Learning Outcomes based Curriculum Framework (LOCF)

for

Master of Technology
Computer Science and Engineering
(Artificial Intelligence and Machine Learning)

Part-time program under sponsored/self-finance mode
(Duration 3 Years)

(w.e.f. 2023-24)

Department of Computer Science and Information Technology

School of Technology

MAULANA AZAD NATIONAL URDU UNIVERSITY

University Profile

Maulana Azad National Urdu University (MANUU) is a Central University, established byan Act of Parliament in 1998 with all India jurisdiction. The headquarters and main campusof MANUU is in Gachibowli, Hyderabad. It is spread over 200 acres. MANUU is recognizedas a major higher education service provider across the remote areas of the country in Urdu Medium through its regular and distance mode programs. MANUU commenced with distance education programs in 1998 and consolidated its regular academic and research programs in 2004.

The University is named after Maulana Abul Kalam Azad, a scholar par excellence, a prolificwriter, an inimitable orator, a gallant freedom fighter, a visionary of the post independent Indian education system and an architect of technical and scientific education in Independent India.

Presently, MANUU is in the process of consolidating the existing institutions, while expanding it to reach the unreached through various intervention measures. Further, to meet the rising aspirations of its youth in general and Urdu speaking community in specific, the University is making considerable progress in all fronts of academics, research and governance with specific vision, mission and objectives.

School Profile

School of Technology (formerly School of Computer Science and Information Technology), was established in 2014 with the objective to create a congenial environment for inspiring students, retaining outstanding teachers, providing quality teaching and developing cutting-edge technology for technological intervention. The school is currently having one Department viz., The Department of Computer Science & Information Technology. The school also comprises of five Polytechnics located at Hyderabad, Bengaluru, Darbhanga, Kadapa and Cuttack.

Department of Computer Science and Information Technology was established in 2006 with the aim to impart quality education and achieve the vision of excellence in the field of Computer Science, IT and interdisciplinary research. Presently, Department of Computer Science and Information Technology offering B.Tech. (Computer Science), M.Tech. in Computer Science and MCA (two-years) programmes all approved by the All India Council for Technical Education (AICTE). Department also provide options of Lateral entry into second year of B.Tech. (Computer Science) for Polytechnic students

Department of Computer Science and Information Technology provide an excellent learning environment with dedicated young faculty members, state-of-the-art laboratories and innovative academic processes. We focus on providing an in-depth knowledge in the field of Artificial Intelligence, Personalized learning, Machine learning, Computational sustainability, Block chain technology, semantic web, internet of things (IoT) and other allied fields of computer science & IT. We aspire our students towards becoming next generation IT professionals capable of generating programming and logical skills, providing networking solutions and becoming leaders in software industry, government and academia.

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

MAULANA AZAD NATIONAL URDU UNIVERSITY
SCHOOL OF TECHNOLOGY
DEPARTMENT OF COMPUTER SCIENCE AND INFORMATION TECHNOLOGY

M.Tech. Computer Science and Engineering (Artificial Intelligence and Machine Learning) Part-time program under sponsored/self-finance mode

Course structure & 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. Part time Students	Credits
1	Program Core Course	PC	20
2	Program Elective Course	PE	24
3	Research Methodology & IPR	RMIPR	4
5	Laboratory	LAB	8
6	Seminar Presentation & Comprehensive viva-voce	SPC	2
7	Dissertation	DISS	22
Total			**80**

MAULANA AZAD NATIONAL URDU UNIVERSITY

DEPARTMENT OF COMPUTER SCIENCE AND INFORMATION TECHNOLOGY

SCHEME OF INSTRUCTIONS, EXAMINATION & EVALUATION

(Effective for Batch Admitted from 2023-24 Academic Year)

M.Tech. Computer Science and Engineering (Artificial Intelligence and Machine Learning)
Part-time program under sponsored/self-finance mode
Total Credits (3 Year Course): 80

Semester – I

Course Code	Course Title	Course Type	Marks			L-T-P	Credits
			Internal Assessment	Semester Exam	Total		
MTCS111PCT	Advanced Algorithm	PC	30	70	100	4-0-0	4
MTCS112PCT	Artificial Intelligence	PC	30	70	100	4-0-0	4
MTCS111RMT	Research Methodology & IPR	RMIPR	30	70	100	4-0-0	4
MTCS160PCP	Lab– I Advanced Algorithm Lab	LAB	50	50	100	0-0-4	2
Total					**400**	**12-0-4**	**14**

Semester – II

Course Code	Course Title	Course Type	Marks			L-T-P	Credits
			Internal Assessment	Semester Exam	Total		
MTCS211PCT	Machine Learning with Python	PC	30	70	100	4-0-0	4
MTCS22XPET	Program Elective-1	PE	30	70	100	4-0-0	4
MTCS23XPET	Program Elective-2	PE	30	70	100	4-0-0	4
MTCS260PCP	Lab – II Python Lab	LAB	50	50	100	0-0-4	2
MTCS21XNGT	Audit Course	AC	15	35	50	2-0-0	Non-Credit
Total					**450**	**14-0-4**	**14**

Semester – III

Course Code	Course Title	Course Type	Marks			L-T-P	Credits
			Internal Assessment	Semester Exam	Total		
MTCS311PCT	Deep Learning	PC	30	70	100	4-0-0	4
MTCS34XPET	Program Elective -3	PE	30	70	100	4-0-0	4
MTCS35XPET	Program Elective -4	PE	30	70	100	4-0-0	4
MTCS360PCP	Lab – III Deep Learning Lab	LAB	50	50	100	0-0-4	2
Total					**400**	**12-0-4**	**14**

Semester – IV

Course Code	Course Title	Course Type	Marks			L-T-P	Credits
			Internal Assessment	Semester Exam	Total		
MTCS411PCT	Internet of Things	PC	30	70	100	4-0-0	4
MTCS46XPET	Program Elective -5	PE	30	70	100	4-0-0	4
MTCS47XPET	Program Elective -6	PE	30	70	100	4-0-0	4
MTCS460PCP	Lab – IV IoT Lab	LAB	50	50	100	0-0-4	2
Total					**400**	**12-0-4**	**14**

Semester – V

Course Code	Course Title	Course Type	Marks			L-T-P	Credits
			Internal Assessment	Semester Exam	Total		
MTCS511PCP	Seminar Presentation & Comprehensive viva-voce	SPC	30	70	100	0-0-4	2
MTCS570PCP	Dissertation- Part 1 (Minor)	DISS	210	490*	700	0-0-20	10
Total					**800**	**0-0-24**	**12**

* Viva-voce will be evaluated by DRC

Semester – VI

Course Code	Course Title	Course Type	Marks			L-T-P	Credits
			Internal Assessment	Semester Exam	Total		
MTCS670PCP	Dissertation- Part 2 (Major)	DISS	240	560	800	0-0-24	12
Total					**800**	**0-0-24**	**12**

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

PROGRAM ELECTIVES (PE)

SEMESTER – 2			
Program Elective – I		**Program Elective – II**	
Course Code	**Course Title**	**Course Code**	**Course Title**
MTCS211PET	Expert System	MTCS221PET	Augmented Reality and Virtual Reality
MTCS212PET	Intelligent System	MTCS222PET	Pattern Matching and Object Recognition
MTCS213PET	Knowledge Representation	MTCS223PET	Computer Vision
MTCS214PET	Human Computer Interface	MTCS224PET	Dependable AI
MTCS215PET	Text Mining	MTCS225PET	Digital Image Processing and Analysis
Audit Course			
Course Code		**Course Title**	
MTAC211PET		English for Research Paper Writing	
MTAC212PET		Value Education	
MTAC213PET		Pedagogy Studies	
MTAC214PET		Stress Management by Yoga	
MTAC215PET		Tarseel-e-Urdu/Elementary Urdu	
SEMESTER - 3			
Program Elective – III		**Program Elective – IV**	
Course Code	**Course Title**	**Course Code**	**Course Title**
MTCS331PET	Artificial Neural Networks	MTCS341PET	Blockchain Technology
MTCS332PET	Machine Learning with Big Data	MTCS342PET	Bio-image computing
MTCS333PET	Robotics Process Automation	MTCS343PET	Digital Image Analysis
MTCS334PET	Speech and Natural Language Processing	MTCS344PET	Edge and Fog Computing
MTCS335PET	Information Retrieval and Web Mining	MTCS345PET	Computational Optimization
SEMESTER - 4			
Program Elective – V		**Program Elective – VI**	
Course Code	**Course Title**	**Course Code**	**Course Title**
MTCS451PET	Cloud Computing	MTCS461PET	Graphics Processing Unit Computing
MTCS452PET	Wireless Access Technologies	MTCS462PET	Statistical Data Analysis
MTCS453PET	Algorithms for Big Data	MTCS463PET	Embedded System
MTCS454PET	Advanced Computer Graphics	MTCS464PET	Advanced Wireless & Mobile Networks
MTCS455PET	Data Visualization	MTCS465PET	Intelligent Bioinformatics

Course Code	Course Title	Lecture			
MTCS111PCT	Advanced Algorithm	L	T	P	**Semester:** I
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	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 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 algorithm, Growth of functions, Master's Theorem, Sorting: Quick Sort, Heap Sort, Shaker Sort, and Counting Sort. Asymptotic Notation; Solving recurrence relations using substitution method.
Unit: 2	Greedy Method: Minimum Spanning Tree-Prim's Algorithm, Tarjan's Algorithm Introduction to Dynamic programming, principal of optimality, Single Source Shortest Path-Bellman-Ford Algorithm, All Pairs Shortest Paths Algorithm-Johnson's Algorithm, Longest Common Sequence (LCS), Huffman's code.
Unit: 3	String Matching: Introduction to String Matching, application of string matching, Naive algorithm, Rabin Karp algorithm, Knuth Morris-Pratt algorithm, Boyer-Moore. Algorithm. Chained Matrix Multiplication, Traveling Salesperson Problem (TSP)
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 algorithm. Parallel Algorithm- Analysis, models, Parallel Random Access Machines (PRAM), Parallel Algorithm Structure, Parallel Algorithms for Sorting, Searching and Merging.

