Learning Outcomes based Curriculum Framework (LOCF)

for

Master of Technology
(Computer Science)
M.Tech. (CS)

(w.e.f. 2025-26)

Department of Computer Science and Information Technology

School of Technology

MAULANA AZAD NATIONAL URDU UNIVERSITY

1. Vision and Mission

1.1 Vision

To meet the requirements of the society by imparting knowledge, ethics and moral values with a holistic approach.

1.2 Mission

To impart quality education and to undertake research and extension with emphasis on application and innovation that cater to the emerging societal needs through all-round development of students of all sections enabling them to be globally competitive and socially responsible citizens embedded with ethical values.

1.3 Strategies for Attaining the Vision and Fulfilling the Mission

Following strategies will be used to ensure the accomplishment of the stated vision and mission:

1. To create an ambiance for healthy teaching-learning process and attract the motivated students to the Department of Computer Science and Information Technology
2. Ensure that the curriculum followed is comparable to the relevance of local, national, regional and global development
3. To motivate the potential faculty members/ educators who are constantly upgrading their pedagogical approaches to motivate students and to enhance learning among them
4. Provide opportunities to students for global exposure, industrial internships, project based and research-based learning

2. Program Educational Objectives

Program Educational Objectives (PEOs) are broad statements that describe the career and professional accomplishments that CS&IT Department is preparing its graduates to achieve during the graduation. Following four PEOs are defined as:

PEO 1. To train the graduates to acquire in depth knowledge of fundamental concepts and programming skills for holistic development.

PEO 2. To prepare the graduates for productive careers in software industry, corporate sector, Government Organizations.

PEO 3. To prepare graduates to acquire excellent computing ability so that they can analyze, design and create Solutions for real time problems.

PEO 4. To apply the current tools and techniques to create systems for solving Industry oriented problems.

3. Program Outcomes (POs)

Program outcomes are the narrower statements that describe what students are expected to know and be able to do upon graduation. POs represent the knowledge, skills and attitudes the students should have at the end of a program. Following are the statements for POs for computer application program. At the time of completing their degree requirements, students will be able to:

PO_1: Apply the knowledge of Mathematics, Science, and Engineering fundamentals, and an engineering specialization to solution of complex engineering problems **(Engineering Knowledge)**.

PO_2: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences (**Problem analysis**).

PO_3: Design of solutions for complex engineering problems and design of system components or processes that meet the specified needs with appropriate considerations of public health and safety, and cultural, societal, and environmental considerations (**Design/development of solutions)**.

PO_4: Use research-based methods including design of experiments, analysis and interpretation of data and synthesis of information leading to logical conclusions **(Conduct investigations of complex problems**).

PO_5: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling complex engineering activities with an understanding of limitations (**Modern tool usage**).

PO_6: Apply reasoning within the contextual knowledge to access societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice **(The engineer and society)**.

PO_7: Understand the impact of the professional engineering solutions in the societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable developments (**Environment and sustainability**).

PO_8: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice (**Ethics**).

PO_9: Function effectively as an individual independently and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and team work**).

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

PO_{11}: Demonstrate knowledge and understanding of engineering management principles and apply those to one's own work as a member and leader of a team to manage projects in multidisciplinary environments (**Project management and finance**).

PO_{12}: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life-long Learning**).

4. Program Specific Outcomes (PSOs)

Program Specific Outcomes (PSOs) are the statements that define outcomes of a program which make students realize the fact that knowledge and techniques learnt in a specific course has direct implication for the betterment of society and its sustainability.

PSO 1: The ability to design and develop applications using the knowledge of Mathematics, Science and Engineering fundamentals.

PSO 2: Ability to test and analyze the quality of developed applications and to integrate them in order to evolve a larger computing system.

PSO 3: Apply appropriate techniques, resources, and modern engineering and IT tools to address societal, health, safety, legal, and cultural issues.

PSO 4: To analyze and assess various functional and technical security challenges in protecting various digital assets and infrastructure in the internet era and to design and develop innovative technological solutions for the same

PSOs have to be attained by the students in due course of the two years program either as part of their Core, Discipline Specific Electives, Tools and techniques or as part of their various levels of seminar/ internship and project work.

5. Mapping between PEOs, POs and PSOs

The following Table lists the relationships between the PEOs, POs. and PSOs. The attainment of POs can be viewed as a strategy for attaining the PEOs. Each PEO is supported by multiple POs to ensure strength in compliance. Also, the relationship between individual PO and PEOs can vary between **Reasonable (1)** and **Strong (3)**.

PEOs	POs												PSOs			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	4
PEO1	2	2	3	3	2	2	1	1	2	1	1	2	2	1	1	2
PEO2	2	2	3	1	3	3	1	1	2	1	2	1	2	2	3	1
PEO3	2	3	2	3	3	2	1	1	3	2	1	2	1	3	1	2
PEO4	3	2	2	1	3	1	1	1	3	2	2	2	3	2	1	3

1 – Reasonable

2 – Significant

3 – Strong

6. Course Outcomes (COs)

Course Outcomes are narrower statements that describe what students are expected to know and be able to do at the end of the course. Course outcomes are defined for all courses as part of the syllabus for the course and are measured through performance on assignments, written and oral presentation reports related to individual and team projects and through the mid-term and semester end examinations. Detailed syllabi for each course associated with Course Objectives and Course Outcomes has been for specific outcomes associated with the course. Attaining the COs is at the heart of the educational activity. If COs of individual courses are successfully attained and the curriculum has been designed to achieve the Program Outcomes, then attainment of the POs is also ensured. An effective Assessment Plan has been devised to meet the objective, quantitative and independent measures to demonstrate that all POs and PEOs are being attained by the program.

7. Continuous Quality Improvement and Assessment Plan

The purpose of the Assessment Plan is to ensure attainment of all Program Outcomes (POs) and also the attainment of the Program Educational Objectives (PEOs) and to independently confirm that the POs and PEOs are being attained. Periodic monitoring of progress allows faculty members and the leadership to take corrective actions where the POs and PEOs are not meeting established targets. The process consists of assessing and evaluating the extent to which the student outcomes are being attained. The results of these assessments and evaluations are subsequently used as the primary inputs for making improvements to the program.

MAULANA AZAD NATIONAL URDU UNIVERSITY

SCHOOL OF TECHNOLOGY

DEPARTMENT OF COMPUTER SCIENCE & IT

M.Tech. (Computer Science)

General, Course structure & Theme & Semester-wise credit distribution

A. Definition of Credit:		
1	1 Hr. Lecture (L) per week	1 credit
2	1 Hr. Tutorial (T) per week	1 credit
3	2 Hours Practical (Lab)/week	1 credit

B. Range of credits:
A student requires to complete total 80 credits to be eligible to get Post Graduate degree in Computer Science.

C. Structure of Post graduate Computer Science program:			
S. No.	Course Type	Credit Breakup for M.Tech. Students	Credits
1	Program Core Course	PC	16
2	Program Elective Course	PE	20
3	Research Methodology & IPR	RMIPR	2
4	Generic Elective	GE	8
5	Laboratory	LAB	8
6	Mini Project with Seminar	MPS	2
7	Dissertation	DISS	24
Total			**80**

MAULANA AZAD NATIONAL URDU UNIVERSITY

DEPARTMENT OF CS&IT

SCHEME OF INSTRUCTIONS, EXAMINATION & EVALUATION

(Effective for Batch Admitted from 2022-23 Academic Year)

M.Tech. (Computer Science)

Total Credits (2 Year Course): 80

I. **INDUCTION PROGRAM (PLEASE REFER APPENDIX-A FOR GUIDELINES)**	
Induction Program (mandatory)	3 Weeks duration (Please refer Appendix-A for guidelines & also details available in the curriculum of Mandatory courses)
Induction program for students to be offered right at the start of the first year.	▪ Physical activity ▪ Creative Arts ▪ Universal Human Values ▪ Literary ▪ Proficiency Modules ▪ Lectures by Eminent People ▪ Visits to local Areas ▪ Familiarization to Dept./Branch & Innovations

Schedule

The activities during the Induction Program would have an Initial Phase, a Regular Phase and a Closing Phase. The Initial and Closing Phases would be two days each.

Initial Phase

Time	Activity
Day 0	
Whole day	Students arrive - Hostel allotment. (Preferably do pre-allotment)
Day 1	
09:00 am - 03:00 pm	Academic registration
04:30 pm - 06:00 pm	Orientation
Day 2	
09:00 am - 10:00 am	Diagnostic test (for English etc.)
10:15 am - 12:25 pm	Visit to respective depts.
12:30 pm - 01:55 pm	Lunch
02:00 pm - 02:55 pm	Director's address
03:00 pm - 05:00 pm	Interaction with parents
03:30 pm - 05:00 pm	Mentor-mentee groups - Introduction within group. (Same as Universal Human Values groups)

Regular Phase

After two days is the start of the Regular Phase of induction. With this phase there would be regular program to be followed every day.

3.2.1 Daily Schedule

Some of the activities are on a daily basis, while some others are at specified periods within the Induction Program. We first show a typical daily timetable.

Sessn.	Time	Activity	Remarks
Day 3 onwards			
	06:00 am	Wake up call	
I	06:30 am - 07:10 am	Physical activity (mild exercise/yoga)	
	07:15 am - 08:55 am	Bath, Breakfast, etc.	
II	09:00 am - 10:55 am	Creative Arts / Universal Human Values	

		Half the groups do Creative Arts
III	11:00 am - 12:55 pm	Universal Human Values / Creative Arts Complementary alternate
	01:00 pm - 02:25 pm	Lunch
IV	02:30 pm - 03:55 pm	Afternoon Session See below.
V	04:00 pm - 05:00 pm	Afternoon Session See below.
	05:00 pm - 05:25 pm	Break / light tea
VI	05:30 pm - 06:45 pm	Games / Special Lectures
	06:50 pm - 08:25 pm	Rest and Dinner
VII	08:30 pm - 09:25 pm	Informal interactions (in hostels)

Sundays are off and Saturdays have the same schedule as above or have outings.

Afternoon Activities (Non-Daily)

The following five activities are scheduled at different times of the Induction Program, and are not held daily for everyone:

1. Familiarization to Dept./Branch & Innovations
2. Visits to Local Area
3. Lectures by Eminent People
4. Literary
5. Proficiency Modules

Here is the approximate activity schedule for the afternoons (may be changed to suit local needs):

Activity	Session	Remarks
Familiarization with Dept/Branch & Innovations	IV	For 3 days (Day 3 to 5)
Visits to Local Area	IV, V and VI	for 3- days For 3 days - interspersed (e.g., 3 Saturdays)
Lectures by Eminent People	IV	As scheduled - 3-5 lectures
Literary (Play / Book Reading / Lecture)	IV	For 3-5 days
Proficiency Modules	V	Daily, but only for those who need it

Closing Phase

Time	Activity
Last But One Day	
08:30 am - 12 noon	Discussions and finalization of presentation within each group
02:00 am - 05:00 pm	Presentation by each group in front of 4 other groups besides their own (about 100 students)
Last Day	
Whole day	Examinations (if any). May be expanded to last 2 days, in case needed.

Semester – I

Course Code	Course Title	Course Type	Marks			L-T-P	Credits
			Internal Assessment	Semester Exam	Total		
MTCS111PCT	Advanced Algorithm	Program Core Course (PC)	30	70	100	3-1-0	4
MTCS112PCT	Advanced Computer Architecture	Program Core Course (PC)	30	70	100	3-1-0	4
MTCS111RMT	Research Methodology & IPR	RMIPR	15	35	50	1-1-0	2
MTCS11XPET	Program Elective-1	Program Elective Course (PE)	30	70	100	3-1-0	4
MTCS12XPET	Program Elective-2	Program Elective Course (PE)	30	70	100	3-1-0	4
PGCS13XGET	Generic Elective-1	Generic Elective Course (GE)	30	70	100	3-1-0	4
MTCS160PCP	Advanced Algorithm Lab	Program Core Course (LAB)	50	50	100	0-0-4	2
MTCS16XPEP	Lab (Based on Elective-I)	Program Elective (LAB)	50	50	100	0-0-4	2
Total					**750**	**22-0-8**	**26**

Semester – II

Course Code	Course Title	Course Type	Marks			L-T-P	Credits
			Internal Assessment	Semester Exam	Total		
MTCS212PCT	Internet of Things	Program Core Course (PC)	30	70	100	3-1-0	4
MTCS213PCT	Artificial Neural Network	Program Core Course (PC)	30	70	100	3-1-0	4
MTCS23XPET	Program Elective-3	Program Elective Course (PE)	30	70	100	3-1-0	4
MTCS24XPET	Program Elective-4	Program Elective Course (PE)	30	70	100	3-1-0	4
PGCS23XGET	Generic Elective-2	Generic Elective Course (GE)	30	70	100	3-1-0	4
MTCS261PCP	IoT Lab	Program Core Course (LAB)	50	50	100	0-0-4	2
MTCS263PCP	Artificial Neural Network - Lab	Program Core Course (LAB)	50	50	100	0-0-4	2
MTCS270PCP	Mini Project with Seminar*	MPS	50	50	100	0-0-4	2
Total					**800**	**20-0-12**	**26**

*****Students are encouraged to go to Industrial Training/Internship for at least 2-3 months during semester break. They need to make a prototype model in the allotted areas on the recommendations of the supervisor.

Semester – III

Course Code	Course Title	Course Type	Marks			L-T-P	Credits
			Internal Assessment	Semester Exam	Total		
MTCS31XPET	Program Elective -5	PE	30	70	100	3-1-0	4
MTCS370PCP	Dissertation Work Part-A	DISS	210	490	700	0-0-20	10
Total					**800**	**4-0-20**	**14**

Semester – IV

Course Code	Course Title	Course Type	Marks			L-T-P	Credits
			Internal Assessment	Semester Exam	Total		
MTCS470PCP	Dissertation Work Part-B	DISS	240	560	800	0-0-28	14
Total					**800**	**0-0-28**	**14**

L-T-P stands for number of contact hours as Lecture-Tutorial-Practical in a week.

PROGRAM ELECTIVES (PE) & GENERIC ELECTIVES (GE)

SEMESTER - 1

Course Code	Course Title	Course Code	Course Title
Program Elective – I		**Program Elective – II**	
MTCS111PET	Advanced Network Security	MTCS121PET	Intelligent Systems
MTCS112PET	Distributed Database	MTCS122PET	Augmented & Virtual Reality
MTCS113PET	Data Science	MTCS123PET	Soft Computing
MTCS114PET	Semantics Web	MTCS124PET	Digital Forensics
MTCS115PET	Component based Software Engineering	MTCS125PET	Distributed Systems
MTCS116PET	Artificial Intelligence	MTCS126PET	Cryptography & Cyber Security

Program Elective – I Lab		Generic Elective-1	
Course Code	**Course Title**	**Course Code**	**Course Title**
MTCS160PEP	Advanced Network Security Lab	PGCS131GET	English for Research Paper Writing
MTCS161PEP	Distributed Database Lab	PGCS132GET	Disaster Management
MTCS162PEP	Data Science Lab	PGCS134GET	Value Education
MTCS163PEP	Semantics Web Lab	PGCS135GET	Digital Marketing

SEMESTER - 2

Program Elective – III		Program Elective – IV	
Course Code	**Course Title**	**Course Code**	**Course Title**
MTCS231PET	Blockchain Technology	MTCS241PET	Advanced Operating System
MTCS232PET	High Performance Computing	MTCS242PET	Digital Image Processing
MTCS233PET	Distributed Computing	MTCS243PET	Advanced Wireless & Mobile Networks
MTCS234PET	Natural Language Processing	MTCS244PET	Mobile Applications & Services
MTCS235PET	Quantum Computing	MTCS245PET	Graphics Processing Unit Computing
MTCS237PET	Data Mining	MTCS246PET	Big Data Analytics
MTCS238PET	Machine Learning		

Generic Elective-2	
Course Code	**Course Title**
PGCS231GET	Constitution of India
PGCS232GET	Pedagogy Studies
PGCS233GET	Stress Management by Yoga
PGCS234GET	Personality Development through Life Enlightenment Skills

SEMESTER – 3

Program Elective – V	
Course Code	**Course Title**
MTCS311PET	Deep Learning
MTCS312PET	Secure Software Design & Enterprise Computing
MTCS313PET	Wireless Access Technologies
MTCS314PET	Data Preparation & Analysis
MTCS315PET	Optimization Techniques

Course Code	Course Title	Lecture			Semester: I
MTCS111PCT	Advanced Algorithm	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Algorithm Design

Course Objectives:

1. To learn an appropriate strategy to solve a problem.
2. To devise algorithms by choosing appropriate data structures.
3. To design and analyze the implementation of algorithms and data structures for different kinds of problems.
4. To gain knowledge about the inherent structure/hardness of a problem.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand the Programming Problem Statements for Algorithms.	PO_1, PO_2, PO_4
CO_2	Understand the necessary mathematical abstraction to solve problems.	PO_2, PO_4
CO_3	Analyze the Efficiency and Proofs of Correctness in Algorithms	PO_3, PO_5
CO_4	Comprehend and select algorithm design approaches in a problem-specific manner.	PO_4, PO_9, PO_{12}

PO_1- Engineering Knowledge, **PO_2**- Problem analysis, **PO_3**- Design/development of solutions, **PO_4**- Conduct investigations of complex problems, **PO_5**- Modern tool usage, **PO_6**- The engineer and society, **PO_7**- Environment and sustainability, **PO_8**- Ethics, **PO_9**- Individual or team work, **PO_{10}**- Communication, **PO_{11}**- Project management and finance, **PO_{12}**- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	3	2		3								
CO_2		3		2								
CO_3			2		3							
CO_4				3					2			1

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Introduction to algorithms, Growth of functions, Master's Theorem, Sorting: Quick Sort, Heap Sort, Shaker Sort, and Counting Sort.
Unit: 2	Greedy Method: Minimum Spanning Tree-Prim's Algorithm, Tarjan's Algorithm, Introduction to Dynamic programming, principle of optimality, Single Source Shortest Path-Bellman-Ford Algorithm, All Pairs Shortest Paths Algorithm-Johnson's Algorithm, Longest Common Sequence (LCS), Chained Matrix Multiplication, Huffman's code.
Unit: 3	String Matching: Introduction to String Matching, application of string matching, Naivealgorithm, Rabin-Karp algorithm, Knuth Morris-Pratt algorithm, Boyer-Moore Algorithm.
Unit: 4	NP-Hard and NP-Complete problems: Basic Concepts, Non-Deterministic Algorithms, NP -Hard and NP-Complete Classes, Cook's theorem. Randomized Algorithms
Unit: 5	Introduction to parallel algorithms. Parallel Algorithm- Analysis, models, Parallel Random Access Machines (PRAM), Parallel Algorithm Structure, Parallel Algorithms forSorting, Searching, and Merging.

Examination and Evaluation Pattern: It includes both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation, etc., and external evaluation (70 marks), which is mainly end semester examination.

Text Books:

1	Algorithms, Coreman, Rivest, Lisserson, PHI, Third Edition.
2	Design and Analysis of Algorithms, Manas Ranjan Kabat, PHI.

Reference Books:

1	Design and Analysis of Algorithms, R. Panneerselvam, PHI.
2	Parallel Algorithms, Henri Casanova, Arnaud Legrand, Yves Robert, CRC Press.

Course Code	Course Title	Lecture			Semester: I
MTCS112PCT	Advanced Computer Architecture	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Computer Organization

Course Objectives:

1. To provide knowledge of the Parallelism concepts in Programming
2. To provide an elaborate idea about the different memory systems and buses.
3. To introduce the advanced processor architectures to the students.
4. To acquaint the students with the importance of multiprocessor and multicomputer.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand the concepts of parallel computer models, pipeline and its hazards.	PO_1, PO_2
CO_2	Explain the concepts of parallel computing and hardware technologies.	PO_2, PO_3
CO_3	Understand the concept and importance of Memory Hierarchy, mapping techniques.	PO_3, PO_4
CO_4	Comprehend Scalable Architectures, Pipelining, Superscalar processors, multiprocessors	PO_4, PO_5

PO_1- Engineering Knowledge, **PO_2**- Problem analysis, **PO_3**- Design/development of solutions, **PO_4**- Conduct investigations of complex problems, **PO_5**- Modern tool usage, **PO_6**- The engineer and society, **PO_7**- Environment and sustainability, **PO_8**- Ethics, **PO_9**- Individual or team work, **PO_{10}**- Communication, **PO_{11}**- Project management and finance, **PO_{12}**- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	3	2										
CO_2		2	3									
CO_3			3	2								
CO_4				2	3							

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Review of Basic Organization and Architectural Techniques: RISC processors, Characteristics of RISC processors, RISC Vs CISC, Classification of Instruction Set Architectures Review of performance measurements, Basic parallel processing techniques: Instruction level, thread level and process level, Classification of parallel architectures.
Unit: 2	Instruction Level Parallelism: Basic concepts of pipelining, Arithmetic pipelines, Instruction pipelines, Hazards in a pipeline: structural, data, and control, Hazards, Overview of hazard resolution techniques, Dynamic instruction scheduling, Branch prediction techniques, Instruction-level parallelism using software approaches, Superscalar techniques, Speculative execution.
Unit: 3	Memory Hierarchies: Basic concept of hierarchical memory organization, Main memories, Cache design and implementation, Virtual memory design and implementation, Secondary technology.
Unit: 4	Thread Level Parallelism: Centralized vs. distributed shared memory, Interconnection topologies, Multiprocessor architecture, Symmetric multiprocessors, Cache coherence problem, Synchronization, Memory consistency, Multicore architecture, Review of modern multiprocessors.
Unit: 5	Process Level Parallelism: Distributed computers, Clusters, Grid, Mainframe computers. Peripheral Devices: Bus structures and standards, Synchronous and asynchronous buses, Types and uses of storage devices, Interfacing I/O to the rest of the system, Reliability and availability, I/O system design, Platform architecture.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Hennessey and Patterson," Computer Architecture: A quantitative Approach", Morgan Kaufman.
2	Kai Hwang, Faye A. Briggs, "Computer Architecture and Parallel Processing "McGraw-Hill international Edition.

