysis and load management in electrical systems.	
UNIT – I	**GENERAL ASPECTS OF ENERGY AUDIT AND MANAGEMENT**	**9 Periods**
Energy Conservation Act 2001 and policies – Eight National Missions - Basics of Energy and its forms (Thermal and Electrical) - Energy Management and Audit - Energy Managers and Auditors - Types and Methodology Audit Report - Material and energy balance diagrams - .Energy Monitoring and Targeting.		
UNIT – II	**STUDY OF BOILERS, FURNACES AND COGENERATION**	**9 Periods**
Boiler Systems - Types - Performance Evaluation of boilers - Energy Conservation Opportunity - Steam Distribution - Efficient Steam Utilisation - Furnaces:types and classification - Performance evaluation of a typical fuel fired furnace. Cogeneration: Need - Principle - Technical options - classification - Technical parameters and factors influencing cogeneration choice - Prime Movers - Trigeneration.		
UNIT – III	**ENERGY STUDY OF ELECTRICAL SYSTEMS**	**9 Periods**
Electricity Billing – Electricity load management - Maximum Demand Control - Power Factor improvement and its benefits - pf controllers - capacitors - Energy efficient transformers and Induction motors - rewinding and other factors influencing energy efficiency - Standards and labeling programme of distribution transformers and IM - Analysis of distribution losses - demand side management - harmonics - filters - VFD and its selection.		
UNIT – IV	**STUDY OF ELECTRICAL UTILITIES**	**9 Periods**
Compressor types - Performance - Air system components - Efficient operation of compressed air systems- Compressor capacity assessment - HVAC: psychrometrics and air-conditioning processes - Types of refrigeration system - Compressor types and applications - Performance assessment of refrigeration plants - Lighting Systems: Energy efficient lighting controls - design of interior lighting - Case study.		
UNIT – V	**PERFORMANCE ASSESSMENT FOR EQUIPMENT**	**9 Periods**
Performing Financial analysis: Fixed and variable costs – Payback period – ROI - methods – factors affecting analysis. Energy Performance Assessment: Heat exchangers - Fans and Blowers - Pumps. Energy Conservation in buildings and ECBC.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Murphy W.R. and G.Mckay Butter worth , "**Energy Management**", Heinemann Publications, 2007*
2	*Albert Thumann, Terry Niehus, William J. Younger, "**Handbook of Energy Audits"**, Ninth Edition, River Publishers, 2012.*
3	*Dr. Subhash Gadhave Anup Goel Siddu S. Laxmikant D. Jathar, **"Energy Audit & Management"**, Second edition, Technical Publications, 2019.*
4	*S. M. Chaudhari, S. A. Asarkar, M. A. Chaudhari, **"Energy Conservation and Audit"**, Second Edition, Nirali Prakashan Publications, 2021.*
5	www.em-ea.org/gbook1.asp

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Analyze the feature of energy audit methodology and documentation of report.	K3
CO2	Perform action plan and financial analysis	K4
CO3	Familiarize with thermal utilities.	K4
CO4	Familiarize with electrical utilities.	K4
CO5	Perform assessment of different systems.	K5

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	2	1	1
CO2	3	2	2	1	1
CO3	3	2	2	1	1
CO4	3	2	2	1	1
CO5	3	2	2	1	1
23PEOE23	**3**	**2**	**2**	**1**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	30	20	10	-	100
CAT2	10	30	30	20	10	-	100
Individual Assessment1/ Case study1/ Seminar 1/Project1	-	30	30	20	20	-	100
Individual Assessment2/ Case study2/ Seminar 2 /Project2	-	30	30	20	20	-	100
ESE	10	30	30	20	10	-	100

23PEOE24	ADVANCED ENERGY STORAGE TECHNOLOGY *(Common to all Branches)*				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	To explore the fundamentals, technologies and applications of energy storage	
UNIT – I	**ENERGY STORAGE: HISTORICAL PERSPECTIVE, INTRODUCTION AND CHANGES**	**9 Periods**
Storage Needs- Variations in Energy Demand- Variations in Energy Supply- Interruptions in Energy Supply- Transmission Congestion - Demand for Portable Energy-Demand and scale requirements - Environmental and sustainability issues-conventional energy storage methods: battery-types.		
UNIT – II	**TECHNICAL METHODS OF STORAGE**	**9 Periods**
Introduction: Energy and Energy Transformations, Potential energy (pumped hydro, compressed air, springs)- Kinetic energy (mechanical flywheels)- Thermal energy without phase change passive (adobe) and active (water)-Thermal energy with phase change (ice, molten salts, steam)- Chemical energy (hydrogen, methane, gasoline, coal, oil)- Electrochemical energy (batteries, fuel cells)- Electrostatic energy (capacitors), Electromagnetic energy (superconducting magnets)- Different Types of Energy Storage Systems.		
UNIT – III	**PERFORMANCE FACTORS OF ENERGY STORAGE SYSTEMS**	**9 Periods**
Energy capture rate and efficiency- Discharge rate and efficiency- Dispatch ability and load flowing characteristics, scale flexibility, durability – Cycle lifetime, mass and safety – Risks of fire, explosion, toxicity- Ease of materials, recycling and recovery- Environmental consideration and recycling , Merits and demerits of different types of Storage.		
UNIT – IV	**APPLICATION CONSIDERATION**	**9 Periods**
Comparing Storage Technologies- Technology options- Performance factors and metrics- Efficiency of Energy Systems- Energy Recovery - Battery Storage System: Introduction with focus on Lead Acid and Lithium- Chemistry of Battery Operation, Power storage calculations, Reversible reactions, Charging patterns, Battery Management systems, System Performance, Areas of Application of Energy Storage: Waste heat recovery, Solar energy storage, Green house heating, Power plant applications, Drying and heating for process industries, energy storage in automotive applications in hybrid and electric vehicles.		
UNIT – V	**HYDROGEN FUEL CELLS AND FLOW BATTERIES**	**9 Periods**
Hydrogen Economy and Generation Techniques, Storage of Hydrogen, Energy generation - Super capacitors: properties, power calculations – Operation and Design methods - Hybrid Energy Storage: Managing peak and Continuous power needs, options - Level 1: (Hybrid Power generation) Bacitor "Battery + Capacitor" Combinations: need, operation and Merits; Level 2: (Hybrid Power Generation) Bacitor + Fuel Cell or Flow Battery operation-Applications: Storage for Hybrid Electric Vehicles, Regenerative Power, capturing methods.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES :

1	*DetlefStolten, "**Hydrogen and Fuel Cells: Fundamentals, Technologies and Applications**", Wiley, 2010.*
2	*Jiujun Zhang, Lei Zhang, Hansan Liu, Andy Sun, Ru-Shi Liu, "**Electrochemical Technologies for Energy Storage and Conversion**", John Wiley and Sons, 2012.*
3	*Francois Beguin and ElzbietaFrackowiak, "**Super capacitors**", Wiley, 2013.*

4	*Doughty Liaw, Narayan and Srinivasan, "**Batteries for Renewable Energy Storage**", The Electrochemical Society, New Jersy, 2010.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Recollect the historical perspective and technical methods of energy storage.	K1
CO2	Explain the basics of different storage methods.	K2
CO3	Determine the performance factors of energy storage systems.	K2
CO4	Identify applications for renewable energy systems.	K4
CO5	Outline the basics of Hydrogen cell and flow batteries.	K2

