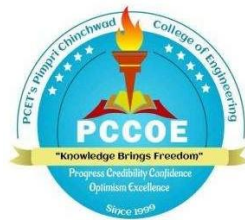**Pimpri Chinchwad Education Trust's**

PIMPRI CHINCHWAD COLLEGE OF ENGINEERING

SECTOR NO.26, PRADHIKARAN, NIGDI, PUNE 411044

An Autonomous Institute Approved by AICTE and Affiliated to SPPU, Pune

DEPARTMENT OF INFORMATION TECHNOLOGY

Curriculum Structure and Syllabus
of
M.Tech. Artificial Intelligence and Data Science (Course 2022)

Effective from Academic Year 2023-24

(Updated with Minor Changes)

VISION AND MISSION OF INSTITUTE

Institute Vision

To Serve the Society, Industry and all the Stakeholders through the **Value-Added Quality Education.**

Institute Mission

To serve the needs of society at large by establishing State-of-the-Art Engineering, Management and Research Institute and impart attitude, knowledge and skills with quality education to develop individuals and teams with ability to think and analyze right values and self-reliance.

Quality Policy

We at PCCOE are committed to impart Value Added Quality Education to satisfy the applicable requirements, needs and expectations of the Students and Stakeholders. We shall strive for academic excellence, professional competence and social commitment in fine blend with innovation and research. We shall achieve this by establishing and strengthening state-of-the-art Engineering and Management Institute through continual improvement in effective implementation of Quality Management System.
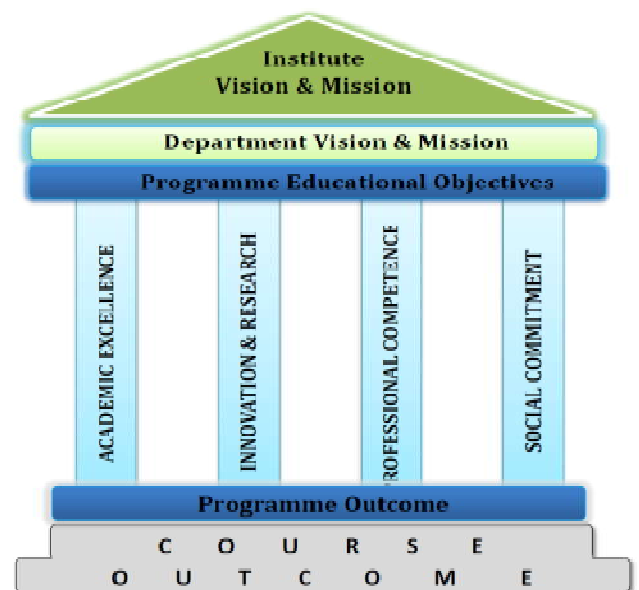
	Pimpri Chinchwad Education Trust's	
	Pimpri Chinchwad College of Engineering	TÜV INDIA ISO 9001 Certified

Course Approval Summary

A. Board of study-Department of Information Technology

Sr. No.	Name of the Course	Course Code	Page Number	Signature and stamp of BoS
1	Research Methodology & IPR	MDS1401	8-9	
2	Foundations of Data Science(FDS)	MDS1402	10-11	
3	Principles of AI and Machine Learning (AIML)	MDS1403	12-13	
4	Professional Core Lab-I (FDS and AIML)	MDS1404	14-15	
5	Professional Elective-I Social Media Analytics Predictive Analytics using R Web Analytics	MDS1501A MDS1501B MDS1501C	16-17 19-21 22-24	
6	Professional Elective-II Natural Language Processing Reinforcement Learning Data Warehousing and Mining	MDS1502A MDS1502B MDS1502C	25-27 28-30 31-33	
7	Professional Elective Lab-I (Ele.I &II)	MDS1503A	18	
8	Open Elective-I	MDS1601	82-83	
9	Skill Development Lab – I (Technical/ Software Skill)	MDS1405	34-35	
10	Audit Course – I	M_1961	75-77	
11	Deep Learning (DL)	MDS2406	37-38	
12	Big Data Technologies (BDT)	MDS2407	39-40	
13	Professional Core Lab- II (DL and BDT)	MDS2408	41-42	
14	Professional Elective-III Industrial IoT and ML Healthcare Data Analytics Advanced Data Visualization and Analytics	MDS2504A MDS2504B MDS2504C	43-46 47-49 50-51	

15	Professional Elective-IV Video Analytics using AI Recommender System Computer Vision	MDS2505A MDS2505B MDS2505C	53-55 56-58 59-61	
16	Professional Elective Lab -II (Ele III and IV)	MDS2506	52	
17	Open Elective –II	MDS2602	84-86	
18	Skill Development Lab– II (Oral & Written Communication)	M_2101	62-63	
19	Integrated Mini-Project	MDS2701	64-65	
20	Audit Course –II	M_2962	78-80	

B. Board of study-Department of Mechanical Engineering

Sr. No.	Name of the Course	Course Code		Signature and stamp of BoS
1	**Open Elective I** • Electronic Cooling • Green Buildings • System Modelling and Simulation	MMH1601A MMH1601B MMH1601C	120 121-122 123	
2	**Open Elective II** • Waste Management for Smart Cities • Battery management for Electric Vehicles • Renewable Energy Sources	MMH2602A MMH2602B MMH2602C	124 125-126 127-128	
3	**Open Elective I** • Advanced Materials • Optimization Methods • Modeling and Simulation of Dynamic system	MMD1601A MMD1601B MMD1601C	87 88 89	
4	**Open Elective II** • Room Acoustics • Design Thinking • Reliability Engineering	MMD2602A MMD2602B MMD2602C	90 91 92	

C. Board of study-Department of Electronics and Telecommunications Engineering

Sr. No.	Name of the Course	Course Code		Signature and stamp of BoS
1	**Open Elective I** • Automotive Electronics and Its applications • Industrial Drives • Basics of FPGA and CPLD	MET1601A MET1601B MET1601C	93-94 95-96 97	
2	**Open Elective II** • Drone Programming for Beginners • Instrumentations and Measurements	MET2602A MET2602B	99 100	

Sr. No.	Name of the Course	Course Code		Signature and stamp of BoS
	• Micro-controllers and Microprocessors Applications	MET2602C	101	

D. Board of study-Department of Computer Engineering

Sr. No.	Name of the Course	Course Code		Signature and stamp of BoS
1	**Open Elective I** • Programming with Python • Software Engineering Basics • Basics of Machine Learning	MCE1601A MCE1601B MCE1601C	103 104-105 106-107	
2	**Open Elective II** • Image Processing with MATLAB • Linux Essentials • Design with UML	MCE2602A MCE2602B MCE2602C	108-109 110-111 112	

E. Board of study-Department of Civil Engineering

Sr. No.	Name of the Course	Course Code		Signature and stamp of BoS
1	**Open Elective I** • Project Management and Finance • Green Technology	MCI1601A MCI1601B	113 114-115	
2	**Open Elective II** • Contracts, Tendering and Arbitration • Total Quality Management • Operation Research	MCI2602A MCI2602B MCI2602C	116 117 118-119	

F. Board of study-Department of Applied Sciences and Humanities

Sr. No.	Name of the Course	Course Code		Signature and stamp of BoS
1	**Skill Development Lab II**	M_2101	62-63	
	Audit Course I			
	Constitution of India	M-1961A	75	
	Value Education	M-1961B	76	
	Stress Management	M-1961C	77	
2	**Audit Course II**			
	Team Building and Leadership	M-2962A	78	
	English for Research Writing	M-2962B	79	
	Disaster Management	M-2962C	80	

Approved by Academic Council:

Chairman, Academic Council
Pimpri Chinchwad College of Engineering

Approved by Board of Governors:

INDEX

ABBREVIATIONS

Abbreviations	Course Full Name
PCC	**P**rofessional **C**ore **C**ourse
PEC	**P**rofessional **E**lective **C**ourse
OEC#	**O**pen **E**lective **C**ourse
PROJ	**Proj**ect, Mini / Minor **Proj**ects, Integrated **Proj**ects
SEM	**Sem**inar
INTR	**Int**e**r**nship
HSMC*	**Humanities / Social Science / Management Course**
AUDIT*	**Audit Course**
MOOC	**Massive Open Online Course**

Note: * Indicates that these courses are at institute level

 # The Course offered by the other department

CURRICULUM STRUCTURE
STRUCTURE FOR 1ST YEAR M.TECH (ARTIFICIAL INTELLIGENCE & DATA SCIENCE)
SEMESTER I & II

M.Tech Structure		Sem -I	Teaching Scheme				Examination Scheme					
Course Code	Course Type	Course Name	L	P	H	CR	IE1	IE2	ETE	TW	OR	Total
MDS1401	PCC	Research Methodology & IPR	3	-	3	3	20	30	50	-	-	100
MDS1402	PCC	Foundations of Data Science(FDS)	3	-	3	3	20	30	50	-	-	100
MDS1403	PCC	Principles of AI and Machine Learning(AIML)	3	-	3	3	20	30	50	-	-	100
MDS1404	PCC	Professional Core Lab-I (FDS and AIML)	-	2	2	1	-	-	-	50	50	100
MDS1501	PEC	Professional Elective-I	3	-	3	3	20	30	50	-	-	100
MDS1502	PEC	Professional Elective-II	3	-	3	3	20	30	50	-	-	100
MDS1503	PEC	Professional Elective Lab-I (Ele.I&II)	-	2	2	1	-	-	-	50	50	100
MDS1601	OEC	Open Elective-I	2	-	2	2	20	-	30	-	-	50
MDS1405	PCC	Skill Development Lab – I (Technical/ Software Skill)	-	2	2	1	-	-	-	50	-	50
M_1961	Audit	Audit Course – I	1	-	1	-	-	-	-	-	-	-
		Total	18	6	24	20	120	150	280	150	100	800

M.Tech Structure		Sem-II	Teaching Scheme				Examination Scheme					
Course Code	Course Type	Course Name	L	P	H	CR	IE1	IE2	ETE	TW	OR	Total
MDS2406	PCC	Deep Learning(DL)	3	-	3	3	20	30	50	-	-	100
MDS2407	PCC	Big Data Technologies(BDT)	3	-	3	3	20	30	50	-	-	100
MDS2408	PCC	Professional Core Lab- II (DL and BDT)	-	2	2	1	-	-	-	50	50	100
MDS2504	PEC	Professional Elective-III	3	-	3	3	20	30	50	-	-	100
MDS2505	PEC	Professional Elective-IV	3	-	3	3	20	30	50	-	-	100
MDS2506	PEC	Professional Elective Lab -II (Ele III and IV)	-	2	2	1	-	-	-	50	50	100
MDS2602	OEC	Open Elective –II	2	-	2	2	20	-	30	-	-	50
M_2101	HSMC	Skill Development Lab– II (Oral & Written Communication)	-	2	2	1	-	-	-	50	-	50
MDS2701	PROJ	Integrated Mini-Project	-	6	6	3	-	50	-	-	50	100
M_2962	Audit	Audit Course –II	1	-	1	-	-	-	-	-	-	-
		Total	15	12	27	20	100	170	230	150	150	800