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	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	Artificial Intelligence	L	T	P	
Version: 1.2	Date of Approval: 16th BoS 17-11-2022	4	0	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
MTCS111RMT	Research Methodology and IPR	L	T	P	
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	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	:	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 (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 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			
MTCS160PCP	Advanced Algorithm Lab	L	T	P	**Semester:** I
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	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 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:

i. Sort a given set of n integer elements using 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 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 TSP problem.

vi. Write a program to implement the Longest Common Sequence (LCS) problem. 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 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	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			
MTCS211PCT	Machine Learning	L	T	P	**Semester:** II
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	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			
MTCS260PCP	Machine Learning with Python - Lab	L	T	P	**Semester:** II
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	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			
MTCS311PCT	Deep Learning	L	T	P	**Semester:** III
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	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			
MTCS360PCP	Deep Learning Lab	L	T	P	**Semester:** III
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	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 deep learning through python programming.
2. To develop skills of using recent deep learning packages for solving practical problems.
3. To gain experience of doing independent study and research.
4. To design and implement deep 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 Deep learning algorithm using python.

1.

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			
MTCS411PCT	Internet of Things	L	T	P	**Semester:** IV
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	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			
MTCS460PCP	Internet of Things Lab	L	T	P	**Semester:** II
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	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: V
MTCS511PCP	Seminar Presentation & Comprehensive viva-voce	L	T	P	
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	0	0	4	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	-	Maximum Score	:	100
Lab Hours/ Week	:	-	Internal Evaluation	:	30
Credits	:	2	End Semester	:	70
Instruction Mode	:	Presentation	Exam Duration	:	-

Prerequisite(s):

Course Objectives:

1.

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 (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	

Reference Books:

1	

Course Code	Course Title	Lecture			Semester: III
MTCS570PCP	Dissertation- Part 1	L	T	P	
Version: 1.2	Date of Approval: 16th BoS 17-11-2022	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:

2. To understand the research issues & challenges, research goals, scientific methods.
3. 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: VI
MTCS670PCP	Dissertation- Part 2	L	T	P	
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	0	0	24	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	40 Hrs.	Maximum Score	:	800
Lab Hours/ Week	:	40	Internal Evaluation	:	240
Credits	:	12	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	

Course Code	Course Title	Lecture			
MTCS211PET	Expert Systems	L	T	P	**Semester:** II
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	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 study the idea of intelligent agents and search methods.
2. To study the reasoning and decision making in uncertain world.
3. To construct plans and methods for generating knowledge.
4. To study the concepts of expert systems.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Ability to design and develop expert systems using knowledge representation and reasoning techniques	**PO_1, PO_2**
CO_2	Ability to apply expert systems in different domains such as medicine, engineering, finance, etc.	**PO_2, PO_3**
CO_3	Familiarity with software tools and platforms for building expert systems.	**PO_4, PO_5**
CO_4	Understanding of the ethical and legal considerations in the development and deployment of expert systems.	**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	The meaning of an expert system, problem domain and knowledge domain, the advantages of an expert system, general stages in the development of an expert system, general characteristics of an expert system, history and uses of expert systems today, rule-based expert systems, procedural and nonprocedural paradigms, characteristics of artificial neural systems.
Unit: 2	The study of logic, difference between formal logic and informal logic, meaning of knowledge, how knowledge can be represented, semantic nets, how to translate semantic nets into PROLOG, limitations of semantic nets, schemas, frames and their limitations, how to use logic and set symbols to represent knowledge, the meaning of propositional and first order predicate logic, quantifiers, imitations of propositional and predicate logic.
Unit: 3	Trees, lattices, and graphs, state and problem spaces, AND-OR trees and goals, methods of inference, rules of inference, limitations of propositional logic, logic systems, resolution rule of inference, resolution systems, and deduction, shallow and causal reasoning, applying resolution to first-order predicate logic, forward and backward chaining, additional methods of reference, Meta knowledge, the Markov decision process.
Unit: 4	The meaning of uncertainty and theories devised to deal with it, types of errors attributed to uncertainty, errors associate, with induction, features of classical probability, experimental and subjective probabilities, compound and conditional probabilities, hypothetical reasoning and backward induction, temporal reasoning, Markov chains, odds of belief, sufficiency and necessity, role of uncertainty in inference chains, implications of combining evidence, role of inference nets in expert systems, how probabilities are propagated.
Unit: 5	Sources of uncertainty in rules, methods of dealing with uncertainty, Dempster-Shafer theory, theory of uncertainty based on fuzzy logic, commercial applications of fuzzy logic. How to select an appropriate problem, the stages in the development of an expert system,

	types of errors to expect in the development stages, the role of the knowledge engineer in the building of expert systems, the expected life cycle of an expert system, how to do a life cycle model.
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	J. Giarratano and G. Riley, "Expert Systems -- Principles and Programming". 4th Edition, PWS Publishing Company, 2004.
2	
Reference Books:	
1	Durkin, J., Expert systems Design and Development, Macmillan, 1994 2. Elias M. Awad, Building Expert Systems, West Publishing Company 1996.
2	

Course Code	Course Title	Lecture			Semester: II
MTCS212PET	Intelligent Systems	L	T	P	
Version: 1.2	Date of Approval: 16th BoS 17-11-2022	4	0	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; Hill Climbing Search, Simulated Annealing Search, Local Beam Search; Online Search; Adversarial Search: The minimax algorithm, Alpha-Beta Pruning.
Unit: 3	**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.
Unit: 4	**Managing Uncertainty**: Dealing with Uncertainty: Conditional Probability, Bayes' Rules, Bayesian Reasoning, Bayesian Networks, Introduction to Dempster-Shafer Theory; Fuzzy Set Theory: Fuzzy Sets, Representing Fuzzy Sets, Operations with Fuzzy Sets, Fuzzy Inference, Fuzzyfication & Defuzzyfication, Fuzzy Models.
Unit: 5	**Biological Foundations to Intelligent Systems**: Artificial Neural Networks (ANN): Neurons, Hebb's Rule, Single &Multi-layer Perceptron, Backpropagation 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: II
MTCS213PET	Knowledge Representation	L	T	P	
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	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. Describe about the current web development and emergence of social web.
2. Design modeling, aggregating and knowledge representation of semantic web.
3. Describe Association rule mining algorithms.
4. Summarize knowledge on extraction and analyzing of social web.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand the basics of social network analysis.	PO_1, PO_2
CO_2	Analyze Ontology representation of social network data.	PO_2, PO_3
CO_3	Apply supervised and unsupervised algorithms on social networks.	PO_4, PO_5
CO_4	Interpret the semantic content of social media data.	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:** Introduction to Web -Limitations of current Web –Development of Semantic Web–Emergence of the Social Web –Statistical Properties of Social Networks -Network analysis -Development of Social Network Analysis -Key concepts and measures in network analysis -Discussion networks -Blogs and online communities -Web-based networks.
Unit: 2	**MODELLING, AGGREGATING AND KNOWLEDGE REPRESENTATION:** Ontology and their role in the Semantic Web: Ontology-based knowledge Representation –Ontology languages for the Semantic Web: Resource Description Framework –Web Ontology Language –Modeling and aggregating social network data: State-of-the-art in network data representation –Ontological representation of social individuals –Ontological representation of social relationships –Aggregating and reasoning with social network data –Advanced representations.
Unit: 3	**ALGORITHMS AND TECHNIQUES:** Association Rule Mining, Supervised Learning, Unsupervised Learning, Semi-supervised Learning, Markov models, K-Nearest Neighboring, Content-based Recommendation, Collaborative Filtering Recommendation, Social Network Analysis, Detecting Community Structure in Networks, the Evolution of Social Networks.
Unit: 4	**EXTRACTING AND ANALYZING WEB SOCIAL NETWORKS:** Extracting Evolution of Web Community from a Series of Web Archive, Temporal Analysis on Semantic Graph using Three-Way Tensor, Decomposition, Analysis of Communities and their Evolutions in Dynamic Networks.
Unit: 5	**APPLICATIONS:** A Learning Based Approach for Real Time Emotion Classification of Tweets, A New Linguistic Approach to Assess the Opinion of Users in Social Network Environments, Explaining Scientific and Technical Emergence Forecasting, Social Network Analysis for Biometric Template Protection.

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	Peter Mika, "Social Networks and the Semantic Web", Springer, 1st edition, 2007.
2	Guandong Xu , Yanchun Zhang and Lin Li, "Web Mining and Social Networking –Techniques and applications", Springer, 1st edition, 2012.
Reference Books:	
1	Ajith Abraham, Aboul Ella Hassanien, Václav Snášel, "Computational Social Network Analysis: Trends, Tools and Research Advances", Springer, 2012.
2	Giles, Mark Smith, John Yen, "Advances in Social Network Mining and Analysis", Springer, 2010.