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	1	3	3	3
CO2	3	1	3	3	3
CO3	3	1	3	3	3
CO4	3	1	3	3	3
CO5	3	1	3	3	3
23PEOE24	**3**	**1**	**3**	**3**	**3**
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	30	20	10	-	100
CAT2	10	30	30	20	10	-	100
Individual Assessment1/ Case study1/ Seminar 1/ Project1	-	30	30	20	10	10	100
Individual Assessment2/ Case study2/ Seminar 2 / Project2	-	30	30	20	20	-	100
ESE	10	30	30	20	10	-	100

23AEOE25	**DESIGN OF DIGITAL SYSTEMS** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To gain knowledge in the design and VHDL programming of synchronous and asynchronous sequential circuits, PLD's and the basic concepts of testing in VLSI circuits

UNIT–I SYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN	**9 Periods**
Analysis of Clocked Synchronous Sequential Circuits - Modeling, state table reduction, state assignment, Design of Synchronous Sequential circuits, Design of iterative circuits- ASM chart –ASM realization.	
UNIT–II ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN	**9 Periods**
Analysis of Asynchronous Sequential Circuits - Races in ASC – Primitive Flow Table - Flow Table Reduction Techniques, State Assignment Problem and the Transition Table – Design of ASC – Static and Dynamic Hazards – Essential Hazards– Data Synchronizers.	
UNIT–III SYSTEM DESIGN USING PLDS	**9 Periods**
Basic concepts – Programming Technologies - Programmable Logic Element (PLE) – Programmable Array Logic (PLA)-Programmable Array Logic (PAL) –Design of combinational and sequential circuits using PLDs– Complex PLDs (CPLDs).	
UNIT– IV INTRODUCTION TO VHDL	**9 Periods**
Design flow -Software tools – VHDL: Data Objects-Data types – Operators –Entities and Architectures – Components and Configurations – Signal Assignment – Concurrent and Sequential statements — Behavioral, Dataflow and Structural modeling– Transport and Inertial delays –Delta delays-Attributes - Generics–Packages and Libraries.	
UNIT–V LOGIC CIRCUIT TESTING AND TESTABLE DESIGN	**9 Periods**
Digital logic circuit testing - Fault models - Combinational logic circuit testing - Sequential logic circuit testing-Design for Testability - Built-in Self-test, Board and System Level Boundary Scan - Case Study: Traffic Light Controller.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

REFERENCES:

1	*Donald G.Givone, "**Digital principles and Design**", TataMcGrawHill, 2002.*
2	*Nelson, V.P., Nagale, H.T., Carroll, B.D., and Irwin, J.D., "**Digital Logic Circuit Analysis and Design"**, Prentice Hall International, Inc., NewJersey, 1995.*
3	*VolneiA.Pedroni,"**Circuit Design withVHDL**",PHILearning,2011.*
4	*ParagK Lala,"**Digital Circuit Testing and Testability**",AcademicPress,1997.*
5	*CharlesHRoth,"**Digital Systems Design Using VHDL",**Cencage2ndEdition2012.*
6	*NripendraN.Biswas,"**Logic Design Theory**"PrenticeHallofIndia,2001.*

COURSEOUTCOMES: Upon completion of the course ,students will be able to/have:		**Bloom's Taxonomy Mapped**
CO1	To design synchronous sequential circuits based on specifications.	K3
CO2	To design asynchronous sequential circuits based on specifications	K3
CO3	Ability to illustrate digital design implementation using PLDs.	K2
CO4	To develop algorithm and VHDL code for design of digital circuits.	K3
CO5	Understand the different testing methods for combinational and sequential circuits.	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	2	-	-	1
CO2	3	-	2	-	-	1
CO3	3	-	2	-	-	1
CO4	3	-	2	-	-	1
CO5	3	-	2	-	-	1
23AEOE25	**3**	**-**	**2**	**-**	**-**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20	-	-	-	100
CAT2	40	40	20	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	50	50	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	50	50	-	-	-	100
ESE	20	45	35	-	-	-	100

23AEOE26	**BASICS OF NANO ELECTRONICS** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objective	The students will be able to acquire knowledge about nano device fabrication technology, nano structures, nano technology for memory devices and applications of nano electronics in data transmission.

UNIT – I TECHNOLOGY AND ANALYSIS	**9 Periods**
Fundamentals : Dielectric, Ferroelectric and Optical properties - Film Deposition Methods – Lithography Material removing techniques - Etching and Chemical Mechanical Polishing - Scanning Probe Techniques.	
UNIT – II CARBON NANO STRUCTURES	**9 Periods**
Principles and concepts of Carbon Nano tubes - Fabrication - Electrical, Mechanical and Vibration Properties - Applications of Carbon Nano tubes.	
UNIT – III LOGIC DEVICES	**9 Periods**
Silicon MOSFET's: Novel materials and alternative concepts - Single electron devices for logic applications - Super conductor digital electronics - Carbon Nano tubes for data processing.	
UNIT – IV MEMORY DEVICES AND MASS STORAGE DEVICES	**9 Periods**
Flash memories - Capacitor based Random Access Memories - Magnetic Random Access Memories - Information storage based on phase change materials - Resistive Random Access Memories - Holographic Data storage.	
UNIT – V DATA TRANSMISSION AND INTERFACING DISPLAYS	**9 Periods**
Photonic Networks - RF and Microwave Communication System - Liquid Crystal Displays - Organic Light emitting diodes.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

REFERENCES:

1	*Rainer Waser, **"Nano Electronics and Information Technology, Advanced Electronicmaterials and novel devices"**, 3rd Edition, Wiley VCH, 2012.*
2	*T. Pradeep, "**Nano: The essentials**", Tata McGraw Hill, 2007.*
3	*Charles Poole, "**Introduction to Nano Technology**", Wiley Interscience, 2003*
4	*Vladimir V.Mitin, Viatcheslav A. Kochelap, Michael A. Stroscio, "**Introduction to Nano Electronics Science, Nanotechnology, Engineering and Applications**", Cambridge University Press, 2011.*
5	*C.Wasshuber Simon, "**Simulation of Nano Structures Computational Single-Electronics**", Springer, 2001.*
6	*Mark Reed and Takhee Lee, "**Molecular Nano Electronics, American Scientific Publisher, California**", 2003.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		Bloom's Taxonomy Mapped
CO1	Explain principles of nano device fabrication technology.	K2
CO2	Describe the concept of Nano tube and Nano structure.	K2
CO3	Explain the function and application of various nano devices	K3
CO4	Reproduce the concepts of advanced memory technologies.	K2
CO5	Emphasize the need for data transmission and display systems.	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	2	-	-	1
CO2	3	-	2	-	-	1
CO3	3	-	2	-	-	1
CO4	3	-	2	-	-	1
CO5	3	-	2	-	-	1
23AEOE26	**3**	**-**	**2**	**-**	**-**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	50	25	25	-	-	-	100
CAT2	50	25	25	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	50	25	25	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	50	25	2	-	-	-	100
ESE	50	25	25	-	-	-	100

23AEOE27	**ADVANCED PROCESSOR** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objective	The students will be able to acquire knowledge about the high performance RISC, CISC and special purpose processors.