Abbreviation: L- Lecture; **P**- Practical; **H**- Hours; **CR**- Credits; **IE1**– Internal Evaluation-1; **IE2**– Internal Evaluation-2; **ETE** – End Term Examination; **TW** – Term Work; **OR** – Oral Exam

STRUCTURE FOR IINDYEAR M.TECH
(ARTIFICIAL INTELLIGENCE & DATA SCIENCE)
SEMESTER-III

M.Tech Structure		Sem - III	Teaching Scheme				Examination Scheme					
Course Code	Course Type	Courses	L	P	H	CR	IE1	IE2	ETE	TW	OR	TOTAL
MDS3702	PROJ	Dissertation Phase - I [Company/ In-house project]	–	20	20	10	-	-	-	100	100	200
MDS3703	SEM	Seminar	–	04	04	02	-	-	-	50	50	100
MDS3801	INTR	Internship [Company/ In-house project] /	–	04	04	02	-	-	-	100	-	100
OR												
MDS3981	MOOC	MOOC's / Entrepreneurship	-	04	04	02	-	-	-	100	-	100
		Total	-	28	28	14	-	-	-	250	150	400

*Internship: -It may be in summer/winter vacation or within semester at least for three months, evaluation after fourth semester

SEMESTER-IV

MTech Structure		Sem –IV	Teaching Scheme				Examination Scheme					
Course Code	Course Type	Courses	L	P	H	CR	IE1	IE2	ETE	TW	OR	TOTAL
MDS4704	PROJ	Dissertation Phase - II [Company/ In-house project]	-	24	24	12	-	-	-	200	200	400
MDS4982	MOOC	MOOC's	-	4	4	2	-	-	-	100	-	100
		Total	-	28	28	14	-	-	-	300	200	500

Abbr: Course Abbreviation; **L**- Lecture; **P**- Practical; **H**- Hours; **CR**- Credits; **IE1**– Internal Evaluation-1; **IE2**– Internal Evaluation-2; **ETE** – End Term Examination; **TW** – Term Work; **OR** – Oral Exam

LIST OF ELECTIVES

	Elective-I		Elective-II
MDS1501A	Social Media Analytics	**MDS1502A**	Natural Language Processing
MDS1501B	Predictive Analytics Using R	**MDS1502B**	Reinforcement Learning
MDS1501C	Web Analytics	**MDS1502C**	Data Warehousing and Mining

	Elective-III		Elective-IV
MDS2504A	Industrial IoT and ML	**MDS2505A**	Video Analytics using AI
MDS2504B	Healthcare Data Analytics	**MDS2505B**	Recommender System
MDS2504C	Advanced Data Visualization and analytics	**MDS2505C**	Computer Vision

LIST OF AUDIT COURSES

	SEM-I		SEM-II
M_1961A	Constitution of India	**M_2962A**	Team Building & Leadership
M_1961B	Value Education	**M_2962B**	English for Research writing
M_1961C	Stress Management	**M_2962C**	Disaster Management

LIST OF OPEN ELECTIVES

OFFERED BY ARTIFICIAL INTELLIGENCE & DATA SCIENCE

	Open Elective – I		Open Elective –II
MDS1601A	R programming	**MDS2602A**	Python for Data Science
MDS1601B	Business Analytics	**MDS2602B**	Introduction to Neural Networks

OFFERED BY DESIGN ENGINEERING

	Open Elective – I		Open Elective –II
MMD1601A	Advanced Materials	**MMD2602A**	Room Acoustics
MMD1601B	Optimization Methods	**MMD2602B**	Design Thinking
MMD1601C	Modeling & Simulation of Dynamic Systems	**MMD2602C**	Reliability Engineering

OFFERED BY VLSI & EMBEDDED SYSTEMS

	Open Elective – I		Open Elective –II
MET1601A	Automotive Electronics & Applications	**MET2602A**	Drone Programming for Beginners
MET1601B	Industrial Drives	**MET2602B**	Instrumentation and Measurement
MET1601C	Basics of FPGA and CPLD	**MET2602C**	Microcontrollers and Microprocessors applications
MET1601D	Robotics	**MET2602D**	Electronics Implementation Platforms

OFFERED BY COMPUTER ENGINEERING

	Open Elective – I		Open Elective –II
MCE1601A	Programming with Python	MCE2602A	Image Processing with MATLAB
MCE1601B	Software Engineering Basics	MCE2602B	Linux Essentials
MCE1601C	Basics of Machine learning	MCE2602C	Design with UML

OFFERED BY CIVIL- CONSTRCTION MANAGEMENT

	Open Elective – I		Open Elective –II
MCI1601A	Project Management and Finance	MCI2602A	Contracts, Tendering and Arbitration
MCI1601B	Green Technology	MCI2602B	Total Quality Management
		MCI2602C	Operation Research

OFFERED BY HEAT POWER ENGINEERING

	Open Elective – I		Open Elective –II
MMH1601A	Electronic Cooling	MMH2602A	Waste Management for Smart Cities
MMH1601B	Green Buildings	MMH2602B	Battery management for Electric Vehicles
MMH1601C	System Modelling and Simulation	MMH2602C	Renewable Energy Sources

Course Syllabus
Semester-I

Program:	M. Tech. (Artificial Intelligence and Data Science)			Semester : I			
Course :	Research Methodology and IPR			Code :MDS1401			
Teaching Scheme			**Evaluation Scheme**				
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**	
3	**3**	**3**	**20**	**30**	**50**	**100**	

Pre-requisite: Project and seminars in undergraduate

Objectives:
1. To select and define appropriate research problem and parameters with appropriate methodology.
2. To understand statistical techniques for the specific perspective data in an appropriate manner.
3. To make predictions and decisions for the data set using open-source software.
4. To understand the mathematical modeling and its predicting capability.
5. To learn the various steps in research writing and publication process
6. To introduce fundamental aspects of Intellectual property Rights

Outcomes:
After learning the course, the students should be able to:
1. Define a research problem and use appropriate research methodology
2. Discuss data using different hypothesis tests and make conclusions about acceptance or rejection of sample data.
3. Analyze numerical data, using standard procedures of probability theory to predict the performance.
4. Develop a mathematical model and analyze the prediction capabilities
5. Write a research paper and research proposal.
6. Write a concept note and prepare to file an IP.

Detailed Syllabus

Unit	Description	Duration Hrs
1.	**Research Problem and Research Design** Objectives, Motivation, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Criteria of Good Research Definition and Feasibility study of research problem, Sources of research problem, Meaning of Hypothesis, Characteristics of Hypothesis, Errors in selecting a research problem, Concept & need of research design	8
2.	**Applied Statistics** Measures of Variability: Standard Deviation, variance, Quartiles, Interquartile Range Inferential Statistics: Statistical Significance (p values), Pearson's r test, t- test, Chi square test, ANOVA (Analysis of variance)	7
3.	**Probability** Sampling, Types of Sampling, Probability Distribution: Binomial Distribution, Poisson Distribution, Normal Distribution, Case Study: Develop a model for Prediction and Decision Making for the data set using open-source software	7
4.	**Mathematical Modeling and prediction of performance** Types of Modeling, Types of solutions to mathematical models, Steps in Setting up a computer model to predict performance of experimental system, Validation of results, Multi-scale modeling and verifying performance of process system, Nonlinear analysis of system and asymptotic analysis, Sensitivity analysis.	8
5.	**Research Report writing and Publication** Research Report: Dissemination of research findings, outline and structure of research	8

	report, different steps and precautions while writing research report, methods and significance of referencing. Publishing Research work: Selection of suitable journal for publishing research work, Open access Vs Subscription Journals, Identifying indexing of selected journals, Impact factor of the journal, structure of research paper, Check for plagiarism of the article, Research paper submission and review process.	
6	**Intellectual property Rights** Definition of IPR, Classification of IP, Patentable and non-patentable inventions, statutory exceptions, Persons entitled to apply for patents. Prior Art Search, Patentability Criteria, Patent Filing Procedure, Forms and Fees, Case Study of Patent, Copyright.	7
	Total	**45**

Text Books:

1. Dr. C. R.Kothari , "Research Methodology: Methods and Trends", New Age International, 2nd Edition, 1985
2. Ranjit Kumar , "Research Methodology: A Step by Step Guide for Beginners", 2ndEdition, 2010.

Reference Books:

1. Stuart Melville and WayneGoddard, "Research Methodology: An Introduction for Science & Engineering students"
2. Dr. S.D. Sharma, " Operational Research", Kedar Nath Ram Nath &Co.
3. Wayne Goddard and Stuart Melville, Research Methodology: An Introduction, Juta and Company Ltd, 2004
4. Ramkrishna B, Anil Kumar H S, "Fundamentals of IPR", NotionPress, 2016
5. Virendra Kumar Ahuja, Lexis Nexis Butterworths , "IPR in India",WadhwaNagpur

IE Activities:

1. Write a review paper based on detailed literature survey and check for plagiarism.
2. Write a research proposal on your domain specific research problem.
3. Write a concept note and prepare to file an IP.