Course Code	Course Title	Lecture			
MTCS214PET	Human Computer Interface	L	T	P	**Semester:** II
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	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 gain an overview of Human-Computer Interaction (HCI), with an understanding of user interface design in general, and alternatives to traditional "keyboard and mouse" computing;
2. To be able to apply models from cognitive psychology to predicting user performance in various human-computer interaction tasks and recognize the limits of human performance as they apply to computer operation;
3. To be familiar with a variety of both conventional and non-traditional user interface paradigms, the latter including virtual and augmented reality, mobile and wearable computing, and ubiquitous computing;
4. To understand the social implications of technology and their ethical responsibilities as engineers in the design of technological systems.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Ability to design and develop user interfaces using industry-standard tools and programming languages.	**PO_1, PO_2**
CO_2	Ability to evaluate and analyze user interfaces using appropriate metrics and methods.	**PO_2, PO_3**
CO_3	Understanding of the importance of user experience design in HCI and how to apply it to different contexts and platforms.	**PO_4, PO_5**
CO_4	Familiarity with emerging technologies and trends in HCI, such as machine learning, natural language processing, and augmented reality.	**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: Importance of user Interface – definition, importance of good design. Benefits of good design. A brief history of Screen design. The graphical user interface – popularity of graphics, the concept of direct manipulation, graphical system, Characteristics, Web user – Interface popularity, characteristics- Principles of user interface.
Unit: 2	Design process – Human interaction with computers, importance of human characteristics human consideration, Human interaction speeds, understanding business junctions. Screen Designing: Design goals – Screen planning and purpose, organizing screen elements, ordering of screen data and content – screen navigation and flow – Visually pleasing composition – amount of information – focus and emphasis – presentation information simply and meaningfully – information retrieval on web – statistical graphics – Technological consideration in interface design.
Unit: 3	Windows – New and Navigation schemes selection of window, selection of devices based and screen-based controls. Components – text and messages, Icons and increases – Multimedia, colors, uses problems, choosing colors.
Unit: 4	HCI in the software process, the software life cycle Usability engineering Iterative design and prototyping Design Focus: Prototyping in practice Design rationale Design rules Principles to support usability Standards Golden rules and heuristics HCI patterns Evaluation techniques, Goals of evaluation, Evaluation through expert analysis, Evaluation through user participation, Choosing an evaluation method. Universal design, Universal design principles

	Multi-modal interaction
Unit: 5	Cognitive models Goal and task hierarchies Design Focus: GOMS saves money Linguistic models The challenge of display-based systems Physical and device models Cognitive architectures Ubiquitous computing and augmented realities Ubiquitous computing applications research Design Focus: Ambient Wood – augmenting the physical Virtual and augmented reality Design Focus: Shared experience Design Focus: Applications of augmented reality Information and data visualization Design Focus: Getting the size right.
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 essential guide to user interface design, Wilbert O Galitz, Wiley Dream Tech.
2	Human – Computer Interaction. Alan Dix, Janet Fincay, Gre Goryd, Abowd, Russell Bealg, Pearson Education
Reference Books:	
1	Designing the user interface. 3rd Edition Ben Shneidermann, Pearson Education Asia.
2	Interaction Design Prece, Rogers, Sharps. Wiley Dreamtech.

Course Code	Course Title	Lecture			
MTCS215PET	Text Mining	L	T	P	**Semester:** II
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	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.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Define data and text mining concepts and techniques	**PO_1, PO_2**
CO_2	Explain collection of data and techniques for pre-processing the data before mining	**PO_2, PO_3**
CO_3	Design the data and text mining models to solve problems by extracting knowledge from data	**PO_4, PO_5**
CO_4	Analyze the implementation of data and text mining techniques which appropriate to the need	**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 of Text Mining and Text mining application, Data Mining Trends and Research Frontiers. Getting to Know Your Data; Data Pre-processing.
Unit: 2	Classification: Basic Concepts - Decision Tree Induction, Rule-Based Classification, Bayes Classification Methods. Feature selection and text categorization algorithms: Naive Bayes, k-Nearest Neighbor (kNN), Logistic Regression, Support Vector Machines and Decision Trees. Evaluation of text classification: precision and recall, confusion matrix, F-score.
Unit: 3	Mining Frequent Patterns, Associations, and Correlations: Basic Concepts and Methods
Unit: 4	Cluster Analysis: Basic Concepts and Methods and Outlier Detection. Clustering algorithms, i.e., connectivity-based clustering (a.k.a., hierarchical clustering) and centroid-based clustering (e.g., k-means clustering). Evaluation of text clustering: purity and Rand index.
Unit: 5	Text mining pre-processing Technique, Categorization, Clustering, Information Extraction, Pre-processing applications using probabilistic and hybrid approaches

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	Ronen Feldman; James Sanger. (2007). The text mining handbook: advanced approaches in analyzing unstructured data. 01. Cambridge University Press. New York. ISBN: 978-0-12-381479-1.
2	

Reference Books:

1	Han, J., Kamber, M., & Pei, Y. (2012). Data Mining: Concepts and Technique. 03. Morgan Kaufmann Publishers. San Francisco. ISBN: 978-0-12-381479-1.
2	

Course Code	Course Title	Lecture			Semester: II
MTCS221PET	Augmented Reality and Virtual Reality	L	T	P	
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	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			
MTCS222PET	Pattern Matching and Object Recognition	L	T	P	**Semester:** II
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	3	1	0	

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

Prerequisite(s): Mathematics and Machine Learning

Course Objectives:

1. To understand the basic concept of pattern recognition.
2. To equip with mathematical and statistical techniques used in pattern recognition.
3. To acquire the technique to develop machine learning algorithms for real world problems.
4. To apply pattern recognition techniques in practical problems.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand the concept of a pattern and the basic approach to the development of pattern recognition and machine intelligence algorithms and applications of PR system.	**PO_1**
CO_2	Demonstrate the basic methods of feature extraction, feature evaluation, analyze and relate research in the pattern recognition area.	**PO_2, PO_4**
CO_3	Apply both supervised and unsupervised classification methods to develop PR system in real-world data.	**PO_3, PO_5, PO_9**
CO_4	Develop pattern recognition techniques to real-world problems such as object detection and recognition and to implement simple pattern classifiers, classifier combinations, and structural pattern recognizers.	**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	2											
CO_2		2		1								
CO_3			2		2				1			
CO_4			2	1	2							

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Introduction to Pattern Recognition. Tree Classifiers Getting our feet wet with real classifiers-Decision Trees: CART, C4.5, ID3 Random Forests-Bayesian Decision Theory Grounding our inquiry- Linear Discriminants Discriminative Classifiers.
Unit: 2	The Decision Boundary, Separability, Perceptron, Support Vector Machines, Parametric Techniques Generative Methods grounded in Bayesian Decision Theory.
Unit: 3	Maximum Likelihood Estimation- Bayesian Parameter Estimation. Non-Parametric Techniques- Kernel Density Estimators.
Unit: 4	Nearest Neighbour Methods - Unsupervised Methods Exploring the Data for Latent Structure - Component Analysis and Dimension Reduction.
Unit: 5	The Curse of Dimensionality, Principal Component Analysis, Fisher Linear Discriminant, Locally Linear Embedding, Clustering, K-Means. Expectation Maximization, Mean Shift, Classifier Ensembles, Bagging, Boosting / AdaBoost.

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	Duda, Hart and Stork, Pattern Classification, Second Edition, Wiley, 2001.
2	Pattern Recognition principles: Julus T. Tou and Rafel C. Gonzalez, Addision –Wesley

Reference Books:

1	S. Theodoridis, K. Koutroumbas, Pattern Recognition, Academic Press, 1999
2	Pattern recognition and machine learning, Christopher M. Bishop, Springer 2006

Course Code	Course Title	Lecture			Semester: II
MTCS223PET	Computer Vision	L	T	P	
Version: 1.2	Date of Approval: 16th BoS 17-11-2022	4	0	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, Linear Algebra, Vector Calculus, Data Structures and Programming.

Course Objectives:

1. To be familiar with both the theoretical and practical aspects of computing with images.
2. To have described the foundation of image formation, measurement, and analysis.
3. To understand the geometric relationships between 2D images and the 3D world.
4. To grasp the principles of state-of-the-art deep neural networks.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Identify basic concepts, terminology, theories, models and methods in the field of computer vision.	PO_1, PO_2
CO_2	Describe basic methods of computer vision related to multi-scale representation, edge detection and detection of other primitives, stereo, motion and object recognition.	PO_2, PO_3
CO_3	Developed the practical skills necessary to build computer vision applications.	PO_4, PO_5
CO_4	To have gained exposure to object and scene recognition and categorization from images.	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	Overview, computer imaging systems, lenses, Image formation and sensing, Image analysis, pre-processing and Binary image analysis.
Unit: 2	Edge detection, Edge detection performance, Hough transform, corner detection, Segmentation, Morphological filtering, Fourier transform
Unit: 3	Feature extraction, shape, histogram, color, spectral, texture, using CV IP tools, Feature analysis, feature vectors, distance /similarity measures, data preprocessing
Unit: 4	Pattern Analysis: Clustering: K-Means, K-Medoids, Mixture of Gaussians Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA, and Non-parametric methods.
Unit: 5	Recent trends in Activity Recognition, computational photography, Biometrics.

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	Computer Vision: Algorithms and Applications by Richard Szeliski.
2	Computer Vision – A modern approach, by D.Forsyth and J.Ponce, Prentice Hall Robot Vision, by B. K. P. Horn, McGraw-Hill.

Reference Books:

1	Dictionary of Computer Vision and Image Processing, by Fisher et al.
2	Three-Dimensional Computer Vision, by Olivier Faugeras, The MIT Press.