Reference Books:

1	KaiHwang,"Advanced Computer Architecture", Tata McGraw-Hill

2	El-Rewini, H., & Abd-El-Barr, M.(2005).Advanced computer architecture and parallel processing (Vol.42). John Wiley & Sons.

Course Code	Course Title	Lecture			Semester: I
MTCS111RMT	Research Methodology and IPR	L	T	P	
Version: 1.2	Date of Approval:	1	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	30 Hrs.	Maximum Score	:	50
Periods/ Week	:	2	Internal Evaluation	:	15
Credits	:	2	End Semester	:	35
Instruction Mode	:	Lecture	Exam Duration	:	2 Hrs.

Prerequisite(s): No specific prerequisite

Course Objectives:

1. To understand research problem and scientific approaches applied for the same
2. To design experiments and to analyze results of the experiments
3. To prepare technical reports and research papers
4. To understand the need of IPR to be promoted among students in general & engineering in particular.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Illustrate the research objectives and construct research problem scientifically	PO_1, PO_2, PO_9, PO_{12}
CO_2	Apply the systematic approach to achieve research objectives and analyses results	PO_4, PO_8, PO_9
CO_3	Explain the self-written research papers and defend in review committee	PO_4, PO_6, PO_{12}
CO_4	Develop Reports and files	PO_6, PO_{12}

PO_1- Engineering Knowledge, PO_2- Problem analysis, PO_3- Design/development of solutions, PO_4- Conduct investigations of complex problems, PO_5- Modern tool usage, PO_6- The engineer and society, PO_7- Environment and sustainability, PO_8- Ethics, PO_9- Individual or team work, PO_{10}- Communication, PO_{11}- Project management and finance, PO_{12}- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	1	2				2			3			
CO_2				2				3	2			
CO_3				3		2						3
CO_4						3						3

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Research Problem & Research Design: Meaning of Research, Types of Research, Research Process, Sources of Research Problem, Characteristics of a Good Research Problem, Errors in Selecting a Research Problem, Objectives and Scope of Research Problem, Approaches of Investigation of Solutions for Research Problem, Research Design, Different Research Designs.
Unit: 2	Data Analysis and Statistical Techniques: Quantitative Methods and Techniques, Sampling Design, Different Types of Sample Designs, Methods of Data Collection, Measures of Central Tendency, Measures of Variation, Measures of Relationship.
Unit: 3	Frequency Distribution, Identifying the Distribution with Data, Central Limit Theorem, Parameter Estimation, Chi-Square Test, Correlation Analysis, Regression Analysis, Time Series and Forecasting, hypothesis Testing.
Unit: 4	Writing Report, Dissertation and Research Papers: Effective Technical Writing, Developing a Research Proposal, Format of Research Proposal, Presentation and Assessment by Review committee, Guidelines for Writing the Report, Research Paper, Understanding References, Citations and Indexing.
Unit: 5	Intellectual property rights (IPR): Patents, Copyrights, Trademarks, Process of Patenting and Development, International cooperation on IPR, Procedure for Grants of Patents, Patenting under PCT.

Examination and Evaluation Pattern: It include both internal evaluation (15 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (35 marks) which is mainly end semester examination.

Text Books:

1	Vinayak Bairagi, Mousami V. Munot, Research Methodology: A Practical and Scientific Approach, CRC Press, 2019
2	C.R. Kothari and Gaurav Garg, "Research Methodology: Methods and Techniques", 4th ed., New Age, International Publishers, 2019

Reference Books:

1	Ranjit Kumar, "Research Methodology: A Step by Step Guide for beginners"4th ed., SAGE Publications, 2014
2	Debora J. Halbert, "Resisting Intellectual Property", Routledge, 2006.

Course Code	Course Title	Lecture			Semester: I
MTCS160PCP	Advanced Algorithm Lab	L	T	P	
Version: 1.2	Date of Approval:	0	0	4	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	50
Credits	:	2	End Semester	:	50
Instruction Mode	:	Practical	Exam Duration	:	3 Hrs.

Prerequisite(s): Algorithm Design

Course Objectives:

1. To practice with programming skill and improve the programming logic.
2. To understand the complexity of algorithms.
3. To develop skills to apply appropriate data structures and algorithms in problem solving
4. To Design and analyze implementations of algorithms and data structures for different kinds of problems.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Apply the Programming Problem Statements for Algorithms.	PO_1, PO_2, PO_4
CO_2	Apply the necessary mathematical abstraction to solve problems.	PO_2, PO_4
CO_3	Analyze the Efficiency and Proofs of Correctness in Algorithms	PO_3, PO_5
CO_4	Demonstrate algorithm design approaches in a problem specificmanner.	PO_4, PO_9, PO_{12}

PO_1- Engineering Knowledge, **PO_2-** Problem analysis, **PO_3-** Design/development of solutions, **PO_4-** Conduct investigations of complex problems, **PO_5-** Modern tool usage, **PO_6-** The engineer and society, **PO_7-** Environment and sustainability, **PO_8-** Ethics, **PO_9-** Individual or team work, **PO_{10}-** Communication, **PO_{11}-** Project management and finance, **PO_{12}-** Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	3	2		3								
CO_2		3		2								
CO_3			2		3							
CO_4				3					2			1

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

i. Sort a given set of n integer elements using the Quick Sort method and compute its time complexity. Run the program for varied values of n > 5000 and record the time taken to sort. Plot a graph of the time taken versus n on a graph sheet. The elements can be read from a file or can be generated using the random number generator. Demonstrate using C/C++/Java/Python how the divide and conquer method works, along with its time complexity analysis: worst case, average case, and best case.

ii. Write the Program to implement the following Sorting Algorithms:
   a) Heap Sort
   b) Shaker Sort
   c) Counting Sort

iii. Write the program to implement the Minimum Spanning Tree:
   a) Prim's Algorithm
   b) Tarjan's Algorithm

iv. Write a program to implement the Bellman-Ford Algorithm

v. Write a program to implement the Matrix Chain Multiplication.

vi. Write a program to implement the Longest Common Sequence (LCS) problem.

vii. Write the Program to implement the following Pattern Matching Algorithms:
   a) Naive algorithm
   b) Rabin-Karp algorithm
   c) Knuth-Morris-Pratt algorithm
   d) Boyer-Moore Algorithm

Examination and Evaluation Pattern: It includes both internal evaluation (50 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation, etc. and external evaluation (50 marks), which is mainly end semester examination.

Text Books:

1	The Algorithm Design Manual by Steve S. Skiena, Springer.
2	https://ds1-iiith.vlabs.ac.in/data-structures-1/ https://ds2-iiith.vlabs.ac.in/data-structures-2/

Reference Books:

1	Algorithms: Design and Analysis, Harsh Bhasin, Oxford Publication.
2	The Design and Analysis of Algorithms, Annay Levitin, Pearson.

Course Code	Course Title	Lecture			Semester: II
MTCS212PCT	Internet of Things	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Computer Networks

Course Objectives:

1. Vision and Introduction to IOT.
2. Understand IoT Market perspective.
3. Data and Knowledge Management and use of Devices in IoT Technology.
4. Understand State of Art-IoT Architecture and its implementation.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Explain & demonstrate various components of IoT along with Issues and Challenges in IoT	PO_2, PO_4
CO_2	Apply and analyze the role and importance of IoT in the modern world.	PO_1, PO_2, PO_5
CO_3	Investigate and propose of various requirements of IoT for real World applications.	PO_2, PO_3, PO_5
CO_4	Evaluate a variety of existing and developing architecture technologies for IoT and to describe and evaluate different applications of the IoT.	PO_1, PO_2, PO_3, PO_4, PO_{12}

PO_1- Engineering Knowledge, **PO_2**- Problem analysis, **PO_3**- Design/development of solutions, **PO_4**- Conduct investigations of complex problems, **PO_5**- Modern tool usage, **PO_6**- The engineer and society, **PO_7**- Environment and sustainability, **PO_8**- Ethics, **PO_9**- Individual or team work, **PO_{10}**- Communication, **PO_{11}**- Project management and finance, **PO_{12}**- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1		2		2								
CO_2	2	2			2							
CO_3		2	2		2							
CO_4	3	2	3	2								2

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Introduction to IoT, IOT Architecture, Sensing, Actuation, Basics of Networking, Basics of Networking Communication Protocols.
Unit: 2	Communication Protocols, Sensor Networks, Machine-to-Machine Communications and Introduction to SDN, SDN for IoT
Unit: 3	Issues and Challenges in IoT, Interoperability in IoT, Introduction to Arduino Programming, IoT development tools/platforms, Integration of Sensors and Actuators with Arduino, Introduction to Raspberry Pi, Implementation of IoT with Raspberry Pi.
Unit: 4	IoT based Cloud Computing, Sensor-Cloud, Fog Computing, Smart Cities and Smart Homes, Data Handling and Analytics.
Unit: 5	IoT Based Connected Vehicles, Smart Grid, Industrial IoT. Applications of IoT, Case Study: Agriculture, Healthcare, Activity Monitoring, Implementation of IoT concepts.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Internet of Things: A Hands-on Approach", by Arshdeep Bahga and Vijay Madisetti (Universities Press).
2	The Internet of Things: Enabling Technologies, Platforms, and Use Cases, by Pethuru Raj and Anupama C. Raman (CRC Press).

Reference Books:

1	Buyya, R., & Dastjerdi, A. V. (Eds.). (2016). Internet of Things: Principles and paradigms. Elsevier.
2	Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", 1st Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting everything", 1st Edition, Apress Publications, 2013

Course Code	Course Title	Lecture			Semester: II
MTCS213PCT	Artificial Neural Network	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Artificial Intelligence

Course Objectives:

1. To understand the role of neural networks in engineering.
2. To acquire the knowledge of artificial intelligence, and cognitive modeling.
3. To implement the concept of types of neural networks.
4. To analyze of computation and dynamical systems using neural networks.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Identify the neural network algorithms.	PO_1, PO_2
CO_2	Apply a variety of neural network algorithm on the available data set.	PO_3, PO_5
CO_3	Implement the neural network algorithms and solve real-world problems.	PO_3, PO_5
CO_4	Perform evaluation of neural network algorithms.	PO_4, PO_9

PO_1- Engineering Knowledge, PO_2- Problem analysis, PO_3- Design/development of solutions, PO_4- Conduct investigations of complex problems, PO_5- Modern tool usage, PO_6- The engineer and society, PO_7- Environment and sustainability, PO_8- Ethics, PO_9- Individual or team work, PO_{10}- Communication, PO_{11}- Project management and finance, PO_{12}- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	2	2										
CO_2			2		1							
CO_3			2		2							
CO_4				2					1			

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	General characteristics of the human brain, Introduction to Biological Neural Networks, Nerve structure and synapse, Basic concepts of Neural Networks, Characteristics of Neural Networks, Terminologies, Applications of the artificial neural networks.
Unit: 2	Structure of a neural net (topology), Directed graphs, Models of Neuron, Neural Network Architectures, Artificial Neuron, Activation functions, Threshold function, Piecewise linear function, Sigmoidal function, Supervised learning, Unsupervised learning, Re-enforcement Learning.
Unit: 3	Knowledge Representation, Artificial Intelligence, learning rules, Error correction learning, Memory based learning, Hebbian learning, Competitive learning, Boltzmann learning, single layer perceptron, Multilayer perceptron, Back propagation, Recurrent networks, Network pruning.
Unit: 4	Adaptive networks, Supervised Learning Neural Networks, Decision-based neural networks, Hierarchical neural networks, Probabilistic neural network, Radial basis function networks, Comparision of RBF Networks and multilayer perceptron.
Unit: 5	Classification of linearly separable patterns, Boltzmann machine, Sigmoid Belief Networks, Helmholtz machine, Support vector machines, Self-organization maps, Genetic Algorithms, Optimization, Prediction Systems, speech and decision-making.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	S. Haykin, "Neural Networks a comprehensive Foundation" second edition, Prentice-Hall India.
2	Laurene Fausett, "Fundamentals of Neural Networks, Architecture, Algorithms, and Applications", Prentice Hall, 1993

Reference Books:

1	Jacek M. Zurada, Introduction to artificial neural systems, Jaico Publ. House, 1994.
2	Anderson, ―An introduction to Artificial Neural Networks‖, Prentice Hall.

Course Code	Course Title	Lecture			Semester: II
MTCS261PCP	Internet of Things Lab	L	T	P	
Version: 1.2	Date of Approval:	0	0	4	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	50
Credits	:	2	End Semester	:	50
Instruction Mode	:	Practical	Exam Duration	:	3 Hrs.

Prerequisite(s): Computer Networks

Course Objectives:

1. Understanding IoT and the role of the Cloud in IoT.
2. Understanding IoT development platform like Arduino, Raspberry Pi.
3. Understanding IoT Sensors and ThingSpeak.
4. Create IoT applications.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand core concept of IoT development.	PO_1
CO_2	Understand the concept of Sensors, Actuators and Cloud.	PO_1, PO_2
CO_3	Understand and create the data acquisition on cloud	PO_2, PO_3, PO_4
CO_4	Create the IoT applications	PO_3, PO_4, PO_5

PO_1- Engineering Knowledge, **PO_2**- Problem analysis, **PO_3**- Design/development of solutions, **PO_4**- Conduct investigations of complex problems, **PO_5**- Modern tool usage, **PO_6**- The engineer and society, **PO_7**- Environment and sustainability, **PO_8**- Ethics, **PO_9**- Individual or team work, **PO_{10}**- Communication, **PO_{11}**- Project management and finance, **PO_{12}**- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	1											
CO_2	2	2										
CO_3		2	2	2								
CO_4			2	2	2							

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

1. Study and Install IDE of Arduino and different types of Arduinos.
2. Write program using Arduino IDE for Blink LED.
3. Write Program for RGB LED using Arduino.
4. Study the Temperature sensor and Write Program for monitor temperature using Arduino.
5. Study and Implement RFID, NFC using Arduino.
6. Study and implement MQTT protocol using Arduino.
7. Study and Configure Raspberry Pi.
8. WAP for LED blisnk using Raspberry Pi
9. Study and Implement Zigbee Protocol using Arduino / Raspberry Pi.
10. To understand what is cloud, its importance, usage, services and types of Cloud.
11. To familiarize with ThingSpeak and understand the procedure of creation of a Channel over ThingSpeak.
12. To upload DHT11 sensor data to ThingSpeak channel through Raspberry pi2.
13. To upload Light sensor (TSL) data to ThingSpeak channel through Raspberry pi2
14. To read Light Sensor data from ThingSpeak channel and store it into database through Raspberry pi2.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Bahga, A., & Madisetti, V. (2014). Internet of Things: A hands-on approach. Vpt.
2	Veneri, G., & Capasso, A. (2018). Hands-on Industrial Internet of Things: Create a Powerful Industrial IoT Infrastructure Using Industry 4.0. Packt Publishing Ltd.

Reference Books:

1	Seneviratne, P. (2018). Hands-On Internet of Things with Blynk: Build on the power of Blynk to configure smart devices and build exciting IOT projects. Packt Publishing Ltd.
2	Ziemann, V. (2018). A hands-on course in sensors using the Arduino and Raspberry Pi. CRC Press.

Course Code	Course Title	Lecture			Semester: II
MTCS263PCP	Artificial Neural Network - Lab	L	T	P	
Version: 1.2	Date of Approval:	0	0	4	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	50
Credits	:	2	End Semester	:	50
Instruction Mode	:	Practical	Exam Duration	:	3 Hrs.

Prerequisite(s): Knowledge of basic data science algorithms.

Course Objectives:

1. To understand the basic concepts and techniques of machine learning through python programming.
2. To develop skills of using recent machine learning packages for solving practical problems.
3. To gain experience of doing independent study and research.
4. To design and implement Machine learning Algorithms.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Able to demonstrate python packages	PO_1, PO_2
CO_2	Able to generate and analyze and interpret data using python	PO_2, PO_3
CO_3	Use Python to design and implement classifiers for machine learning applications.	PO_2, PO_3, PO_4
CO_4	Implement an end-to-end machine learning system	PO_2, PO_3, PO_4, PO_5

PO_1- Engineering Knowledge, **PO_2**- Problem analysis, **PO_3**- Design/development of solutions, **PO_4**- Conduct investigations of complex problems, **PO_5**- Modern tool usage, **PO_6**- The engineer and society, **PO_7**- Environment and sustainability, **PO_8**- Ethics, **PO_9**- Individual or team work, **PO_{10}**- Communication, **PO_{11}**- Project management and finance, **PO_{12}**- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	1	1										
CO_2		3	2									
CO_3		2	3	2								
CO_4		2	3	2	2							

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Lab experiments are based on the syllabus prescribed for Machine learning algorithm using python.

1. Basic data structures and operations of python programming.
2. Write the python code for data cleaning the data (Note: Don't import repackage in python)
3. Write the python code for finding the Euclidean distance between two data points.
4. Write a python code for handling the missing value feature in the provided data set.
5. Implementation of k-nearest neighbors (KNN) algorithm to classify the iris data set. Print both correct and wrong predictions. Python ML library classes can be used for this problem.
6. Implement the classification problem, training and testing data can be used to build classification models.
7. Implement the class of accuracy metrics for classification: precision, recall, f1 score, accuracy score.
8. Implementation of K -Means algorithm.
9. Implementation of Decision Tree-based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
10. Implementation of the Random Forest algorithm.
11. Implementation of Naive Bayesian classifier for a sample training data set stored as a.CSV file. Compute the accuracy of the classifier, considering few test data sets.
12. Implementation of Simple Linear Regression using sklearn.
13. Implementation of regression using ordinary least squares method.
14. Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs.
15. Implementation of Different multi-class SVM techniques using Binary class SVM library.
16. Case study: Predicting the price of pre-owned cars, Classifying personal income.
17. Implementation of CNN using Tensorflow/Keras library and classify the Images (Note: Take your own dataset of your choice).
18. Implementation of Grid search and Random search using Logistic Regression.

Examination and Evaluation Pattern: It include both internal evaluation (50 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (50 marks) which is mainly end semester examination.	
Text Books:	
1	Mastering python for data science, Samir Madhavan
2	Introduction to linear algebra - by Gilbert Strang
3	Machine Learning using Python, U Dinesh Kumar Manaranjan Pradhan
Reference Books:	
1	Applied statistics and probability for engineers – by Douglas Montgomery
2	McKinney, W. (2012). Python for data analysis: Data wrangling with Pandas, NumPy, and IPython. " O'Reilly Media

Course Code	Course Title	Lecture			Semester: II
MTCS270PCP	Mini Project with Seminar*	L	T	P	
Version: 1.2	Date of Approval:	0	0	4	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	20 Hrs.	Maximum Score	:	100
Lab Hours/ Week	:	4	Internal Evaluation	:	50
Credits	:	2	End Semester	:	50
Instruction Mode	:	Practical	Exam Duration	:	3 Hrs.

Prerequisite(s):

Course Objectives:

1. To understand Software requirement specification and designing methodology.
2. To familiarize of the syntax, semantics, data-types and library functions of any programming languages.
3. To apply ER Diagram, DFD, UML for designing the software application.
4. To implement the specified problems.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Applying SRS, techniques	$PO_2, PO_3, PO_8, PO_9, PO_{11}$
CO_2	Apply Design methods for given SRS	$PO_3, PO_5, PO_9, PO_{11}$
CO_3	Write the codes as per SRS and designed Framework	PO_3, PO_5
CO_4	Able to implement real world problem into software solution	$PO_3, PO_5, PO_9, PO_{11}$

PO_1- Engineering Knowledge, PO_2- Problem analysis, PO_3- Design/development of solutions, PO_4- Conduct investigations of complex problems, PO_5- Modern tool usage, PO_6- The engineer and society, PO_7- Environment and sustainability, PO_8- Ethics, PO_9- Individual or team work, PO_{10}- Communication, PO_{11}- Project management and finance, PO_{12}- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1		2	2					2	2		2	
CO_2			2		2				2		2	
CO_3			2		2							
CO_4			2		2				2		2	

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

- Based on real-time/ in-house/ problem specific

*****Students are encouraged to go to Industrial Training/Internship for at least 2-3 months during semester break. They need to make a prototype model in the allotted areas on the recommendations of the supervisor.