Program:	M. Tech. (Artificial Intelligence and Data Science)		Semester : I			
Course :	Foundations of Data Science (FDS)		Code : MDS1402			
	Teaching Scheme			Evaluation Scheme		
Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Pre-requisite: Probability and Statistics

Objectives:
1. To introduce the fundamentals of Data Science.
2. To apply Data Science in different domain
3. To facilitate learning of data pre-processing.
4. To introduce plotting and visualization.
5. To do exploratory analysis on a given data

Outcomes:
After learning the course, the students should be able to:
1. Apply statistics and probability methods to solve real-life problems.
2. Demonstrate the Data Science Process and how its components interact.
3. Use R to carry out basic statistical modeling and analysis
4. Apply pre-processing techniques to data using R.
5. Create effective visualization of given data Using R.
6. Apply basic tools (plots, graphs, summary statistics) to carry out EDA

Detailed Syllabus

Unit	Description	Duration (Hrs.)
1.	**Statistics** Describing a Single Set of Data, Correlation, Simpson's Paradox, Some Other Correlational Caveats, Correlation and Causation Probability: Dependence and Independence, Conditional Probability, Bayes's Theorem, Random Variables, Continuous Distributions, The Normal Distribution, The Central Limit Theorem	8
2.	**Introduction** Defining data science and big data, Recognizing the different types of data, Machine Learning Definition and Relation with Data Science, Data Science Process: Data collection; Data preparation; Training a model on the data; Evaluation of the model performance; Data visualization techniques and inferences.	8
3	**Data Science Programming** Introduction to R, R packages, R Markdown, Programming e.g. functions, loops, if/else, comments, Tidy data, Tabular data and data import, Strings and regular expressions.	7
4	**Data Pre-Processing** Understanding the Data, Dealing with Missing Values, Data Formatting, Data Normalization, Data Binning, Importing and Exporting data in R, Turning categorical variables into quantitative variables in R, Accessing Databases with R	7
5.	**Manipulation of Data** Data Wrangling, Data manipulation dplyr. Plotting- Visualization with ggplot2. Statistical inference using R, What-if analysis, case studies, Use cases.	7
6.	**Data Science in Applications** Exploratory Data Analysis, Basic tools (plots, graphs and summary statistics) of EDA. Case studies - Web scraping, Text data and Natural Language Processing. Data Science in Business, Ethical Issues, privacy, security.	8
	Total	45

Text Books:
1. Data Science from Scratch: Joel Grus, O'Reilly Media Inc. 2015, ISBN: 9781491901427
2. R for data science: import, tidy, transform, visualize, and model data", Wickham, Hadley, and Garrett Grolemund. O'Reilly Media, Inc.", 2016
Reference Books:
1. Introduction to Probability and Statistics for and Engineers and Scientists, S. Ross, 3rd Edition, Elsevier, 2004.
2. Software for Data Analysis: Programming with R (Statistics and Computing), John M. Chambers, Springer
3. Data Mining: Concepts and Techniques, 3rd Edition. Jiawei Han, Micheline Kamber, Jian Pei.
4. Doing Data Science, Straight Talk from The Frontline. O'Reilly. 2014, Cathy O'Neil and Rachel Schutt.
5. Data Science for Business: What You Need to Know about Data Mining and Data-analytic Thinking. ISBN 1449361323. 2013, Foster Provost and Tom Fawcett.

Program:	M. Tech. (Artificial Intelligence and Data Science)		Semester : I	
Course :	Principles of AI & Machine Learning(AIML)		Code : MDS1403	
Teaching Scheme			**Evaluation Scheme**	

Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Pre-requisite:
1. Basics of Algorithms
2. Basics of Linear Algebra
3. Basics of Python Programming Language

Objectives:
1. To understand fundamental concepts of machine learning and its various algorithms.
2. To understand various strategies of generating models from data and evaluating them.
3. To apply ML algorithms on given data and interpret the results obtained.
4. To design appropriate ML solution to solve real world problems in AI domain.

Outcomes:
After learning the course, the students should be able to:
1. Interpret the fundamental principles of machine learning.
2. Discuss various classification algorithms of Machine Learning.
3. Evaluate performance of various machine learning algorithms on various data sets of a domain.
4. Apply supervised/unsupervised machine learning algorithms for classification/prediction/clustering.
5. Apply various machine learning algorithms to solve a given problem using languages such as Python
6. Explain various Clustering Techniques

Detailed Syllabus

Unit	Description	Duration Hrs.
1.	**Foundations of Artificial Intelligence** AI Definition, The Foundations of Artificial Intelligence, The History of Artificial Intelligence, The State of the Art ; Intelligent Agents : Agents and Environments, Good Behavior: The Concept of Rationality, The Nature of Environments, The Structure of Agents; Solving Problems by Searching: Problem Solving Agents, Example Problems, Searching for Solutions, Uninformed Search Strategies, Informed (Heuristic) Search Strategies, Heuristic Functions	8
2.	**Classification Algorithms** K Nearest Neighbors, Linear Regression, Logistic Regression, Bias Variance tradeoff. Naive Bayes Classifier, Solving optimization problems, Maxima and Minima, Gradient Descent, Stochastic Gradient Descent algorithm,	7
3.	**Performance measurement of models** Accuracy, Confusion matrix, TPR, FPR, FNR, TNR Precision and recall, F1-score,Receiver Operating Characteristic Curve (ROC) curve and AUC, Log-loss, R-Squared/Coefficient of determination, Median absolute deviation (MAD)	7
4.	**Supervised Learning Algorithms** Support Vector Machines, Loss function (Hinge Loss) based interpretation, Dual form of SVM formulation, kernel trick, Polynomial Kernel, RBF-Kernel, Decision Tree: Entropy KL Divergence, Building a decision Tree, Information Gain, Gini Impurity,	8

		Constructing a DT, Splitting numerical features, Feature standardization, Categorical features with many possible values, Over fitting and Under fitting.	
5.	**Ensembles** What are ensembles? Bootstrapped Aggregation (Bagging) Intuition, Random Forest and their construction, Bias-Variance tradeoff, Bagging Train and run time complexity, Extremely randomized trees, Random Forest :Cases, Boosting Intuition, Residuals, Loss functions and gradients, Gradient Boosting, XGBoost: Boosting + Randomization, AdaBoost, Stacking models Cascading classifiers		**8**
6.	**Clustering Techniques:** Linkage Techniques: Single linkage, Average linkage and Complete linkage, Minimum spanning tree, K-nearest neighbour clustering, BIRCH, CURE, DBSCAN algorithms, adjusted RAND indexed Anomaly and outlier detection methods		**7**
		Total	**45**

Text Books:

1. E. Alpaydin, "Introduction to Machine Learning", PHI, 2005.
2. AurolienGeron, "Hands-On Machine Learning with Scikit-Learn and TensorFlow, Shroff/O'Reilly", 2017

Reference Books:

1. Tom Mitchell, "Machine Learning", McGraw Hill, 1997
2. Andreas Muller and Sarah Guido, "Introduction to Machine Learning with Python: A Guide for Data Scientists", Shroff/O'Reilly, 2016
3. Alejandro Barredo Arrieta, Natalia D´ıaz-Rodr´ıguez, Javier Del Ser, et.al., "Explainable Artificial Intelligence (XAI): Concepts, taxonomies, opportunities and challenges toward responsible AI, Information Fusion", Volume 58, 2020, Pages 82-115,ISSN 1566-2535, https://doi.org/10.1016/j.inffus.2019.12.012.
4. Andrew Ng, Machine learning yearning, https://www.deeplearning.ai/machine-learning-yearning/

Program:	M. Tech. (Artificial Intelligence and Data Science)		Semester : I		
Course :	**Professional Core Lab-I: Principles of Artificial Intelligence and Machine Learning and Foundation of Data Science**		**Code : MDS1404**		
Teaching Scheme			**Evaluation Scheme**		
Practical	**Hours**	**Credit**	**TW**	**PR**	**OR**	**Total**
2	2	1	50	-	50	100

Pre-requisite:
1. Basic Mathematics and Programming.
2. Knowledge of R language

Objectives:
1. To implement searching algorithms.
2. To implement knowledge schemes.
3. To introduce plotting and visualization.
4. To facilitate learning of data pre-processing.

Outcomes
After learning the course, the students should be able to:
1. Apply mathematical libraries for problem solving.
2. Analyze the different datasets of AI applications.
3. Apply AI searching techniques for solving real world application
4. Apply data pre processing operations on the different datasets.
5. Apply effective visualization on given data Using R
6. Apply pre-processing techniques to data using R

Detailed Syllabus:

Part A: Principles of Artificial Intelligence and ML (Any Three)		
Expt.	**Description**	**Duration (Hrs)**
1.	Data preprocessing and annotation and creation of datasets.	**02**
2.	Learn existing datasets and Treebanks	**02**
3.	Implementation of searching techniques in AI.	**02**
4.	Implementation of Knowledge representation schemes.	**03**
	Total	**07**

Part B: Foundation of Data Science (Any Three)		
Expt.	**Description**	**Duration (Hrs)**
1.	Perform the following operations using R on the data sets 1) Create data subsets 2) Merge Data 3) Sort Data 4) Transposing Data 5) Melting Data to long format 6) Casting data to wide format	**02**
2.	Assignment based on visualization tool in R. Use Scatter plot, bar plot, Box plot and Histogram to analyze the given data	**02**

3.	Perform the following operations using R on the data sets a. Data cleaning b. Data transformation c. Error correcting	**02**
4.	Mini Project	**04**
	Total	**08**

Text Books:
1. R for data science: import, tidy, transform, visualize, and model data.", Wickham, Hadley, and Garrett Grolemund. O'Reilly Media, Inc.", 2016
2.Luger G.F. and Stubblefield W.A. (2008). Artificial Intelligence: Structures and strategies for Complex Problem Solving. Addison Wesley, 6th edition

Reference Books:
A.Ohri, "R for Business Analytics", Springer, 2012.

Online References for data set
1) http://archive.ics.uci.edu/ml/

Program:	M. Tech. (Artificial Intelligence and Data Science)		Semester : I			
Course :	Social Media Analytics – Elective 1		Code :MDS1501A			
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Pre-requisite: Data mining and Data Analysis.

Objectives:
1. To demonstrate foundations of Social Media Analytics.
2. To analyze data mining aspects in social networks.
3. To solve mining problems by different algorithms.
4. To describe network measures for social data.
5. To explain behavioural part of web applications for Analysis.
6. To analyze the data available on any social media applications.

Outcomes:
After learning the course, the students should be able to:
1. Discuss the basics of Social Media Analytics.
1. Describe the significance of Data mining in Social media.
2. Interpret the algorithms used for text mining.
3. Apply network measures for social media data.
4. Explain Behavior Analytics techniques used for social media data.
5. Apply social media analytics for Face book and Twitter kind of applications.