Course Code	Course Title	Lecture			
MTCS224PET	Dependable AI	L	T	P	**Semester:** II
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	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 develop and deploy AI systems that are reliable, trustworthy, and secure, while minimizing the risk of harm to humans and society.
2. To involve addressing issues such as bias, privacy, transparency, accountability, and the robustness of AI systems.
3. To ensure that AI systems perform as intended, consistently and accurately, in different contexts and environments.
4. To build AI systems that can be trusted to operate ethically, transparently, and with integrity.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understanding the challenges of developing AI systems that can operate safely and reliably.	**PO_1, PO_2**
CO_2	Familiarizing oneself with the ethical considerations involved in AI development and deployment, such as privacy, fairness, and transparency.	**PO_2, PO_3**
CO_3	Learning about the methods for testing and verifying AI systems to ensure their reliability and safety.	**PO_4, PO_5**
CO_4	Understanding the legal and regulatory frameworks surrounding the development and deployment of AI systems.	**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 to Dependable AI: This module covers the basic concepts, challenges, and objectives of Dependable AI. AI Ethics: This module focuses on ethical considerations when developing AI systems, such as fairness, accountability, transparency, and privacy.
Unit: 2	AI Safety and Reliability: This module covers techniques for ensuring the safety and reliability of AI systems, such as testing, verification, and validation. Robustness and Resilience: This module discusses how to make AI systems robust and resilient to errors, adversarial attacks, and other unexpected situations.
Unit: 3	Explainable AI: This module focuses on techniques for making AI systems transparent and explainable, so that humans can understand how they make decisions. Human-AI Interaction: This module covers the design of human-AI interfaces and interactions, including user experience, trust, and collaboration.
Unit: 4	Risk Assessment and Management: This module covers techniques for identifying and managing risks associated with AI systems.
Unit: 5	Case Studies: This module examines real-world examples of Dependable AI in action, such as autonomous vehicles, medical diagnosis systems, and financial fraud detection. Future Directions: This module discusses emerging trends and future directions in Dependable AI research and development.

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	Designing AI: Reliable, Scalable, and Maintainable Models" by Dr. Susan E. McGregor
2	Responsible AI: A Global Policy Framework" by the IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems
Reference Books:	
1	Building Dependable Distributed Systems" by Peter G. Neumann
2	Trustworthy Machine Learning" by Martin Vechev, Alina Sîrbu, and Mijung Park

Course Code	Course Title	Lecture			Semester: II
MTCS225PET	Digital Image Processing and Analysis	L	T	P	
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	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 learn the fundamental concepts and applications of digital image processing and analysis, image fundamentals, intensity transformations and spatial filtering.
2. To learn basics of frequency domains filtering, image restoration and reconstruction concepts.
3. To learn about wavelets and other transformations, basics of color image processing and various image compression methods.
4. To learn morphological image processing concepts and various image segmentation techniques.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Explain the fundamentals of digital image processing, color models and intensity transformations	PO_1, PO_2
CO_2	Demonstrate smoothing and sharpening in both spatial and frequency domains, image restoration and reconstruction	PO_2, PO_3
CO_3	Demonstrate the usage of wavelets and other image transforms	PO_4, PO_5
CO_4	Recommend proper use of morphological and segmentation algorithms	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 applications**; **Digital Image Fundamentals**, Elements of Visual Perception, Light and the Electromagnetic Spectrum, Image Sampling and Quantization, Basic Concepts in Sampling and Quantization, Some Basic Relationships Between Pixels; **Intensity Transformations and Spatial Filtering**, Some Basic Intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering, The Mechanics of Linear Spatial Filtering, Smoothing (Lowpass) Spatial Filters, Sharpening (Highpass) Spatial Filters;
Unit: 2	**Filtering in the Frequency Domain,** Preliminary Concepts, Sampling and the Fourier Transform of Sampled Functions, The Discrete Fourier Transform of Two Variables, Some Properties of the 2-D DFT and IDFT, The Basics of Filtering in the Frequency Domain, Image Smoothing Using Lowpass Frequency Domain Filters, Image Sharpening Using Highpass Filters; I**mage Restoration and Reconstruction,** A Model of the Image Degradation/Restoration Process, Noise Models, Restoration in the Presence of Noise Only—Spatial Filtering, Periodic Noise Reduction Using Frequency Domain Filtering, Linear, Position-Invariant Degradations, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering, Constrained Least Squares Filtering
Unit: 3	**Wavelet and other Image Transforms,** Matrix-based Transforms, Correlation, Basis Functions in the Time-Frequency Plane, Basis Images, Fourier-Related Transforms, Walsh-Hadamard Transforms, Slant Transform, Haar Transform, Wavelet Transforms; **Color Image Processing,** Color Fundamentals, Color Models, Pseudo color Image Processing, Basics of Full-Color Image Processing; **Image Compressions,** Fundamentals, Huffman Coding, Arithmetic Coding, LZW Coding, Bit-plane Coding, Block Transform Coding
Unit: 4	**Morphological Image Processing**, Preliminaries, Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transform, Some Basic Morphological Algorithms, **Image Segmentation,**

	Fundamentals, Point, Line, and Edge Detection, Thresholding, Segmentation by Region Growing and by Region Splitting and Merging, Region Segmentation Using Clustering and Super pixels, Region Segmentation Using Graph Cuts, Segmentation Using Morphological Watersheds, The Use of Motion in Segmentation
Unit: 5	**Feature Extraction,** Background, Boundary Preprocessing, Boundary Feature Descriptors, Region Feature Descriptors, Some Basic Descriptors, Principal Components as Feature Descriptors, Whole-Image Features, Scale-Invariant Feature Transform (SIFT); **Image Pattern Classification,** Background, Patterns and Pattern Classes, Pattern Classification by Prototype Matching, Optimum (Bayes) Statistical Classifiers
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	Rafael C. Gonzalez and Richard E. Woods, —Digital Image Processing‖, Pearson Education, Fourth Edition, 2019.
2	Thomas B. Moeslund, —Introduction to Video and Image Processing: Building Real Systems and Applications‖, Springer, 2012.
Reference Books:	
1	Milan Sonka, Vaclav Halvac and Roger Boyle, —Image Processing, Analysis, and Machine Vision‖, Second Edition, Thomson Learning Publishers.
2	Kenneth R.Castleman, —Digital Image Processing‖, Pearson Education, 2006.

Course Code	Course Title	Lecture			Semester: III
MTCS331PET	Artificial Neural Network	L	T	P	
Version: 1.2	Date of Approval: 16th BoS 17-11-2022	4	0	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			
		L	T	P	
MTCS332PET	Machine Learning with Big Data				**Semester:** III
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	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 introduce big data and HDFS.
2. To impart knowledge on Mapper and Reducer.
3. To provide the concepts of NoSQL and MongoDB.
4. To introduce programming tools PIG and HIVE in Hadoop echo system.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Perform data analysis in Hadoop framework.	**PO_1, PO_2**
CO_2	Build applications using MapReduce.	**PO_2, PO_3**
CO_3	Model the data using NoSQL and MongoDB.	**PO_4, PO_5**
CO_4	Perform analysis on large datasets using Pig and Hive.	**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 to Big Data:** Big Data Important, Big Data Solution, Big Data Use Cases: IT for IT Log Analytics, the Fraud Detection Pattern, Social Media Pattern. **The Hadoop Distributed Files system:** The Design of HDFS, HDFS Concepts, Blocks, Name nodes and Data nodes, Block Caching, HDFS Federation, HDFS High Availability, The Command-Line Interface, Basic File system Operations, Hadoop File systems, Interfaces, The Java Interface, Reading Data from a Hadoop URL, Reading Data Using the File System API, Writing Data, Directories, Querying the File system, Deleting Data, Data Flow, Anatomy of a File Read, Anatomy of a File Write.
Unit: 2	**MapReduce:** Introduction, Architecture of map reduce, Anatomy of a MapReduce Job Run, Job Submission, Job Initialization, Task Assignment, Task Execution, Progress and Status Updates, Job Completion, Failures, Task Failure, Application Master Failure, Node Manager Failure, Resource Manager Failure, Shuffle and Sort, The Map Side, The ReduceSide, **MapReduce Types and Formats:** MapReduce Types, The Default MapReduce Job, Input Formats, Input Splits and Records, Text Input, Output Formats, Text Output, Developing a MapReduce Application. **Hadoop Ecosystem and YARN:** Hadoop ecosystem components -Schedulers -Fair and Capacity, Hadoop 2.0 New Features NameNode High Availability, HDFS Federation, MRv2, YARN, Running MRv1 in YARN.
Unit: 3	**No SQL Databases**: Review of traditional Databases, Need for NoSQL Databases, Columnar Databases, Failover and reliability principles, CAP Theorem, Differences between SQL and NoSQL databases, **Working Mechanisms of Mongo DB**: Overview, Advantages, Environment, Data Modelling, Create Database, Drop Database, Create collection, Drop collection, Data types, Insert, Query, Update and Delete operations, Limiting and Sorting records, Indexing, Aggregation
Unit: 4	**Pig:**Generating Examples, Comparison with Databases, Pig Latin, User-Defined Functions, Data Processing Operators, Pig in Practice.

	Hive: Comparison with Traditional Databases, HiveQL, Tables, Querying Data, User-Defined Functions, Writing a User Defined Functions, Writing a User Defined Aggregate Function.
Unit: 5	**Spark:**Spark and its Purpose, Components of the Spark Unified Stack, Batch and Real-Time Analytics with Apache Spark, Resilient Distributed Dataset,**Scala** (Object Oriented and Functional Programming) **Machine Learning with Spark:** Designing a Machine Learning System, Obtaining, Processing and Preparing Data with Spark, Building a Recommendation Engine with Spark, Building a Classification Model with Spark, Building a Regression Model with Spark and Building a Clustering Model with Spark.
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", Fourth Edition, O'Reilly Media Inc, 2015.
2	Nick Pentreath, —Machine Learning with Spark‖, First Edition, Packt Publishing, 2015.
Reference Books:	
1	Thilinagunarathne, —Hadoop MapReduce v2 Cookbook‖, Second Edition, Packet Publishing, 2015.
2	Chuck Lam, Mark Davis, Ajit Gaddam, —Hadoop in Action‖, Manning Publications Company, 2016.