UNIT – I MICROPROCESSOR ARCHITECTURE	**9 Periods**
Instruction set – Data formats – Instruction formats – Addressing modes – Memory hierarchy – registerfile – Cache – Virtual memory and paging – Segmentation – Pipelining – The instruction pipeline – pipeline hazards – Instruction level parallelism – reduced instruction set – Computer principles – RISC versus CISC – RISC properties – RISC evaluation.	
UNIT – II HIGH PERFORMANCE CISC ARCHITECTURE –PENTIUM	**9 Periods**
The software model – functional description – CPU pin descriptions – Addressing modes – Processor flags – Instruction set – Bus operations – Super scalar architecture – Pipe lining – Branch prediction – The instruction and caches – Floating point unit– Programming the Pentium processor.	
UNIT – III HIGH PERFORMANCE CISC ARCHITECTURE – PENTIUM INTERFACE	**9 Periods**
Protected mode operation – Segmentation – paging – Protection – multitasking – Exception and interrupts - Input /Output – Virtual 8086 model – Interrupt processing.	
UNIT – IV HIGH PERFORMANCE RISC ARCHITECTURE: ARM	**9 Periods**
ARM architecture – ARM assembly language program – ARM organization and implementation – ARM instruction set - Thumb instruction set.	
UNIT – V SPECIAL PURPOSE PROCESSORS	**9 Periods**
Altera Cyclone Processor – Audio codec – Video codec design – Platforms – General purpose processor –Digital signal processor – Embedded processor – Media Processor – Video signal Processor – Custom Hardware – Co-Processor.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

REFERENCES:

1	*Daniel Tabak, "**Advanced Microprocessors**", McGraw Hill Inc., 2011.*
2	*James L. Antonakos, "**The Pentium Microprocessor**", Pearson Education, 1997.*
3	*Steve Furber, "**ARM System –On –Chip architecture**", Addison Wesley, 2009.*
4	*Gene. H. Miller, "**Micro Computer Engineering**", Pearson Education, 2003.*
5	*Barry. B. Brey, "**The Intel Microprocessors Architecture, Programming and Interfacing**", PHI, 2008.*
6	*Valvano, "**Embedded Microcomputer Systems**" Cencage Learing India Pvt Ltd, 2011.*
7	*Iain E.G. Richardson, "**Video codec design**", John Wiley & sons Ltd, U.K, 2002.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Describe the fundamentals of various processor architecture.	K2
CO2	Interpret and understand the high performance features in CISC architecture.	K2
CO3	Describe the concepts of Exception and interrupt processing.	K2
CO4	Develop programming skill for ARM processor.	K3
CO5	Explain various special purpose processor	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	2	-	-	1
CO2	3	-	2	-	-	1
CO3	3	-	2	-	-	1
CO4	3	-	2	-	-	1
CO5	3	-	2	-	-	1
23AEOE27	**3**	**-**	**2**	**-**	**-**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20	-	-	-	100
CAT2	40	40	20	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	50	50	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	50	50	-	-	-	100
ESE	30	40	30	-	-	-	100

23VLOE28	**HDL PROGRAMMING LANGUAGES** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objective	• To code and simulate any digital function in Verilog HDL and understand the difference between synthesizable and non-synthesizable codes.	
UNIT – I	**VERILOGINTRODUCTIONANDMODELING**	**9 Periods**
Introduction to Verilog HDL, Language Constructs and Conventions, Gate Level Modeling, Modeling at Dataflow Level, Behavioral Modeling, Switch Level Modeling, System Tasks, Functions and Compiler Directives.		
UNIT – II	**SEQUENTIALMODELINGANDTESTING**	**9 Periods**
Sequential Models - Feedback Model, Capacitive Model, Implicit Model, Basic Memory Components, Functional Register, Static Machine Coding, Sequential Synthesis. Test Bench - Combinational Circuits Testing, Sequential Circuit Testing, Test Bench Techniques, Design Verification, Assertion Verification.		
UNIT – III	**SYSTEMVERILOG**	**9 Periods**
Introduction, System Verilog declaration spaces, System Verilog Literal Values and Built-in Data Types, System Verilog User-Defined and Enumerated Types, system Verilog Arrays, Structures and Unions, system verilog Procedural Blocks, Tasks and Functions.		
UNIT – IV	**SYSTEMVERILOGMODELING**	**9 Periods**
System Verilog Procedural Statements, Modeling Finite State Machines with System Verilog, System Verilog Design Hierarchy.		
UNIT – V	**INTERFACES AND DESIGN MODEL**	**9 Periods**
System Verilog Interfaces, A Complete Design Modeled with System Verilog, Behavioral and Transaction Level Modeling.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*T.R.Padmanabhan, B Bala Tripura Sundari, "**Design through Verilog HDL",** Wiley 2009.*
2	*Stuart Sutherland, Simon Davidmann ,Peter Flake , Foreword by Phil Moorby, "**System Verilog For Design Second Edition A Guide to Using System Verilog for Hardware Design and Modelling",** Springer 2006.*
3	*Samir Palnitkar, "**Verilog HDL**", 2nd Edition, Pearson Education, 2009.*
4	*ZainalabdienNavabi,"**Verilog Digital System Design",**TMH,2ndEdition,2005.*
5	*System Verilog 3.1a, Language Reference Manual, Accellera, 2004*
6	*Dr.SRamachandran, "**Digital VLSI Systems Design: A Design Manual for Implementation of Projects on FPGAs and ASICs Using Verilog",** Springer, 2007.*
7	*Chris Spear, "**System verilog for verification a guide to learning the test bench Language Features**", Springer 2006.*
6	*Stuart Sutherland, Simon Davidmann, Peter Flake, "**System Verilog For Design: A Guide to Using System Verilog for Hardware Design and Modeling**" 1st Edition, 2003*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the verilog coding and simulate any digital function using Verilog HDL	K2
CO2	Develop sequential modeling based Verilog HDL code and develop the test bench for the modeling	K3
CO3	Explain the system verilog modeling	K2
CO4	Differentiate the synthesizable and non-synthesizable code	K3
CO5	Apply good coding techniques on system verilog interfaces and complete design model	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	-	2	-	2
CO2	3	3	-	2	-	2
CO3	3	3	-	2	-	2
CO4	3	3	-	2	-	2
CO5	3	3	-	2	-	2
23VLOE28	**3**	**3**	**-**	**2**	**-**	**2**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20	-	-	-	100
CAT2	40	40	20	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	50	50	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	50	50	-	-	-	100
ESE	40	40	20	-	-	-	100