Examination and Evaluation Pattern: It include both internal evaluation (50 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (50 marks) which is mainly end semester examination.

Text Books:

1	

Reference Books:

1	

Course Code	Course Title	Lecture			Semester: III
MTCS370PCP	Dissertation-1	L	T	P	
Version: 1.2	Date of Approval:	0	0	20	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	20 Hrs.	Maximum Score	:	700
Lab Hours/ Week	:	20	Internal Evaluation	:	210
Credits	:	10	End Semester	:	490
Instruction Mode	:	Practical	Exam Duration	:	-

Prerequisite(s):

Course Objectives:

1. To understand the research issues & challenges, research goals, scientific methods.
2. To Review Literature and Research Papers; Writing Research Papers, Thesis, Reports and Project Proposals Plagiarism and Copyrights.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand the issues & challenges, goals, scientific methods in research.	PO_1, PO_2
CO_2	Prepare a project proposal (to undertake a project) and conduct research in a more appropriate manner, writing research report and dissertation.	PO_3, PO_5

PO_1- Engineering Knowledge, PO_2- Problem analysis, PO_3- Design/development of solutions, PO_4- Conduct investigations of complex problems, PO_5- Modern tool usage, PO_6- The engineer and society, PO_7- Environment and sustainability, PO_8- Ethics, PO_9- Individual or team work, PO_{10}- Communication, PO_{11}- Project management and finance, PO_{12}- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	2	2										
CO_2			2		2							

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

- **Based on research problem R&D**

Examination and Evaluation Pattern: It include both internal evaluation (210 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (490 marks) which is mainly end semester examination.

Text Books:

1	

Reference Books:

1	

Course Code	Course Title	Lecture			Semester: IV
MTCS470PCP	Dissertation-2	L	T	P	
Version: 1.2	**Date of Approval:**	0	0	28	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	40 Hrs.	Maximum Score	:	800
Lab Hours/ Week	:	28	Internal Evaluation	:	240
Credits	:	14	End Semester	:	560
Instruction Mode	:	Practical	Exam Duration	:	-

Prerequisite(s):

Course Objectives:

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	To understand the research issues & challenges, research goals, scientific methods.	**PO_1, PO_2**
CO_2	To Review Literature and Research Papers; Writing Research Papers, Thesis, Reports and Project Proposals Plagiarism and Copyrights.	**PO_3, PO_5**

PO_1- Engineering Knowledge, **PO_2**- Problem analysis, **PO_3**- Design/development of solutions, **PO_4**- Conduct investigations of complex problems, **PO_5**- Modern tool usage, **PO_6**- The engineer and society, **PO_7**- Environment and sustainability, **PO_8**- Ethics, **PO_9**- Individual or team work, **PO_{10}**- Communication, **PO_{11}**- Project management and finance, **PO_{12}**- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	2	2										
CO_2			2		2							

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

- **Based on research problem R&D**

Examination and Evaluation Pattern: It include both internal evaluation (240 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (560 marks) which is mainly end semester examination.

Text Books:

1	

Reference Books:

1	

PROGRAM ELECTIVES

Course Code	Course Title	Lecture			Semester: I
MTCS111PET	Advanced Network Security	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Network Security

Course Objectives:

1. To understand the concept of security and privacy.
2. To understand various protocols for network security to protect against the threats in the networks.
3. To understand E-mail security, PEM& S/MIME, PGP, Firewalls.
4. To introduce new developing security features.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand the developing security features in networkingsystems and real time communication security.	PO_1, PO_2, PO_4, PO_5, PO_{10}, PO_{12}
CO_2	Implement various networking protocols.	PO_3, PO_4
CO_3	Apply research in the emerging areas of cryptography and network security.	PO_3, PO_4, PO_5
CO_4	Analyze and protect any network from the threats in theworld.	PO_6, PO_9, PO_{12}

PO_1- Engineering Knowledge, **PO_2**- Problem analysis, **PO_3**- Design/development of solutions, **PO_4**- Conduct investigations of complex problems, **PO_5**- Modern tool usage, **PO_6**- The engineer and society, **PO_7**- Environment and sustainability, **PO_8**- Ethics, **PO_9**- Individual or team work, **PO_{10}**- Communication, **PO_{11}**- Project management and finance, **PO_{12}**- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	2	3		3	2	1				1		2
CO_2			2	3								
CO_3			2	2	3							
CO_4						1			2			2

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Introduction to the concepts of Security: The need for security, security approaches, principles of security, modular arithmetic, prime numbers, relative prime numbers, Euler's function, Symmetric Cryptography: Overview of symmetric cryptography, Algorithm types and Modes, International Data Encryption, Algorithm (IDEA), Advanced Encryption Standard (AES)
Unit: 2	Asymmetric Cryptography: Overview of asymmetric cryptography, Robin algorithm, ElGamal Algorithm, Knapsack Algorithm, Elliptic Curve Cryptography.
Unit: 3	Identity Based Cryptography: Introduction, Boneh-Franklin IBE (BF-IBE), Sakai-Kasahara IBE (SK-IBE), Boneh-Boyen IBE, (BB-IBE)
Unit: 4	Public Key Infrastructure: Digital Certificates, Key Management. Hash Functions, Digital Signature, Message Integrity, Message Authentication, Entity Authentication
Unit: 5	Security at the Application Layer: Email, PGP. Security at the Transport Layer: SSL and TLS. Security at the Network Layer: IPSec. System Security: Malicious Programs, IDS, Firewalls.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Cryptography and Network security, Behrouz A. Forouzan and Debdeep Mukhopadhyay, McGraw Hill.
2	Introduction to Modern Cryptography, Jonathan Katz and Yehuda Lindell, CRC Press.

Reference Books:

1	Understanding Cryptography, Christof Paar and Jan Pelzl, Springer.
2	Cryptography and Information Security, V K Pachghare, PHI.

Course Code	Course Title	Lecture			Semester: I
MTCS112PET	Distributed Database	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Database Management System

Course Objectives:

1. To understand principles and foundations of distributed databases.
2. To learn concepts related to architecture, design issues, integrity control, query processing.
3. To understand the concept of a database transaction and related database facilities, including concurrency control, backup and recovery.
4. To interpret the modeling symbols for the most popular ER modeling tools. And real-world database design which often involves conflicting goals.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand and successfully apply logical database design principles, including E-R diagrams and database normalization.	PO_1, PO_2, PO_3, PO_4
CO_2	Design and implement a small distributed database project.	PO_3, PO_4, PO_9
CO_3	Understand the modeling symbols for the most popular ER modeling tools in context to real-world database design which often involves conflicting goals.	PO_2, PO_3,PO_4, PO_9
CO_4	Apply optimization, transactions, and concurrency control in distributed environment	PO_1, PO_{11}, PO_{12}

PO_1- Engineering Knowledge, **PO_2**- Problem analysis, **PO_3**- Design/development of solutions, **PO_4**- Conduct investigations of complex problems, **PO_5**- Modern tool usage, **PO_6**- The engineer and society, **PO_7**- Environment and sustainability, **PO_8**- Ethics, **PO_9**- Individual or team work, **PO_{10}**- Communication, **PO_{11}**- Project management and finance, **PO_{12}**- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	3	2	3	2								
CO_2			3	2					2			
CO_3		2	3	3					2			
CO_4	2										2	2

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Introduction: Distributed Data Processing, what is a Distributed Database System? Promises of DDBSs Problem Areas. advantages and disadvantages of distributed database, additional functions of Distributed database, distributed DBMS,
Unit: 2	Distributed DBMS Architecture: DBMS Standardization, Architectural Models for Distributed DBMSs, Distributed DBMS Architecture. Distributed Database Design: Alternative Design Strategies, Distribution Design Issues, Fragmentation, Replication, Replication Techniques, Fragmentation schema, allocation schema data replication.
Unit: 3	Overview of Query Processing: Query Processing Problem, Objectives of Query Processing, Complexity of Relational Algebra Operations, Layers of Query Processing. Query Decomposition and Optimization: Query Decomposition, Query Optimization, Centralized Query Optimization, Semi joins Distributed Query Optimization Algorithms.
Unit: 4	Transaction Management and Concurrency Control: Definition of a Transaction, properties of Transactions, Serializability Theory, Taxonomy of Concurrency Control Mechanisms, Locking-based Concurrency Control Algorithms, Timestamp-based Concurrency Control Algorithms, Deadlock Management.
Unit: 5	Distributed DBMS Reliability: Reliability Concepts and Measures, Failures and Fault Tolerance in Distributed Systems, Failures in Distributed DBMS, Local Reliability Protocols, Distributed Reliability Protocols.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1 OzsuM. Tamer, ValduriezPatrick, “Distributed Database Systems”, 2nd Edition, Pearson, 2011

2	Ceei and Pelagatti,'Distributed Database', TMH.
Reference Books:	
1	NavatheElmasri, "Fundamental of Database Systems", 5th Edition, Pearson Education, 2008. Page 210 of 243 2
2	ConnollyThomas, BeggCarolyn, "Database Systems – A Practical Approach to Design, implementation and Management", 4th Edition, Pearson Education, 2008.

Course Code	Course Title	Lecture			Semester: I
MTCS113PET	Data Science	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Data warehouse and Data Mining

Course Objectives:

1. To provide with the knowledge and expertise to become a proficient data scientist.
2. To Demonstrate an understanding of statistics and machine learning concepts that are vital for datascience
3. To Produce Python code to statistically analyses a dataset
4. To Critically evaluate data visualizations based on their design and use for communicating stories from data

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand the concepts - Obtain, clean/process, and transform data	PO_1, PO_4, PO_5
CO_2	Analyze and interpret data using an ethically responsible approach.	PO_2, PO_8
CO_3	Apply mathematical and statistical models, and the principles of optimization to appropriately formulate and use data analyses	PO_1, PO_4, PO_5
CO_4	Interpret data findings visually, and in written formats	PO_2, PO_3, PO_{10}

PO_1- Engineering Knowledge, **PO_2**- Problem analysis, **PO_3**- Design/development of solutions, **PO_4**- Conduct investigations of complex problems, **PO_5**- Modern tool usage, **PO_6**- The engineer and society, **PO_7**- Environment and sustainability, **PO_8**- Ethics, **PO_9**- Individual or team work, **PO_{10}**- Communication, **PO_{11}**- Project management and finance, **PO_{12}**- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	3			2	2							
CO_2		3						3				
CO_3	3			3	3							
CO_4		2			3					3		

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Introduction to core concepts and technologies: Introduction, Terminology, data science process, data science toolkit, Types of data, Example applications
Unit: 2	Data collection and management: Introduction, Sources of data, Data collection and APIs, Exploring and fixing data, Data storage and management, Using multiple data sources
Unit: 3	Data analysis: Introduction, Terminology and concepts, Introduction to statistics, Central tendencies and distributions, Variance, Distribution properties and arithmetic, Samples/CLT, Basic machine learning algorithms, Linear regression, SVM, Naive Bayes.
Unit: 4	Data visualization: Introduction, Types of data visualization, Data for visualization: Data types, Data encodings, Retinal variables, Mapping variables to encodings, Visual encodings.
Unit: 5	Applications of Data Science, Technologies for visualization, Bokeh (Python), Recent trends in various data collection and analysis techniques, various visualization techniques, application development methods of used in data science.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline. O'Reilly.
2	Jure Leskovek, AnandRajaraman and Jeffrey Ullman. Mining of Massive Datasets. v2.1, Cambridge University Press.

Reference Books:

1	Field Cady, The Data Science Handbook, Wiley
2	Jake VanderPlas, Python Data Science Handbook: Essential Tools for working with Data, OReily

Course Code	Course Title	Lecture			Semester: I
MTCS114PET	Semantics Web	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Database Management System & Networks

Course Objectives:

1. To acquaint about the Semantic Web Vision.
2. To Understand about XML, RDF, RDFS, OWL.
3. To Create and Query the Ontology.
4. To introduce Ontology Reasoning and Migrate from Document to Data Web.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand the concepts of structure of the semantic web technology, semantics of knowledge and resource, ontology.	PO_1, PO_2, PO_4
CO_2	Evaluate logic semantics and inference with OWL.	PO_1, PO_2, PO_5, PO_8, PO_9
CO_3	Apply ontology engineering approaches in semantic applications	PO_3, PO_4
CO_4	Understand Web graph processing for various applications such as search engine, community detection	PO_1, PO_5, PO_8, PO_{12}

PO_1- Engineering Knowledge, PO_2- Problem analysis, PO_3- Design/development of solutions, PO_4- Conduct investigations of complex problems, PO_5- Modern tool usage, PO_6- The engineer and society, PO_7- Environment and sustainability, PO_8- Ethics, PO_9- Individual or team work, PO_{10}- Communication, PO_{11}- Project management and finance, PO_{12}- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	2	2		2								
CO_2	3	2			2			3	2			
CO_3		2		3								
CO_4	3				3			3				2

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	**Foundation of Semantic Web Technologies**: Introduction, Current web vs Semantic Web, Semantic Web Technologies, A layered approach Descriptive Logic, Introduction, Definition of the basic formalism, Reasoning algorithms, Language extensions
Unit: 2	**Structured Web Documents in XML:** Introduction, XML, Structuring, Namespaces, Addressing andquerying XML document, Processing
Unit: 3	**Describing Web Resources:** RDF : Introduction, RDF: Basic Ideas, RDF: XML-Based Syntax, RDFserialization, RDF Schema: Basic Ideas, RDF Schema: The Language, RDF and RDF Schema in RDF Schema
Unit: 4	**Web Ontology Language:** OWL, Introduction, OWL and RDF/RDFS, Three Sublanguages of OWL, Description of the OWL Language, Layering of OWL, Examples, OWL in OWL
Unit: 5	**SPARQL**: SPARQL simple Graph Patterns, Complex Graph Patterns, Group Patterns, Queries with DataValues, Filters, OWL Formal Semantics

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	John Davies, Rudi Studer, and Paul Warren John, "Semantic Web Technologies: Trends and Research in Ontology-based Systems", Wiley and Son's, 2006.
2	John Davies, Dieter Fensel and Frank Van Harmelen, "Towards the Semantic Web: Ontology- Driven KnowledgeManagement", John Wiley and Sons, 2003.

Reference Books:

1	Foundation of Semantic Web Technologies, Pascal Hitzler, Markus and Sebastian
2	Michael C. Daconta, Leo J. Obrst, and Kevin T. Smith, "The Semantic Web: A Guide to the Future of XML, Web Services, and Knowledge Management", Fourth Edition, Wiley Publishing, 2003.

Course Code	Course Title	Lecture			Semester: II
MTCS115PET	Component based Software Engineering	L	T	P	
Version: 1.2	Date of Approval: 19th BoS	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	45 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Data structure and algorithm

Course Objectives:

1. To understand the idea of decomposing the given problem into Analysis, Design, Implementation, Testing and Maintenance phases.
2. To provide an idea of using various process models in the software industry according to given circumstances
3. To gain the knowledge of how Analysis, Design, Implementation,
4. To test and maintain processes of a software project.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Decompose the given project in various phases of a lifecycle. Knowledge, Understand	PO_1, PO_2, PO_3, PO_{11}
CO_2	Selection of appropriate process model depending on the user requirements apply the knowledge, techniques, and skills in the development of a software product	PO_2, PO_5, PO_6, PO_{11}
CO_3	Perform various life cycle activities like Analysis, Design, Implementation, Testing and Maintenance.	PO_3, PO_4, PO_5
CO_4	Analyze various processes used in all the phases of the product.	PO_2, PO_6

PO_1- Engineering Knowledge, **PO_2**- Problem analysis, **PO_3**- Design/development of solutions, **PO_4**- Conduct investigations of complex problems, **PO_5**- Modern tool usage, **PO_6**- The engineer and society, **PO_7**- Environment and sustainability, **PO_8**- Ethics, **PO_9**- Individual or team work, **PO_{10}**- Communication, **PO_{11}**- Project management and finance, **PO_{12}**- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	2	2	2								1	
CO_2		2			1	1					1	
CO_3			2	1	1							
CO_4		2				1						

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Introduction to Component Based Development: Definition of Software Component and its Elements, The Component Industry Metaphor, Component Models and Component Services: Concepts and Principles, An Example Specification for Implementing a Temperature Regulator Software Component.
Unit: 2	Case for Components: The Business Case for Software Components, COTS Myths and Other Lessons Learned in Component-Based Software Development, Roles for Component-Based Development, Common High Risk Mistakes in Component-Based Software Engineering, CBSE Success Factors: Integrating Architecture, Process, and Organization.
Unit: 3	Software Component Infrastructure: Software Components and the UML, Component Infrastructures: Placing Software Components in Context, Business Components, Components and Connectors: Catalysis Techniques for Defining Component Infrastructures, an Open Process for Component-Based Development, Designing Models of Modularity and Integration.
Unit: 4	Management of CBD: Measurement and Metrics for Software Components, The Practical Reuse of Software Components, Selecting the Right COTS Software: Why Requirements are important, Build vs. Buy, Software Component Project Management Processes, The Trouble with Testing Software Components, Configuration Management and Component Libraries, The Evolution, Maintenance and Management of Component-Based Systems
Unit: 5	Component Technologies: Overview of the CORBA Component Model, Transactional COM+ Designing Scalable Applications, The Enterprise JavaBeans Component Model, Choosing Between COM+, EJB, and CCM, Software Agents as Next Generation Software Components.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Component Software, Clemens Szyperski, Addison-Wesley Professional; 2 edition, 2002, ISBN-10: 0201745720, ISBN-13: 978-0201745726
Reference Books:	
1	Component-Based Software Engineering: Putting the Pieces Together by George T. Heinemann and William T. Council, Addison-Wesley Professional, 2001 ISBN 1`0: 0201704854, ISBN- 13:9780201704853

Course Code	Course Title	Lecture			Semester: I
MTCS116PET	Artificial Intelligence	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Discrete Mathematics

Course Objectives:

1. To understand the area of artificial intelligence and designing intelligent machines.
2. To learn thinking and intelligence in ways that enable the construction of computer systems that works in uncertain environments.
3. To develop the intelligent machines using various approaches.
4. To distinction between Conventional Systems and an Intelligent System.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Able to choose the appropriate representation for an AI Problem and construct in that representation.	PO_1, PO_2
CO_2	Selection of appropriate Algorithm and implementation	PO_2
CO_3	Design and Analyze the Performance of an AI System	PO_3, PO_4
CO_4	To able to analyses research in artificial intelligence	PO_2, PO_4, PO_9

PO_1- Engineering Knowledge, PO_2- Problem analysis, PO_3- Design/development of solutions, PO_4- Conduct investigations of complex problems, PO_5- Modern tool usage, PO_6- The engineer and society, PO_7- Environment and sustainability, PO_8- Ethics, PO_9- Individual or team work, PO_{10}- Communication, PO_{11}- Project management and finance, PO_{12}- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	2	2										
CO_2		2										
CO_3			2	1								
CO_4		2		1					1			

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	**Introduction:** Introduction to Artificial Intelligence, Foundations and History of Artificial Intelligence, Applications of Artificial Intelligence, Intelligent Agents, Structure of Intelligent Agents. Computer vision, Natural Language Possessing.
Unit: 2	**Introduction to Search:** Searching for solutions, Uniformed search strategies, Informed search strategies, Local search algorithms and optimistic problems, Adversarial Search, Search for games, Alpha - Beta pruning.
Unit: 3	**Knowledge Representation & Reasoning:** Propositional logic, Theory of first order logic, Inference in first order logic, Resolution, Unification, Forward & Backward chaining, Probabilistic reasoning, Utility theory, Hidden Markov Models (HMM), Bayesian Networks.
Unit: 4	**Machine Learning:** Supervised and unsupervised learning, Decision trees, Statistical learning models, learning with complete data - Naive Bayes models, Learning with hidden data - EM algorithm, Reinforcement learning.
Unit: 5	**Pattern Recognition:** Introduction, Design principles of pattern recognition system, Statistical Pattern recognition, Parameter estimation methods - Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA), Classification Techniques – Nearest Neighbor (NN) Rule, Bayes Classifier, K–means clustering algorithms.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Russell S. and Norvig P., "Artificial Intelligence – A Modern Approach", Pearson Education
2	Rich E. and Knight K., "Artificial Intelligence", Tata McGraw Hill.