Course Code	Course Title	Lecture			
MTCS333PET	Robotics Process Automation	L	T	P	**Semester:** III
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	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. Understand the RPA and the ability to differentiate it from other types of automation.
2. Explain about using data tables to store and easily manipulate data in memory.
3. Model the workflow of different scrapping methodologies.
4. Interpret the events that can be used to trigger actions.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Describe RPA, where it can be applied and how it's implemented.	PO_1, PO_2
CO_2	Describe the different types of variables, Control Flow and data manipulation techniques.	PO_2, PO_3
CO_3	Describe how to handle the User Events and various types of Exceptions and strategies.	PO_4, PO_5
CO_4	Understand the Deployment of the Robot and to maintain the connection.	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 TO ROBOTIC PROCESS AUTOMATION: Scope and techniques of automation, Robotic process automation - What can RPA do?, Benefits of RPA, Components of RPA, RPA platforms, The future of automation. RPA BASICS: History of Automation - What is RPA - RPA vs Automation - Processes & Flowcharts - Programming Constructs in RPA - What Processes can be Automated - Types of Bots - Workloads which can be automated - RPA Advanced Concepts - Standardization of processes - RPA Development methodologies - Difference from SDLC - Robotic control flow architecture - RPA business case - RPA Team - Process Design Document/Solution Design Document - Industries best suited for RPA - Risks & Challenges with RPA - RPA and emerging ecosystem.
Unit: 2	RPA TOOL INTRODUCTION AND BASICS: Introduction to RPA Tool - The User Interface - Variables - Managing Variables - Naming Best Practices - The Variables Panel - Generic Value Variables - Text Variables - True or False Variables - Number Variables - Array Variables - Date and Time Variables - Data Table Variables - Managing Arguments - Naming Best Practices - The Arguments Panel - Using Arguments - About Imported Namespaces - Importing New Namespaces- Control Flow - Control Flow Introduction - If Else Statements - Loops - Advanced Control Flow - Sequences - Flowcharts - About Control Flow - Control Flow Activities - The Assign Activity - The Delay Activity - The Do While Activity - The If Activity - The Switch Activity - The While Activity - The For Each Activity - The Break Activity - Data Manipulation - Data Manipulation Introduction - Scalar variables, collections and Tables - Text Manipulation - Data Manipulation - Gathering and Assembling Data
Unit: 3	ADVANCED AUTOMATION CONCEPTS & TECHNIQUES: Recording Introduction - Basic and Desktop Recording - Web Recording - Input/Output Methods - Screen Scraping - Data Scraping - Scraping advanced techniques - Selectors - Defining and Assessing Selectors - Customization - Debugging - Dynamic Selectors - Partial Selectors - RPA Challenge - Image, Text & Advanced Citrix Automation - Introduction to Image & Text Automation - Image

	based automation - Keyboard based automation - Information Retrieval - Advanced Citrix Automation challenges - Best Practices - Using tab for Images - Starting Apps - Excel Data Tables & PDF - Data Tables in RPA - Excel and Data Table basics - Data Manipulation in excel – Extracting Data from PDF - Extracting a single piece of data - Anchors - Using anchors in PDF.
Unit: 4	HANDLING USER EVENTS & ASSISTANT BOTS, EXCEPTION HANDLING: What are assistant bots? - Monitoring system event triggers - Hotkey trigger - Mouse trigger - System trigger - Monitoring image and element triggers - An example of monitoring email - Example of monitoring a copying event and blocking it - Launching an assistant bot on a keyboard event. EXCEPTION HANDLING: Debugging and Exception Handling - Debugging Tools - Strategies for solving issues - Catching errors.
Unit: 5	DEPLOYING AND MAINTAINING THE BOT: Publishing using publish utility - Creation of Server - Using Server to control the bots - Creating a provision Robot from the Server - Connecting a Robot to Server - Deploy the Robot to Server - Publishing and managing updates - Managing packages - Uploading packages - Deleting packages
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	Alok Mani Tripathi, “Learning Robotic Process Automation”, Packt Publishing, 2018.
2	Frank Casale, Rebecca Dilla, Heidi Jaynes, Lauren Livingston, “Introduction to Robotic Process Automation: a Primer”, Institute of Robotic Process Automation,1st Edition 2015.
Reference Books:	
1	Richard Murdoch, Robotic Process Automation: Guide to Building Software Robots, Automate Repetitive Tasks & Become an RPA Consultant”, Independently Published, 1st Edition 2018.
2	Srikanth Merianda,” Robotic Process Automation Tools, Process Automation and their benefits: Understanding RPA and Intelligent Automation”, Consulting Opportunity Holdings LLC, 1st Edition 2018.

Course Code	Course Title	Lecture			Semester:
MTCS334PET	Speech and Natural Language Processing	L	T	P	III
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	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	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: 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			
MTCS335PET	Information Retrieval and Web Mining	L	T	P	**Semester:** III
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	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 and Statistics

Course Objectives:

1. To understand about web mining and understand the need for web mining.
2. To learn differentiate between Web mining and data mining.
3. To apply the different Methods and application areas for web mining.
4. To analyse Web Mining strategies and algorithms in their workplace or research career.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand the need for web mining and Data Mining.	**PO_1, PO_2**
CO_2	Conduct business intelligence from online resources.	**PO_3**
CO_3	Apply Web Mining strategies and algorithms in their workplace or research career.	**PO_3, PO_5**
CO_4	Create the search engines index and rank web documents.	**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									
CO_3			2		2							
CO_4			2	1					1			

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Introduction to Web Data Mining and Data Mining Foundations, Introduction – World Wide Web (WWW), A Brief History of the Web and the Internet, Web Data Mining-Data Mining, Web Mining. Data Mining Foundations – Association Rules and Sequential Patterns – Basic Concepts of Association Rules, Apriori Algorithm- Frequent Itemset Generation, Association Rule Generation, Data Formats for Association Rule Mining, Mining with multiple minimum supports – Extended Model, Mining Algorithm, Rule Generation, Mining Class Association Rules, Basic Concepts of Sequential Patterns, Mining Sequential Patterns on GSP,
Unit: 2	Supervised and Unsupervised Learning Supervised Learning – Basic Concepts, Decision Tree Induction – Learning Algorithm, Impurity Function, Handling of Continuous Attributes, Classifier Evaluation, Rule Induction – Sequential Covering, Rule Learning, Classification Based on Associations, Naïve Bayesian Classification, Naïve Bayesian Text Classification – Probabilistic Framework, Naïve Bayesian Model. Unsupervised Learning – Basic Concepts, K-means Clustering – K-means Algorithm, Representation of Clusters, Hierarchical Clustering, Strength and Weakness.
Unit: 3	Information Retrieval and Web Search: Basic Concepts of Information Retrieval, Information Retrieval Methods – Boolean Model, Vector Space Model and Statistical Language Model, Relevance Feedback, Evaluation Measures, Text and Web Page Preprocessing – Stopword Removal, Stemming, Web Page Preprocessing, Duplicate Detection, Inverted Index and Its Compression – Inverted Index, Search using Inverted Index, Index Construction, Index Compression, Latent Semantic Indexing – Singular Value Decomposition, Query
Unit: 4	Link Analysis and Web Crawling: Link Analysis – Social Network Analysis, Co-Citation and Bibliographic Coupling, Page Rank Algorithm, HITS Algorithm, Community Discovery-Problem Definition, Bipartite Core Communities, Maximum Flow Communities, Email Communities. Web Crawling – A Basic Crawler Algorithm- Breadth First Crawlers, Preferential Crawlers, Implementation Issues – Fetching, Parsing, Stopword Removal, Link Extraction, Spider Traps, Page Repository, Universal Crawlers, Focused Crawlers,
Unit: 5	Opinion Mining and Web Usage Mining Opinion Mining – Sentiment Classification –

	Classification based on Sentiment Phrases, Classification Using Text Classification Methods, Feature based Opinion Mining and Summarization – Problem Definition, Object feature extraction, Feature Extraction from Pros and Cons of Format1, Feature Extraction from Reviews of Format 2 and 3, Comparative Sentence and Relation Mining, Web Usage Mining – Data Collection and Preprocessing- Sources and Types of Data, Key Elements of Web usage Data Preprocessing, Data Modeling for Web Usage Mining, Discovery
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	Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data by Bing Liu (Springer Publications)
2	Mining the Web: Discovering Knowledge from Hypertext Data by Soumen Chakrabarti
Reference Books:	
1	Data Mining: Concepts and Techniques, Second Edition Jiawei Han, Micheline Kamber (Elsevier Publications)
2	Web Mining: Applications and Techniques by Anthony Scime

Course Code	Course Title	Lecture			
MTCS341PET	Blockchain Technology	L	T	P	**Semester:** III
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	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			
MTCS342PET	Bio-image Computing	L	T	P	**Semester:** III
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	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. Familiarize students with different imaging modalities and the types of biological images encountered in research and medical settings.
2. Introduce students to the methods and algorithms used in image processing, analysis, and interpretation, including image segmentation, feature extraction, and machine learning techniques.
3. Enable students to apply Bio-image Computing techniques to real-world problems in biomedical research, such as drug discovery, disease diagnosis, and treatment planning.
4. Develop students' critical thinking and problem-solving skills through the analysis of complex biological images and the development of image processing and analysis algorithms.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Students should be able to recognize different types of biological images and understand the principles of imaging modalities	**PO_1, PO_2**
CO_2	Students should be able to apply various image processing techniques, including segmentation, feature extraction, and machine learning algorithms, to analyze and interpret biological images.	**PO_2, PO_3**
CO_3	Students should be proficient in using software tools and programming languages such as MATLAB, Python, and ImageJ to implement image processing and analysis algorithms.	**PO_4, PO_5**
CO_4	Students should be able to work effectively in teams and collaborate on research projects that involve the application of Bio-image Computing techniques.	**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 to Bio-image Computing Overview of the field, Types of biological images, Applications of Bio-image Computing; Image Acquisition and Processing, Imaging modalities, Image preprocessing and enhancement, Image segmentation and analysis
Unit: 2	Machine Learning for Bio-image Analysis, Supervised and unsupervised learning, Classification and clustering, Deep learning for Bio-image analysis; Biomedical Image Analysis, Image registration and fusion, Image visualization and interpretation, Quantitative analysis of biomedical images
Unit: 3	Computer-Aided Diagnosis and Treatment Planning, Medical image analysis for diagnosis, Computer-aided detection and diagnosis, Treatment planning using biomedical images
Unit: 4	Bio-image Computing in Drug Discovery, High-throughput screening of compounds, Image-based drug discovery, Image-based phenotypic profiling
Unit: 5	Advanced Topics in Bio-image Computing, Image-based modeling and simulation, Bio-image Computing in neuroscience, Bio-image Computing in cancer research