Detailed Syllabus

Unit	Description	Duration Hrs
1.	**ANALYTICS IN SOCIAL MEDIA AND TYPES OF ANALYTICS TOOLS** The foundation for analytics, Social media data sources, Defining social media data, data sources in social media channels, Estimated Data sources and Factual Data Sources, Public and Private data, data gathering in social media analytics.	8
2.	**VISUALIZING SOCIAL NETWORKS** Introduction, A Taxonomy of Visualization, The convergence of Visualization, Interaction and Analytics. Data mining in Social Media: Introduction, Motivations for Data mining in Social Media, Data mining methods for Social Media, Related Efforts.	8
3.	**TEXT MINING IN SOCIAL NETWORKS** Introduction, Keyword search, Classification Algorithms, Clustering Algorithms- Greedy Clustering, Hierarchical clustering, k-means clustering, Transfer Learning in heterogeneous Networks, Sampling of online social networks, Comparison of different algorithms used for mining, tools for text mining.	8
4.	**NETWORK MEASURES** Centrality: Degree Centrality , Eigenvector Centrality, Katz Centrality , Page Rank, Betweenness Centrality, Closeness Centrality ,Group Centrality ,Transitivity and Reciprocity, Balance and Status, Similarity: Structural Equivalence, Regular Equivalence	8
5.	**BEHAVIOR ANALYTICS** Individual Behavior: Individual Behavior Analysis, Individual Behavior Modeling,	7

	Individual Behavior Prediction Collective Behavior: Collective Behavior Analysis, Collective Behavior Modeling, Collective Behavior Prediction	
6	**CASE STUDY** **Mining Twitter:** Overview, Exploring Twitter's API, Analyzing 140 Characters **Mining Facebook:** Overview, Exploring Facebook's Social Graph API's, Analyzing Social Graph Connections.	6
	Total	**45**

Text Books:
1. Reza Zafarani Mohammad Ali Abbasi Huan Liu, Social Media Mining, Cambridge University Press,ISBN: 10: 1107018854.
2. Charu C. Aggarwal, Social Network Data Analytics, Springer, ISBN: 978-1-4419-8461-6.

Reference Books:
1. Marshall Sponder, Social Media Analytics: Effective Tools for Building, Interpreting, and Using Metrics, McGraw Hill Education, 978-0-07-176829-0.
2. Matthew A. Russell, Mining the Social Web, O'Reilly, 2nd Edition, ISBN:10: 1449367615.
3. Jiawei Han University of Illinois at Urbana-Champaign Micheline Kamber, Data Mining: Concepts and Techniques, Morgan Kaufmann, 2nd Edition, ISBN: 13: 978-1-55860-901-3 ISBN: 10: 1-55860-901-6.
4. Bing Liu, Web Data Mining : Exploring Hyperlinks, Contents and Usage Data, Springer, 2nd Edition, ISBN: 978-3-642-19459-7.

Program:	M. Tech. (Artificial Intelligence and Data Science)		Semester : I			
Course :	**Professional Elective Lab (Elective 1): Social Media Analytics**		**Code :MDS1503A**			
	Teaching Scheme		**Evaluation Scheme**			
Practical	**Hours**	**Credit**	**TW**	**PR**	**OR**	**Total**
2	2	1	50	-	50	100

Pre-requisite:
• Information Visualization

Objectives:
1. To describe the different types of data commonly found on social platforms.
2. To analyze the corpus along geographic and temporal axes.
3. To apply tagging to social media text by analyzing sentiment over social text.

Outcomes:
After learning the course, the students should be able to:
1. Describe the different types of data commonly found on social platforms.
2. Analyze the corpus along geographic and temporal axes.
3. Apply tagging to social media text by analyzing sentiment over social text.

Detailed Syllabus

	Social Media Analytics	
Expt.	**Description**	**Duration (Hrs.)**
1.	**Social Media Analytics** Describe the different types of data commonly found on social platforms. Understand the ethical sensitivities in obtaining and operating on social data. Use a social platform API to obtain data. Understand the structure of those data.	**02**
2.	**Visualizing and Modeling Patterns in Social Media Data** Load a large social media corpus. Produce summary statistics over a large social media corpus. Visualize that corpus along geographic and temporal axes.	**04**
3.	**Social Media Text** Describe the various types of text commonly found on social platforms. Compute topics over time in a social dataset. Compute sentiment over social text. Apply tagging to social media text.	**02**
	Total	**08**

Text Books:
1. Reza Zafarani Mohammad Ali Abbasi Huan Liu, Social Media Mining, Cambridge University Press, ISBN: 10: 1107018854.
2. Charu C. Aggarwal, Social Network Data Analytics, Springer, ISBN: 978-1-4419-8461-6.

Reference Books:
1. Marshall Sponder, Social Media Analytics: Effective Tools for Building, Interpreting, and Using Metrics, McGraw Hill Education, 978-0-07-176829-0.
2. Matthew A. Russell, Mining the Social Web, O'Reilly, 2nd Edition, ISBN:10: 1449367615.

Program:	M. Tech. (Artificial Intelligence and Data Science)			Semester : I		
Course :	Predictive Analytics Using R – Elevtive1			Code :MDS1501B		
Teaching Scheme			**Evaluation Scheme**			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Pre-requisite: Mathematics fundamentals, data structures in CPP

Objectives:
1. To introduce Predictive Modeling.
2. To familiarize Regression and Classification Techniques.
3. To impart knowledge on the concepts of Support vector machines and Neural Networks.
4. To explore tree based classifiers and ensemble methods
5. To introduce Topic modeling

Outcomes:
After learning the course, the students should be able to:
1. Comprehend predictive modeling and assess the performance
2. Apply regression techniques and analyze the performance
3. InterpretLDA Topic modeling
4. Discuss concepts of Neural Network
4. Analyze ensemble methods by choosing Tree based classifiers
5. identify appropriate probabilistic Graphic models

Detailed Syllabus

Unit	Description	Duration (Hrs.)
1.	**Gearing Up for Predictive Modeling** Types of models: Supervised, unsupervised, semi-supervised, and reinforcement learning models, Parametric and nonparametric models, Regression and classification models, Real-time and batch machine learning models. The process of Predictive Modeling: Defining the model's objective, Collecting the data, Picking a model, Preprocessing the data, Exploratory data analysis, Feature transformations, Encoding categorical features, Missing data, Outliers, dimensionality reduction, Training and assessing the model, Evaluation Matrix.	8
2.	**Linear Regression** Introduction to linear regression, Simple linear regression, Multiple linear regression, Assessing linear regression models, Problems with linear regression, Feature selection, Regularization, Ridge regression. Logistic Regression: Classifying with linear regression, Assessing logistic regression models, Regularization with the lasso, Classification metrics, Extensions of the binary and Multinomial logistic classifier.	8
3.	**Topic Modeling** An overview of topic modeling, Latent Dirichlet Allocation, The Dirichlet distribution, The generative process, Fitting an LDA model, Modeling the topics of online news stories, Model stability, Finding the number of topics, Topic distributions, Word distributions, LDA extensions.	7

4.	**Neural Networks** Stochastic gradient descent: Gradient descent and local minima, The perceptron algorithm, Linear separation, The logistic neuron, Multilayer perceptron networks: Training multilayer perceptron networks.		7
5.	**Tree-based Methods** The intuition for tree models, Algorithms for training decision trees Classification and regression trees, CART regression trees, Tree pruning, Missing data, Regression model trees CART classification trees, C5.0, Predicting complex skill learning, Variable importance in tree models, Ensemble Methods: Bagging - Margins and out-of-bag observations, Predicting heart disease with bagging, Limitations of bagging, Boosting – AdaBoost, Limitations of boosting, Random forests- The importance of variables in random forests		8
6.	**Probabilistic Graphical Models** A little graph theory, Bayes' Theorem, Conditional independence, Bayesian networks, The Naïve Bayes classifier. Hidden Markov models- Predicting letter patterns in English words.		7
	Total		45

Text Books:
1. Rui Miguel Forte, ―Mastering Predictive Analytics with R‖, Packt Publishing Ltd, 2015.
2. Roger D. Peng,―R Programming for Data Science‖, Lean Publishing, 2015.

Reference Books:
1. Lantz Brett, ―Machine Learning with R‖, 2nd Edition, Packt Publishing Limited.
2. SunilaGollapudi, ―Practical Machine Learning‖, Packt Publishing Ltd.
3. EthemAlpaydin, ―Introduction to Machine Learning‖, 2nd Edition, PHI, 2013.

Program:	M. Tech. (Artificial Intelligence & Data Science)		Semester : I		
Course :	Predictive Analytics Using R lab-Elective I		Code :MDS1503B		
Teaching Scheme			Evaluation Scheme			
Practical	Hours	Credit	TW	PR	OR	Total
2	2	1	50	-	50	100

Pre-requisite:
• Basics of Machine Learning
• Python Programming Language

Objectives:
1. To introduce R libraries for managing and interrogating raw and derived, observed, experimental datasets.
2. To build programs using Predictive Modelling.
3. To familiarize Regression and Classification Techniques with case studies.
4. Impart knowledge on the concepts of Neural Networks and various model Evaluation Techniques.
5. Explore time series models, Topic Modelling and Recommender Systems

Outcomes:
After learning the course, the students should be able to:
1. Demonstrate the basic functions and implement R packages and commands
2. Apply regression analysis methods and infer the problems
3. Develop applications of neural networks and evaluate the techniques
4. Build a system to perform topic modeling on real time datasets

Detailed Syllabus (Any Three)

Predictive Analytics Using R lab		
Expt.	Description	Duration Hrs
1.	Demonstrate the regularization with the lasso in R	02
2.	Build a neural network model that predicts a numerical digit (0-9) from *MNIST* database of handwritten digits	02
3.	Demonstrate the file operations read and write, importing and exporting datasets	02
4.	Implement Topic Modeling on online news stories	04
	Total	08

Text Books:
1. Rui Miguel Forte, ―Mastering Predictive Analytics with R‖, Packt Publishing Ltd, 2015.
2. Roger D. Peng,―R Programming for Data Science‖, Lean Publishing, 2015.

Program:	M. Tech. (Artificial Intelligence and Data Science)			Semester : I	
Course :	Web Analytics – Elective 1			Code : MDS1501C	

Teaching Scheme			Evaluation Scheme			
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
3	3	3	20	30	50	100

Pre-requisite:
A basic knowledge of Internet tools and a good proficiency working in Windows environment is essential.

Objectives:
1. To understand basic concepts of web analytics
2. Learn to use and deploy web/social/mobile analytics platforms such as Adobe Analytics, ComScore combined with an introduction to Mobile Analytics, Geo-Tracking and Geo-Location services.
3. To examines a variety of digital tools, definitions, techniques and properties that can be applied across various channels including Google Analytics web platform.

Outcomes:
After learning the course, the students should be able to:

1. Interpret theBasics of Web Analytics and Data Collection
2. Define and elaborate main key metrics of Qualitative analysis
3. Identify KPI and its relevant technologies
4. Manage web and social analytics principles to drive marketing campaign or strategies
5. Developing Social Listening project
6. Evaluate Google Tag Manager Fundamentals & Social Analytics case studies.