Reference Books:

1	Patterson D. W., "Artificial Intelligence and Expert Systems", Prentice Hall of India.
2	Russell S. and Norvig P., "Artificial Intelligence – A Modern Approach", Pearson Education

Course Code	Course Title	Lecture			Semester: I
MTCS121PET	Intelligent Systems	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Artificial Intelligence

Course Objectives:

1. To provide the concepts of intelligent systems.
2. To develop problem solving skills by searching.
3. To explain knowledge representation, problem solving, and reasoning.
4. To deal with uncertainty and design agents to handle them.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand the characteristics, scope and limits of the intelligent systems.	PO_1, PO_2
CO_2	Analyze the problem solving by searching	PO_2, PO_3
CO_3	Apply the knowledge representation, problem solving, and reasoning	PO_4, PO_5
CO_4	Analyze the reasons for uncertainty, biological inspired algorithms and design agents to handle them	PO_4, PO_9, PO_{10}

PO_1- Engineering Knowledge, PO_2- Problem analysis, PO_3- Design/development of solutions, PO_4- Conduct investigations of complex problems, PO_5- Modern tool usage, PO_6- The engineer and society, PO_7- Environment and sustainability, PO_8- Ethics, PO_9- Individual or team work, PO_{10}- Communication, PO_{11}- Project management and finance, PO_{12}- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	3	2										
CO_2		2	2									
CO_3				2	2							
CO_4				2					2	3		

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	**Introduction and Overview of Intelligent Systems and Intelligent Agents**: History and Foundation of Intelligent Systems, Knowledge-based systems, Expert Systems. Intelligent Agents: Agents and Environments, Characteristics of Intelligent Agents, Definition of a Rational Agent, Structure of an Agent, Reflex agents, Goal-based agents, Utility-based agents, Multi-agent Systems.
Unit: 2	**Problem Solving by Search**: Uninformed Search (Blind Search): BFS, DFS, Depth- Limited Search, Iterative Deepening DFS, Bidirectional Search; Informed (Heuristic) Search: Best-First Search, A* Search, IDA* Search.
Unit: 3	**Local and Adversarial Search:** Hill Climbing Search, Simulated Annealing Search, Local Beam Search; Online Search; Adversarial Search: The minimax algorithm, Alpha-Beta Pruning.
Unit: 4	**Knowledge Representation and Reasoning**: Propositional Logic: Operators, Inference, Equivalence, Validity, Satisfiability, Resolution; First Order Predicate Logic (FOPL); Inference in First Order Logic; Rule Based System; Forward and Backward Chaining; Semantic Network.
Unit: 5	**Biological Foundations to Intelligent Systems**: Artificial Neural Networks (ANN): Neurons, Hebb's Rule, Single & Multi-layer Perceptron, Back-propagation Algorithm; Genetic Algorithms: Crossover, Mutation, Selection; Introduction to Particle Swarm Optimization; Introduction to Ant Colonies Optimization; Hybrid Intelligent Systems.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	CrinaGrosan, Ajith Abraham, "Intelligent Systems: A Modern Approach ", Springer-Verlag, 2011
2	Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", 4thed., Pearsons, 2022

Reference Books:

1	Adrian A. Hopgood, "Intelligent systems for engineers and scientists", 4th ed., CRC press, 2021
2	Denis Rothman, "Artificial Intelligence By Example", Packt Publishing, 2018

Course Code	Course Title	Lecture			Semester: I
MTCS122PET	Augmented & Virtual Reality	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Artificial Intelligence

Course Objectives:

1. To understand the basic concept and framework of virtual reality.
2. To understand the elements, architecture, input and output devices of virtual and augmented reality systems.
3. To explore the research issues in Augmented Reality and Virtual Reality (AR &VR).
4. To Understand AR environments

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Analyze the research issues in Augmented Reality and Virtual Reality (AR&VR).	PO_1, PO_2, PO_3
CO_2	Evaluate the main application of VR and AR technologies in various area like education games etc.	PO_1, PO_2, PO_5
CO_3	Analyze the role and importance of VR &AR in the modern world.	PO_3, PO_4, PO9
CO_4	Create the Application of 3D in Augmented Reality and the challenges faced	PO_2, PO_{12}

PO_1- Engineering Knowledge, **PO_2**- Problem analysis, **PO_3**- Design/development of solutions, **PO_4**- Conduct investigations of complex problems, **PO_5**- Modern tool usage, **PO_6**- The engineer and society, **PO_7**- Environment and sustainability, **PO_8**- Ethics, **PO_9**- Individual or team work, **PO_{10}**- Communication, **PO_{11}**- Project management and finance, **PO_{12}**- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	2	2	3									
CO_2	3	2			2							
CO_3			1	2					2			
CO_4		2										2

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Introduction of Virtual Reality: Fundamental Concept and Components of Virtual Reality. Primary Features and Present Development on Virtual Reality.
Unit: 2	Multiple Models of Input and Output Interface in Virtual Reality: Input -- Tracker, Sensor, Digital Glove, Movement Capture, Video-based Input, 3D Menus & 3DScanner etc. Output - Visual /Auditory / Haptic Devices.
Unit: 3	Visual Computation in Virtual Reality: Fundamentals of Computer Graphics. Software and Hardware Technology on Stereoscopic Display. Advanced Techniques in CG: Management of Large-Scale Environments & Real Time Rendering.
Unit: 4	Interactive Techniques in Virtual Reality: Body Track, Hand Gesture, 3D Manus, Object Grasp. Development Tools and Frameworks in Virtual Reality: Frameworks of Software Development Tools in VR. X3D Standard; Vega, MultiGen, Virtools etc. Application of VR in Digital Entertainment: VR Technology in Film & TV Production. VR Technology in Physical Exercises and Games. Demonstration of Digital Entertainment by VR.
Unit: 5	Augmented and Mixed Reality, Taxonomy, technology and features of augmented reality, difference between AR and VR, Challenges with AR, AR systems and functionality, Augmented reality methods, visualization techniques for augmented reality, wireless displays in educational augmented reality applications, mobile projection interfaces, marker-less tracking for augmented reality, enhancing interactivity in AR environments, evaluating AR systems.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1. Burdea, G. C. and P. Coffet. Virtual Reality Technology, Second Edition. Wiley-IEEE Press, 2003/2006.
2. Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, 2013.

Reference Books:

1	Alan Craig, William Sherman and Jeffrey Will, Developing Virtual Reality Applications, Foundations of Effective Design, Morgan Kaufmann, 2009.
2	Gerard Jounghyun Kim, Designing Virtual Systems: The Structured Approach, 2005.

Course Code	Course Title	Lecture			Semester: I
MTCS123PET	Soft Computing	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Machine Learning, MATLAB

Course Objectives:

1. To introduce soft computing concepts and techniques and foster their abilities in designing appropriate technique for a given scenario.
2. To implement soft computing-based solutions for real-world problems.
3. To provide knowledge of non-traditional technologies and fundamentals of artificial neural networks, fuzzy sets, fuzzy logic, genetic algorithms.
4. To provide student hands-on experience on MATLAB to implement various strategies.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Evaluate soft computing techniques and their roles in building intelligent machines.	PO_2, PO_4
CO_2	Apply fuzzy logic and reasoning to handle uncertainty and solve various engineering problems.	PO_1, PO_3, PO_4
CO_3	Apply genetic algorithms to combinatorial optimization problems.	PO_2, PO_3, PO_4, PO_{12}
CO_4	Evaluate and compare solutions by various soft computing approaches for a given problem.	PO_2, PO_4

PO_1- Engineering Knowledge, PO_2- Problem analysis, PO_3- Design/development of solutions, PO_4- Conduct investigations of complex problems, PO_5- Modern tool usage, PO_6- The engineer and society, PO_7- Environment and sustainability, PO_8- Ethics, PO_9- Individual or team work, PO_{10}- Communication, PO_{11}- Project management and finance, PO_{12}- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1		1		3								
CO_2	3		3	2								
CO_3		3	2	2								2
CO_4		3		3								

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	**Introduction to Soft Computing and Neural Network:** Evolution of Computing: Soft Computing Constituents, From Conventional AI to Computational Intelligence: MachineLearning Basics.
Unit: 2	**Fuzzy Logic:** Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy Relations, Membership Functions: Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Expert Systems, Fuzzy Decision Making.
Unit: 3	**Neural Networks:** Machine Learning Using Neural Network, Adaptive Networks, Feed forward Networks, Supervised Learning Neural Networks, Radial Basis Function Networks: Reinforcement Learning, Unsupervised Learning Neural Networks, Adaptive Resonance architectures, Advances in Neural networks.
Unit: 4	**Genetic Algorithms:** Introduction to Genetic Algorithms (GA), Applications of GA in MachineLearning: Machine Learning Approach to Knowledge Acquisition.
Unit: 5	Recent Trends in deep learning, various classifiers, neural networks and genetic algorithm. Implementation of recently proposed soft computing techniques.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Jyh:Shing Roger Jang, Chuen:Tsai Sun, EijiMizutani, Neuro: Fuzzy and Soft Computing, Prentice: Hall of India,2003.
2	George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice Hall, 1995.

Reference Books:

1	Luger G.F. and Stubblefield W.A. (2008). Artificial Intelligence: Structures and strategies for Complex Problem Solving. Addison Wesley, 6th edition.
2	Russell S. and Norvig P. (2009). Artificial Intelligence: A Modern Approach. Prentice-Hall, 3rd Edition.

Course Code	Course Title	Lecture			Semester: I
MTCS124PET	Digital Forensics	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Cyber Security

Course Objectives:

1. Understand the concept of Cybercrime & digital forensic, digital evidence & its role.
2. Interpret & apply various digital forensic models.
3. Interpret & apply various phases of methodology on incident.
4. Interpret & apply digital forensic Tools in real-Time scenario.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Analyze the need for cybercrime investigation and understand the hardware and software components responsible for seeking evidence.	PO_1, PO_5
CO_2	Apply knowledge on the techniques used for collecting evidences.	PO_1, PO_2, PO_3, PO_4
CO_3	Analyze the evidence through suitable tools.	PO_3, PO_4, PO_5, PO_{10}
CO_4	Analyze other sources of evidences	PO_2, PO_3, PO_4

PO_1- Engineering Knowledge, **PO_2**- Problem analysis, **PO_3**- Design/development of solutions, **PO_4**- Conduct investigations of complex problems, **PO_5**- Modern tool usage, **PO_6**- The engineer and society, **PO_7**- Environment and sustainability, **PO_8**- Ethics, **PO_9**- Individual or team work, **PO_{10}**- Communication, **PO_{11}**- Project management and finance, **PO_{12}**- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	2				2							
CO_2	2	3	3	3								
CO_3			3	2	1					3		
CO_4		2	3	2								

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Introduction to Digital Forensics: Cybercrimes, Types of Cybercrimes, Digital Evidence, Cyber Forensics, Classification of Cyber Forensics, Digital Forensics Process, people involved in SFI, setting up a Forensics Lab, Building a Computer Forensic Tool kit.
Unit: 2	Understanding Hard Disks and File Systems: Disk Drive & Types of Disk Drives, Physical structure of KDD, HDD Addressing, Types of Partitions, Booting, Difference between Cold Bot Warm Bot, File Systems, FAT & NTFS, List of Forensic software used for File System Analysis.
Unit: 3	Defeating Anti-Forensics Techniques, various Anti-forensics Techniques, File recovery tools for WINDOWS OS, Partition, Partition recovery Tools, Password Cracker. Data acquisition & Duplication, Live data acquisition & Static data acquisition, Data Acquisition & Duplication Hardware & Software Tools.
Unit: 4	Network Forensics: Active & Passive Network Forensics, Types of Network vulnerabilities. Investigating Web Attacks, Web Application Forensics, Challenges in Web Application Forensics, Symptoms of Web Attacks, steps for investigating Web Attacks, Investigation Web Attacks in WINDOWS & LINUX based servers, Mobile Forensics, analyzing malicious files.
Unit: 5	Data Base Forensics: Database, Database Forensics, analyzing DB Files using DB Browser for SQLite. IOT Forensics, Performing Data Acquisition in Android Devices. Cloud Forensics: Cloud computing, Cloud Forensics, types of Cloud services, Types of Cloud Deployment Models, Challenges faced by investigators during Cloud Forensics, investigating E-mail Crimes, E-mail Forensics Tools.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Dr. Nilakshi Jain, Dr. Dhanajay R. Kalbande
2	Richard Boddington, Practical Digital Forensics, PACKT publishing, First Edition, 2016 ANDRÉ ÅRNES.

Reference Books:

1	Practical Mobile Forensics, PACKT publishing , 2014 Satish Bommisetty, Rohit Tamma, Heather Mahalik

2	"Guide to Computer Forensics and Investigations" 4e, Nelson, Phillips Enfinger, Steuart, Cengage Learning.

Course Code	Course Title	Lecture			Semester: I
MTCS125PET	Distributed Systems	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	45 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Basic networking concepts and Basic OS

Course Objectives:

1. To understand the overview of the principles, architectures, algorithms and programming models used in distributed systems.
2. To acquire the concept of distributed system design.
3. To gain the knowledge in synchronization, consistency and replication, fault tolerance and security.
4. To apply and analysis of the current popular distributed systems such as peer-to-peer (P2P) systems.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand the characteristics, issues and importance of distributed systems	PO_1, PO_2
CO_2	Demonstrate the architecture and processes of Distributed System.	PO_3, PO_4
CO_3	Analyze the concept of synchronization processes.	PO_2, PO_4
CO_4	Apply and analyze the importance of security in distributed systems	PO_2, PO_3

PO_1- Engineering Knowledge, PO_2- Problem analysis, PO_3- Design/development of solutions, PO_4- Conduct investigations of complex problems, PO_5- Modern tool usage, PO_6- The engineer and society, PO_7- Environment and sustainability, PO_8- Ethics, PO_9- Individual or team work, PO_{10}- Communication, PO_{11}- Project management and finance, PO_{12}- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	2	2										
CO_2			2	1								
CO_3		2		1								
CO_4		2	2									

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	**Introduction:** Motivation, objectives, characterization & classification of distributed systems. Distributed system architecture. Hardware & software issues. Communication: Layered protocols, Client server protocols, RPC, group communication. Coordination, synchronization & consistency: Logical clocks, Physical clocks, mutual exclusion, election algorithms, atomic broadcast, sequential consistency transaction distributed consensus, Threads: Thread synchronization, implementation issues, and threads vs. RPC
Unit: 2	**Models of distributed computing:** Client server and RPC, RPC architecture, exceptions, underlying protocols, IDL, marshalling etc. Group models and peer to peer: Groups for service replication/ reliability, groups for parallelism / performance, client/ server vs. peer-to-peer, multicast, atomic broadcast.
Unit: 3	**Inter-process Communication:** API for Internet protocols. External data representation and Marshalling. Client-Server communication and Group communication. Distributed Objects and Remote Invocation- Communication between distributed objects, Remote procedure call, Events and notifications.
Unit: 4	**Distributed file system:** Security, Naming/ location transparency, R/W semantics, cache coherence, replication. Distributed shared memory: DSM architecture, consistency models and relation to caching, release consistency, comparison with message passing and RPC. Advanced Distributed Computing Paradigms: Message Queuing, Mobile agents, Network services, Object spaces
Unit: 5	**Fault tolerant distributed systems:** Introduction, dependability, faults vs. errors vs. failure, space time and value redundancy, fault tolerant architecture, failure detection algorithms, partitioning, FT consensus. Distributed multimedia system: Introduction, characteristics, and resource management stream adaptation

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Jean Dollimore, Tim Kindberg, George Coulouris, Distributed Systems: Concepts and Design, 4th Edition, Addison Wesley, 2005
2	A. Taunenbaum, Distributed Systems: Principles and Paradigms

Reference Books:

1	G. Coulouris, J. Dollimore, and T. Kindberg, Distributed Systems: Concepts and Design, Pearson Education
2	Sape Mullender : Distributed system, 2nd Edition, Addison Wesley.

Course Code	Course Title	Lecture			Semester: I
MTCS126PET	Cryptography and Cyber Security	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	45 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): No Prerequisite

Course Objectives:

1. To understand fundamentals of Cryptography and Cyber Security.
2. To learn about how to maintain the Confidentiality, Integrity and Availability of a data.
3. To acquire the concept of various protocols and cryptographic algorithms for network security to protect against the threats in the networks.
4. To analyze the emerging technologies in the cyber security areas and assess their current capabilities, limitations and potential applications.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand fundamentals of Cryptography and Cyber Security.	PO_1, PO_2
CO_2	Know about how to maintain the Confidentiality, Integrity and Availability of a data.	PO_3, PO_4
CO_3	Demonstrate various protocols and cryptographic algorithms for network security to protect against the threats in the networks.	PO_2, PO_3
CO_4	Able to analyze the concept of emerging technologies in the cyber security areas and assess their current capabilities, limitations and potential applications	PO_2, PO_4

PO_1- Engineering Knowledge, **PO_2**- Problem analysis, **PO_3**- Design/development of solutions, **PO_4**- Conduct investigations of complex problems, **PO_5**- Modern tool usage, **PO_6**- The engineer and society, **PO_7**- Environment and sustainability, **PO_8**- Ethics, **PO_9**- Individual or team work, **PO_{10}**- Communication, **PO_{11}**- Project management and finance, **PO_{12}**- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	2	2										
CO_2			2	1								
CO_3		2	2									
CO_4		2		1								

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Introduction to the Concepts of Security: The need for security, Security Approaches, Principles of Security, Types of Attacks. Symmetric and Asymmetric Key Cryptography, Key Range and Key Size. Classical encryption techniques: substitution ciphers and transposition ciphers, cryptanalysis, stenography, stream and block ciphers. Shannon's theory of confusion and diffusion, fiestal structure, data encryption standard (DES), AES.
Unit: 2	Introduction to graph, ring and field, prime and relative prime numbers, modular arithmetic, Fermat's and Euler's theorem, primality testing, Euclid's Algorithm, Chinese Remainder theorem, discrete logarithms. Principals of public key crypto systems, RSA algorithm, security of RSA, key management, Diffie-Hellman key exchange algorithm, ElGamal Encryption, Elliptic curve cryptography,
Unit: 3	Message Authentication and Hash Function: Authentication requirements, authentication functions, message authentication code, hash functions, birthday attacks, security of hash functions and MAC, MD5, Secure hash algorithm (SHA). Digital Signatures.
Unit: 4	Authentication Applications: Kerberos and X.509, directory authentication service, electronic mail security-pretty good privacy (PGP), S/MIME.
Unit: 5	IP Security: Architecture, Authentication header, encapsulating security payloads, Combining security associations, key management. Web Security: Secure socket layer and transport layer security, secure electronic Transaction (SET). System Security: Intruders, Viruses and related threads, firewall design principals, trusted systems.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Cryptography and Network Security by Behrouz A. Forouzan, 2nd Edition TMH.
2	Cryptography and Network Security, W. Stallings, Prentice Hall, 5th Edition, 20102.

Reference Books:	
1	Network Security Essentials, William Stallings, Prentice Hall, 5th Edition, 2013.
2	Network Security and Cryptography, Bernard Menezes, Cengage Publication.

Course Code	Course Title	Lecture			Semester: I
MTCS160PEP	Advanced Network Security Lab	L	T	P	
Version: 1.2	Date of Approval:	0	0	4	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	50
Credits	:	2	End Semester	:	50
Instruction Mode	:	Practical	Exam Duration	:	3 Hrs.

Prerequisite(s): Network Security Lab

Course Objectives:

1. To understand and protect the network infrastructure, architecture, protocols and applications in order to deliver secured protocols, applications, services and data.
2. To Train the students to develop 'hands-on' skills on using tools and test beds in order.
3. To design network and security experiments/simulations.
4. To prepare the students to perform critical thinking, idea generation and implementation, and integration with existing systems when solving real research problems.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Demonstrate the ability to understand and synthesize the principles of network security architectures and security frameworks and models;	PO_1, PO_2
CO_2	Understand Data integrity, Authentication, Digital Signatures.	PO_3, PO_4, PO_5
CO_3	Analyze, design and manage the requirements of a secure network architecture based on risk analysis and operational requirements in accordance with regulations and standards.	PO_2, PO_3
CO_4	Analyze Various network security applications, IPSec, Firewall, IDS, Web security, Email security, and Malicious software etc.	PO_4, PO_5, PO_{12}

PO_1- Engineering Knowledge, **PO_2**- Problem analysis, **PO_3**- Design/development of solutions, **PO_4**- Conduct investigations of complex problems, **PO_5**- Modern tool usage, **PO_6**- The engineer and society, **PO_7**- Environment and sustainability, **PO_8**- Ethics, **PO_9**- Individual or team work, **PO_{10}**- Communication, **PO_{11}**- Project management and finance, **PO_{12}**- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	2	2										
CO_2			2	3	2							
CO_3		2	3									
CO_4				2	3							2

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

1. Write a Program to implement International Data Encryption Algorithm (IDEA).
2. Write a Program to implement Advanced Encryption Standard (AES) Algorithm.
3. Write a Program to implement Rabin Algorithm.
4. Write a Program to implement ElGamal Algorithm
5. Write a Program to implement Knapsack Algorithm.
6. Write a Program to implement Elliptic Curve Cryptography (ECC).
7. Write a Program to implement Digital Signature.
8. Write the program to implement the ID based cryptography algorithms:
   i. Boneh-Franklin IBE (BF-IBE)
   ii. Sakai-Kasahara IBE (SK-IBE)
   iii. Boneh-Boyen IBE, (BB-IBE)
9. Study the web server's code, and find examples of code vulnerable to memory corruption through a buffer overflow. Write down a description of each vulnerability in the file /home/httpd/lab/bugs.txt; use the format described in that file. For each vulnerability, describethe buffer which may overflow, how you would structure the input to the web server (i.e., the HTTP request) to overflow the buffer, and whether the vulnerability can be prevented using stack canaries. Locate at least 5 differentvulnerabilities.