23VLOE29	**CMOS VLSI DESIGN** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objective	• To gain knowledge on CMOS Circuits with its characterization and to design CMOS logic and sub-system with low power	
UNIT – I	**INTRODUCTION TO MOS CIRCUITS**	**9 Periods**
MOS Transistor Theory -Introduction MOS Device Design Equations -MOS Transistor as a Switches - Pass Transistor - CMOS Transmission Gate -Complementary CMOS Inverter - Static Load MOS Inverters - Inverters with NMOS loads - Differential Inverter - Tri State Inverter - BiCMOS Inverter.		
UNIT – II	**CIRCUIT CHARACTERIZATION AND PERFORMANCE ESTIMATION**	**9 Periods**
Delay Estimation, Logical Effort and Transistor Sizing, Power Dissipation, Sizing Routing Conductors, Charge Sharing, Design Margin and Reliability.		
UNIT – III	**CMOS CIRCUIT AND LOGIC DESIGN**	**9 Periods**
CMOS Logic Gate Design, Physical Design of CMOS Gate, Designing with Transmission Gates, CMOS Logic Structures, Clocking Strategies, I/O Structures.		
UNIT – IV	**CMOS SUBSYSTEM DESIGN**	**9 Periods**
DataPath Operations-Addition/Subtraction, Parity Generators, Comparators, Zero/One Detectors, Binary Counters, ALUs, Multipliers, Shifters, Memory Elements, Control-FSM, Control Logic Implementation.		
UNIT – V	**LOWPOWERCMOS VLSIDESIGN**	**9 Periods**
Introduction to Low Power Design, Power Dissipation in FET Devices, Power Dissipation in CMOS, Low-Power Design through Voltage Scaling – VTCMOS Circuits, MTCMOS Circuits, Architectural Level Approach – Pipelining and Parallel Processing Approaches, Low Power Basics CMOS Gate and Adder Design.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Sung Mo Kang,Yusuf Lablebici,**"CMOS Digital Integrated Circuits:Analysis & Design"**, Tata Mc-Graw Hill, 2011.*
2	*N.Weste and K.Eshranghian, **"Principles of CMOS VLSI Design"**, AddisonWesley, 1998.*
3	*Neil H. E. Weste, David Harris, Ayan Banerjee, **"CMOS VLSI Design: A Circuits and Systems Perspective"**, Pearson Education 2013.*
4	*Kiat-Seng Yeo,Kaushik Roy,**"Low-Voltage, Low-Power VLSI Subsystems",** McGraw-Hill Professional, 2004.*
5	*Gary K.Yeap, **"Practical Low Power Digital VLSI Design"**, Kluwer Academic Press, 2002.*
6	*Jan M .Rabaey,**"Digital Integrated Circuits: A Design Perspective"**, Pearson Education, 2003.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the MOS circuits and Transmission gates	K2
CO2	Illustrate the CMOS Circuits with its characterization	K2
CO3	Design CMOS logic circuits	K3
CO4	Design CMOS sub-system	K3
CO5	Discuss low power CMOS VLSI Design	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	-	2	-	3
CO2	2	1	-	2	-	3
CO3	2	1	-	2	-	3
CO4	3	1	-	2	-	3
CO5	3	1	-	2	-	3
23VLOE29	**3**	**1**	**-**	**2**	**-**	**3**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20	-	-	-	100
CAT2	40	40	20	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	50	50	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	50	50	-	-	-	100
ESE	40	40	20	-	-	-	100

23VLOE30	**HIGH LEVEL SYNTHESIS** *(Common to all Branches)*				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objective	• To provide students with foundations in High level synthesis, verification and CAD Tools	
UNIT – I	**HIGH-LEVEL SYNTHESIS (HLS) FUNDAMENTALS**	**9 Periods**
Overview HLS flow, Scheduling Techniques, Resource sharing and Binding Techniques, Data-path and Controller Generation Techniques.		
UNIT – II	**HIGH LEVEL SYNTHESIS**	**9 Periods**
Introduction to HDL, HDL to DFG, operation scheduling: constrained and unconstrained scheduling, ASAP, ALAP, List scheduling, Force directed Scheduling, operator binding, Static Timing Analysis: Delay models, setup time, hold time, cycle time, critical paths, Topological mvs. Logical timing analysis, False paths, Arrival time (AT), Required arrival Time (RAT), Slacks.		
UNIT – III	**HIGH-LEVEL SYNTHESIS VERIFICATION**	**9 Periods**
Simulation based verification - Formal Verification of digital systems- BDD based approaches, functional equivalence, finite state automata, ω-automata, FSM verification.		
UNIT – IV	**CAD TOOLS FOR SYNTHESIS**	**9 Periods**
CAD tools for synthesis, optimization, simulation and verification of design at various levels as well as for special realizations and structures such as microprogrammes, PLAs, gate arrays etc. Technology mapping for FPGAs. Low power issues in high level synthesis and logic synthesis.		
UNIT – V	**ADVANCED TOPICS**	**9 Periods**
Relative Scheduling, IO scheduling modes - cycle fixed scheduling modes, super-fixed scheduling modes, free-floating scheduling mode, Pipelining, Handshaking, System Design, High-Level Synthesis for FPGA.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES :

1	*Philippe Coussy and Adam Morawiec, "**High-level Synthesis from Algorithm to Digital Circuit**",*
2	*Sherwani, N., "**Algorithms for VLSI Physicsl Design Automation**", Springer, 3rd ed., 2005.*
3	*D. Micheli,"**Synthesis and optimization of digital systems**", Mc Graw Hill, 2005.*
4	*Dutt, N. D. and Gajski, D. D., "**High level synthesis**", Kluwer, 2000.*
5	*Gerez S.H., "**Algorithms for VLSI Design Automation**", John Wiley (1998)*
6	*David. C. Ku and G. De Micheli, "**High-level Syntehsis of ASICs Under Timing and Synchronization Constraints**", Kluwer Academic Publishers, 1992.*
7	*K. Parhi, "**VLSI Digital Signal Processing Systems: Design and Implementation**", Jan 1999, Wiley.*
8	*Egon Boerger and Robert Staerk "**Abstract State Machines: A Method for High-Level System Design and Analysis**", Springer, 2006.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		Bloom's Taxonomy Mapped
CO1	Understand the fundamentals of High level synthesis	K2
CO2	Synthesis the HDL for operation scheduling	K2
CO3	Simulate and verify any digital systems	K2
CO4	Apply CAD tools for synthesis	K2
CO5	Have knowledge on various scheduling modes	K2

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	-	2	2	-
CO2	2	2	-	2	2	-
CO3	2	2	-	2	2	-
CO4	2	2	-	2	2	-
CO5	2	2	-	2	2	-
23VL0E30	**2**	**2**	**-**	**2**	**2**	**-**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	50	50		-	-	-	100
CAT2	50	50		-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	50	50	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	50	50	-	-	-	100
ESE	50	50		-	-	-	100

23CSOE31	**ARTIFICIAL INTELLIGENCE** *(Common to all Branches)*

PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	Identify and apply AI techniques in the design of systems that act intelligently, making automatic decisions and learn from experience.	
UNIT – I	**SEARCH STRATEGIES**	**L(9)**
Uninformed Strategies – BFS, DFS, Djisktra, Informed Strategies – A* search, Heuristic functions, Hill Climbing, Adversarial Search – Min-max algorithm, Alpha-beta Pruning		
UNIT – II	**PLANNING AND REASONING**	**L(9)**
State Space search, Planning Graphs, Partial order planning, Uncertain Reasoning – Probabilistic Reasoning, Bayesian Networks, Dempster Shafer Theory, Fuzzy logic		
UNIT – III	**PROBABILISTIC REASONING**	**L(9)**
Probabilistic Reasoning over Time - Hidden Markov Models, Kalman Filters, Dynamic Bayesian Networks. Knowledge Representations – Ontological Engineering, Semantic Networks and description logics.		
UNIT – IV	**DECISION MAKING**	**L(9)**
Utility Theory, Utility Functions, Decision Networks – Sequential Decision Problems – Partially Observable MDPs – Game Theory.		
UNIT – V	**REINFORCEMENT LEARNING**	**L(9)**
Reinforcement Learning - Passive and active reinforcement learning - Generations in Reinforcement Learning - Policy Search – Deep Reinforcement Learning.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES :

1	*Deepak Khemani,* ***"A First Course in Artificial Intelligence",*** *Tata Mc Graw Hill Education 2013*
2	*Yang Q,* ***" Intelligent Planning: A decomposition and Abstraction based Approach",*** *Springer, 2006*
3	*Russell and Norvig,* ***"Artificial Intelligence, A Modern Approach"****, 3rd edition, Pearson Prentice Hall, 2010.*
4	*Elaine Rich,Kevin Knight,Shivashankar B. Nair,* ***"Artificial Intelligence",*** *3rd edition, TataMcGraw Hill, 2009.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		Bloom's Taxonomy Mapped
CO1	Use search techniques to solve AI problems	K2
CO2	Reason facts by constructing plans and understand uncertainty efficiently.	K3
CO3	Examine data using statistical codes and solve complex AI problems	K6
CO4	Apply techniques to make apt decisions.	K4
CO5	Use deep reinforcement learning to solve complex AI problems	K6

COURSE ARTICULATION MATRIX						
COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	2	-	3	3
CO2	3	-	2	-	3	3
CO3	3	-	3	-	3	3
CO4	3	-	3	-	3	3
CO5	3	-	3	-	3	3
23CSOE31	**3**	**-**	**3**	**-**	**3**	**3**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	-	20	40	20	20	-	100
CAT2	-	10	20	40	10	20	100
Individual Assessment 1/ Case study 1/ Seminar 1/ Project 1	-	-	-	-	50	50	100
Individual Assessment 2/ Case study 2/ Seminar 2/ Project 2	-	-	-	-	50	50	100
ESE	30	30	40	-	-	-	100

23CSOE32	COMPUTER NETWORK MANAGEMENT *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	After the completion of the course, the students will be able to understand the concept of layering in networks, functions of protocols of each layer of TCP/IP protocol suite, concepts related to network addressing and routing and build simple LANs, perform basic configurations for routers and switches, and implement IPv4 and IPv6 addressing schemes using Cisco Packet Tracer.	
UNIT – I	**INTRODUCTION AND APPLICATION LAYER**	**L(9)**
Building network – Network Edge and Core – Layered Architecture – OSI Model – Internet Architecture (TCP/IP) Networking Devices: Hubs, Bridges, Switches, Routers, and Gateways – Performance Metrics - Ethernet Networking – Introduction to Sockets – Application Layer protocols – HTTP – FTP Email Protocols – DNS.		
UNIT – II	**TRANSPORT LAYER AND ROUTING**	**L(9)**
Transport Layer functions –User Datagram Protocol – Transmission Control Protocol – Flow Control – Retransmission Strategies – Congestion Control - Routing Principles – Distance Vector Routing – Link State Routing – RIP – OSPF – BGP – Introduction to Quality of Service (QoS).Case Study: Configuring RIP, OSPF BGP using Packet tracer		
UNIT – III	**NETWORK LAYER**	**L(9)**
Network Layer: Switching concepts – Internet Protocol – IPV4 Packet Format – IP Addressing – Subnetting – Classless Inter Domain Routing (CIDR) – Variable Length Subnet Mask (VLSM) – DHCP – ARP – Network Address Translation (NAT) – ICMP – Concept of SDN.Case Study: Configuring VLAN, DHCP, NAT using Packet tracer		
UNIT – IV	**INTERNETWORK MANAGEMENT**	**L(9)**
Introduction to the Cisco IOS - Router User Interface – CLI - Router and Switch Administrative Functions - Router Interfaces - Viewing, Saving, and Erasing Configurations - Switching Services - Configuring Switches - Managing Configuration Registers - Backing Up and Restoring IOS - Backing Up and Restoring the Configuration - Using Discovery Protocol (CDP) - Checking Network Connectivity		
UNIT – V	**TRAFFIC MANAGEMENT AND WAN PROTOCOLS**	**L(9)**
Managing Traffic with Access Lists: Introduction to Access Lists - Standard Access Lists - Extended Access Lists - Named Access Lists - Monitoring Access Lists - Wide Area Networking Protocols: Introduction to Wide Area Networks - Cabling the Wide Area Network - High-Level Data-Link Control (HDLC) Protocol - Point-to-Point Protocol (PPP) - Frame Relay: Frame Relay Implementation and Monitoring - Integrated Services Digital Network (ISDN) - Dial-on-Demand Routing (DDR): Configuring DDR		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES :

1	*James F. Kurose, Keith W. Ross,* ***"Computer Networking: A Top-Down Approach",*** *Seventh Edition, Pearson Education, 2017.*
2	*William Stallings,* ***"Data and Computer Communications",*** *Tenth Edition, Pearson Education, 2014*
3	*Larry L. Peterson, Bruce S. Davie,* ***"Computer Networks: A Systems Approach",*** *Fifth Edition, Morgan Kaufmann Publishers Inc., 2011.*
4	*Todd Lammle,* ***"CCNA™: Cisco® Certified Network Associate Study Guide",*** *5th Edition, Sybex, 2003*

5	*Ying-Dar Lin, Ren-Hung Hwang, Fred Baker,* ***"Computer Networks: An Open Source Approach",*** *McGraw Hill, 2012.*
6	*Ron Gilster, Jeff Bienvenu, and Kevin Ulstad,* ***"CCNA for Dummies",*** *IDG Books Worldwide, 2000*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Highlight the significance of the functions of each layer in the network.	K1
CO2	Identify the devices and protocols to design a network and implement it.	K4
CO3	Apply addressing principles such as subnetting and VLSM for efficient routing.	K3
CO4	Build simple LANs, perform basic configurations for routers and switches	K6
CO5	Illustrate various WAN protocols	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	3	-	2	1
CO2	3	-	3	-	2	2
CO3	3	-	3	-	3	2
CO4	3	-	3	-	3	3
CO5	3	-	3	-	3	3
23CSOE32	**3**	**-**	**3**	**-**	**3**	**2**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	30	20	20	-	-	100
CAT2	-	30	20	30	10	10	100
Individual Assessment 1 /Case Study 1 / Seminar 1 / Project 1	10	30	20	20	20	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2/ Project 2	-	20	20	20	20	20	100
ESE	20	40	40	-	-	-	100