Detailed Syllabus

Unit	Description	Duration Hrs
1.	**Web Analytics** Introduction: Definition, Process, Key terms: Site references, Keywords and Key phrases; building block terms: Visit characterization terms, Content characterization terms, Conversion metrics; Categories: Offsite web, On site web; Web analytics platform, Web analytics evolution, Need for web analytics, Advantages, Limitations. Data Collection: Click stream Data: Web logs, Web Beacons, JavaScript tags, Packet Sniffing; Outcomes Data: E-commerce, Lead generation, Brand/Advocacy and Support; Research data: Mindset, Organizational structure, Timing; Competitive Data: Panel-Based measurement, ISP-based measurement, Search Engine data.	8
2.	**Qualitative Analysis** Basics, Traditional Ways, Expectations, Data Collection , Clickstream Data, Weblogs, Beacons , JavaScript Tags , Packet Sniffing , Outcomes data, Competitive data, Search Engine Data.	7
3.	**Web Analytic Concepts** URLS, Cookies , Time on site , Page views , Understand standard reports, Website content quality , Navigation reports (top pages, top destinations, site overlay)., Search Analytics, Internal search, SEO and PPC , Measuring Email and Multichannel Marketing, Competitive intelligence and Web 2.0 Analytics, Segmentation , Connectable reports.	8

4.	**Web Metrics** Common metrics: Hits, Page views, Visits, Unique visitors, Unique page views, Bounce, Bounce rate, Page/visit, Average time on site, New visits; Optimization, Improving bounce rates, Optimizing adwords campaigns; Real time report, Audience report, Traffic source report, Custom campaigns, Content report, Google analytics, Introduction to KPI, characteristics, Need for KPI, Perspective of KPI, Uses of KPI. Relevant Technologies: Internet & TCP/IP, Client / Server Computing, HTTP (Hypertext Transfer Protocol), Server Log Files & Cookies, Web Bugs.	8
5.	**Google Analytics** Analytics, Cookies, Accounts vs Property, Tracking Code, Tracking Unique Visitors, Demographics, Page Views & Bounce Rate Acquisitions, Custom Reporting.	6
6.	**Case Study-Google Tag Manager Fundamentals & Social Analytics** Starting out with Google Tag Manager, Setting up Google Tag Manager, Collecting data using the Data Layer, variables, and events, Using additional tags for marketing and remarketing, Facebook Analytics, Twitter Insights. **Social Analytics & User Generated Content:** Definition of User Generated Contents, Getting started with Web Listening, Main KPIs about web listening, Main web listening platforms, Free tools for web listening analysis	8
	Total		45

Text Books:
1. Goals & Funnels Wayne Goddard , Stuart Melville, "Research Methodology: An Introduction" , Juta and Company Ltd, 2004
2. Michael Beasley, "Practical Web Analytics for User Experience: How Analytics can help you Understand your Users", Morgan Kaufmann, 2013.

Reference Books:
1. Magy Seif El-Nasr, Anders Drachen, Alessandro Canossa, eds., "Game Analytics: Maximizing the Value of Player Data", Springer, 2013.
2. Justin Cutroni, "Google Analytics", O'Reilly, 2010.
3. Eric Fettman, Shiraz Asif, FerasAlhlou , "Google Analytics Breakthrough", John Wiley & sons, 2016.
4. Kaushik A., Web Analytics 2.0, The Art of Online Accountability and Science of Customer Centricity, Wiley Publishing, Inc. 1st ed.

Program:	M. Tech (Artificial Intelligence and Data Science)		Semester : I	
Course :	Professional Elective Lab : Elective I – Web Analytics		Code: MDS1503C	

Teaching Scheme			Evaluation Scheme			
Practical	Hours	Credit	TW	PR	OR	Total
2	2	1	50	--	50	100

Pre-requisite: Web Technology

Objectives:
1. Equip students with the mindset, concepts, terminology, knowledge, skills and processes in the field of web analytics
2. Train students with web analytics skills by utilize real-world examples and projects

Outcomes:
After learning the course the students should be able to:
1. Interpret website visitor's view and interact with a site's pages and features..
2. Design the customer purchasing patterns, demographics, and demanding trends to make effective strategic decisions.
3. Study of articles based on web or digital analytics.

Detailed Syllabus

Elective - Web Analytics (ANY Three)		
Expt.	Description	Duration Hrs
1.	Study of Web Analytics debugging tools.	2
2.	Finding 2 articles on web or digital analytics, with a paragraph your input.	4
3.	Assignment based on KPIs	2
4.	Assignment based on Click stream Analysis	2
	Total	8

Text Books:
Web Analytics
• Web Analytics 2.0 – The Art of Online Accountability & Science of Customer Centricity. Avinash Kaushik, Wiley Publishing, Inc. 2010, ISBN 978-470-52939-3 (Abbreviated as WA

Reference Books:
Web Analytics
• Clifton B., Advanced Web Metrics with Google Analytics, Wiley Publishing, Inc. (2010), 2nd ed
• Kaushik A., Web Analytics 2.0 The Art of Online Accountability and Science of Customer Centricity, Wiley Publishing, Inc. (2010),1st ed. 3. Sterne J.,

Program:	M. Tech. (Artificial Intelligence and Data Science)		Semester : I			
Course :	Natural Language Processing – Elective II		Code :MDS1502A			
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Pre-requisite:
• Basics of Machine Learning
• Python Programming Language
• Basics of Probability

Objectives:
1. Understand leading trends and systems in natural language processing.
2. Describe concepts of morphology, syntax, semantics and pragmatics of the language.
3. Understand Language Models and its evaluation.
4. Writing programs in Python to carry out natural language processing.
5. Implement deep learning algorithms in Python and learn how to train deep networks for NLP applications.

Outcomes:
After learning the course, the students should be able to:
1. Explain processes and representations used in syntax, semantics, and other components of natural language processing.
2. Use machine learning and deep learning algorithms for Natural Language Processing applications.
3. Explore the models used for word/sentence representations for various NLP applications.
4. Use the tools for performing text analytics in a variety of contexts.
5. Apply the different Feature Extraction and Embeddings processes.
6. Describe Mathematical and programming tools for visualization of the data.

Detailed Syllabus

Unit	Description	Duration (Hrs.)
1.	**Introduction** - terminologies -basic techniques in natural language processing, including tokenization, part-of-speech tagging, chunking, syntax parsing, Dependency parsing, named entity recognition, Co-reference Resolution Word-sense Disambiguation.	8
2.	**Text representations and embeddings: One-hot encoding, Bag-of-Words (BoW) Dictionary**: Term Frequency – Inverse Document Frequency (TF IDF), N-gram. Introduction to various nlp toolkits such as nltk, Spacy etc.	7
3.	**Introduction to Deep Learning:** Neural Networks Basics, Feed forward Neural Network, Recurrent Neural Networks, LSTM, An Introduction to Transformers and Sequence-to-Sequence Learning. Neural Networks for NLP – Vector Representation of words – Contextual Understanding of text – Co-occurrence of matrix – N-grams – Dense Word Vector.	8
4.	**Feature Extraction and Embeddings** Word2Vec – CBOW and Skip- gram Models – One-word learning architecture- Forward pass for Word2Vec – Reduction of complexity – sub-sampling and negative sampling. Continuous Skip-Gram Model, GloVe, BERT,XLNet.	8
5.	**NLP Challenges** Word sense Disambiguation NER. Named Entity Recognition, Sentiment	7

	analysis, Text categorization: Basic supervised text categorization algorithms, including Naive Bayes, k Nearest Neighbour (kNN) and Logistic Regression.		
6.	**Topic modeling:** SVD and Latent semantic Indexing, Probabilistic Latent Semantic Indexing (pLSI) and Latent Dirichlet Allocation (LDA). Introduce Mathematical and programming tools to visualize a large collection of text documents.	7
	Total	**45**

Text Books:

1. C.D. Manning et al, "Foundations of Statistical Natural Language Processing," MitPress. MIT Press, 1999. isbn: 9780262133609.
2. James Allen, "Natural Language Processing with Python", O'Reilly Media, July 2009.

Reference Books:

1. Daniel Jurafsky and James H. Martin "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition," 1st. Upper Saddle River, NJ, USA: Prentice Hall PTR, 2000. isbn: 0130950696.
2. Jacob Perkins, "Python 3 text processing with NLTK 3 cookbook," Packet Publishing Ltd, 2014.
3. Ian Goodfellow, YoshuaBengio, and Aaron Courville, Deep Learning, http://www.deeplearningbook.org. MIT Press, 2016.

Program:	M. Tech (Artificial Intelligence and Data Science)		Semester : I	
Course :	Professional Elective Lab (Elective II): Natural Language Processing		Code: MDS1503A	
Teaching Scheme			**Evaluation Scheme**				

Practical	Hours	Credit	TW	PR	OR	Total
2	2	1	50	--	50	100

Pre-requisite:
- Data Structures
- Python / R Programming

Objectives:
1. To provide practical knowledge of language processing that involves various operations that can be performed on text data.
2. To familiarize with fundamental topics in language processing that include tokenization, stemming, tagging, classification, and information extraction using Python programs.
3. To facilitate understanding of regular expressions, formal grammar that describe the structure of an unlimited set of sentences.
4. To create classifiers and choose the best classifier.
5. To perform NLP operations on existing corpora and build simple AI Applications

Course Outcomes:
Upon completing this course, students will be able to:
1. Apply the concept of natural language processing (NLP) using Natural Language Toolkit (NLTK).
2. Build text corpora with tokenization, Stemming, Lemmatization and apply visualization techniques.
3. Evaluate the classifiers and choose the best classifier.

Detailed Syllabus		
Elective NLP (ANY Three)		
Expt.	**Description**	**Duration Hrs.**
1.	Perform Automatic, N-gram and Transformation based Tagging for text data. ii) Write a program to demonstrate Mapping Words to Properties Using Python Dictionaries	**2**
2.	Implement Chatbot.	**3**
3.	Perform Tokenization, Stemming, and Lemmatization to carry out the analysis with text corpora.	**2**
4.	Classification of product reviews on ecommerce websites	**2**
	Total	**7**

Text Books:
1. Steven Bird, Evan Klein and Edward Loper, ―Natural Language Processing with Python‖, O'Reilly Media, Inc., 2009.

Reference Books:
1. Daniel Jurafsky and James H Martin. Speech and Language Processing, 2nd Edition, Pearson Education, 2009.
2. Nitin Indurkhya and Fred J. Damerau, ―Handbook of Natural Language Processing, 2[nd]Edition, Chapman and Hall/CRC Press, 2010.
3. Tanveer Siddiqui, U.S. Tiwary, ―Natural Language Processing and Information Retrieval, Oxford University Press, 2008.
4. Nitin Hardaniya, Jacob Perkins, ―Natural Language Processing: Python and NLTK‖, Packt Publishers, 2016.