Examination and Evaluation Pattern: It include both internal evaluation (50 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (50 marks) which is mainly end semester examination.

Text Books:

1	Practical Cryptography in Python, James Nielson and Christopher K. Monson, Apress Publication.
2	Applied Cryptography: Protocols, Algorithms and Source Code in C, Bruce Schneier, Wiley.

Reference Books:	
1	Practical Cryptography for Developers, Svetlin Nakov, https://cryptobook.nakov.com/ (This book is freely available.)
2	Practical Cryptography: Algorithms and Implementations Using C++, Saiful Azad and Al-Sakib Khan Pathan, CRC Press. Source Code: https://sites.google.com/site/spathansite/praccrypt
3	Virtual Lab: http://cse29-iiith.vlabs.ac.in/Introduction.html

Course Code	Course Title	Lecture			Semester: I
MTCS161PEP	Distributed Database Lab	L	T	P	
Version: 1.2	Date of Approval:	0	0	4	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	50
Credits	:	2	End Semester	:	50
Instruction Mode	:	Practical	Exam Duration	:	3 Hrs.

Prerequisite(s): Digital Electronics

Course Objectives:

1. Understand principles and foundations of distributed databases.
2. Learn concepts related to architecture, design issues, integrity control, query processing.
3. Understand the concept of a database transaction and related database facilities, including concurrencycontrol, backup and recovery.
4. To interpret the modeling symbols for the most popular ER modeling tools. And real-world database design whichoften involves conflicting goals.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Be able to apply methods and techniques for distributed query processing and optimization.	PO_1, PO_2
CO_2	Understand distributed database systems architecture and design.	PO_3, PO_4
CO_3	Understand the broad concepts of distributed transaction process.	PO_3, PO_4, PO_5
CO_4	Implement of replication in distributed database system	PO_3, PO_4, PO_5, PO_9

PO_1- Engineering Knowledge, PO_2- Problem analysis, PO_3- Design/development of solutions, PO_4- Conduct investigations of complex problems, PO_5- Modern tool usage, PO_6- The engineer and society, PO_7- Environment and sustainability, PO_8- Ethics, PO_9- Individual or team work, PO_{10}- Communication, PO_{11}- Project management and finance, PO_{12}- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	2	3										
CO_2			2	2								
CO_3			3	2	3							
CO_4			2	2	3				2			

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

List of Excrement

1. Examine and implement of Basic database management operations and SQL queries.
2. Examine and implement fragmentation and its types in distributed database system.
3. Examine and implement materialized view.
4. Implement different types of joins.
5. Implement heterogeneous databases.
6. Examine and implement of replication in distributed database system.
7. A mini project based on Distributed Databases.

Examination and Evaluation Pattern: It include both internal evaluation (50 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (50 marks) which is mainly end semester examination.

Text Books:

1	OzsuM. Tamer, ValduriezPatrick, "Distributed Database Systems", 2nd Edition, Pearson, 2011
2	Ceei and Pelagatti,'Distributed Database', TMH.

Reference Books:

1	NavatheElmasri, "Fundamental of Database Systems", 5th Edition, Pearson Education, 2008. Page 210 of 243 2
2	ConnollyThomas, BeggCarolyn, "Database Systems – A Practical Approach to Design, implementation and Management", 4th Edition, Pearson Education, 2008.

Course Code	Course Title	Lecture			Semester: I
MTCS162PEP	Data Science Lab	L	T	P	
Version: 1.2	Date of Approval:	0	0	4	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	50
Credits	:	2	End Semester	:	50
Instruction Mode	:	Practical	Exam Duration	:	3 Hrs.

Prerequisite(s): Object Oriented Database

Course Objectives:

1. To Optimize business decisions and create competitive advantage with Big Data analytics.
2. To Impart the architectural concepts of Hadoop and introducing map reduce paradigm.
3. To Develop Big Data applications for streaming data using Apache Spark.
4. To learn the Data Analytics

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand data summarization, query, and analysis.	PO_1, PO_2
CO_2	Apply data modelling techniques to large data sets	PO_2, PO_7, PO_{12}
CO_3	Creating applications for Big Data analytics	PO_4, PO_5
CO_4	Building a complete business data analytic solution	PO_3, PO_4, PO_5

PO_1- Engineering Knowledge, PO_2- Problem analysis, PO_3- Design/development of solutions, PO_4- Conduct investigations of complex problems, PO_5- Modern tool usage, PO_6- The engineer and society, PO_7- Environment and sustainability, PO_8- Ethics, PO_9- Individual or team work, PO_{10}- Communication, PO_{11}- Project management and finance, PO_{12}- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	1	2										
CO_2		2					3					2
CO_3				2	3		2					
CO_4			3	2	3							

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

1. Form setting up and Installing Hadoop in its two operating modes: □ Pseudo distributed, □ fully distributed.
2. Implement the following file management tasks in Hadoop:
   i) Adding files and directories □ Retrieving files
   ii) Deleting files Benchmark and stress test an Apache Hadoop cluster.
3. Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm. □ Find the number of occurrences of each word appearing in the input file(s) □ Performing a MapReduce Job for word search count (look for specific keywords in afile)
4. Stop word elimination problem:
5. Input: o A large textual file containing one sentence per line o A small file containing a set of stop words (One stop word per line)
6. Output: o A textual file containing the same sentences of the large input file without the words appearing in the small file.
7. Write a Map Reduce program that mines weather data. Weather sensors collecting data every hour at many locations across the globe gather large volume of log data, which is a good candidate for analysis with MapReduce, since it is semi structured and record-oriented. Data availableat: https://github.com/tomwhite/hadoopbook/tree/master/input/ncdc/all.
8. Find average, max and min temperature for each year in NCDC data set?
9. Filter the readings of a set based on value of the measurement, Output the line of input files associated with a temperaturevalue greater than 30.0 and store it in a separate file.
10. Install and Run Pig then write Pig Latin scripts to sort, group, join, project, and filter your data.
11. Write a Pig Latin scripts for finding TF-IDF value for book dataset (A corpus of eBooks available at: Project Gutenberg)
12. Install and Run Hive then use Hive to create, alter, and drop databases, tables, views, functions, and indexes.
13. Install, Deploy & configure Apache Spark Cluster. Run apache spark applications using Scala.
14. Data analytics using Apache Spark on Amazon food dataset, find all the pairs of items frequently reviewed together.
15. Write a single Spark application that: o Transposes the original Amazon food dataset, obtaining a PairRDD of the type: → o

Counts the frequencies of all the pairs of products reviewed together; o Writes on the output folder all the pairs of productsthat appear more than once and their frequencies. The pairs of products must be sorted by frequency.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.	
Text Books:	
1	Big Data – A Primer, H. Mohanty, P. Bhuyan, D. Chenthati (Eds.), Springer , Studies in Big Data, vol. 11, 2015.
2	Big Data Analytics with Rand Hadoop, VigneshPrajapati, PACKT Publishing
Reference Books:	
1	Mining of Massive Datasets, Jure Leskovec, AnandRajaraman, Jeffrey D. Ullman, Cambridge Universities Press, 2012.
2	Big Data at Work: Dispelling the Myths, Uncovering the OpportunitiesBook by Thomas H. Davenpor

Course Code	Course Title	Lecture			Semester: I
MTCS163PEP	Semantics Web Lab	L	T	P	
Version: 1.2	Date of Approval:	0	0	4	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	50
Credits	:	2	End Semester	:	50
Instruction Mode	:	Practical	Exam Duration	:	3 Hrs.

Prerequisite(s): Semantics Web

Course Objectives:

1. To acquaint about the Semantic Web Vision.
2. To Understand about XML, RDF, RDFS, OWL.
3. To Create and Query the Ontology.
4. To form Ontology Reasoning and Migrate from Document to Data Web.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understanding about XML, RDF, RDFS, OWL	PO_1, PO_2, PO_4
CO_2	Describe logic semantics and inference with OWL	PO_1, PO_2, PO_5
CO_3	Apply Querying Ontology	PO_1, PO_2, PO_5, PO_8, PO_9
CO_4	Create Web graph processing for various applications such as Search engine, community detection	PO_1, PO_5, PO_8

PO_1- Engineering Knowledge, **PO_2**- Problem analysis, **PO_3**- Design/development of solutions, **PO_4**- Conduct investigations of complex problems, **PO_5**- Modern tool usage, **PO_6**- The engineer and society, **PO_7**- Environment and sustainability, **PO_8**- Ethics, **PO_9**- Individual or team work, **PO_{10}**- Communication, **PO_{11}**- Project management and finance, **PO_{12}**- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	2	2		2								
CO_2	3	2			2							
CO_3	3	2			3			3	2			
CO_4	3				3			2				

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

List of experiments:

1. Working with XML,
2. Working with XML Schema, DTD
3. Design Of Ontology using RDF
4. Design RDF document with different Serialization format (e.g. tutle,N-triple)
5. Design Of Ontology using RDFS
6. Design Of Ontology using OWL
7. Case study: Pizza Ontology
8. Querying Ontology using SPARQL
9. Design of any domain specific Ontology in Protégé
10. Case Study: Dbpedia
11. Case study: LOD Cloud

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	John Davies, Rudi Studer, and Paul Warren John, "Semantic Web Technologies: Trends and Research in Ontology-based Systems", Wiley and Son's, 2006.
2	John Davies, Dieter Fensel and Frank Van Harmelen, "Towards the Semantic Web: Ontology- Driven Knowledge Management", John Wiley and Sons, 2003.

Reference Books:

1	Foundation of Semantic Web Technologies, Pascal Hitzler, Markus and Sebastian
2	Michael C. Daconta, Leo J. Obrst, and Kevin T. Smith, "The Semantic Web: A Guide to the Future of XML, Web Services, and Knowledge Management", Fourth Edition, Wiley Publishing, 2003.

Course Code	Course Title	Lecture			Semester: II
MTCS231PET	Blockchain Technology	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Network Security

Course Objectives:

1. To understand the function of Blockchain as a method of securing distributed ledgers.
2. To familiarize the functional/operational aspects of cryptocurrency ecosystem.
3. To familiarize about wallets and learn their utilization of wallet during transaction.
4. To understand that how to write and apply the Smart Contracts.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Apply the Blockchain implementation	PO_1, PO_2, PO_3
CO_2	Apply the smart contracts on Ethereum platform.	PO_4, PO_5
CO_3	Apply the use cases on Hyperledger.	PO_4, PO_6
CO_4	Evaluate the major research challenges and technical gaps existing between theory and practice in Blockchain.	PO_1, PO_3

PO_1- Engineering Knowledge, PO_2- Problem analysis, PO_3- Design/development of solutions, PO_4- Conduct investigations of complex problems, PO_5- Modern tool usage, PO_6- The engineer and society, PO_7- Environment and sustainability, PO_8- Ethics, PO_9- Individual or team work, PO_{10}- Communication, PO_{11}- Project management and finance, PO_{12}- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	3	2	2									
CO_2				2	2							
CO_3				2		2						
CO_4	3		2									

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Introduction to Cryptography, Introduction to graph, ring and field, prime and relative prime numbers, modular arithmetic, Fermat's and Euler's theorem, Euclid's Algorithm, RSA algorithm, Diffie-Hellman key exchange algorithm, ElGamal Encryption, Elliptic curve cryptography, SHA 256, Digital Signature, Zero Knowledge Proof (ZKP)
Unit: 2	Introduction from barter system to Cryptocurrency, fundamental of Blockchain, Block structure, Genesis Block, Orphaned Blocks, Stale Block, Uncle Block, Distributed Ledger Technology (DLT), peer-to- peer network, Merkle Tree, Lifecycle of Blockchain, Evolutions of Blockchain, Fork, double spending money, Transactions and UTXO's, Types of Blockchain. Need of Blockchain, Benefits of Blockchain.
Unit: 3	Build the Blockchain, Chain validation, Create the Blockchain Network, Mining pools, Mining, Difficulty Level, Current Target, Nonce, how miners pick transactions, Work of mempools work, 51% attack. Consensus Algorithms: Proof of Work (PoW), Asynchronous Byzantine Agreement, Proof of Stake (PoS), Hybrid models (PoW + PoS), DPoS.
Unit: 4	Wallets, Types of wallets-Hardware, Software, Paper, Web, Desktop. Ethereum - Ethereum network, Ethereum Virtual Machine (EVM), Wallets for Ethereum, Solidity - Smart Contracts, Truffle, Web3, some attacks on smart contracts, Design and issue Cryptocurrency ICO, Mining, Gas - Transactional Fee & Incentivisations, DApps, Decentralized Autonomous Organizations (DAO). Implement the use case of supply chain on Ethereum.
Unit: 5	Introduction to Hyperledger, what is Hyperledger, Why Hyperledger, Where can Hyperledger be used, Hyperledger Architecture, Membership, Blockchain, Transaction, Chaincode, Hyperledger Fabric, Features of Hyperledger, Fabric Installation of prerequisite, Architecture of Hyperledger Fabric, Transaction, Ledger, Nodes, Peer, Endorser, Ordering Nodes, Channels, Certificate Authority, Transaction Flow. Implement the use case of supply chain on Hyperledger.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1 | Mastering Blockchain, Imran Bashir, Packt Publishing

2	Bitcoin and Cryptocurrency Technologies, Arvind Narayanan, Joseph Bonneau, Edward Felten,Andrew Miller,Steven Goldfeder, Princeton University Press. https://bitcoinbook.cs.princeton.edu/
Reference Books:	
1	Grokking Bitcoin, Kalle Rosenbaum, Manning Publications. http://rosenbaum.se/book/grokking-bitcoin.html
2	Blockchain Basics, Daniel Drescher, Apress Publicationhttp://vlabs.iitb.ac.in/vlabs- dev/labs/blockchain/labs/index.php

Course Code	Course Title	Lecture			Semester: II
MTCS232PET	High Performance Computing	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Compiler Design

Course Objectives:

1. To introduce structure of compilers and high-performance compiler design.
2. To understand the Concepts of Data Dependance in compilation.
3. To understand concurrency analysis in translation.
4. To understand cache coherence and parallel loops in compilers.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand parallel programming patterns and data dependence	PO_1, PO_2
CO_2	Analyze the design and develop parallel programs	PO_1, PO_2, PO_3
CO_3	Analyze different parallel programming patterns	PO_2, PO_3
CO_4	Evaluate comparative analysis among different parallel solutions	PO_2, PO_3, PO_5

PO_1- Engineering Knowledge, PO_2- Problem analysis, PO_3- Design/development of solutions, PO_4- Conduct investigations of complex problems, PO_5- Modern tool usage, PO_6- The engineer and society, PO_7- Environment and sustainability, PO_8- Ethics, PO_9- Individual or team work, PO_{10}- Communication, PO_{11}- Project management and finance, PO_{12}- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	3	2										
CO_2	2	2	3									
CO_3		2	3									
CO_4		2	2		3							

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	High Performance Systems, Structure of a Compiler, Programming Language Features, Languages for High Performance, Data Dependence: Data Dependence in Loops, Data Dependence in Conditionals, Data Dependence in Parallel Loops, Program Dependence Graph.
Unit: 2	Scalar Analysis with Factored Use-Def Chains: Constructing Factored UseDef Chains, FUD Chains for Arrays, Induction Variables Using FUD Chains, Constant Propagation with FUD Chains, Data Dependence for Scalars. Data Dependence Analysis for Arrays, Array Region Analysis, Pointer Analysis, I/O Dependence, Procedure Calls, Inter-procedural Analysis.
Unit: 3	Loop Restructuring: Simple Transformations, Loop Fusion, Loop Fission, Loop Reversal, Loop Interchanging, Loop Skewing, Linear Loop Transformations, Strip-Mining, Loop Tiling, Other Loop Transformations, and Inter-procedural Transformations, Optimizing for Locality: Single Reference to Each Array, Multiple References, General Tiling, Fission and Fusion for Locality.
Unit: 4	Concurrency Analysis: Concurrency from Sequential Loops, Concurrency from Parallel Loops, Nested Loops, Round off Error, Exceptions and Debuggers. Vector Analysis: Vector Code, Vector Code from Sequential Loops, Vector Code from For all Loops, Nested Loops, Round off Error, Exceptions, and Debuggers, Multi-vector Computers.
Unit: 5	Message-Passing Machines: SIMD Machines, MIMD Machines, Data Layout, Parallel Code for Array Assignment, Remote Data Access, Automatic Data Layout, Multiple Array Assignments, Scalable Shared-Memory Machines: Global Cache Coherence, Local Cache Coherence, Latency Tolerant Machines. Recent trends in compiler design for high performance computing and message passing machines and scalable shared memory machine.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Michael Wolfe, High-Performance Compilers for Parallel Computing, Pearson
2	Keith Cooper, Linda Torczon, Engineering: A Compiler, MK Publishers

Reference Books:

1	Robert Robey and Yuliana Zamora, Parallel and High Performance Computing, Manning Publications
2	Randy Allen and Ken Kennedy, Optimizing Compilers for modern architectures, MK Publishers

Course Code	Course Title	Lecture			Semester: II
MTCS233PET	Distributed Computing	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Artificial Intelligence

Course Objectives:

1. To understand the basics of networking and the protocols used in distributed environment.
2. To evaluate the impact of memory on parallel/distributed algorithm formulations.
3. To validate the performance of parallel/distributed algorithm.
4. To gain knowledge of design and implementation of distributed algorithms.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Analyze various issues in the design and implementation of distributed computing systems.	PO_1, PO_2, PO_3
CO_2	Categorize the various system models, communication between client and server.	PO_2, PO_3, PO_4
CO_3	Apply the knowledge of deadlock methods and its algorithms.	PO_4, PO_5
CO_4	Understand the significance of distributed file system with real time applications.	PO_2, PO_3, PO_6

PO_1- Engineering Knowledge, PO_2- Problem analysis, PO_3- Design/development of solutions, PO_4- Conduct investigations of complex problems, PO_5- Modern tool usage, PO_6- The engineer and society, PO_7- Environment and sustainability, PO_8- Ethics, PO_9- Individual or team work, PO_{10}- Communication, PO_{11}- Project management and finance, PO_{12}- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	3	3	3									
CO_2		3	3	2								
CO_3				3	2							
CO_4		2	2			2						

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Introduction Distributed Computing Models, Software Concepts, Hardware Concepts, The Client Server model, Issues in design of a distributed operating system. Communication Introduction to Message Passing, Advantages and features of message passing, Message format, Message Buffering, Remote Procedure Call, Extended RPC Models, Remote Object Invocation, Message Oriented Communication.
Unit: 2	Processes And Synchronization Threads, code migration, clock synchronization, logical clocks, global state, Election algorithms, mutual exclusion, Distributed transaction.
Unit: 3	Distributed Deadlock Detection System model, Resources vs. communication deadlocks, deadlock prevention, avoidance, detection and resolution, Centralized deadlock detection, distributed deadlock detection, path pushing and edge chasing algorithm
Unit: 4	Distributed Shared Memory Introduction, General architecture of distributed shared memory, Design and implementation, Issues of DSM, Granularity, structure of shared memory space, consistency models, thrashing, advantages of DSM
Unit: 5	Distributed File System Introduction, Desirable features of good distributed file system, file models, file accessing, sharing, caching methods, file replication, fault tolerance, Case Study: CORBA (CORBA RMI and Services)

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Dr. Nilakshi Jain, Dr. Dhanajay R. Kalbande
2	Richard Boddington, Practical Digital Forensics, PACKT publishing, First Edition, 2016 ANDRÉ ÅRNES.

Reference Books:

1	Practical Mobile Forensics, PACKT publishing , 2014 Satish Bommisetty, Rohit Tamma, Heather Mahalik
2	"Guide to Computer Forensics and Investigations" 4e, Nelson, Phillips Enfinger, Steuart, Cengage Learning.