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	Bioimage Data Analysis" by Kota Miura
2	Bioimage Informatics" edited by A. K. Singh and X. Zhuang
Reference Books:	
1	Medical Image Analysis" by Atam P. Dhawan and Jasjit S. Suri
2	Handbook of Biomedical Imaging: Methodologies and Clinical Research" edited by J. Michael Fitzpatrick and Milan Sonka

Course Code	Course Title	Lecture			
MTCS343PET	Digital Image Analysis	L	T	P	**Semester:** III
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	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): Students should have basic knowledge of linear algebra, calculus, probability theory, and programming (Python, MATLAB or equivalent).

Course Objectives:

1. Understand the principles of digital image processing.
2. Implement and apply image processing techniques to enhance and segment images.
3. Extract meaningful features from images and use them for classification and recognition.
4. Evaluate and compare different image processing algorithms.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Learning how to apply digital image analysis techniques to solve real-world problems in various fields, such as medicine, biology, engineering, and computer science.	**PO_1, PO_2**
CO_2	Understanding the fundamental concepts and techniques of image processing, such as image enhancement, restoration, segmentation, feature extraction, and classification.	**PO_2, PO_3**
CO_3	Gaining knowledge of the limitations and challenges of digital image analysis, including noise, artifacts, and image quality issues.	**PO_4, PO_5**
CO_4	Developing critical thinking and analytical skills to interpret and analyze digital images accurately and effectively.	**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 to Digital Image Processing, Overview of digital image processing, Digital image representation, Basic image operations; Image Enhancement, Image enhancement techniques, Histogram equalization, Spatial domain filtering
Unit: 2	Image Segmentation, Image thresholding, Region-based segmentation, Edge-based segmentation
Unit: 3	Feature Extraction, Feature representation, Feature extraction techniques, Feature selection
Unit: 4	Classification, Supervised and unsupervised classification, Classification algorithms, Evaluation metrics; Object Recognition, Object recognition techniques, Template matching, Object detection
Unit: 5	Machine Learning for Image Analysis, Introduction to machine learning, Classification and regression, Feature learning; Applications of Digital Image Analysis Medical image analysis, Remote sensing, Surveillance

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	Digital Image Processing" by Rafael C. Gonzalez and Richard E. Woods.
2	Image Processing, Analysis, and Machine Vision" by Milan Sonka, Vaclav Hlavac, and Roger Boyle.

Reference Books:

1	Handbook of Medical Image Processing and Analysis" edited by Isaac Bankman.

2	Pattern Recognition and Machine Learning" by Christopher M. Bishop.

Course Code	Course Title	Lecture			
MTCS344PET	Edge and Fog Computing	L	T	P	**Semester:** III
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	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. Identify the key differences between edge and fog computing and other computing paradigms such as cloud computing and mobile computing.
2. Understand the importance of security and privacy in edge and fog computing.
3. Learn about the various hardware and software architectures used in edge and fog computing.
4. Gain practical experience in developing and deploying edge and fog computing applications.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Improved understanding of edge and fog computing concepts: Studying edge and fog computing can help you understand the concepts and technologies that underpin these paradigms	**PO_1, PO_2**
CO_2	Ability to design and deploy edge and fog computing solutions: By studying edge and fog computing, you can learn how to design and deploy edge and fog computing solutions that meet specific business needs.	**PO_2, PO_3**
CO_3	Improved efficiency and performance of computing systems: Edge and fog computing are designed to improve the efficiency and performance of computing systems	**PO_4, PO_5**
CO_4	Improved security and privacy of data: Edge and fog computing can help improve the security and privacy of data by reducing the amount of data that needs to be transmitted over networks and reducing the number of points of vulnerability in a computing system.	**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 to Edge and Fog Computing, Overview of Edge and Fog Computing, Characteristics and Key Benefits of Edge and Fog Computing, Comparison with Other Computing Paradigms
Unit: 2	Edge and Fog Computing Architectures, Hardware and Software Architectures, Edge and Fog Nodes, Communication Protocols and Network Topologies
Unit: 3	Applications of Edge and Fog Computing, Internet of Things (IoT), Smart Cities, Healthcare, Autonomous Vehicles, Industry 4.0
Unit: 4	Security and Privacy in Edge and Fog Computing, Threats and Challenges, Authentication and Authorization, Data Encryption and Decryption, Privacy-preserving Techniques
Unit: 5	Development and Deployment of Edge and Fog Computing Applications, Programming Models and Languages, Testing and Debugging, Deployment and Management, Case Studies

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	Fog and Edge Computing: Principles and Paradigms" by Rajkumar Buyya, Satish Narayana Srirama, and Ivona Brandic.

2	Edge Computing for the Internet of Things" by Chi-Yu Li, Yan Zhang, and Laurence T. Yang.
Reference Books:	
1	Fog Computing: Concepts, Frameworks and Technologies" by Rupak Biswas and Yogesh Simmhan.
2	Mobile Cloud Computing: Models, Advances, and Applications" by F. Richard Yu, Victor Leung, and Long Hu.

Course Code	Course Title	Lecture			
MTCS345PET	Computational Optimization	L	T	P	**Semester:** III
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	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.

Course Code	Course Title	Lecture			
MTCS451PET	Cloud Computing	L	T	P	**Semester:** IV
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	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 Network and Distributed System

Course Objectives:

1. To present a comprehensive understanding of cloud architecture and cloud computing methodology.
2. To understand the different types of cloud computing services namely.
3. To demonstrate the architecture of cloud services and the trusted cloud computing system.
4. To apply virtualization, security and privacy issues.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Identify the architecture, infrastructure and delivery models of cloud computing	**PO_1, PO_2**
CO_2	Analyze cloud, data center, hypervisor, CPU, and memory management concerns.	**PO_2, PO_3, PO_4, PO_5, PO_7**
CO_3	Apply suitable virtualization concept.	**PO_3, PO_5**
CO_4	Handle the cloud computing, virtualization, security, and privacy issues.	**PO_4, 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										
CO_2		2	2	1	2		1					
CO_3			2		2							
CO_4				1	2			1				

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Cloud Computing Fundamentals: overview of Cloud Computing, Types of cloud, Cloud services: Benefits and challenges of cloud computing, Evolution of Cloud Computing, Applications cloud computing, Business models around Cloud–Major Players in Cloud Computing Titans-Issues in Cloud
Unit: 2	Cluster Computing, Grid Computing, Grid Computing Versus Cloud Computing, Key Characteristics of Cloud Computing. Cloud Models: Benefits of Cloud Models, Public Cloud, Private Cloud, Hybrid Cloud, Community Cloud, Shared Private Cloud, Dedicated Private Cloud, and Dynamic Private Cloud.
Unit: 3	Cloud Services and File System: Types of Cloud services: Software as a Service - Platform as a Service – Infrastructure as a Service - Database as a Service- Monitoring as a Service – Communication as services. Service providers- Google App Engine, Amazon EC2, Microsoft Azure, Salesforce.
Unit: 4	Virtualization: Basics of Virtualization – Need of Virtualization- Benefits of Virtualization- Limitation of Virtualization- Approaches to Virtualization -Virtualization Structures -Types of Virtualization – Virtual machine - Types of virtual Machine- Virtual Machine software - Virtualization of CPU, Memory, I/O Devices - Resource Virtualization- Virtualization Tools (VMware, Citrix, Microsoft, Oracle virtual Box) – Advance concepts in cloud computing : Data center for cloud, Cloud management . Introduction to MapReduce, GFS, HDFS, Hadoop Framework.
Unit: 5	Security in the Cloud: Security Overview – Cloud Security Challenges and Risks – Identified cloud security Issues-Categorization of cloud security issues– State of the Art solutions, Integrated Solutions: Amazon as Case study– Cloud computing Security Reference Architecture –Identity and Access Management Security Monitoring – Security Architecture Design – Data Security – Application Security – Virtual Machine Security

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	Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", TMH, 2009.
2	John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010.
Reference Books:	
1	Cloud Computing" A Practical Approach" Anthony T. Velte, Toby J. Velte, Robert Elsenpeter. McGraw-Hill.
2	Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012