23CSOE33	BLOCKCHAIN TECHNOLOGIES *(Common to all Branches)*				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	The objective of the course is to explore basics of block chain technology and its application in various domaiin	
UNIT – I	**INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN**	**L(9)**
History of Blockchain - Types of blockchain- CAP theorem and blockchain – benefits and Limitations of Blockchain – Decentalization using blockchain – Blockchain implementations- Block chain in practical use - Legal and Governance Use Cases		
UNIT – II	**BITCOIN AND CRYPTOCURRENCY**	**L(9)**
Introduction to Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain and Digital Currency, Transactional Blocks, Impact of Blockchain Technology on Cryptocurrency		
UNIT – III	**ETHEREUM**	**L(9)**
Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, , Transactions, Receiving Ethers, Smart Contracts		
UNIT – IV	**HYPERLEDGER AND SOLIDITY PROGRAMMING**	**L(9)**
Introduction to Hyperledger, Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer. Solidity – Programming with solidity		
UNIT – V	**BLOCKCHAIN APPLICATIONS**	**L(9)**
Ten Steps to build your Blockchain application – Application: Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Imran Bashir,* ***"Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained"****, Second Edition, Packt Publishing, 2018.*
2	*Joseph J. Bambara Paul R. Allen,* ***"Blockchain A Practical Guide to Developing Business, Law, and Technology Solutions"****,McGraw Hill Education ,2018.*
3	*Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder,* ***"Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction"*** *Princeton University Press, 2016.*
4	*Manav Gupta* ***"Blockchain for Dummies",*** *IBM Limited Edition 2017.*
5	*Antonopoulos and G. Wood,* ***"Mastering Ethereum: Building Smart Contracts and Dapps",*** *O'Reilly Publishing, 2018*
6	***NPTEL Course : Blockchain and its applications*** *https://archive.nptel.ac.in/courses/106/105/106105235/*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Comprehend the working of Blockchain technology	K2
CO2	Narrate working principle of smart contracts and create them using solidity for given scenario.	K3
CO3	Comprehend the working of Hyperledger in an real time application	K2
CO4	Apply the learning of solidity to build de-centralized apps on Ethereum	K3
CO5	Develop applications on Blockchain	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2		3	2	-	3
CO2	2	3	3	3	2	3
CO3	3		3	2	-	3
CO4	3	3	3	3	2	3
CO5	3	3	3	3	2	3
23CSOE33	**3**	**3**	**3**	**3**	**2**	**3**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1)%**	**Understanding (K2) %**	**Applying (K3)%**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	40	-	-	-	100
CAT2	20	30	50	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	70	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	40	60	-	-	-	100
ESE	10	60	30	-	-	-	100

23CSACZ1	ENGLISH FOR RESEARCH PAPER WRITING *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	AC	2	0	0	0

Course Objectives	The objective of the course is to make the learners understand the format and intricacies involved in writing a research paper.	
UNIT – I	**PLANNING AND PREPARATION**	**6 Periods**
Need for publishing articles, Choosing the journal, Identifying a model journal paper, Creation of files for each section, Expectations of Referees, Online Resources.		
UNIT – II	**SENTENCES AND PARAGRAPHS**	**6 Periods**
Basic word in English, Word order in English and Vernacular, placing nouns, Verbs, Adjectives, and Adverb suitably in a sentence, Using Short Sentences, Discourse Markers and Punctuations- Structure of a Paragraph, Breaking up lengthy Paragraphs.		
UNIT – III	**ACCURACY, BREVITY AND CLARITY (ABC) OF WRITING**	**6 Periods**
Accuracy, Brevity and Clarity in Writing, Reducing the linking words, Avoiding redundancy, Appropriate use of Relative and Reflexive Pronouns, Monologophobia, verifying the journal style, Logical Connections between others author's findings and yours.		
UNIT – IV	**HIGHLIGHTING FINDINGS, HEDGING AND PARAPHRASING**	**6 Periods**
Making your findings stand out, Using bullet points headings, Tables and Graphs- Availing non-experts opinions, Hedging, Toning Down Verbs, Adjectives, Not over hedging, Limitations of your research.		
UNIT – V	**SECTIONS OF A PAPER**	**6 Periods**
Titles, Abstracts, Introduction, Review of Literature, Methods, Results, Discussion, Conclusions, References.		
Contact Periods: **Lecture: 30 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 30 Periods**		

REFERENCES :

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

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	**U**nderstand the need for writing good research paper.	K2
CO2	Practice the appropriate word order, sentence structure and paragraph writing.	K4
CO3	Practice unambiguous writing.	K3
CO4	Avoid wordiness in writing.	K2
CO5	Exercise the elements involved in writing journal paper.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	1	1	1	1
CO2	3	3	1	1	1	1
CO3	3	3	1	1	1	1
CO4	3	3	1	1	1	1
CO5	3	3	1	1	1	1
23CSACZ1	**3**	**3**	**1**	**1**	**1**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20	-	-	-	100
CAT2	40	40	20	-	-	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1/ Project 1	-	50	50	-	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	-	50	50	-	-	-	100
ESE	30	30	40	-	-	-	100

23CSACZ2	**DISASTER MANAGEMENT** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	AC	2	0	0	0

Course Objectives	1. To become familiar in key concepts and consequences about hazards, disaster and area of occurrence. 2. To know the various steps in disaster planning. 3. To create awareness on disaster preparedness and management.	
UNIT – I	**INTRODUCTION**	**6 Periods**
Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude. Areas proneto ,EarthquakesFloods ,Droughts, Landslides , Avalanches ,Cyclone and Coastal Hazards with Special Reference to Tsunami.		
UNIT – II	**REPERCUSSIONS OF DISASTERS AND HAZARDS**	**6 Periods**
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 PLANNING**	**6 Periods**
Disaster Planning-Disaster Response Personnel roles and duties, Community MitigationGoals, Pre-Disaster Mitigation Plan, Personnel Training, Comprehensive Emergency Management, Early Warning Systems.		
UNIT – IV	**DISASTER PREPAREDNESS AND MANAGEMENT**	**6 Periods**
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 Periods**
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.		
Contact Periods: **Lecture: 30 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 30 Periods**		

REFERENCES:

1	*R. Nishith, Singh AK, **"Disaster Management In India: Perspectives, Issues And Strategies"**, New Royal book Company, 2007.*
2	*Sahni, PardeepEt.Al. (Eds.), **"Disaster Mitigation Experiences And Reflections"**, Prentice Hall Of India, New Delhi, 2010*
3	*Goel S. L, **"Disaster Administration And Management Text And Case Studies"**, Deep &Deep Publication Pvt. Ltd., New Delhi, 2008.*
4	*Jagbir Singh, **"Disaster Management: Future Challenges And Opportunities"**, I.K. International Publishing House Pvt. Ltd., New Delhi, 2007.*
5	*Damon Coppola **"Introduction To International Disaster Management"**, Butterworth-Heinemann, 2015*
6	*Ryan Lanclos **"Dealing With Disasters: Gis For Emergency Management"**,ESRI Press 2021.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Differentiate hazard and disaster with their significance.	K4
CO2	Analyse the causes and impact of natural and manmade disaster.	K4
CO3	Execute the steps involved in disaster planning.	K4
CO4	Predict vulnerability of disaster and to prevent, mitigate their impact.	K4
CO5	Prepare risk assessment strategy for national and global disaster.	K4