Course Code	Course Title	Lecture			Semester:
MTCS234PET	Natural Language Processing	L	T	P	II
Version: 1.2	**Date of Approval:**	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Computer Programming and Database

Course Objectives:

1. To understand natural language processing and
2. To learn how to apply basic algorithms in this field of NLP.
3. To get acquainted with the algorithmic description of the main language levels: morphology, syntax, semantics, and pragmatics, as well as the resources of natural language data - corpora.
4. To conceive basics of knowledge representation, inference, and relations to the artificial intelligence.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand natural language processing and learn how to apply basic algorithms in this field.	**PO_1, PO_2**
CO_2	Understand the algorithmic description of the main language levels: morphology, syntax, semantics, and pragmatics, as well as the resources of natural language processing.	**PO_4, PO_6, PO_8**
CO_3	Analyze language modelling and sequence tagging.	**PO_2, PO_4, PO_6, PO7, PO8**
CO_4	Understand the design features of information retrieval systems	**PO_1, PO_3, PO_6, PO_{12}**

PO_1- Engineering Knowledge, **PO_2**- Problem analysis, **PO_3**- Design/development of solutions, **PO_4**- Conduct investigations of complex problems, **PO_5**- Modern tool usage, **PO_6**- The engineer and society, **PO_7**- Environment and sustainability, **PO_8**- Ethics, **PO_9**- Individual or team work, **PO_{10}**- Communication, **PO_{11}**- Project management and finance, **PO_{12}**- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO 12
CO_1	3	2										
CO_2				3		1		2				
CO_3		2		1		2	2	2				
CO_4	2		3			2						2

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	**Introduction:** Introduction to the Morphology, Syntax, Semantics by linking the "linguistics view" (computational linguistics) with the "artificial intelligence view" (natural language processing).
Unit: 2	**Morphology:** Analysis and generation of language on word level: e.g. problems with compounding and idiomatic phrases, homophonous strings as well as loan words and their processing using e.g. finite state automata as well as semantic networks. Ambiguities in words like "pen" and "pipe", but will also discuss some complex strings.
Unit: 3	**Syntax:** Analysis and generation of language on phrasal and sentence level: e.g. applications such as machine translation and grammar checking and the processing using phase structure grammars as well as unification-based formalisms and relating those formalisms to recursive transition networks (RTNs) as well as augmented transition networks (ATNs).
Unit: 4	**Semantics:** Language ambiguities on the level of "meaning": represented by case structures and conceptual dependency structures. We will look at famous utterances such as: Colorless green ideas sleep furiously. And will discuss why the machine runs into problems during analysis, and how these problems can be overcome.
Unit: 5	**Applications of NLP:** Machine Translation, Grammar Checkers Dictation, Automatic Document Generation, NL Interfaces.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Daniel Jurafsky, James H. Martin "Speech and Language Processing" Second Edition, Prentice Hall, 2008.
2	Chris Manning and Hinrich Schütze, "Foundations of Statistical Natural Language Processing", MIT Press. Cambridge, MA: May 1999.

Reference Books:

1	Allen, James, Natural Language Understanding, Second Edition, Benjamin/Cumming, 1995.
2	Charniack, Eugene, Statistical Language Learning, MIT Press, 1993.

Course Code	Course Title	Lecture			Semester: II
MTCS235PET	Quantum Computing	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Artificial Intelligence and Machine Learning

Course Objectives:

1. To understand the building blocks of Quantum computers and highlight the paradigm change between conventional computing and quantum computing.
2. To understand entangled quantum subsystems and properties of entangled states.
3. To understand the Quantum state transformations and the algorithms.
4. To explore the applications of quantum computing.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand the basic principles of quantum computing.	PO_1, PO_3
CO_2	Analyze the knowledge of the fundamental differences between conventional computing and quantum computing.	PO_1, PO_2, PO_9
CO_3	Apply several basic quantum computing algorithms.	PO_2, PO_3, PO_4
CO_4	Analyze the classes of problems that can be expected to be solved well by quantum computers.	PO_1, PO_2, PO_3, PO_4, PO_5

PO_1- Engineering Knowledge, PO_2- Problem analysis, PO_3- Design/development of solutions, PO_4- Conduct investigations of complex problems, PO_5- Modern tool usage, PO_6- The engineer and society, PO_7- Environment and sustainability, PO_8- Ethics, PO_9- Individual or team work, PO_{10}- Communication, PO_{11}- Project management and finance, PO_{12}- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	3		2									
CO_2	3	2							2			
CO_3		3	3	1								
CO_4	3	3	3	2	2							

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Qubit & Quantum States: The Qubit, Vector Spaces. Linear Combination Of Vectors, Uniqueness of a spanning set, basis & dimensions, inner Products, orthonormality, gram-schmidt orthogonalization, bra-ket formalism, the Cauchy-schwarez and triangle Inequalities.
Unit: 2	Matrices & Operators: Observables, The Pauli Operators, Outer Products, The Closure Relation, Representation of operators using matrices, outer products & matrix representation, matrix representation of operators in two dimensional spaces, Pauli Matrix, Hermitian unitary and normal operator, Eigen values & Eigen Vectors, Spectral Decomposition, Trace of an operator, important properties of Trace, Expectation Value of Operator, Projection Operator, Positive Operators.
Unit: 3	Commutator Algebra, Heisenberg uncertainty principle, polar decomposition & singular values, Postulates of Quantum Mechanics.
Unit: 4	Tensor Products: Representing Composite States in Quantum Mechanics, Computing inner products, Tensor products of column vectors, operators and tensor products of Matrices. Density Operator: Density Operator of Pure & Mix state, Key Properties, Characterizing Mixed State, Practical Trace & Reduce Density Operator, Density Operator & Bloch Vector.
Unit: 5	Quantum Measurement Theory: Distinguishing Quantum states & Measures, Projective Measurements, Measurement on Composite systems, Generalized Measurements, Positive Operator- Valued Measures. Recent trends in Quantum Computing Research, Quantum Computing Applications of Genetic Programming.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Quantum Computing without Magic by Zdzislaw Meglicki
2	Quantum Computing Explained By DAVID Mc MAHON

Reference Books:

1	Quantum Computer Science By Marco Lanzagorta, Jeffrey Uhlmann
2	An Introduction to Quantum Computing Phillip Kaye, Raymond Laflamme, Michele Mosca.

Course Code	Course Title	Lecture			Semester: III
MTCS237PET	Data Mining	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	45 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): DBMS

Course Objectives:

1. To introduce data mining principles and techniques.
2. To acquire the concept of critical thinking, problem solving and DECISION-MAKING skills with respect to Data warehouse and data mining.
3. To demonstrate various schema model and the Star Schema to design a Data Warehouse.
4. To apply different data mining techniques and algorithms.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand a data warehouse or data mart to present information needed by the manager and can be utilized for managing clients	PO_1, PO_2
CO_2	Demonstrate a quality data warehouse or data mart effectively and administer the data resources in such a way that it will truly meet management's requirements	PO_3, PO_4
CO_3	Evaluate standards and new technologies to determine their potential impact on your information resource for a large complex data warehouse/data mart.	PO_4, PO_9
CO_4	Apply the emerging technologies in Data mining.	PO_3, PO_4, PO_9

PO_1- Engineering Knowledge, **PO_2**- Problem analysis, **PO_3**- Design/development of solutions, **PO_4**- Conduct investigations of complex problems, **PO_5**- Modern tool usage, **PO_6**- The engineer and society, **PO_7**- Environment and sustainability, **PO_8**- Ethics, **PO_9**- Individual or team work, **PO_{10}**- Communication, **PO_{11}**- Project management and finance, **PO_{12}**- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	2	2										
CO_2			2	1								
CO_3				2					1			
CO_4			2	1					1			

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	**Introduction:** Fundamentals of Data Mining, Kinds of Patterns can be mined, Technologies Used, Applications and Issues in Data Mining. **Types of Data:** Attribute types, Basic Statistical descriptions of Data, Measuring data Similarity and Dissimilarity. **Data Preprocessing:** Need of Preprocessing, Data Cleaning, Data Integration, Data Reduction, Data Transformation.
Unit: 2	**Data Warehouse and OLAP:** Data Warehouse, Data Warehouse Modeling, Data Warehouse Design and Usage, Data Warehouse Implementation, Data Generalization by Attribute-oriented induction
Unit: 3	**Mining Frequent Patterns, Associations and Correlations:** Market Basket Analysis, Association rule mining, Frequent Item set mining methods, Pattern Evaluation methods, Constraint based frequent pattern mining, Mining Multilevel and Multidimensional patterns.
Unit: 4	**Classification:** General approach to classification, Classification by Decision Tree Induction, Bayes Classification methods, Bayesian Belief Networks, Classification by Back-propagation, Lazy Learners, Other Classification methods, Classification using Frequent patterns, Model Evaluation and selection
Unit: 5	**Cluster Analysis:** Basic Clustering methods, Partitioning methods, Density –Based Methods, Grid- based methods, and Evaluation of Clustering, Outlier Analysis and Detection methods. **Data Mining Trends and Research Frontiers:** Mining Complex Data Types, Data Mining Applications, Data Mining Trends and usage of Data Mining Tools.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Han J & Kamber M, "Data Mining: Concepts and Techniques", Harcourt India, Elsevier India, Second Edition.
2	Pang-Ning Tan. Michael Steinback, Vipin Kumar, "Introduction to Data Mining", Pearson Education, 2008.

Reference Books:

1	Margaret H Dunham,S.Sridhar, "Data mining: Introductory and Advanced Topics", Pearson Education, 2008
2	Humphires,hawkins,Dy, "Data Warehousing: Architecture and Implementation", Pearson Education, 2009.

Course Code	Course Title	Lecture			Semester: II
MTCS238PET	Machine Learning	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Knowledge of basic data science algorithms

Course Objectives:

1. To learn about the purpose of Machine Learning and where it applies to the real worlds.
2. To understand a range of machine learning algorithms along with their strengths and weaknesses.
3. To learn methodology and tools to apply machine learning algorithms.
4. To real data and evaluate their performance.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand the importance of data pre-processing before machine learning modeling.	PO_1, PO_2, PO_5
CO_2	Ability to formulate machine learning techniques to respective problems.	PO_2, PO_4, PO_5
CO_3	Performance and evaluation of learning algorithms and model selection.	PO_1, PO_5
CO_4	Apply machine learning algorithms to solve problems of various complexity.	PO_1, PO_2, PO_3

PO_1- Engineering Knowledge, **PO_2**- Problem analysis, **PO_3**- Design/development of solutions, **PO_4**- Conduct investigations of complex problems, **PO_5**- Modern tool usage, **PO_6**- The engineer and society, **PO_7**- Environment and sustainability, **PO_8**- Ethics, **PO_9**- Individual or team work, **PO_{10}**- Communication, **PO_{11}**- Project management and finance, **PO_{12}**- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	2	3			2							
CO_2		3		2	3							
CO_3	3				3							
CO_4	2	2		3								

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Introduction to Machine Learning - Defining learning systems, Goals and applications of machine learning in different fields such as health care, banking, telecommunication, digital marketing and so on. Aspects of developing a learning system: training and testing data, concept representation, function approximation, a general overview of supervised, semi-supervised, unsupervised learning algorithms and the usage of each algorithm.
Unit: 2	Basics of Python: Introduction to Python, Control structure and function: if-elif-else, while loop, for loop, break and continue, Introduction to function, Types of functions, Function arguments, Lambda functions, File Handling, packages and modules. Python Data Structures: Lists, Tuples, Dictionary, Sets, strings, NumPy: NumPy operation, Array and its operation, Matrix and associated operations, Linear algebra and related operations using python. Understand the advantage of using Python libraries for implementing Machine Learning models. Types of data sets.
Unit: 3	Pandas data frame and data frame related operations on dataset: Reading and writing data files, pandas append, insert, replace, dropping columns from dataframe, groupby and aggregate function, join operations, Exploratory data analysis, Data preparation and preprocessing (Dealing with missing value, cross-validation, classification, performance measure). Data visualization on dataset using matplotlib and seaborn libraries: Scatter plot, Line plot, Bar plot, Histogram, Box plot, Pair plot.
Unit: 4	Regression - Linear, Non-linear, Logistic regression and Multiple regression, and their applications. Classification technique - KNN, ANN, Decision Trees- Minimum Description. Information Gain, Entropy, Cross Validation and different classification accuracy metrics.
Unit: 5	Clustering approaches - Types of clustering, k-means clustering, Partitioned-based Clustering, Hierarchical Clustering, and Density-based Clustering. Support Vector Machines: Maximum margin linear separators. Kernels for learning non-linear functions. Bayesian Learning: theory and Bayes rule. Naive Bayes learning algorithm. Parameter smoothing. Bayes nets and Markov nets for representing dependencies.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.	
Text Books:	
1	Tom Michel, Machine Learning, McGraw Hill, 1997.
2	Introduction to Machine Learning with Python, Andreas C. Mueller.
3	Mastering Python for data science, Samir Madhavan.
Reference Books:	
1	Machine Learning Methods in the Environmental Sciences, Neural Networks, William W Hsieh, Cambridge Univ Press.
2	McKinney, W. (2012). Python for data analysis: Data wrangling with Pandas, NumPy, and iPython.

Course Code	Course Title	Lecture			Semester: II
MTCS241PET	Advanced Operating System	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Operating System

Course Objectives:

1. To provide knowledge of the main components of OS and their working.
2. To Introduce the concepts of process and thread and their scheduling policies.
3. To impart knowledge of Handling synchronization of concurrent processes and deadlocks.
4. To Analyze the different techniques for managing memory, I/O, disk and files.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand the general architecture of computer system.	PO_2, PO_3, PO_4
CO_2	Understand, contrast and compare differing structures for operating systems.	PO_1, PO_2, PO_6, PO_8, PO_9
CO_3	Gain proficiency needed to analyze theory and implementation of: processes, scheduling, I/O and files systems.	PO_1, PO_2, PO_3, PO_5, PO_7, PO_{12}
CO_4	Analyze various types of operating systems including Unix/Linux and Get in-depth knowledge of memory management for operating systems.	PO_2, PO_3

PO_1- Engineering Knowledge, PO_2- Problem analysis, PO_3- Design/development of solutions, PO_4- Conduct investigations of complex problems, PO_5- Modern tool usage, PO_6- The engineer and society, PO_7- Environment and sustainability, PO_8- Ethics, PO_9- Individual or team work, PO_{10}- Communication, PO_{11}- Project management and finance, PO_{12}- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1		3	3	2								
CO_2	3	2				3		2	2			
CO_3	2	3	3		2		2					2
CO_4		2	3									

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Introduction: Operating system concept - processes and threads, process model, process creation, process termination, process hierarchies, and process states, Implementation of processes, Threads- Thread model, thread usage, Implementation of threads in user space and kernel, Hybrid implementations
Unit: 2	Inter Process Communication: Race conditions, critical regions, Mutual Exclusion with busy waiting, sleep and wakeup, Semaphores, Mutexes, Monitors, Message passing; Scheduling: scheduling in batch systems, Interactive systems, Real time systems, Thread scheduling.
Unit: 3	Deadlocks: Introduction, Deadlock Detection and Recovery – Deadlock Detection with one resource of each type, with multiple resource of each type, recovery from deadlock; Deadlock Avoidance, Deadlock Prevention.
Unit: 4	Memory and Device Management: Introduction, Swapping, Paging, Virtual memory – Demand paging, page replacement Algorithms; File System Management- Organization of File System, File Permissions, MS DOS and UNIX file system case studies, NTFS; Device Management- I/O Channels, Interrupts and Interrupt Handling, Types of device allocation.
Unit: 5	Distributed Operating Systems: Distributed operating system concept – Architectures of Distributed Systems, Distributed Mutual Exclusion, Distributed Deadlock detection, Agreement protocols, Threads, processor Allocation, Allocation algorithms , Distributed File system design; Real Time Operating Systems: Introduction to Real Time Operating Systems, Concepts of scheduling, Real time Memory Management.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	MukeshSinghal and Niranjan, "Advanced Concepts in Operating Systems", TMH, 1st Edition, 2001.
2	Andrew S. Tanenbaum, "Modern Operating Systems", Pearson Education, 2nd Edition, 2006

Reference Books:

1	Andrew S. Tanenbaum, "Distributed Operating Systems", Pearson Education, 2ndEdition, 2001.
2	Pradeep K. Sinha, "Distributed Operating Systems and concepts", PHI, First Edition, 2002

Course Code	Course Title	Lecture			Semester: II
MTCS242PET	Digital Image Processing	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Machine Learning

Course Objectives:

1. To study the image fundamentals and mathematical transforms necessary for image processing.
2. To Understand image restoration and image compression procedures.
3. To Analyze and identify different feature extraction techniques for image analysis and recognition.
4. To introduce segmentation and morphological processing techniques.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand the basics of image processing enhancement techniques such as Image formation and transformation using sampling and quantization.	PO_1, PO_4, PO_6
CO_2	Apply the mathematical modelling of image restoration and compression techniques.	PO_2, PO_3, PO_4, PO_5
CO_3	Comprehend image compression standards by image segmentation and representation techniques.	PO_1, PO_3, PO_4
CO_4	Analyze and apply compression and coding techniques used for Image data.	PO_2, PO_3, PO_{12}

PO_1- Engineering Knowledge, PO_2- Problem analysis, PO_3- Design/development of solutions, PO_4- Conduct investigations of complex problems, PO_5- Modern tool usage, PO_6- The engineer and society, PO_7- Environment and sustainability, PO_8- Ethics, PO_9- Individual or team work, PO_{10}- Communication, PO_{11}- Project management and finance, PO_{12}- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	2			1		1						
CO_2		2	3	2	2							
CO_3	3		3	2								
CO_4		3	3									1

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Introduction to Image Processing: Image formation, image geometry perspective and other transformation, stereo imaging elements of visual perception. Digital Image-sampling and quantization serial & parallel Image processing.
Unit: 2	Signal Processing: Signal Processing - Fourier, Walsh-Hadmard discrete cosine and Hotelling transforms and their properties, filters, correlators and convolvers. Image enhancement-Contrast modification, Histogram specification, smoothing, sharpening, frequency domain enhancement, pseudo-colour.
Unit: 3	Image Restoration: Image Restoration-Constrained and unconstrained restoration Wiener filter, motion blur remover, geometric and radiometric correction Image data compression-Huffman and other codes transform compression, predictive compression two tone Image compression, block coding, run length coding, and contour coding.
Unit: 4	Segmentation Techniques: Segmentation Techniques-thresh holding approaches, region growing, relaxation, line and edge detection approaches, edge linking, supervised and unsupervised classification techniques, remotely sensed image analysis and applications.
Unit: 5	Shape Analysis: Shape Analysis – Gestalt principles, shape number, moment Fourier and other shape descriptors, Skelton detection, Hough transform, topological and texture analysis, shape matching. Practical Applications – Finger print classification, signature verification, text recognition, map understanding, bio-logical cell classification.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Gonzalez and Wood, "Digital Image Processing", Addison Wesley, 1993.
2	Anil K.Jain, "Fundamental of Image Processing", Prentice Hall of India.

Reference Books:

1	Rosenfeld and Kak, "Digital Picture Processing" vol.I&vol.II, Academic,1982
2	Ballard and Brown, "Computer Vision", Prentice Hall, 1982

Course Code	Course Title	Lecture			Semester: II
MTCS243PET	Advanced Wireless & Mobile Networks	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Mathematics

Course Objectives:

1. To Understand the wireless/mobile market and the future needs and challenges.
2. To acquaint with key concepts of wireless networks, standards, technologies and their basic operations.
3. To analyze and design various medium access.
4. To demonstrate the applications.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Apply advanced knowledge of networking and wireless networking and understand various types of wireless networks, standards, operations and use Cases	PO_1, PO_2, PO_6
CO_2	Analyze and design WLAN, WPAN, WWAN, Cellular based upon under lying propagation and performance analysis.	PO_1, PO_3, PO_4, PO_9
CO_3	Create and Design wireless networks exploring trade-offs between wire line and wireless links.	PO_3, PO4, PO_{10}
CO_4	Analyze and develop mobile applications to solve some of the real-world problems.	PO_3, PO_5, PO_{12}

PO_1- Engineering Knowledge, PO_2- Problem analysis, PO_3- Design/development of solutions, PO_4- Conduct investigations of complex problems, PO_5- Modern tool usage, PO_6- The engineer and society, PO_7- Environment and sustainability, PO_8- Ethics, PO_9- Individual or team work, PO_{10}- Communication, PO_{11}- Project management and finance, PO_{12}- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	1	1				2						
CO_2	2		1	2					2			
CO_3			1	2						2		
CO_4			2		2							1

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Introduction: Wireless Networking Trends, Key Wireless Physical Layer Concepts, Multiple Access Technologies -CDMA, FDMA, TDMA, Spread Spectrum technologies, Frequency reuse, Radio Propagation and Modelling, Challenges in Mobile Computing: Resource poorness, Bandwidth, energy etc. Wireless Local Area Networks: IEEE 802.11 Wireless LANs Physical & MAC layer, 802.11 MAC Modes (DCF & PCF) IEEE 802.11 standards, Architecture & protocols, Infrastructure vs. Adhoc Modes, Hidden Node & Exposed Terminal Problem, Problems, Fading Effects in Indoor and outdoor WLANs, WLAN Deployment issues.
Unit: 2	Wireless Cellular Networks: 1G and 2G, 2.5G, 3G, and 4G, Mobile IPv4, Mobile IPv6, TCP over Wireless Networks, Cellular architecture, Frequency reuse, Channel assignment strategies, Handoff strategies, Interference and system capacity, Improving coverage and capacity in cellular systems, Spread spectrum Technologies.
Unit: 3	WiMAX (Physical layer, Media access control, Mobility and Networking), IEEE 802.22 Wireless Regional Area Networks, IEEE 802.21 Media Independent Handover Overview Wireless Sensor Networks: Introduction, Application, Physical, MAC layer and Network Layer, Power Management, Tiny OS Overview.
Unit: 4	Wireless PANs: Bluetooth AND Zigbee, Introduction to Wireless Sensors. Security: Security in wireless Networks Vulnerabilities, Security techniques, Wi-Fi Security, DoS in wireless communication.
Unit: 5	Advanced Topics: IEEE 802.11x and IEEE 802.11i standards, Introduction to Vehicular Adhoc Networks, Opportunistic Networks.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1 Schiller J., Mobile Communications, Addison Wesley 2000.