Course Code	Course Title	Lecture			
MTCS452PET	Wireless Access Technologies	L	T	P	**Semester:** IV
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	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			
MTCS453PET	Algorithms for Big Data	L	T	P	**Semester:** IV
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	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. Understand the challenges and opportunities of big data processing and analysis.
2. Learn the fundamental principles of distributed computing and parallel algorithms.
3. Learn common data mining and machine learning techniques for big data analysis.
4. Understand the privacy and security challenges in big data and their mitigation techniques.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Analyze and assess the requirements and challenges of big data processing and analysis, and identify appropriate algorithmic solutions.	**PO_1, PO_2**
CO_2	Implement and apply distributed computing and parallel algorithms, such as MapReduce, to handle large-scale data processing and analysis.	**PO_2, PO_3**
CO_3	Apply data mining and machine learning techniques to analyze and extract valuable insights from large-scale datasets, and understand their strengths and limitations.	**PO_4, PO_5**
CO_4	Understand the privacy and security challenges in big data, and apply appropriate techniques to mitigate 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 to Big Data and Algorithmic Challenges: Overview of big data and its sources; Characteristics of big data: volume, variety, velocity, veracity, and value; Algorithmic challenges: scalability, efficiency, fault-tolerance, and privacy
Unit: 2	MapReduce and Distributed Computing: Introduction to MapReduce and its programming model; Distributed file systems: Hadoop Distributed File System (HDFS), Google File System (GFS), and others; MapReduce implementations: Hadoop MapReduce, Apache Spark, and others; MapReduce algorithms: word count, inverted index, PageRank, and others
Unit: 3	Data Mining and Machine Learning for Big Data: Overview of data mining and machine learning techniques; Supervised learning: linear regression, logistic regression, decision trees, and random forests; Unsupervised learning: clustering, dimensionality reduction, and association rule mining; Deep learning: convolutional neural networks, recurrent neural networks, and deep reinforcement learning
Unit: 4	Streaming Algorithms and Sketching Techniques: Introduction to streaming algorithms and sketching techniques; Sketching algorithms: Count-Min Sketch, Bloom Filter, HyperLogLog, and others; Streaming algorithms: frequency estimation, heavy hitters detection, and distinct element estimation; Applications of streaming algorithms: network monitoring, recommendation systems, and fraud detection
Unit: 5	Privacy and Security in Big Data: Introduction to privacy and security challenges in big data; Privacy-preserving techniques: differential privacy, homomorphic encryption, and secure multiparty computation; Security threats: data breaches, cyber attacks, and malicious insiders; Security measures: access control, authentication, and auditing

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	Mining of Massive Datasets" by Jure Leskovec, Anand Rajaraman, and Jeff Ullman.
2	Data-Intensive Text Processing with MapReduce" by Jimmy Lin and Chris Dyer
Reference Books:	
1	Big Data: Principles and Paradigms" edited by Rajkumar Buyya, James Broberg, and Andrzej Goscinski
2	Scalable Machine Learning for Big Data" by Bijan Parsia and Yevgeny Kazakov.

Course Code	Course Title	Lecture			
MTCS454PET	Advanced Computer Graphics	L	T	P	**Semester:** IV
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	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 understand interactive computer graphics, two-dimensional system and mapping.
2. To acquire the knowledge of drawing algorithms and techniques of 2D transformations.
3. To analysis the concept of clipping and filling algorithms.
4. To apply 3-D objects representation concepts.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand the various graphics systems and the output primitive techniques	**PO_1, PO_2**
CO_2	Demonstrate the different 2D Geometric transformations and viewing functions	**PO_3**
CO_3	Illustrate the Structure and Modeling concepts	**PO_3, PO_4**
CO_4	Apply the 3D transformations and surface detection methods	**PO_3, 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	2								
CO_4			2						1			

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	**Overview of Graphics Systems** – Video display devices, raster-scan systems. Random–scan system, graphics monitors and workstations. Input devices, Hardcopy devices, Graphics software. Output primitives: Line drawing algorithms, Circle generation algorithms, ellipse generating algorithms, pixel addressing, Filled area primitives, Fill area functions, cell array and character generations.
Unit: 2	**Attributes of output primitives:** Line attributes, curve attributes color and Gray-scale level, Area fill attributes, character attributes, and Bundled attributes Enquiry functions. **Two dimensional Geometric transformations:** Basic transformations, Homogenous co-ordinates, affine transformations, transformation functions. Raster methods for transformations.
Unit: 3	**Two dimensional viewing:** Viewing pipeline, viewing transformation, viewing functions, line clipping – Cohen Sutherland line clipping, Liang Barsky line clipping. Polygon, clipping:Sutherland–Hodgman polygon clipping, Wiler Atherton polygon clipping.
Unit: 4	**Structures and Hierarchical Modeling:** Structure concepts, editing structures, Basic modeling concepts, hierarchical modeling with structures. Graphical user interfaces and **Interactive input methods:** The user Dialogue, logical classification of input devices, Input functions and Models Interactive picture construction techniques.
Unit: 5	**Three – Dimensional object representations:** Poly-surfaces curved lines and surfaces, spline representation, Bezier curves and surfaces, B-Spline curves and surface, CSG Methods: Octrees, BSP Trees. **Three Dimensional Transformation:** Three dimensional viewing: Viewing coordinates, projections, Visible surface detection methods: Back-face Detection, Depth-buffer methods, scan line methods, Depth-sorting methods, BSP – Tree Methods, Arc sub division methods, Basic illuminations models – Gourand shading phong shading.

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	Heanry Donald, Pauline Baker M: Computer Graphics, PIH 2nd edn., 1995.
Reference Books:	
1	Harrington S: Computer Graphics A Programming Approach 2nd Edn. McGraw Hill,1987.

Course Code	Course Title	Lecture			
MTCS455PET	Data Visualization	L	T	P	**Semester:** IV
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	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 statistics and data analysis

Course Objectives:

1. Understand the principles and best practices of data visualization.
2. Learn how to select appropriate visualizations for different types of data.
3. Develop the skills to create effective and visually appealing visualizations using a variety of tools and techniques.
4. Learn how to design visualizations for clarity and simplicity.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Understand the principles and best practices of data visualization, and be able to apply them to real-world datasets.	**PO_1, PO_2**
CO_2	Select appropriate visualizations for different types of data and communicate data effectively using visualizations.	**PO_2, PO_3**
CO_3	Develop the skills to create effective and visually appealing visualizations using a variety of tools and techniques.	**PO_4, PO_5**
CO_4	Design visualizations for clarity and simplicity, considering the audience and accessibility considerations.	**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 to Data Visualization: Definition and importance of data visualization; Basic principles and best practices of data visualization; Types of data and visualizations
Unit: 2	Data Visualization Tools and Techniques: Overview of popular data visualization tools (e.g. Tableau, Power BI, D3.js); Data preprocessing and cleaning; Mapping and geospatial visualization; Basic charts and graphs (e.g. bar charts, line charts, scatter plots); Advanced charts and graphs (e.g. heatmaps, treemaps, network diagrams); Interactive and animated visualizations
Unit: 3	Designing Effective Visualizations: Principles of visual design (e.g. color theory, typography, layout); Best practices for designing effective visualizations; Accessibility considerations in data visualization; Data storytelling and visual narrative
Unit: 4	Communicating Data Effectively: Understanding your audience and their needs; Incorporating narrative and context in visualizations; Designing for presentation and sharing Evaluating and improving the effectiveness of your visualizations
Unit: 5	Final Project: Applying data visualization principles and techniques to a real-world dataset; Creating a portfolio-quality visualization project

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	Data Visualization: A Practical Introduction" by Kieran Healy
2	Storytelling with Data: A Data Visualization Guide for Business Professionals" by Cole Nussbaumer Knaflic

Reference Books:

1	Visualization Analysis and Design" by Tamara Munzner

2	Data Visualization: A Handbook for Data Driven Design" by Andy Kirk

Course Code	Course Title	Lecture			
MTCS461PET	Graphics Processing Unit Computing	L	T	P	**Semester:** IV
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	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			
MTCS462PET	Statistical Data Analysis	L	T	P	**Semester:** IV
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	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 Mathematics

Course Objectives:

1. To provide students with the foundations of statistical analysis, probability and modeling the real-life problems.
2. To understand probability distributions and their properties.
3. To learn the statistical parameters for different distributions, correlation and regression.
4. To understand the concept of hypothesis and significance tests.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Apply different statistical measures on data.	PO_1, P02
CO_2	Analyze statistical tests in testing hypotheses on data.	P05
CO_3	Apply concept of probability and statistics to translate and solve real world problems.	PO2
CO_4	Develop problem solving techniques needed to accurately calculate probabilities.	PO4

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										
CO_4				2								

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	Basic Statistics: Frequency Distribution, Frequency curve and histogram, Measures of Central Tendencies (Mean, Median, Mode, Range, Standard Deviation, Coefficient of Variation, Quartiles), Measures of Dispersion, Skewness, moments and kurtosis.
Unit: 2	Regression Analysis: Correlation and Regression: Karl Pearson's coefficient of Correlation, Correlation of ranks, Tied Ranks, Curve of regression, lines of regression, properties of regression coefficients and angle between two regression lines Curve fitting – Method of least square, Linear and reducible to linear curves.
Unit: 3	Random Variables and Probability Distribution: Random Variable – Discrete and Continuous, Probability Distribution of a Random Variable, Probability Mass Function, Probability Density Function, -evaluation of statistical parameters for these distributions, Distribution Functions, Bivariate Random Variable- Discrete and Continuous Bivariate Random Variables with examples, Joint probability distribution, Marginal and conditional distributions and applications, Probability
Unit: 4	Distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions and applications.
Unit: 5	Sampling Distribution: Test of significance for large & small samples: test for single proportion, difference of proportions, single mean, difference of means, and difference of standard deviations Sampling Distributions: t- distribution, Chi-square distribution, F-distribution, Standard and Probable errors, Different Methods of Estimation, Testing of Hypothesis -Type I and Type II errors, classification of hypothesis tests; large & small sample tests.