COURSE ARTICULATION MATRIX					
COS/POS	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	1	1	2	2
CO2	1	2	1	1	1
CO3	1	1	1	2	2
CO4	1	1	1	2	2
CO5	2	1	1	2	2
23CSACZ2	**1**	**1**	**1**	**2**	**2**
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	50	50	-	-	-	-	100
CAT2	-	-	100	-	-	-	100
Individual Assessment 1/Case Study 1/Seminar 1/Project 1	50	50	-	-	-	-	100
Individual Assessment 2/Case Study 2/Seminar 2/Project 2	-	-	100	-	-	-	100
ESE	25	25	50	-	-	-	100

23CSACZ3	**VALUE EDUCATION** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	AC	2	0	0	0

Course Objectives	1. Value of education and self- development 2. Requirements of good values in students 3. Importance of character	
UNIT – I	**ETHICS AND SELF-DEVELOPMENT**	**6 Periods**
Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements.		
UNIT – II	**PERSONALITY AND BEHAVIOR DEVELOPMENT**	**6 Periods**
Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness.Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance.		
UNIT – III	**VALUES IN HUMAN LIFE**	**6 Periods**
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 – IV	**VALUES IN SOCIETY**	**6 Periods**
True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association andCooperation. Doing best for saving nature.		
UNIT – V	**POSITIVE VALUES**	**6 Periods**
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.		
Contact Periods: **Lecture: 30 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 30 Periods**		

REFERENCES :

1	*Chakroborty, S.K.* ***"Values and Ethics for organizations Theory and practice"****, Oxford University Press,New Delhi,1998*
2	*Dr. Yogesh Kumar Singh,* ***"Value Education"****, A.P.H Publishing Corporation,New Delhi,2010*
3	*R.P Shukla,* ***"Value Education and Human Rights"****, Sarup and Sons, NewDelhi,2004*
4	*https://nptel.ac.in/courses/109104068/36*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Know the values and work ethics.	K3
CO2	Enhance personality and 164ehavior development.	K3
CO3	Apply the values in human life.	K3
CO4	Gain Knowledge of values in society.	K3
CO5	Learn the importance of positive values in human life.	K3

COURSE ARTICULATION MATRIX

Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	3	-	-	1
CO2	-	-	3	-	-	1
CO3	-	-	3	-	-	1
CO4	-	-	3	-	-	1
CO5	-	-	3	-	-	1
23CSACZ3	**-**	**-**	**3**	**-**	**-**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	50	30	-	-	-	100
CAT2	20	50	30	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	50	30	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	50	30	-	-	-	100
ESE	20	50	30	-	-	-	100

23CSACZ4	**CONSTITUTION OF INDIA** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	AC	2	0	0	0

Course Objectives	• To address the importance of constitutional rights and duties • To familiarize about Indian governance and local administration. • To know about the functions of election commission.	
UNIT – I	**INDIAN CONSTITUTION**	**6 Periods**
History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working) - Philosophy of the Indian Constitution: Preamble Salient Features.		
UNIT – II	**CONSTITUTIONAL RIGHTS & DUTIES**	**6 Periods**
Contours of Constitutional Rights & 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 – III	**ORGANS OF GOVERNANCE**	**6 Periods**
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 – IV	**LOCAL ADMINISTRATION**	**6 Periods**
Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Panchayat raj: Introduction, PRI: Zila Panchayat. Elected officials and their roles, CEO Zila Panchayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.		
UNIT – V	**ELECTION COMMISSION**	**6 Periods**
Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.		
Contact Periods: **Lecture: 30 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 30 Periods**		

REFERENCES:

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.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Discuss the growth of the demand for civil rights in India.	K2
CO2	Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.	K2
CO3	Understand the various organs of Indian governance.	K2
CO4	Familiarize with the various levels of local administration.	K2
CO5	Gain knowledge on election commission of india.	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	1	1	1	1
CO2	-	-	1	1	1	2
CO3	-	-	1	1	2	1
CO4	-	-	1	1	1	1
CO5	-	-	1	1	1	1
23CSACZ4	**-**	**-**	**1**	**1**	**1**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	50	30	-	-	-	100
CAT2	20	50	30	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	50	30	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	50	30	-	-	-	100
ESE	20	50	30	-	-	-	100

23CSACZ5	**PEDAGOGY STUDIES** *(Common to all Branches)*

PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**AC**	**2**	**0**	**0**	**0**

Course Objectives	1. To Understand of various theories of learning, prevailing pedagogical practices and design of curriculum in engineering studies. 2. Application of knowledge in modification of curriculum, its assessment and introduction of innovation in teaching methodology.	
UNIT – I	**INTRODUCTION**	**6 Periods**
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	**PEDAGOGICAL PRACTICES**	**6 Periods**
Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education. Evidence on the effectiveness of pedagogical practices Methodology for the in depth stage: quality assessment of included studies.		
UNIT – III	**PEDAGOGICAL APPROACHES**	**6 Periods**
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. Teacher's attitudes and beliefs and Pedagogic strategies.		
UNIT – IV	**PROFESSIONAL DEVELOPMENT**	**6 Periods**
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	**CURRICULUM AND ASSESSMENT**	**6 Periods**
Research gaps and future directions Research design Contexts Pedagogy Teacher education Curriculum and assessment Dissemination and research impact.		
Contact Periods: **Lecture: 30 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 30 Periods**		

REFERENCES:

1	*Ackers J, Hardman F ,* ***Classroom interaction in Kenyan primary schools,Compare****, 31 (2): 245-261, 2001.*
2	*Alexander RJ ,****Culture and pedagogy: International comparisons in primary education****. Oxford and Boston: Blackwell, 2001*
3	*Akyeampong K, Lussier K, Pryor J, Westbrook J,* ***Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count?*** *International Journal Educational Development, 33 (3): 272–282, 2013.*
4	*Agrawal M ,****Curricular reform in schools: The importance of evaluation****, Journal of Curriculum Studies, 36 (3): 361-379, 2004*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the concept of curriculum, formal and informal education systems and teacher education.	K3
CO2	Explain the present pedagogical practices and the changes occurring in pedagogical approaches	K3
CO3	Understand the relation between teacher and community, support from various levels of teachers to students and limitation in resources and size of the class.	K3
CO4	Perform research in design a problem in pedagogy and curriculum development.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	1	1	2	1
CO2	-	-	1	1	1	2
CO3	-	-	1	1	2	1
CO4	-	-	1	1	2	1
23CSACZ5	**-**	**-**	**1**	**1**	**2**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	50	30	-	-	-	100
CAT2	20	50	30	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	50	30	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	50	30	-	-	-	100
ESE	20	50	30	-	-	-	100

23CSACZ6	STRESS MANAGEMENT BY YOGA *(Common to all Branches)*					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**AC**	**2**	**0**	**0**	**0**
Course Objectives	1. To create awareness on the benefits of yoga and meditation. 2. To understand the significance of Asana and Pranayama.					
UNIT – I	**PHYSICAL STRUCTURE AND ITS FUNCTIONS**					**6 Periods**
Yoga - Physical structure, Importance of physical exercise, Rules and regulation of simplified physical exercises, hand exercise, leg exercise, breathing exercise, eye exercise, kapalapathy, maharasana, body massage, acupressure, body relaxation.						
UNIT – II	**YOGA TERMINOLOGIES**					**6 Periods**
Yamas - Ahimsa, satya, astheya, bramhacharya, aparigraha Niyamas- Saucha, santosha, tapas, svadhyaya, Ishvara pranidhana.						
UNIT – III	**ASANA**					**6 Periods**
Asana - Rules & Regulations – Types & Benefits						
UNIT – IV	**PRANAYAMA**					**6 Periods**
Regularization of breathing techniques and its effects-Types of pranayama						
UNIT – V	**MIND**					**6 Periods**
Bio magnetism& mind - imprinting & magnifying – eight essential factors of living beings, Mental frequency and ten stages of mind, benefits of meditation, such as perspicacity, magnanimity, receptivity, adaptability, creativity.						
Contact Periods: **Lecture: 30 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 30 Periods**						