Program:	M. Tech. (Artificial Intelligence and Data Science)		Semester : I			
Course :	Reinforcement Learning – Elective II		Code : MDS1502B			
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Pre-requisite: Linear Algebra, Basic Probability and Statistics, Foundations of Machine Learning.

Objectives:
1. Learn how to define RL tasks and the core principles behind the RL, including policies and value functions
2. Identify and work with tabular methods to solve classical control problems
3. Identify and use approximate solutions
4. Recognize current, advanced techniques and applications in RL

Outcomes:
After learning the course, the students should be able to:
1. Discuss some basic concepts of reinforcement learning
2. Identify concept of probability primer, joint and multiple random variable
3. Identify Prediction and Control by Dynamic Programming for MDP.
4. Analyze various reinforcement learning technologies.
5. Demonstrate different deep reinforcement learning methods.
6. Evaluate the policy optimization in RL.

Detailed Syllabus

Unit	Description	Duration Hrs
1.	**Introduction to Reinforcement Learning** Introduction and Basics of RL, Defining RL Framework, Multi-Agent Learning, Meta-learning, Ethics in RL, Applications of RL for Real-World Problems.	7
2.	**Probability Primer** Brush up of Probability concepts - Axioms of probability, concepts of random variables, PMF, PDFs, CDFs, Expectation. Concepts of joint and multiple random variables, joint, conditional and marginal distributions. Correlation and independence.	8
3.	**Markov Decision Process and and Dynamic Programming** Markov Property, Markov Chains, Markov Reward Process (MRP), Bellman Equations for MRP, Dynamic Programming: Polices (Evaluation, Improvement, Iteration, Value Iteration),Asynchronous Dynamic Programming, Generalized Policy Iteration, Efficiency of Dynamic Programming	8
4.	**Monte Carlo Methods for Model Free Prediction and Control** Overview of Monte Carlo methods for model free RL, First visit and every visit Monte Carlo, Monte Carlo control, On policy and off policy learning, Importance sampling.	7
5.	**Deep Reinforcement Learning** Deep Q-Networks, Double Deep-Q Networks(DQN, DDQN, Dueling DQN, Prioritized Experience Replay).	7

6	**Policy Optimization in RL** Introduction to Policy-based Methods, Vanilla Policy Gradient, Reinforcement Algorithm and Stochastic Policy Search, Asynchronous Actor-Critic and Asynchronous Advantage Actor-Critic (A2C, A3C), Advanced Policy Gradient (PPO, TRPO, DDPG).	**8**
	Total	**45**

Text Books:
- Richard S. Sutton and Andrew G. Barto, "Reinforcement Learning: An Introduction", 2nd Edition Link
- Alberto Leon-Garcia, "Probability, Statistics, and Random Processes for Electrical Engineering", 3rd Edition,
- Ian Goodfellow, YoshuaBengio, and Aaron Courville. "Deep learning." MIT press, 2017.

Reference Books:
- Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective"
- Keng, Wah Loon, Graesser, Laura, "Foundations of Deep Reinforcement Learning: Theory and Practice in Python", Addison Wesley Data & Analytics Series, 2020.
- Stuart J. Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach".[link]
- Marco Wiering, Martijn van Otterlo(Ed),"Reinforcement Learning, State-of-the-Art, Adaptation, Learning, and Optimization book series, ALO, volume 12, Springer, 2012.

Online Courses
- https://onlinecourses.nptel.ac.in/noc20_cs74/preview
- https://web.stanford.edu/class/cs234/
- David Silver's course on Reinforcement Learning [link]

Program:	M. Tech (Artificial Intelligence and Data Science)		Semester : I	
Course :	Professional Elective Lab : Elective II – Reinforcement Learning		Code: MDS1503B	

Teaching Scheme			Evaluation Scheme			
Practical	Hours	Credit	TW	PR	OR	Total
2	2	1	50	--	50	100

Prerequisite:
• Python

Objectives:
1. Apply reinforcement learning algorithms.
2. Apply RL applications to solve real life problems..

Outcomes:
After learning the course the students should be able to:
1. Design and apply markov decision process and dynamic programming.
2. Design and apply reinforcement learning for classification problems.
3. Design and apply applications of RL to solve real life problems.

Detailed Syllabus:

Reinforcement Learning (ANY Three)		
Expt.	Description	Duration Hrs
1.	Demonstrate markov decision process and dynamic programming	2
2.	Implement reinforcement learning for classification problems.	2
3.	Demonstrate policy optimization in RL.	2
4.	Mini Project	3
Total		7

Text Books:
• Sutton and Andrew G. Barto,Richard S, "Reinforcement Learning: An Introduction", 2nd Edition
• Alberto Leon-Garcia, "Probability, Statistics, and Random Processes for Electrical Engineering", 3rd Edition,

Reference Books:

• Keng, Wah Loon, Graesser, Laura, "Foundations of Deep Reinforcement Learning: Theory and Practice in Python", Addison Wesley Data & Analytics Series, 2020.
• Marco Wiering, Martijn van Otterlo(Ed),"Reinforcement Learning, State-of-the-Art, Adaptation, Learning, and Optimization book series, ALO, volume 12, Springer, 2012.

Program:	M. Tech. (Artificial Intelligence and Data Science)		Semester : I			
Course :	Data Warehousing and Mining		Code :MDS1502C			
Teaching Scheme			Evaluation Scheme			
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
3	3	3	20	30	50	100

Pre-requisite: Mathematics fundamentals, data structures in CPP

Objectives:
1. Understand the necessity of Data Warehousing and its continuous growth.
2. Planning and Management of Data Warehouse.
3. To know the issues in various Architectural types of Data warehouse.
4. To learn the application of various models of Data Warehouse.
5. Understand the web-enabled data warehouse and role of data mining

Outcomes:
After learning the course, the students should be able to:
1. Decide the type of Data warehouse to build.
2. Perform Requirement gathering and Design suitable architecture for Data warehouse project.
3. Design and prepare data for Data warehouse using ETL tools
4. Build web-enabled data warehouse
5. Analyze and Apply Data Mining techniques on real life applications
6. Demonstrate phases in data warehouse development life cycle with Data warehouse project.

Detailed Syllabus

Unit	Description	Duration (Hrs.)
1.	**Overview and Concept** Need for Data warehousing: Escalating need for strategic information, failure of past system, operational versus decision support systems, data warehouse defined, data warehouse movement, Evolution of Business Intelligence. Data ware housing building blocks: Data ware house and Data Marts, architecture, components, metadata Trends in warehousing: Continue growth in data warehousing, significant trends	7
2.	**Architecture and Infrastructure** Principles of dimension modeling: Dimensional modeling basics, star schema, advantages, examples. Advanced dimension modeling: updates to dimensional tables, miscellaneous dimensions, snowflake schema, Aggregate Fact tables, families of Stars. Data Extraction, Transformation, and Loading: ETL overview, requirement, Data extraction, Data Transformation, Data Loading, other integration approaches	8
3.	**Design and Data Preparation** Principles of dimension modeling: Dimensional modeling basics, star schema, advantages, examples Advanced dimension modeling: updates to dimensional tables, miscellaneous dimensions, snowflake schema, Aggregate Fact tables, families of Stars. Data Extraction, Transformation, and Loading: ETL overview, requirement, Data extraction, Data Transformation, Data Loading, other integration approaches	7

4.	**Information Access and delivery** Users of Information: Information from the data warehouse, who will use information, information delivery, delivery tools On Line Analytical Processing in the data warehouse: Demand for OLAP, major features and functions, OLAP models, OLAP implementation considerations Data warehouse and the web: Web enables data warehouse, web-based information delivery, OLAP and the WEB, building a web-enabled data warehouse	8
5.	**Data Mining** Why data mining, what is Data Mining, Data mining as a process of Knowledge Discovery ,Major issues in Data Mining, Mining Frequent Pattern, Classification : basic concept and methods, Clustering : basic concept and methods, Data Mining Trends and Research Frontiers : Mining Complex Data Types, other Methodologies of Data Mining, Data Mining Applications, Data Mining trends.	7
6.	**Implementation and Maintenance** Physical design process: Physical design steps, considerations, physical storage, indexing, performance enhancement techniques. Data warehouse development: Data warehouse testing, major deployment activity, security, backup and recovery. Growth and Maintenance: Monitoring the data warehouse, user training and support, managing the data warehouse.	8
	Total	45

Text Books:
1. Data Warehousing Fundamentals – Paulraj Ponnaiah Wiley student Edition
2. Data Mining – Concepts and Techniques - Jiawei Han &Micheline Kamber, Morgan Kaufmann Publishers, Elsevier,2nd Edition, 2006.

Reference Books:
1. Matthew A. Russell, "Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn, Google+, GitHub, and More" , Shroff Publishers, 2nd Edition, ISBN: 9780596006068
2. G.K. Gupta, "Introduction to Data Miing with Case Studies," PHI Learning Private Limited, 2nd Edition, ISBN 978-81-203-4326-9.
3. Data Warehousing in the Real World – Sam Aanhory& Dennis Murray Pearson Edition Asia.

Program:	M. Tech. (Artificial Intelligence and Data Science)		Semester : I	
Course :	Data Warehousing and mining Lab (Elective II)		Code :MDS1503C	

Teaching Scheme			Evaluation Scheme			
Practical	Hours	Credit	TW	PR	OR	Total
2	2	1	50	-	50	100

Pre-requisite:
DBMS, Data Structure

Objectives:
1. Understand the necessity of Data Warehousing and its continuous growth.
2. Planning and Management of Data Warehouse.
3. To know the issues in various Architectural types of Data warehouse

Outcomes:
After learning the course, the students should be able to:
1. Decide the type of Data warehouse to build.
2. Perform Requirement gathering and Design suitable architecture for Data warehouse project.
3. Design and prepare data for Data warehouse using ETL tools
4. Build web-enabled data warehouse

Detailed Syllabus(Any Three)

Expt.	Description	Duration (Hrs.)
1.	Extract data from different data sources, apply suitable transformations and load into destination tables using an ETL tool. For Example: Business Origination: Sales, Order, and Marketing Process.	02
2.	Extract data from different data sources, apply suitable transformations and load into destination tables using an ETL tool. For Example: Business Origination: Sales, Order, and Marketing Process.	03
3.	Case Study 1: Discuss design of data warehouse/ Data Mart for suitable system	02
4.	Case Study 2: Discovering web access patterns and trends by Data Mining Technology on web logs	02
	Total	07

Text Books:
1. Data Warehousing Fundamentals – Paulraj Ponnaiah Wiley student Edition
2. Data Mining – Concepts and Techniques - Jiawei Han & Micheline Kamber, Morgan Kaufmann Publishers, Elsevier,2nd Edition, 2006.
3. Data Warehousing in the Real World – Sam Aanhory & Dennis Murray Pearson Edition Asia.