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	Sheldon M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, Third Edition, Elsevier Academic Press.
2	S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics – 1st Edition S Chand
Reference Books:	
1	Kai Hwang, "Advanced Computer Architecture", Tata McGraw-Hill
2	J. Susan Milton, Jesse C. Arnold, Introduction to Probability & Statistics – 4th Edition, Tata McGraw Hill

Course Code	Course Title	Lecture			
MTCS463PET	Embedded System	L	T	P	**Semester:** IV
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	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 an understanding of the fundamental concepts and components of embedded systems.
2. To develop the skills required to design, implement and test embedded systems using microcontrollers/microprocessors and programming languages.
3. To introduce the concepts of real-time operating systems and their role in the design of embedded systems.
4. To provide hands-on experience with interfacing techniques and tools commonly used in embedded systems.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Explain the basic concepts and components of embedded systems.	**PO_1, PO_2**
CO_2	Design and implement an embedded system using microcontrollers/microprocessors and programming languages.	**PO_2, PO_3**
CO_3	Apply real-time operating systems concepts in the design of an embedded system.	**PO_4, PO_5**
CO_4	Apply interfacing techniques and tools commonly used in embedded systems.	**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 to Embedded Systems: Definition, Characteristics, and Examples of Embedded Systems; Architecture of Embedded Systems; Components of an Embedded System; Types of Embedded Systems
Unit: 2	Microcontrollers and Microprocessors: Introduction to Microcontrollers and Microprocessors; Architecture and Memory Organization; Interfacing with Peripherals Comparison between Microcontrollers and Microprocessors
Unit: 3	Assembly Language Programming: Introduction to Assembly Language Programming; Instruction Set Architecture (ISA); Programming Techniques and Examples; Code Optimization Techniques
Unit: 4	Embedded C Programming: Introduction to Embedded C Programming; Data Types, Variables, and Operators; Control Structures and Functions; Standard Libraries and Header Files
Unit: 5	Real-time Operating Systems (RTOS): Introduction to Real-time Operating Systems; Scheduling Algorithms; Task Management and Synchronization; Interrupt Handling and Timing Analysis

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	Embedded Systems: Real-Time Operating Systems for Arm Cortex M Microcontrollers" by Jonathan W. Valvano
2	Embedded Systems: Introduction to Arm Cortex-M Microcontrollers" by Jonathan W. Valvano

Reference Books:

1	Programming Embedded Systems: With C and GNU Development Tools" by Michael Barr and Anthony Massa
2	Embedded Systems Design: An Introduction to Processes, Tools, and Techniques" by Arnold S. Berger

Course Code	Course Title	Lecture			
MTCS464PET	Advanced Wireless & Mobile Networks	L	T	P	**Semester:** IV
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	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 Networking & Wireless Communication

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			
MTCS465PET	Intelligent Bioinformatics	L	T	P	**Semester:** IV
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	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 Basic Biology

Course Objectives:

1. To familiarize students with the fundamental concepts of Bioinformatics and Artificial Intelligence techniques.
2. To acquire knowledge on different Classification and clustering techniques in implementation of Bioinformatics.
3. To impart how to apply Neural networks and Genetic Algorithms in different applications related to Bioinformatics.
4. To familiarize students with the concepts of future techniques in Genetic applications.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Recognize the purpose of molecular biology and challenges in the Bioinformatics.	**PO_1, PO_2**
CO_2	Enumerate different techniques of classification and clustering with respect to bioinformatics applications.	**PO_2, PO_3**
CO_3	Comprehend the methods related to neural network and genetic algorithms.	**PO_4, PO_5**
CO_4	Elaborate the concepts of Genetic Programming, Cellular Automata and Hybrid methods.	**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: Introduction to the Basics of Molecular Biology:** Basic cell architecture, The structure, content and scale of deoxyribonucleic acid (DNA), History of the human genome, Genes and proteins, Current knowledge and the 'central dogma', Why proteins are important, Gene and cell regulation, When cell regulation goes wrong, what is bioinformatics? **Introduction to Problems and Challenges in Bioinformatics:** Introduction, Genome, Transcriptome, Proteome, Interference technology, viruses, and the immune system.
Unit: 2	**Introduction to Artificial Intelligence and Computer Science:** Introduction to search, Search algorithms, Heuristic search methods, Optimal search strategies, Problems with search techniques, Complexity of search, Use of graphs in bioinformatics, Grammars, languages and automata, Classes of problems.
Unit: 3	**Current Techniques: Probabilistic Approaches:** Introduction to probability, Bayes' Theorem, Bayesian networks, Markov networks. **Nearest Neighbor and Clustering Approaches:** Introduction, Nearestneighbour method, Nearest neighbor approach for secondary structure protein folding prediction, Clustering, Advanced clustering techniques, Application guidelines. **Decision Trees:** Method, Gain criterion, Over fitting and pruning, Application guidelines, Bioinformatics applications.
Unit: 4	**Neural Networks and Genetic Algorithms:** Method, Application guidelines, Bioinformatics applications, Background. **Genetic Algorithms:** Single-objective genetic algorithms –method and example, multi-objective genetic algorithms –method, Application guidelines, Genetic algorithms – bioinformatics applications.
Unit: 5	**Future Techniques: Genetic Programming:** Method, Application guidelines, Bioinformatics

	applications, Background. **Cellular Automata:** Method, Application guidelines, Bioinformatics applications, Background. **Hybrid Methods:** Method, Neural-genetic algorithm for analyzing gene expression data, Genetic algorithm, and *k* nearest neighbor hybrid for biochemistry solvation, Genetic programming neural networks for determining gene –gene interactions in epidemiology, Application guidelines, Conclusions.
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	Edward Keedwell and Ajit Narayanan, —Intelligent Bioinformatics‖, Wiley, First Edition, 2005.
2	Gary B. Fogel, David W. Corne, Yi Pan, —Computational Intelligence in Bioinformatics‖, Wiley-IEEE Press, First Edition, 2010.
Reference Books:	
1	Jin Xiong, —Essential Bioinformatics‖, Cambridge University Press, First Edition, 2006.
2	Supratim Choudhuri, —Bioinformatics for Beginners‖ Academic Press, First Edition, 2014.

Course Code	Course Title	Lecture			Semester: II
MTAC211PET	English For Research Paper Writing	L	T	P	
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	2	0	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	30 Hrs.	Maximum Score	:	50
Periods/ Week	:	2	Internal Evaluation	:	15
Credits	:	-	End Semester	:	35
Instruction Mode	:	Lecture	Exam Duration	:	2 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 (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	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: II
MTAC212PET	Value Education	L	T	P	
Version: 1.2	Date of Approval: 16th BoS 17-11-2022	2	0	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	30 Hrs.	Maximum Score	:	50
Periods/ Week	:	2	Internal Evaluation	:	15
Credits	:	-	End Semester	:	35
Instruction Mode	:	Lecture	Exam Duration	:	2 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 (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	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: II
MTAC213PET	Pedagogy Studies	L	T	P	
Version: 1.2	Date of Approval: 16th BoS 17-11-2022	2	0	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	30 Hrs.	Maximum Score	:	50
Periods/ Week	:	2	Internal Evaluation	:	15
Credits	:	-	End Semester	:	35
Instruction Mode	:	Lecture	Exam Duration	:	2 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 (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	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
MTAC214PET	Stress Management by Yoga	L	T	P	
Version: 1.2	Date of Approval: 16th BoS 17-11-2022	2	0	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	30 Hrs.	Maximum Score	:	50
Periods/ Week	:	2	Internal Evaluation	:	15
Credits	:	-	End Semester	:	35
Instruction Mode	:	Lecture	Exam Duration	:	2 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 (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	'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
MTAC215PET	Tarseel-e-Urdu/Elementary Urdu	L	T	P	
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	2	0	0	

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

Prerequisite(s): No Specific prerequisite

Course Objectives:

1. Understand the basic elements of Urdu language, including its script, pronunciation, and grammar rules.
2. Develop a basic vocabulary of Urdu words and phrases, including commonly used verbs, nouns, and adjectives.
3. Understand the basic sentence structures of Urdu, including word order and verb conjugation.
4. Communicate effectively in Urdu in basic social situations, such as greetings, introductions, and basic conversations.

Course Outcomes (CO):

COs No.	Statement	Mapped Program Outcomes (POs)
CO_1	Ability to read and write Urdu script and basic texts in Urdu.	**PO_{10}**
CO_2	Ability to understand and use basic Urdu vocabulary, grammar, and syntax in simple sentences and conversations.	**PO_{10}**
CO_3	Ability to use basic Urdu language skills in everyday situations, such as shopping, ordering food, and asking for directions.	**PO_{10}, PO_{12}**
CO_4	Understanding of the cultural context and social norms of Urdu-speaking communities.	**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		
CO_2										2		
CO_3										2		2
CO_4										2		2

1 – Reasonable; 2 – Significant; 3 – Strong

Detailed Contents:

Unit: 1	اردو حروف تہجی، حروف تہجی کی شکلیں، دو چشمی ھ، حروف کی تحریر، اعراب، دو حرفی الفاظ، تین حرفی الفاظ، چار حرفی الفاظ، دو لفظی جملے، چار لفظی جملے۔
Unit: 2	دن اور مہینے، پھل اور سبزیاں، موسم اور آب و ہوا، گھر اور چیزیں۔
Unit: 3	بازار، ڈاک گھر، ریلوے اسٹیشن، بینک، عام استعمال کے چند الفاظ، خاص موقعوں کے جملے، اعداد۔
Unit: 4	اسم، ضمیر، فعل، صفت، اسم فعل اور صفت کی جمع، محاورے اور ضرب الامثال۔
Unit: 5	عبارتیں، نظمیں، کہانیاں، مولانا آزاد نیشنل اردو یونیورسٹی کا ترانہ۔

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	Elementary Urdu" by Azra Khanam
2	Urdu for Beginners" by Syed Akbar Ali Shah

Reference Books:

1	A Progressive Course of Urdu" by M. Haroon Khan Sherwani and Intekhab Ojha
2	Urdu: An Essential Grammar" by Ruth Laila Schmidt and C. M. Naim