REFERENCES :

1	*Janardan Swami Yogabhyasi Mandal , **"Yogic Asanas for Group Training-Part-I"**, Nagpur.*
2	*Swami Vivekananda, **"Rajayoga or conquering the Internal Nature"**, Advaita Ashrama (Publication Department), Kolkata.*
3	*Pandit Shambu Nath, **"Speaking of Stress Management Through Yoga and Meditation"**, New Dawn Press, New Delhi, 2016.*
4	*K. N. Udupa, **"Stress and its management by Yoga",** Motilal Banarsidass Publishers, New Delhi, 2007.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		Bloom's Taxonomy Mapped
CO1	Practice physical exercises and maintain good health.	K3
CO2	Attain knowledge on the various concepts of Yoga.	K2
CO3	Perform various asanas with an understanding on their benefits.	K3
CO4	Practice breathing techniques in a precise manner.	K3
CO5	Attain emotional stability and higher level of consciousness.	K2

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	-	-	-	-	2
CO2	-	-	-	-	3
CO3	-	-	-	-	2
CO4	-	-	-	-	1
CO5	-	-	-	-	1
23CSACZ6	**-**	**-**	**-**	**-**	**2**
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	30	30	-	-	-	100
CAT2	30	40	30	-	-	-	100
Individual Assessment1/ Case study1/ Seminar 1/Project1	40	40	20	-	-	-	100
Individual Assessment2/ Case study2/ Seminar 2 /Project2	30	30	40	-	-	-	100
ESE	30	30	40	-	-	-	100

23CSACZ7	**PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS** *(Common to all Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	AC	2	0	0	0

Course Objectives	1. To familiar with Techniques to achieve the highest goal in life. 2. To become a person with stable mind, pleasing personality and determination.	
UNIT – I		**6 Periods**
Neetisatakam-Holistic development of personality-Verses- 19,20,21,22 (wisdom)-Verses29,31,32 (pride & heroism)-Verses- 26,28,6.		
UNIT – II		**6 Periods**
Verses- 52,53,59 (dont's)-Verses- 71,73,75,78 (do's). - Approach to day to day work and duties.- Shrimad BhagwadGeeta - Chapter 2-Verses 41, 47,48,		
UNIT – III		**6 Periods**
Shrimad BhagwadGeeta -Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,- Chapter 18-Verses 45, 46, 48.		
UNIT – IV		**6 Periods**
Statements of basic knowledge.-Shrimad BhagwadGeeta: -Chapter2-Verses 56, 62, 68 -Chapter 12 -Verses 13, 14, 15, 16,17, 18-Personality of Role model.		
UNIT – V		**6 Periods**
Shrimad BhagwadGeeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42, Chapter 4-Verses 18, 38,39-Chapter18 – Verses 37,38,63.		
Contact Periods: **Lecture: 30 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 30 Periods**		

REFERENCES :

1	*Swami SwarupanandaAdvaita Ashram "**Srimad Bhagavad Gita**",AdvaitaAshrama, Kolkata,2016*
2	*P.Gopinath, Rashtriya Sanskrit Sansthanam "**Bhartrihari's Three Satakam**" (Niti-sringar-vairagya), New Delhi, 1986.*
3	*Swami Mukundananda, JagadguruKripalujiYog "**Bhagavad Gita: The Song Of God**", USA,2019*
4	*A.C. Bhaktivedanta Swami Prabhupada "**Bhagavad-Gita As It Is**",Bhaktivedanta Book Trust Publications,2001*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the Holistic development in life	K4
CO2	Effective Planning of day to day work and duties	K4
CO3	Identify mankind to peace and prosperity	K4
CO4	Develop versatile personality.	K4
CO5	Awakening wisdom in life	K4

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	1	-	-	-
CO2	-	-	1	-	-	-
CO3	-	-	1	-	-	-
CO4	-	-	1	-	-	-
CO5	-	-	1	-	-	-
23CSACZ7	**-**	**-**	**1**	**-**	**-**	**-**

1 – Slight, 2 – Moderate, 3 – Substantial

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	50	30	-	-	-	100
CAT2	20	50	30	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	50	30	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	50	30	-	-	-	100
ESE	20	50	30	-	-	-	100

23CSACZ8	SANSKRIT FOR TECHNICAL KNOWLEDGE *(Common to all Branches)*				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**AC**	**2**	**0**	**0**	**0**

Course Objectives	1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world. 2. Learning of Sanskrit to improve brain functioning. 3. Enhancing the memory power. 4. Learning of Sanskrit to develop the logic in mathematics, science & other subjects.	
UNIT – I	**BASICS OF SANSKRIT**	**6 Periods**
Alphabets in Sanskrit, Past/Present/Future Tense.		
UNIT – II	**SENTENCES AND ROOTS**	**6 Periods**
Simple Sentences - Order, Introduction of roots		
UNIT – III	**SANSKRIT LITERATURE**	**6 Periods**
Technical information about Sanskrit Literature		
UNIT – IV	**TECHNICAL CONCEPTS -1**	**6 Periods**
Technical concepts of Engineering-Electrical, Mechanical		
UNIT – V	**TECHNICAL CONCEPTS -2**	**6 Periods**
Technical concepts of Engineering-Architecture, Mathematics		
Contact Periods: **Lecture: 30 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 30 Periods**		

REFERENCES:

1	*Dr.Vishwas, "**Abhyaspustakam",** Samskrita -Bharti Publication, New Delhi, 2020.*
2	*Prathama Deeksha Vempati Kutumbshastri, "**Teach Yourself Sanskrit**", Rashtriya Sanskrit Sansthanam, New Delhi, Publication, 2009.*
3	*Suresh Soni, "**India's Glorious Scientific Tradition**" , Ocean books (P) Ltd., New Delhi,2006.*

COURSE OUTCOMES: Upon Completion of the course, the students will able to:		**Bloom's Taxonomy Mapped**
CO1	Recognize ancient literature and their basics	K3
CO2	Formulate the sentences with order and understand the roots of Sanskrit	K2
CO3	Acquire familiarity of the major traditions of literatures written in Sanskrit	K3
CO4	Distinguish the Technical concepts of Electrical & Mechanical Engineering	K2
CO5	Categorize the Technical concepts of Architecture & Mathematics	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	-	1	2	1
CO2	-	-	-	1	2	-
CO3	-	-	-	1	1	1
CO4	-	-	-	2	1	1
CO5	-	-	-	1	2	1
23CSACZ8	**-**	**-**	**-**	**1**	**2**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	50	30	-	-	-	100
CAT2	20	50	30	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	50	30	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	50	30	-	-	-	100
ESE	20	50	30	-	-	-	100