2	Stallings W., Wireless Communications and Networks, Pearson Education 2005.
Reference Books:	
1	Stojmenic Ivan, Handbook of Wireless Networks and Mobile Computing, John Wiley and Sons Inc 2002.
2	Yi Bing Lin and Imrich Chlamtac, Wireless and Mobile Network Architectures, John Wiley and Sons Inc 2000.

Course Code	Course Title	Lecture			Semester: II
MTCS244PET	Mobile Applications and Services	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Computer Networks

Course Objectives:

1. To introduce soft computing concepts and techniques and foster their abilities in designing appropriate technique for a given scenario.
2. To implement soft computing-based solutions for real-world problems.
3. To give students knowledge of non-traditional technologies and fundamentals of artificial neural networks, fuzzy sets, fuzzy logic, genetic algorithms.
4. To provide student hands-on experience on MATLAB to implement various strategies.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand the fundamentals, frameworks, of mobile application Platforms including iOS, Android, and PhoneGap.	PO_1, PO_2, PO_{10}
CO_2	Analyze the target platform and users and be able to define and sketch of a mobile application.	PO_3, PO_4, PO_5
CO_3	Analyze, Design and develop a mobile application prototype in one of the platforms (challenge project).	PO_3, PO_5, PO_9, PO_{11}
CO_4	Analyze, Evaluate and Implement app development lifecycle including Architecture Design, Testing, Security and Hacking.	PO_3, PO_4, PO_5, PO_6, PO_{12}

PO_1- Engineering Knowledge, **PO_2**- Problem analysis, **PO_3**- Design/development of solutions, **PO_4**- Conduct investigations of complex problems, **PO_5**- Modern tool usage, **PO_6**- The engineer and society, **PO_7**- Environment and sustainability, **PO_8**- Ethics, **PO_9**- Individual or team work, **PO_{10}**- Communication, **PO_{11}**- Project management and finance, **PO_{12}**- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	2	3								2		
CO_2			3	2	2							
CO_3			3		3				1		2	
CO_4			2	2	3	1						2

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Introduction: Introduction to Mobile Computing, Introduction to Android Development Environment, Factors in Developing Mobile Applications, Mobile Software Engineering, Frameworks and Tools, Generic UI Development Android User
Unit: 2	More on Uis: VUIs and Mobile Apps, Text-to-Speech Techniques, Designing the Right UI, Multichannel and Multimodal Uis, Storing and Retrieving Data, Synchronization and Replication of Mobile Data, Getting the Model Right, Android Storing and Retrieving Data, Working with a Content Provider
Unit: 3	Communications via Network and the Web: State Machine, Correct Communications Model, Android Networking and Web, Telephony Deciding Scope of an App, Wireless Connectivity and Mobile Apps, Android Telephony
Unit: 4	Notifications and Alarms: Performance, Performance and Memory Management, Android Notifications and Alarms, Graphics, Performance and Multithreading, Graphics and UI Performance, Android Graphics Packaging and Deploying, Performance Best Practices, Android Field Service App, Location Mobility and Location Based Android Services
Unit: 5	Multimedia: Mobile Agents and Peer-to-Peer Architecture, Android Multimedia Platforms and Additional Issues: Development Process, Architecture, Design, Technology Selection, Mobile App Development Hurdles, Testing, Security and Hacking, Active Transactions, More on Security, Hacking Android.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	John Horton, Android Programming with Kotlin for Beginners: Build Android apps starting from zero programming experience with the new Kotlin programming language Kindle
2	Catalin Ghita, Kickstart Modern Android Development with Jetpack and Kotlin: Enhance your applications by integrating Jetpack and applying modern app architectural concepts

Reference Books:	
1	Xamarin Mobile Application Development: Cross-Platform C# and Xamarin. Forms Fundamentals
2	Android Programming: The Big Nerd Ranch Guide (5th Edition)

Course Code	Course Title	Lecture			Semester: II
MTCS245PET	Graphics Processing Unit Computing	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Computer Graphics

Course Objectives:

1. To understand basics of GPU architecture, issues in mapping algorithms and different GPU programming Models.
2. To introduce parallel programming fundamentals while focusing on CUDA programming interface.
3. To acquaint emerging multi-core parallel computing architecture with Graphics Processing Units (GPUs).
4. To introduce the concept of offloading work onto GPUs as accelerators for various applications.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Analyze GPU architecture, assess their advantages and identify potential software optimizations based on knowledge of the GPU architecture	PO_2, PO_3, PO_{12}
CO_2	Understand the working proficiency with CUDA to optimize and debug GPU code.	PO_1, PO_2, PO_3, PO_4
CO_3	Implement efficient algorithms, parallel programming patterns to solve real world problems.	PO_2, PO_3, PO_4, PO_9
CO_4	Comprehend the parallel programming techniques and implementation of programs on GPUs.	PO_2, PO_3, PO_4, PO_{12}

PO_1- Engineering Knowledge, **PO_2**- Problem analysis, **PO_3**- Design/development of solutions, **PO_4**- Conduct investigations of complex problems, **PO_5**- Modern tool usage, **PO_6**- The engineer and society, **PO_7**- Environment and sustainability, **PO_8**- Ethics, **PO_9**- Individual or team work, **PO_{10}**- Communication, **PO_{11}**- Project management and finance, **PO_{12}**- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1		2	1									3
CO_2	3	2	2	1								
CO_3		3	1	2					1			
CO_4		2	3	1								1

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Introduction: History, Graphics Processors, Graphics Processing Units, GPGPUs. Clock speeds, CPU / GPU comparisons, Heterogeneity, Accelerators, Parallel programming, CUDA Open CL / Open ACC, Hello World Computation Kernels, Launch parameters, Thread hierarchy, Warps / Wave fronts, Thread blocks / Workgroups, Streaming multiprocessors, 1D / 2D / 3D thread mapping, Device properties, Simple Programs.
Unit: 2	Memory: Memory hierarchy, DRAM / global, local / shared, private / local, textures, Constant Memory, Pointers, Parameter Passing, Arrays and dynamic Memory, Multi-dimensional Arrays, Memory Allocation, Memory copying across devices, Programs with matrices, Performance evaluation with different memories.
Unit: 3	Synchronization: Memory Consistency, Barriers (local versus global), Atomics, Memory fence. Prefix sum, Reduction. Programs for concurrent Data Structures such as Work lists, Linked-lists. Synchronization across CPU and GPU Functions: Device functions, Host functions, Kernels functions, Using libraries (such as Thrust), and developing libraries.
Unit: 4	Support: Debugging GPU Programs. Profiling, Profile tools, Performance aspects Streams: Asynchronous processing, tasks, Task-dependence, Overlapped data transfers, Default Stream, Synchronization with streams. Events, Event-based- Synchronization - Overlapping data transfer and kernel execution, pitfalls.
Unit: 5	Image Processing, Graph algorithms, Simulations, Deep Learning. Advanced topics: Dynamic parallelism, Unified Virtual Memory, Multi-GPU processing, Peer access, Heterogeneous processing.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Shane Cook, CUDA Programming: ―A Developer's Guide to Parallel Computing with GPUs (Applications of GPU Computing), First Edition, Morgan Kaufmann, 2012

2	David R. Kaeli, Perhaad Mistry, Dana Schaa, Dong Ping Zhang, ―Heterogeneous computing with OpenCL, 3rd Edition, Morgan Kauffman, 2015.
Reference Books:	
1	Jason Sanders, Edward Kandrot, ―CUDA by Example: An Introduction to General Purpose GPU Programming, Addison – Wesley, 2010
2	Nicholas Wilt, ―CUDA Handbook: A Comprehensive Guide to GPU Programming, Addison – Wesley, 2013.

Course Code	Course Title	Lecture			Semester: II
MTCS246PET	Big Data Analytics	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Computer Graphics

Course Objectives:

1. To learn the need of Big Data and the various challenges involved and to acquire Knowledge about different analytical architectures.
2. To understand Hadoop Architecture, ecosystems and acquire knowledge about the NoSQL database.
3. To acquire knowledge about the NewSQL, MongoDB and Cassandra databases.
4. To Apply the processing of Big Data with advanced architectures like Spark.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand the knowledge of Big Data, Data Analytics, challenges and their solutions in Big Data.	PO_2, PO_3, PO_{12}
CO_2	Analyze Hadoop Framework and Eco systems.	PO_1, PO_2, PO_3, PO_4
CO_3	Analyze MapReduce and Yarn, Work on NoSQL environment. MongoDB and Cassandra.	PO_2, PO_3, PO_4, PO_9
CO_4	Apply Big Data using Map-reduce programming in Hadoop and spark framework	PO_2, PO_3, PO_4, PO_{12}

PO_1- Engineering Knowledge, **PO_2**- Problem analysis, **PO_3**- Design/development of solutions, **PO_4**- Conduct investigations of complex problems, **PO_5**- Modern tool usage, **PO_6**- The engineer and society, **PO_7**- Environment and sustainability, **PO_8**- Ethics, **PO_9**- Individual or team work, **PO_{10}**- Communication, **PO_{11}**- Project management and finance, **PO_{12}**- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1		2	1									3
CO_2	3	2	2	1								
CO_3		3	1	2					1			
CO_4		2	3	1								1

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Introduction to big data: Data, Characteristics of data and Types of digital data: Unstructured, Semi-structured and Structured - Sources of data. Big Data Evolution - Definition of big data-Characteristics and Need of big data-Challenges of big data. Applications of Big Data, Data Analytics, Types of Data Analytics, Data Analytics Methods and Techniques, Big data analytics, Data Lake, Architecture of Data Lake. Overview of business intelligence.
Unit: 2	Big data technologies and Databases: Hadoop – Requirement of Hadoop Framework - Design principle of Hadoop –Comparison with other system SQL and RDBMS- Hadoop Components – Architecture -Hadoop 1 vs Hadoop 2.
Unit: 3	MapReduce and YARN framework: Introduction to MapReduce, Processing data with Hadoop using MapReduce, Introduction to YARN, Architecture, Managing Resources and Applications with Hadoop YARN. Big data technologies and Databases: NoSQL: Introduction to NoSQL - Features and Types- Advantages & Disadvantages -Application of NoSQL.
Unit: 4	New SQL: Overview of New SQL - Comparing SQL, NoSQL and NewSQL. Mongo DB: Introduction – Features – Data types – Mongo DB Query language – CRUD operations – Arrays – Functions: Count – Sort – Limit – Skip – Aggregate – Map Reduce. Cursors – Indexes – Mongo Import – Mongo Export. Cassandra: Introduction – Features – Data types – CQLSH – Key spaces – CRUD operations – Collections – Counter – TTL – Alter commands – Import and Export – Querying System tables.
Unit: 5	Hadoop Frame Work: Map Reduce Programming: I/O formats, Map side join-Reduce Side Join-Secondary Sorting- Pipelining MapReduce jobs. Spark Frame Work: Introduction to Apache Spark-How spark works, Programming with RDDs: Create RDDspark Operations-Data Frame.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1 Tom White, "Hadoop: The Definitive Guide", O"Reilly, 4th Edition, 2015.

2	Mohammed Guller, “Big Data Analytics with Spark”, Apress, 2015
Reference Books:	
1	Seema Acharya and Subhashini Chellappan, “Big Data and Analytics”, Wiley India Pvt. Ltd., 2016.
2	Mike Frampton, “Mastering Apache Spark”, Packt Publishing, 2015.

Course Code	Course Title	Lecture			Semester: III
MTCS311PET	Deep Learning	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Machine Learning

Course Objectives:

1. To understand the context of neural networks and deep learning.
2. To understand the use of a neural network and need of deep learning.
3. To gain working knowledge of neural networks and deep learning.
4. To Explore the parameters for neural networks.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand the basics concepts of deep learning.	PO_1, PO_2, PO_3, PO_4
CO_2	Apply the knowledge of various deep learning algorithms.	PO_2, PO_3, PO_4, PO_{10}
CO_3	Understand and Apply CNN and RNN in simulation for real-world applications	PO_3, PO_4, PO_5, PO_9
CO_4	Analyze the challenges inherent in developing deep learning algorithms for different uses.	PO_2, PO_3, PO_4, PO_5, PO_{11}, PO_{12}

PO_1- Engineering Knowledge, **PO_2**- Problem analysis, **PO_3**- Design/development of solutions, **PO_4**- Conduct investigations of complex problems, **PO_5**- Modern tool usage, **PO_6**- The engineer and society, **PO_7**- Environment and sustainability, **PO_8**- Ethics, **PO_9**- Individual or team work, **PO_{10}**- Communication, **PO_{11}**- Project management and finance, **PO_{12}**- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	2	2	3	3								
CO_2		3	3	2						1		
CO_3			3	2	2				2			
CO_4		3	3	3	3						3	2

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Introduction to Deep Learning: Basics: 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: 2	Feed forward Networks: Multilayer Perceptron, Gradient Descent, Back propagation, Empirical Risk Minimization, regularization, auto encoders.
Unit: 3	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: 4	Recurrent Neural Networks: Bidirectional RNNs - Deep Recurrent Networks Recursive Neural Networks – The Long Short-Term Memory and Other Gated RNNs
Unit: 5	Deep Generative Models: Boltzmann Machines - Restricted Boltzmann Machines - Introduction to MCMC and Gibbs Sampling- gradient computations in RBMs Applications: Large-Scale Deep Learning - Computer - Speech Recognition - Natural Language Processing - Other Applications

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Goodfellow,I.,Bengio,Y.,andCourville,A.,DeepLearning,MITPress,2016.
2	Bengio, Yoshua. "Learning deep architectures for AI." Foundations and trends in Machine Learning 2.1 (2009): 1127.

Reference Books:

1	Nikhil Buduma, “Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms”,O’Reilly publications.

Course Code	Course Title	Lecture			Semester: III
MTCS312PET	Secure Software Design &Enterprise Computing	L	T	P	
Version: 1.2	**Date of Approval:**	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Software Engineering

Course Objectives:

1. To fix software flaws and bugs in various software.
2. To provide an overview of various issues like weak random number generation, Information leakage, poor usability, and weak or no encryption on data traffic.
3. To introduce techniques for successfully implementing and supporting network services on an enterprise scale and heterogeneous systems environment.
4. To design Methodologies and tools for developing secure software containing minimum vulnerabilities and flaws.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Analyze various software vulnerabilities.	**PO_1, PO_2**
CO_2	Understand Software process vulnerabilities for an organization.	**PO_2, PO_3, PO_4**
CO_3	Understand and Monitor resources consumption in a software.	**PO_4, PO_5**
CO_4	Apply security and software development process.	**PO_3, PO_4, PO_5, PO_9, PO_{12}**

PO_1- Engineering Knowledge, **PO_2**- Problem analysis, **PO_3**- Design/development of solutions, **PO_4**- Conduct investigations of complex problems, **PO_5**- Modern tool usage, **PO_6**- The engineer and society, **PO_7**- Environment and sustainability, **PO_8**- Ethics, **PO_9**- Individual or team work, **PO_{10}**- Communication, **PO_{11}**- Project management and finance, **PO_{12}**- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	1	2										
CO_2		1	2	3								
CO_3				3	2							
CO_4			2	3	2				2			2

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Secure Software Design - Identify software vulnerabilities and perform software security analysis, Master security programming practices, Master fundamental software security design concepts, Perform security testing and quality assurance.
Unit: 2	Enterprise Application Development - Describe the nature and scope of enterprise software applications, Design distributed N-tier software application, Research technologies available for the presentation, business and data tiers of an enterprise software application, Design and build a database using an enterprise database system, Develop components at the different tiers in an enterprise system, Design and develop a multi-tier solution to a problem using technologies used in enterprise system, Present software solution.
Unit: 3	Enterprise Systems Administration: Design, implement and maintain a directory-based server infrastructure in a heterogeneous systems environment, monitor server resource utilization for system reliability and availability, Install and administer network services (DNS/DHCP/Terminal Services/Clustering/Web/Email).
Unit: 4	Obtain the ability to manage and troubleshoot a network running multiple services, Understand the requirements of an enterprise network and how to go about managing them.
Unit: 5	Handle insecure exceptions and command/SQL injection, Defend web and mobile applications against attackers, software containing minimum vulnerabilities and flaws. Case study of DNS server, DHCP configuration and SQL injection attack.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1 Theodor Richardson, Charles N Thies, Secure Software Design, Jones & Bartlett

Reference Books:

1 Kenneth R. van Wyk, Mark G. Graff, Dan S. Peters, Diana L. Burley, Enterprise Software

Course Code	Course Title	Lecture			Semester: III
MTCS313PET	Wireless Access Technologies	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Computer Networks

Course Objectives:

1. To gain an overview of wireless access technologies, Fixed wireless access networks. Terminal mobility issues regarding wireless access to Internet
2. To introduce various Network topologies, hotspot networks, Communication links: point-to- point, point-to-multipoint, multipoint-to-multipoint.
3. To provide an overview of Standards for most frequently used wireless access networks: WPAN, UWB, WLAN, WMAN, WWAN. Network services. Wireless access networks planning, design and installation.
4. To get and insight of Wireless networking security issues, Wireless access network exploitation and management, software requirements, link quality control.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand basic terms and characteristics of wireless access networks.	PO_1, PO_5
CO_2	Analyze various wireless access technologies	PO_2, PO_4, PO_6
CO_3	Analyze measurements of wireless access network parameter.	PO_3, PO_4, PO_5
CO_4	Apply and Assess security issues in wireless networks	$PO_4, PO_5, PO_{10}, PO_{12}$

PO_1- Engineering Knowledge, PO_2- Problem analysis, PO_3- Design/development of solutions, PO_4- Conduct investigations of complex problems, PO_5- Modern tool usage, PO_6- The engineer and society, PO_7- Environment and sustainability, PO_8- Ethics, PO_9- Individual or team work, PO_{10}- Communication, PO_{11}- Project management and finance, PO_{12}- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	2				2							
CO_2		2		2		2						
CO_3			2	3	3							
CO_4				2	2					2		2

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Necessity for wireless terminals connectivity and networking. Wireless networking advantages and disadvantages, Overview of wireless access technologies. Narrowband and broadband networks, fixed and nomadic networks. Wireless local loop (WLL), Public Switched Telephone Network (PSTN) interfaces.
Unit: 2	Fixed wireless access (FWA) networks, frequency bands for different networks. Criterions for frequency bands allocation, Network topologies, hotspot networks. Communication links: point-to-point (PTP), point- to- multipoint (PMP), multipoint-to-multipoint (MTM).
Unit: 3	Standards for most frequently used wireless access networks: WPAN (802.15, Bluetooth, DECT, IrDA), UWB (Ultra-Wideband), WLAN (802.11, Wi-Fi, HIPERLAN, IrDA), WMAN(802.16, WiMAX, HIPERMAN, HIPERACCESS), WWAN (802.20), Other technologies for broadband wireless access, Local Multipoint Distribution Service (LMDS), Multichannel Multipoint Distribution Service (MMDS). Ad -Hoc networks, Network services. Services types based on carrier frequency and bandwidth
Unit: 4	Wireless access networks planning, design and installation. Services provision, legislative and technical aspects, Technical and Economical factors for network planning: expenses, coverage, link capacity, network complexity and carrier-to-interference ratio (C/I). Base station or access point allocation. Base station and access point equipment. Terminal mobility issues regarding wireless access to Internet. Wireless networking security issues.
Unit: 5	Example of laptop or handheld PC wireless connection in real environment. PC wireless interface equipment. Wireless access network exploitation and management, software requirements, link quality control. Business model, wireless network services market, market research and marketing, service providers, wireless data application service providers (WDASP) and their role on public telecommunication services market, billing systems. Recent trends in wireless networking and various access mechanism, new standards of wireless communication.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.	
Text Books:	
1	M. P. Clark, Wireless Access Networks: Fixed Wireless Access and WLL networks -- Design and Operation, John Wiley & Sons, Chichester
2	D. H. Morais, Fixed Broadband Wireless Communications: Principles and Practical Applications, Prentice Hall, Upper Saddle River
Reference Books:	
1	R. Pandya, Introduction to WLLs: Application and Deployment for Fixed and Broadband Services, IEEE Press, Piscataway.