Program:	M. Tech. (Artificial Intelligence and Data Science)	Semester : I	
Course:	Skill Development Lab-I (Python Programming)	Code: MDS1405	

Teaching Scheme			Evaluation Scheme			
Practical	**Hours**	**Credit**	**TW**	**PR**	**OR**	**Total**
2	2	1	50	--	--	50

Pre-requisite:
1. Data Structure and Problem Solving

Objectives:
1. To acquire programming skills in core Python.
2. To acquire Object Oriented Skills in Python
3. To develop the ability to draw graphs/plots in Python
4. To develop the ability to do data analysis in Python

Outcomes:
After learning the course the students should be able to:
1. Develop proficiency in creating based applications using the Python Programming Language.
2. Use various data structures available in Python programming language and apply them in solving computational problems.
3. Do data analysis using open source library Pandas and Numpy.
4. Draw various kinds of plots using Matplotlib library.

Guidelines :
• Total experiments to be conducted are Six out of eight.
• Total: 6 Experiments, 12Hours.

Detailed Syllabus

Skill Development Lab (ANY SIX)		
Expt.	**Description**	**Duration Hrs**
1.	Write a Python program which iterates the integers from 1 to a given number and print "Fizz" for multiples of three, print "Buzz" for multiples of five, print "FizzBuzz" for multiples of both three and five using itertools module.	2
2.	Write a program to compute the number of characters, words and lines in a file.	2
3.	Write a function called convert to days() that takes no parameters. Have your function prompt the user to input numbers of hours, minutes, and seconds. Write a helper function called get days() that uses these values and converts them to days in float form (fractions of a day are allowed). get days() should return the number of days. Use this helper function within the convert to days() function to display the numbers of days to the user. The built- in function round() takes two arguments: a number and an integer indicating the desired precision (i.e., the desired number of digits beyond the decimal point). Use this function to round the number of days four digits after the decimal point.	4
4.	An Armstrong number of three digits is an integer such that the sum of the cubes of its digits is equal to the number itself. For example, 371 is an Armstrong number since 33 + 73 + 13 = 371. Write a program to find all Armstrong number in the range of 0 to N.	2
5.	Write a program to create Shape class with draw method. Define two child class Circle and Square and override draw method. Use OOPs Polymorphism and	2

	Inheritance concepts.	
6.	The celebrity problem is the problem of finding the celebrity among n people. A celebrity is someone who does not know anyone (including themselves) but is known by everyone. Write a Python program to solve the celebrity problem.	**2**
7.	Consider appropriate dataset in CSV format and solve following questions using pandas • Print first 5records • Apply data cleaning concepts. • Print last 10 records • Apply data analysis operations • Print analysis in graphical format using Matplotlib library	**3**
	Total	**15**

Text Books:
1. Allen B Downey, "Think PYTHON", O'Rielly, ISBN: 13:978-93-5023-863-9, 4th Indian Reprint2015
2. Peng, Roger D and Elizabeth Matsui, "The Art of Data Science - A Guide for Anyone Who Works with Data" Skybrude Consulting 200 (2015):162

Reference Books:
1. Zed A. Shaw, "Learn Python the HardWay"
2. Narsimha Karumanchi, "Data Structures and Algorithmic Thinking withPython"

Course Syllabus

Semester-II

Program:	M. Tech. (Artificial Intelligence and Data Science)		Semester : II			
Course :	Deep Learning		Code : MDS2406			
Teaching Scheme			**Evaluation Scheme**			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Pre-requisite: Programming is the fundamental, Statistics, Statistics refer to the study of using data and its visualization, Calculus forms the basis for many machine learning algorithms, Linear Algebra, Probability, Data Science.

Objectives:
1. To Introduce deep learning (DL) algorithms including convolutional neural networks (CNN), recurrent neural networks (RNN) and its variants viz. LSTM and GRU
2. To train on how to fine tune hyperparameters of DL algorithms
3. To impart concepts that help identify suitable applications for CNN, RNN, LSTM and GRU and study them

Outcomes:
After learning the course, the students should be able to:
1. Discuss algorithms simulating the human brain.
2. Explore the essentials of Deep Learning and Deep Network architectures.
3. Define, train and use a Deep Neural Network for solving real world problems that require artificial Intelligence based solutions.
4. Apply Deep Learning methods for given problem
5. Make use of appropriate DL algorithm to solve the problem with appropriate hyper parameter setting
6. Impart concepts that help identify suitable applications for CNN, RNN, LSTM and study them

Detailed Syllabus

Unit	Description	Duration Hrs
1.	**Introduction -** History of Neural networks and Deep Learning. How Biological Neurons work? Growth of biological neural networks. Diagrammatic representation: Logistic Regression and Perceptron, Multi-Layered Perceptron (MLP). Notation. Training a single-neuron model. Training an MLP: Chain rule, Training an MLP: Memoization, Backpropagation algorithm. Activation functions. Vanishing Gradient problem. Bias-Variance tradeoff.	8
2.	**Deep Learning: Deep Multi-layer perceptrons** Deep Multi-layer perceptrons: 1980s to 2010s, Dropout layers & Regularization. Rectified Linear Units (ReLU). Weight initialization. Batch Normalization. Optimizers: Hill-descent analogy in 2D Optimizers: Hill descent in 3D and contours. SGD recap. Batch SGD with Momentum. Nesterov Accelerated Gradient (NAG)	8
3.	**Optimizers:** AdaGrad, Optimizers: Adadelta and RMSProp, Adam, Which algorithm to choose when? Gradient Checking and Clipping. Softmax and cross-entropy for multi-class classification. How to train a Deep MLP? Auto Encoders. Word2Vec: CBOW. Word2Vec: Skip-gram, Word2Vec: Algorithmic Optimizations.	7
4.	**Convolution Neural Networks.** Biological inspiration: Visual Cortex, Convolution: Edge Detection on images. Convolution: Padding and strides, Convolution over RGB images. Convolutional layer. Max-pooling. CNN Training: Optimization Example CNN: LeNet [1998], ImageNet dataset, Data Augmentation. Convolution Layers in Keras, AlexNet, VGGNet, Residual Network. Inception Network. What is Transfer Learning?	8

5.	**Recurrent Neural Networks (RNNs) - Long Short-Term Memory (LSTMS)** Why RNNs? Recurrent Neural Network. Training RNNs: Backprop. Types of RNNs. Need for LSTM/GRU.LSTM. GRUs. Deep RNN. Bidirectional RNN. Dialogue Generation using LSTM	**7**
6.	**Applications of Deep Learning** Generative Adversarial Networks(GANs), Encoder-Decoder Models, Attention Models in Deep Learning, Introduction to Image Segmentation, Sentiment analysis	**7**
Total		**45**

Text Books:

1. Simon Haykins, "Neural Network- A Comprehensive Foundation", Pearson Prentice Hall, 2nd Edition, 1999. ISBN-13: 978-0-13-147139-9/ISBN-10: 0-13-147139-2
2. Nikhil Buduma, Nicholas Locascio, "Fundamentals of Deep Learning: Designing NextGeneration Machine Intelligence Algorithms", O'Reilly Media, 2017.

Reference Books:

1. Ian Goodfellow, YoshuaBengio, Aaron Courville, "Deep Learning (Adaptive Computation and Machine Learning series", MIT Press, 2017.
2. M T Hagan, H B Demoth, M Beale, "Neural Networks Design", Thomson Learning, 2002. ISBN10: 0-9717321-1-6/ ISBN-13: 978-0-9717321-1-7
3. Dr. S.D. Sharma, " Operational Research", Kedar Nath Ram Nath & Co.

Program:	M. Tech. (Artificial Intelligence and Data Science)		Semester : II	
Course :	Big Data Technology		Code : MDS2407	
Teaching Scheme			**Evaluation Scheme**				

Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Prerequisite: Introduction to Probability theory, Statistics, Python/R

Objectives:
1. To identify the big data concepts and big data analytics lifecycle
2. To learn the big data analytics algorithms and tools
3. To study the importance of big data visualization tools and techniques
4. To get acquainted with advancements in tools and techniques used for big data analytics

Outcomes:
After learning the course, the students should be able to:
1. Interpret the data analytics life cycle for selected problem statement.
2. Discuss various technologies for the big data
3. Demonstrate the use of Hadoop and its ecosystem elements to analyze big data.
4. Apply different programming platforms for big data analytics.
5. Make a use of visualization tools for Big data applications.
6. Summarize the case studies using big data analytics

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	**Basics of Big Data** Big data characteristics, types, sources, architectures, Data analysis process, Data analytics lifecycle, Preprocessing data, Market and Business Drivers for Big Data Analytics, Business Problems Suited to Big Data Analytics Case Studies : Case study on data analytics lifecycle	7
2.	**Technologies for big data analytics** Distributed and Parallel Computing for Big Data, Cloud Computing and Big Data, In-Memory Computing Technology for Big Data, Introduction to Hadoop, HDFS, MapReduce, YARN, HBase, Combining HDFS and HBase. Case Studies : Using MapReduce to scale algorithms for Big Data analytics	8
3.	**Hadoop ecosystem for big data analytics** Hadoop ecosystem: Sqoop, Impala, Apache Flume, Pig, Hive, Data transformation and analysis using Pig, Data analysis using Hive and Impala, Mahout, Oozie, Zookeeper etc. Case Studies: Sentiment analysis	7
4.	**Big data analytics with Apache Spark** Apache Spark, Spark core, Interactive data analysis with spark shell, Writing a spark application, Spark RDD Optimization Techniques, Spark Algorithm, Spark SQL Case Studies : Big data for maintaining HER: healthcare records	7
5.	**Programming languages for Big data analytics** Big data analytics with PySpark: Python and Apache Spark Big data analytics with RHadoop: R and Hadoop, Text mining in RHadoop, Data mining in Hive, Data Analysis MapReduce techniques using RHadoop. Case Studies : Cloudera platform: western union bank	8

6	**Visualization techniques and tools for big data** Visualizing Big Data, Importance of data visualization, Challenges, Need for advanced visualization techniques, Tools used in data visualization, Big Data Visualization with R/Python/Tableau/other tools Case Studies(if any) Industrial Big Data Visualization: A Case Study Using Flight Data Recordings.	8
	Total	**45**

Text Books:
1. DT Editorial Services, Big Data, Black Book, DT Editorial Services, ISBN: 9789351197577, 2016 Edition.
2. Tom White " Hadoop: The Definitive Guide" Fourth Edit on, O'reily Media, 2015

Reference Books:
1. "Big Data Analytics", Seema Acharya, SubhasiniChellappan, Second Edition, 2019, Wiley India Pvt.Ltd, ISBN 978-81-2657-951-8.
2. Mueller Massaron, Python for Data science, Wiley, ISBN :978812655739 4. Judith Hurwitz, Alan Nugent, Big Data For Dummies, Wiley India, ISBN : 9788126543281 5. Michael Mineli, Michele Chambers, Ambiga Dhiraj, "Big Data, Big Analytics: Emerging
3. Alex Holmes, Hadoop in practice, Dreamtech press, ISBN:9781617292224. 8. Arvind Sathi, Big Data Analytics: Disruptive Technologies for Changing the Game, IBM Corporation, ISBN:978-1-58347-380-1.