Course Code	Course Title	Lecture			Semester: III
MTCS314PET	Data Preparation and Analysis	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Machine Learning and Data Mining

Course Objectives:

1. To prepare the data for analysis.
2. To develop meaningful Data Visualizations.
3. To Learn data transformations and segmentation to solve statistical problems
4. To Create accurate dataset for applications.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand the data parsing and transformations. and the difference between data and information with formats	PO_1, PO_2
CO_2	Analyze the basic concept of data cleaning for valuable information with a minimum consistency checking.	PO_2, PO_4, PO_6
CO_3	Understand statistical exploratory analysis with hypothesis generation	PO_4, PO_7, PO_9
CO_4	Analyze Design visualizations for exploratory analysis and understand the concept of correlations and connections for geo located data	PO_3, PO_4, PO_5, PO_{12}

PO_1- Engineering Knowledge, PO_2- Problem analysis, PO_3- Design/development of solutions, PO_4- Conduct investigations of complex problems, PO_5- Modern tool usage, PO_6- The engineer and society, PO_7- Environment and sustainability, PO_8- Ethics, PO_9- Individual or team work, PO_{10}- Communication, PO_{11}- Project management and finance, PO_{12}- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	2	3										
CO_2		2		3		2						
CO_3				3			2		2			
CO_4			2	2	2							2

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Data Gathering and Preparation: Data formats, parsing and transformation, Scalability and real- time issues
Unit: 2	Data Cleaning: Consistency checking, Heterogeneous and missing data, Data Transformation and Segmentation.
Unit: 3	Exploratory Analysis: Descriptive and comparative statistics, Clustering and association, Hypothesis Generation.
Unit: 4	Visualization: Designing visualizations, Time series, Geolocated data, Correlations and connections, Hierarchies and networks, interactivity.
Unit: 5	Ethics in the Profession: Cases in Computing, Statistics, Communication, Professional Ethics Codes: ACM, IEEE, Am Stat. Assoc.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Making sense of Data: A practical Guide to Exploratory Data Analysis and Data Mining, by Glenn
2	The Visual Display of Quantitative Information, by Edward R. Tufte

Reference Books:

1	Visualizing Data: Exploring and Explaining Data with Processing Environment, by Ben Fry
2	Exploratory Data Mining and Data Cleaning, by Tamraparni Dasu

Course Code	Course Title	Lecture			Semester: III
MTCS315PET	Optimization Techniques	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Machine Learning

Course Objectives:

1. To provide insight to the mathematical formulation of real-world problems.
2. To understand problem formulation by using linear, dynamic programming, game theory and queuing models.
3. To optimize this mathematical solution especially useful for NP-Hard problems using nature-based algorithms.
4. To introduce operation research models using optimization techniques based upon the fundamentals of engineering mathematics (minimization and Maximization of objective function).

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand appropriate optimization method to solve complex problems involved in various industries.	PO_1, PO_2, PO_4
CO_2	Analyze the appropriate algorithm for allocation of resources to optimize the various programming techniques.	PO_3, PO_4, PO_5
CO_3	Understand the concept of theoretical workings of the graphical, simplex and analytical methods for making effective decision on variables so as to optimize the objective function.	PO_4, PO_6, PO_9
CO_4	Comprehend the theoretical foundations of various issues related to linear programming modeling to formulate real-world problems as a L P model.	PO_4, PO_5, PO_6, PO_9

PO_1- Engineering Knowledge, **PO_2**- Problem analysis, **PO_3**- Design/development of solutions, **PO_4**- Conduct investigations of complex problems, **PO_5**- Modern tool usage, **PO_6**- The engineer and society, **PO_7**- Environment and sustainability, **PO_8**- Ethics, **PO_9**- Individual or team work, **PO_{10}**- Communication, **PO_{11}**- Project management and finance, **PO_{12}**- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	3	2		2								
CO_2			2	1	2							
CO_3				2		2			2			
CO_4				3	1	2			2			

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Introduction to Optimization: Engineering application of Optimization – Statement of an Optimization problem - Optimal Problem formulation - Classification of Optimization problem. Optimum design concepts: Definition of Global and Local optima – Optimality criteria - Review of basic calculus concepts – Global optimality
Unit: 2	Linear Programming: Introduction and formulation of models, Convexity, Simplex method, BigM method, Two-phase method, Degeneracy, non-existent and unbounded solutions, revised simplex method, duality in LPP, dual simplex method, sensitivity analysis, transportation and assignment problems, traveling salesman problem .
Unit: 3	Nonlinear Programming: Introduction and formulation of models, Classical optimization methods, equality and inequality constraints, Lagrange multipliers and Kuhn-Tucker conditions, quadratic forms, quadratic programming problem, Wolfe's method.
Unit: 4	Dynamic Programming: Principle of optimality, recursive relations, solution of LPP. Optimization algorithms for solving constrained optimization problems – direct methods – penalty function methods – steepest descent method - Engineering applications of constrained and unconstrained algorithms.
Unit: 5	Integer Linear Programming: Gomory's cutting plane method, Branch and bound algorithm, Knapsack problem, linear 0-1 problem. Modern methods of Optimization: Genetic Algorithms - Simulated Annealing - Ant colony optimization - Tabu search – Neural-Network based Optimization – Fuzzy optimization techniques – Applications. Use of Matlab to solve optimization problems. Software: Introduction to software for optimization techniques (TORA).

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:	
1	Kanti Swarup, Man Mohan and P.K.Gupta, Introduction to Operations Research, S.Chand & Co., 2006
2	J.C. Pant, Introduction to Operations Research, Jain Brothers, New Delhi, 2008
Reference Books:	
1	N.S.Kambo, Mathematical Programming Techniques, East-West Pub., Delhi, 1991.
2	Maurice Saseini, Arhur Yaspan, Lawrence Friedman, "Operations Research: Methods & Problems", 1 st Edition, 1959.

GENERIC ELECTIVES

Course Code	Course Title	Lecture			Semester: I
PGCS131GET	English For Research Paper Writing	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Basic knowledge of English

Course Objectives:

1. Understand that how to improve your writing skills and level of readability.
2. Learn about what to write in each section.
3. Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission.
4. Ensure the quality of paper at very first-time submission.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand the English for Writing Research Papers, Thesis.	PO_1, PO_2, PO_6, PO_{10}
CO_2	Show conciseness, clarity and avoid redundancy in writing.	PO_3, PO_4
CO_3	Summarize, evaluate literature, and write methodology, results and conclusion	PO_2, PO_3, PO_4, PO_5
CO_4	Apply correct style of referencing and use punctuation appropriately.	PO_{10}, PO_{12}

PO_1- Engineering Knowledge, **PO_2**- Problem analysis, **PO_3**- Design/development of solutions, **PO_4**- Conduct investigations of complex problems, **PO_5**- Modern tool usage, **PO_6**- The engineer and society, **PO_7**- Environment and sustainability, **PO_8**- Ethics, **PO_9**- Individual or team work, **PO_{10}**- Communication, **PO_{11}**- Project management and finance, **PO_{12}**- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	3	2				2				2		
CO_2			2	2								
CO_3		1	2	1	2							
CO_4										2		1

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Planning and Preparation, Word Order, breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.
Unit: 2	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction.
Unit: 3	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.
Unit: 4	Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.
Unit: 5	Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions. useful phrases, how to ensure paper is as good as it could possibly be the first- time submission.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Glodbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2	Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press.

Reference Books:

1	Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book
2	Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

Course Code	Course Title	Lecture			Semester: I
PGCS132GET	Disaster Management	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): Data structure & Algorithms

Course Objectives:

1. To learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. To critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. To develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. To critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Explain disaster management theory (cycle, phases, risk, crisis, emergency, disasters, resilience).	PO_6, PO_7
CO_2	Create Technological innovations in Disaster Risk Reduction: Advantages and problems.	PO_1, PO_2, PO_4, PO_5
CO_3	Evaluate DM study including data search, analysis and presentation as a case study.	PO_2, PO3, PO_5
CO_4	Apply knowledge about existing global frameworks and existing agreements and role of community in successful Disaster Risk Reduction.	PO_7, PO_{10}, PO_{12}

PO_1- Engineering Knowledge, **PO_2**- Problem analysis, **PO_3**- Design/development of solutions, **PO_4**- Conduct investigations of complex problems, **PO_5**- Modern tool usage, **PO_6**- The engineer and society, **PO_7**- Environment and sustainability, **PO_8**- Ethics, **PO_9**- Individual or team work, **PO_{10}**- Communication, **PO_{11}**- Project management and finance, **PO_{12}**- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1						1	2					
CO_2	2	3		1	1							
CO_3		1	2		1							
CO_4							2			2		2

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Introduction Disaster: Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.
Unit: 2	Repercussions Of Disasters and Hazards: 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 Diseases and Epidemics, War and Conflicts.
Unit: 3	Disaster Prone Areas in India Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides and Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post Disaster Diseases And Epidemics
Unit: 4	Disaster Preparedness and Management 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: 5	Risk Assessment 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. Disaster Mitigation Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1 | Sahni, Pardeep et.al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall

	Of India, New Delhi.
2	Goel S. L., Disaster Administration and Publication Pvt. Ltd., New Delhi.
Reference Books:	
1	R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.

Course Code	Course Title	Lecture			Semester: I
PGCS134GET	Value Education	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): No Specific prerequisite

Course Objectives:

1. Understand value of education and self- development
2. Imbibe good values in students
3. Let they should know about the importance of character.
4. To teach and inculcate the essential qualities to become a good leader.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Knowledge of self-development.	PO_6, PO_7, PO_8, PO_9, PO_{10}, PO_{12}
CO_2	Learn the importance of Human Values.	PO3, PO_7, PO_8, PO_9, PO_{10}, PO_{12}
CO_3	Developing the overall personality.	PO_3, PO_6, PO_7, PO_8, PO_9, PO_{10}, PO_{12}
CO_4	Gain deeper understanding about the purpose of them life.	PO_3, PO_6, PO_7, PO_8, PO_9, PO_{10}, PO_{12}

PO_1- Engineering Knowledge, **PO_2**- Problem analysis, **PO_3**- Design/development of solutions, **PO_4**- Conduct investigations of complex problems, **PO_5**- Modern tool usage, **PO_6**- The engineer and society, **PO_7**- Environment and sustainability, **PO_8**- Ethics, **PO_9**- Individual or team work, **PO_{10}**- Communication, **PO_{11}**- Project management and finance, **PO_{12}**- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1						3	2	2	3	3		2
CO_2			2				3	2	3	2		3
CO_3			3			3	3	3	2	3		2
CO_4			3			3	3	3	3	2		3

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgments.
Unit: 2	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: 3	Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labor. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self- destructive habits. Association and Cooperation. Doing best for saving nature.
Unit: 4	Character and Competence –Holy books vs Blind faith. Self-management and good health. Science of reincarnation. Equality, Nonviolence, Humility.
Unit: 5	Role of Women. All religions and same message. Mind your Mind, Self-control Honesty, Studying effectively.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

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

Reference Books:

1	https://fdp-si.aicte-india.org/8dayUHV__download.php

Course Code	Course Title	Lecture			Semester: III
PGCS135GET	Digital Marketing	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	45 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): No Prerequisite

Course Objectives:

1. To understand digital marketing, important conceptual insights and perspectives.
2. To demonstrate the use of tools required for effective digital marketing**.**
3. To analyze the market impact from digital marketing,
4. To apply the tools of digital marketing to get best visibility in market.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understanding digital marketing along with technical acumen will be an added tool as a problem solver and solution provider.	**PO_1, PO_2**
CO_2	Demonstrate the use of search engine optimization keyword planner Tools	**PO_2, PO_3, PO_7**
CO_3	Assist and advice the marketer to take right decision	**PO_4, PO_6, PO_9**
CO_4	Apply various social media platform for marketing such as Facebook, Twitter, LinkedIn etc.	**PO_3, PO_5, PO_{10}**

PO_1- Engineering Knowledge, **PO_2**- Problem analysis, **PO_3**- Design/development of solutions, **PO_4**- Conduct investigations of complex problems, **PO_5**- Modern tool usage, **PO_6**- The engineer and society, **PO_7**- Environment and sustainability, **PO_8**- Ethics, **PO_9**- Individual or team work, **PO_{10}**- Communication, **PO_{11}**- Project management and finance, **PO_{12}**- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	2	2										
CO_2		2	2				2					
CO_3				1		1			1			
CO_4			2		2					2		

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Introduction to Digital Marketing and its Significance Traditional Marketing Vs Digital Marketing Digital Marketing Process. Website Planning and Development: Types of websites Website Planning and Development, Understanding Domain and Webhosting Building Website/Blog using CMS Word Press, Using Word Press Plug-ins
Unit: 2	Introduction to Search Engine Optimization Keyword Planner Tools on Page SEO Techniques- Indexing and Key Word Placement, On Page SEO Techniques- Content Optimization on Page SEO: Yoast, SEO Plug-in, Off –Page SEO Techniques, Email Marketing- Introduction and Significance, Designing e-mail marketing campaigns using Mail Chimp
Unit: 3	Building E-mail List and Signup Forms, Email Marketing Strategy and Monitoring Email – Atomization. Pay Per Click Advertising: Introduction Pay Per Click Advertising: Google Ad word, Types of Bidding strategies Designing and Monitoring search campaigns, Designing and Monitoring Display campaigns
Unit: 4	Designing and Monitoring Video campaigns Designing and Monitoring Universal App Campaigns Google Analytics: Introduction and Significance Google Analytics Interface and Setup Understanding Goals and Conversions. Monitoring Traffic Behavior and preparing Reports Social Media Marketing: Introduction and Significance Facebook Marketing, Types of Various Ad Formats
Unit: 5	Setting up Facebook Advertising Account, Understanding Facebook Audience and its Types Designing Facebook Advertising Campaigns. Working with Facebook Pixel, Twitter Marketing: Basics Designing, Twitter Advertising Campaigns. Introduction to LinkedIn Marketing Developing digital marketing strategy in Integration form

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	The Art of Digital Marketing: The Definitive Guide to Creating Strategic, Targeted, and Measurable Online Campaigns by Ian Dodson, Wiley; 1st edition (2016)
2	Digital Marketing For Dummies by Ryan Deiss and Russ Henneberry, For Dummies.

Reference Books:

1	Understanding Digital Marketing: Marketing Strategies for Engaging the Digital Generation by Damian Ryan, Kogan Page Publisher
2	Digital Marketing by Seema Gupta, McGraw Hill Education

Course Code	Course Title	Lecture			Semester: II
PGCS231GET	Constitution of India	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): No Specific prerequisite

Course Objectives:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik.
4. Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.	PO_2, PO_6, PO_{12}
CO_2	Understand the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.	PO_4, PO_8, PO_{12}
CO_3	Understand the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.	PO_1, PO_3, PO_6, PO_7, PO_8, PO_{12}
CO_4	Understand the passage of the Hindu Code Bill of 1956.	PO_1, PO_2, PO_8

PO_1- Engineering Knowledge, **PO_2**- Problem analysis, **PO_3**- Design/development of solutions, **PO_4**- Conduct investigations of complex problems, **PO_5**- Modern tool usage, **PO_6**- The engineer and society, **PO_7**- Environment and sustainability, **PO_8**- Ethics, **PO_9**- Individual or team work, **PO_{10}**- Communication, **PO_{11}**- Project management and finance, **PO_{12}**- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1			2			2						3
CO_2				2				3				2
CO_3	2		3			2	3	2				2
CO_4	2	2	3					3				

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working), Philosophy of the Indian Constitution: Preamble Salient Features.
Unit: 2	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: 3	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: 4	Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments),Village level: Role of Elected and Appointed officials, Importance of grass root democracy.
Unit: 5	Election Commission: Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioner, State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

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.

Reference Books:	
1	M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
2	D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Course Code	Course Title	Lecture			Semester: II
PGCS232GET	Pedagogy Studies	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): No Specific prerequisite

Course Objectives:

1. To Acquire knowledge of pedagogical theories of relevance to work with people.
2. To understand the basic view of different pedagogical orientations.
3. To demonstrate concepts related to communication theory - describe and reflect on different theories of motivation and learning.
4. To Illustrate the critical evidence gaps to guide the development and account for different forms of supervision.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand the pedagogical practices used by teachers in formal and informal classrooms in developing countries	PO_1, PO_2, PO_3
CO_2	Analyze the evidence on the effectiveness of these pedagogical practices in what conditions, and with what population of learners?	PO_3, PO_4, PO_6
CO_3	Analyze teacher education (curriculum and practicum) and The school curriculum and guidance materials best support effective pedagogy?	PO_7, PO_8, PO_9
CO_4	Evaluate different forms of Supervision	PO_2, PO_8, PO_9, PO_{12}

PO_1- Engineering Knowledge, PO_2- Problem analysis, PO_3- Design/development of solutions, PO_4- Conduct investigations of complex problems, PO_5- Modern tool usage, PO_6- The engineer and society, PO_7- Environment and sustainability, PO_8- Ethics, PO_9- Individual or team work, PO_{10}- Communication, PO_{11}- Project management and finance, PO_{12}- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	2	1	2									
CO_2			1	2		2						
CO_3							2	2	2			
CO_4		2						2	2			2

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	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: 2	Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.
Unit: 3	Evidence on the effectiveness of pedagogical practices Methodology for the in-depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.
Unit: 4	Professional development: alignment with classroom practices and follow-up support, Peer Support from the head teacher and the community. Curriculum and assessment Barriers to learning: limited resources and large class sizes.
Unit: 5	Research gaps and future directions Research design. Contexts Pedagogy. Teacher education. Curriculum and assessment Dissemination and research impact.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2	Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3):361-379.

Reference Books:

1	Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
2	Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3):272–282.

Course Code	Course Title	Lecture			Semester: II
PGCS233GET	Stress Management by Yoga	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): No Specific prerequisite

Course Objectives:

1. To achieve overall health of body and mind.
2. To overcome stress.
3. To learn different asans.
4. To organize yoga workshops

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand the healthy mind in a healthy body thus improving social health.	PO_6, PO_7, PO_8
CO_2	Understand the Improved efficiency with different asans.	PO_6, PO_7, PO_8, PO12
CO_3	Understand the Improvement in breathing with asans.	PO_6, PO_7, PO_9
CO_4	Apply and Practice Prayanama and asans.	PO_6, PO_7, PO_8, PO_{12}

PO_1- Engineering Knowledge, PO_2- Problem analysis, PO_3- Design/development of solutions, PO_4- Conduct investigations of complex problems, PO_5- Modern tool usage, PO_6- The engineer and society, PO_7- Environment and sustainability, PO_8- Ethics, PO_9- Individual or team work, PO_{10}- Communication, PO_{11}- Project management and finance, PO_{12}- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1						3	2	2				
CO_2						2	3	2				2
CO_3						3	3		2			
CO_4						2	3	3				3

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Definitions of Eight parts of yog. (Ashtanga)
Unit: 2	Yam and Niyam. Do`s and Don't's in life. Ahinsa, satya, astheya, bramhacharya and aparigraha.
Unit: 3	Shaucha, santosh, tapa, swadhyay,ishwar pranidhan
Unit: 4	Asan and Pranayam, Various yog poses and their benefits for mind &body.
Unit: 5	Regularization of breathing techniques and its effects-Types of pranayama.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	'Yogic Asanas for Group Tarining-Part-I":Janardan Swami Yogabhyasi Mandal, Nagpur.

Reference Books:

1	"Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata.

Course Code	Course Title	Lecture			Semester: II
PGCS234GET	Personality Development Through Life Enlightenment Skills	L	T	P	
Version: 1.2	Date of Approval:	3	1	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): No Specific prerequisite

Course Objectives:

1. To learn to achieve the highest goal happily.
2. To become a person with stable mind, pleasing personality and determination.
3. To awaken wisdom in students.
4. To learn how to live a pure life.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand the Study of Shrimad-Bhagwad-Geeta and develop personality to achieve the highest goal in life	PO_1, PO_2, PO_3
CO_2	Apply the knowledge of Geeta to lead the nation and mankind to peace and prosperity.	PO_1, PO_3, PO_4, PO_{12}
CO_3	Apply the Study of Neetishatakam in developing versatile personality of students.	PO_3, PO_4, PO=, PO_{12}
CO_4	Create the ability to live better way of life	PO_1, PO_2, PO_3, PO_4, PO_6, PO_7, PO_{12}

PO_1- Engineering Knowledge, PO_2- Problem analysis, PO_3- Design/development of solutions, PO_4- Conduct investigations of complex problems, PO_5- Modern tool usage, PO_6- The engineer and society, PO_7- Environment and sustainability, PO_8- Ethics, PO_9- Individual or team work, PO_{10}- Communication, PO_{11}- Project management and finance, PO_{12}- Life-long Learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	3	2	2									
CO_2	2		3	3								2
CO_3			3	1			2					2
CO_4	2	2	3	3		2	3					2

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Neeti satakam- Holistic development of personality, Verses- 19,20,21,22(wisdom), Verses- 29,31,32 (pride &heroism), Verses- 26,28,63,65(virtue), Verses- 52,53,59(dont's), Verses- 71,73,75,78(do's)
Unit: 2	Approach to day-to-day work and duties., Shrimad Bhagwad Geeta: Chapter 2-Verses 41,47,48,, Chapter 3- Verses 13, 21, 27, 35,
Unit: 3	Chapter 6-Verses 5,13,17, 23,35,, Chapter 18-Verses 45, 46,48., Statements of basic knowledge., Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62,68
Unit: 4	Chapter 12 -Verses 13, 14, 15, 16,17,18, Personality of Role model. Shrimad Bhagwad Geeta:
Unit: 5	Chapter2-Verses 17, Chapter 3-Verses36,37,42, Chapter 4-Verses 18,38,39, Chapter18 – Verses37,38,63

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram(Publication Department),Kolkata.

Reference Books:

1	Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.