Program:	M. Tech. (Artificial Intelligence and Data Science)		Semester: II	
Course:	Professional Core Lab-II: Deep Learning and Big Data Technology		Code :MDS2408	
Teaching Scheme			**Evaluation Scheme**			

Practical	Hours	Credit	TW	PR	OR	Total
2	2	1	50	-	50	100

Pre-requisite:
- Programming is the fundamental, Statistics, Statistics refer to the study of using data and its visualization

Objectives:
1. To find optimized solutions for a given problem.
2. To implement, train, and validate the neural network, and improve understanding of various application areas of Deep Learning.
3. To study the importance of big data visualization tools and techniques
4. To get acquainted with advancements in tools and techniques used for big data analytics

Outcomes:
After learning the course, the students should be able to:

1. Implement various deep learning algorithms.
2. Design and implement Deep Neural network systems.
3. Design and apply CNN for Object detection and RNN for image captioning.
4. Apply different programming platforms for big data analytics.
5. Develop results for selected problem statements through visualization techniques.
6. Demonstrate the use of Hadoop and its ecosystem elements to analyze big data.

Detailed Syllabus:

Part A: Deep Learning (Any Three)		
Expt.	**Description**	**Duration (Hrs.)**
1.	Train a Deep learning model to classify a given image using a pre-trained model.	02
2.	Object detection using Convolution Neural Network.	02
3.	Study the effect of batch normalization and dropout in neural network classifiers.	02
4.	Perform Sentiment Analysis in network graph using RNN	04
	Total	08

Part B: Big Data Technology (Any Three)		
Expt.	**Description**	**Duration (Hrs.)**
1.	Installation of Hadoop & R	02
2.	Demonstrate application of Apache spark to analyze streaming data from social media. (Installation of multi-node Hadoop as well as Spark is to be done by students.)	02
3.	Building Hadoop MapReduce Application for counting frequency of words/phrase in simple text file	03
4.	Take any text or image dataset (e.g. Stanford Sentiment Treebank, Sentiment140, Amazon Product data) and perform analysis on it.	02
	Total	07

Text Books:
1. Goodfellow I., Bengio,Y., and Courville, A., "Deep Learning", MIT Press, 20
2. Umberto Michelucci "Applied Deep Learning. A Case-based Approach to Understanding Deep Neural

	Networks" Apress, 2018.
	3. Alex Holmes, Hadoop in practice, Dreamtech press, ISBN:9781617292224. 8. Arvind Sathi, Big Data Analytics: Disruptive Technologies for Changing the Game, IBM Corporation, ISBN:978-1-58347-380-1.
Reference Books:	
	1. Explore neural networks with Python", Packt Publisher, 2017
	2. Josh Patterson, Adam Gibson, "Deep Learning: A Practitioners Approach", O"REILLY, SPD, ISBN: 978-93-5213- 604-9, 2017 Edition 1st.
	3. "Big Data Analytics", Seema Acharya, SubhasiniChellappan, Second Edition, 2019, Wiley India a. Pvt.Ltd, ISBN 978-81-2657-951-8.
	4. Mueller Massaron, Python for Data science, Wiley, ISBN :978812655739 4. Judith Hurwitz, Alan Nugent, Big Data For Dummies, Wiley India, ISBN : 9788126543281 5. Michael Mineli, Michele Chambers, Ambiga Dhiraj, "Big Data, Big Analytics: Emerging

Program:	M. Tech. (Artificial Intelligence and Data Science)		Semester : II			
Course :	Industrial IoT and ML – Elective III		Code :MDS2504A			
Teaching Scheme			**Evaluation Scheme**			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Pre-requisite:
1. Basic knowledge on Python Programming
2. Basic knowledge on Machine Learning

Objectives:
1. Understand the general concepts in IoT and get familiar with the various hardware and software components of it
2. Understand how to build real-life IoT based projects for different application domains
3. Hands-on training to implement IoT with Raspberry Pi

Outcomes:
After learning the course, the students should be able to:
1. Explain the architecture, the design principles and elements of IoT.
2. Gain the necessary skills needed to build Machine learning models for edge devices
3. Discuss IOT aplication using different communication models
4. Evaluate scalable real-life IoT systems for different application domains
5. Build scalable ML pipeline using Flask, Python, uWSGI, TensorFlow

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	**Introduction to IoT,** Architectural Overview and Design Principles, Elements of IoT (Arduino, Raspberry Pi, Node MCU, Sensors & Actuators), Industrial Internet of things (IIoT) IoT enabling technologies (WSN, Cloud Computing, Big Data Analytics, RFID, **IoT Applications,** Sensing, Actuation, Networking Basics, Embedded OS, IoT and Cloud, Security aspects in IoT NFC),	7
2.	**Types of boards** - Arduino, Raspberry-pi, Interfacing of sensors with development boards. Roles of sensors & actuators, **Types of sensors**, Active and passive, analog and digital, Contact and no-contact, Absolute and relative Working of **Sensors:** position, occupancy and motion, velocity and acceleration, force, pressure, flow, Acoustic, Humidity, light, radiation, temperature, chemical, biosensor, camera. Development Boards:	8
3.	**IoT Application Development,** Introduction to Raspberry Pi, Integrating Sensors and Actuators with Raspberry Pi, Pushing and Managing Data in IoT Clouds, IoT communication models,	8
4.	**Programming APIs** IoT communication APIs (Representational State Transfer (REST) API, Web Socket Based Communication APIs), IoT issues and challenges, IoT reference architecture, (Python/Node.js/Arduino) for communication protocols (MQTT, ZigBee, Bluetooth, UDP, TCP), Implementation of IoT with Raspberry Pi (lab - sensor, MQTT, visualization)	8
5.	**Introduction to ML and Deep learning models for IoT** (challenges, opportunities, solutions), Sensor data classification using ML in Raspberry Pi (lab)	6
6	**Introduction to TensorFlow Lite,** Image classification on Raspberry Pi (lab), object detection on Raspberry Pi (optional lab), building scalable ML pipeline using Flask, Python, WSGI, Tensor Flow	8
Total		45

Text Books:
1. Vijay Madisetti, ArshdeepBahga, ¨Internet of Things, "A Hands on Approach", University Press
2. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill

Reference Books:
1. Elaine Rich and Kevin Knight, "Artificial Intelligence", Tata McGraw Hill
2. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach" , 3rd Edition, Prentice Hall
3. https://www.tensorflow.org/lite/tutorials

Program:	M. Tech (Artificial Intelligence and Data Science)		Semester :II	
Course :	Professional Elective Lab : Industrial IoT and ML Lab		Code: MDS2506A	
	Teaching Scheme		**Evaluation Scheme**	

Practical	Hours	Credit	TW	PR	OR	Total
2	2	1	50	--	50	100

Pre-requisite:
Web Analytics

Objectives:

1. Equip students with the mindset, concepts, terminology, knowledge, skills and processes in the field of web analytics
2. Train students with web analytics skills by utilize real-world examples and projects

Outcomes:
After learning the course the students should be able to:
1. To interpret website visitors view and interact with a site's pages and features, and business intelligence.
2. To design the customer purchasing patterns, demographics, and demanding trends to make effective strategic decisions.

Guidelines :

• The laboratory assignments are to be submitted by student in the form of journal.

Journal consists of Certificate, table of contents, and handwritten write-up of each assignment (Title, Date of Completion, Objectives, Problem Statement, Software & Hardware requirements, Assessment grade/marks and assessor's sign, Theory- Concept in brief, algorithm, flowchart, test cases, Test Data Set(if applicable), mathematical model (if applicable), conclusion/analysis. Program codes with sample output of all performed assignments are to be submitted as softcopy.

Guidelines for Laboratory Conduction

• Operating System recommended :- 64-bit Open source Linux or its derivative Programming tools recommended: - Data Mining Tool like WEKA , R Studio for R Programming, Anaconda for Python programming, Arduino IDE Hardware Requirement: Various sensors as per selected application: Temperature Sensor , Humid

Detailed Syllabus

IoT & ML Lab (ANY Three)		
Expt.	**Description**	**Duration (Hrs)**
1.	Programming for IOT : R- programming, Python Libraries, Azure Cloud platform Examining Machine Learning for IoT Develop an Application on Arduino/Raspberry-Pi to capture the values of temperature sensor after every 15 sec of time interval, store this values in .csv format and predict the temperature at particular time t using linear regression analysis. Hint: Create the dataset of at least 20-25 instances, use any data analysis tool (WEKA/R)	2
2.	1. Deploy your first IoT Edge module to a Linux device 2. Deploy your first IoT Edge module to a Windows device 3. Things Speak for IoT 4. Collect the sensor data on private cloud using Things Speakt. (Any Two)	3
3.	First Machine Learning with Python 1. Download the Dataset of your choice 2. Divide the dataset into Training data and Testing data.	2

4.	Perform the classification of the instances using any machine learning algorithm like KNN Algorithm, Naïve Bayes, Decision Tree or any. Evaluate the machine learning model by considering the parameter (TPR, TNR, FPR, FNR, accuracy, precision, recall, error rate etc.	**2**
	Total	**7**

Text Books:
1. Web Analytics 2.0 – The Art of Online Accountability & Science of Customer Centricity. Avinash Kaushik, Wiley Publishing, Inc. 2010, ISBN 978-470-52939-3

Reference Books:
1. Clifton B., Advanced Web Metrics with Google Analytics, Wiley Publishing, Inc. (2010), 2nd ed
2. Kaushik A., Web Analytics 2.0 The Art of Online Accountability and Science of Customer Centricity, Wiley Publishing, Inc. (2010),1st ed. 3. Sterne J.

Program:	M. Tech. (Artificial Intelligence and Data Science)		Semester : II	
Course :	Healthcare Data Analytics – Elective III		Code : MDS2504B	
Teaching Scheme			**Evaluation Scheme**	

Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Prior Knowledge of
Foundations of data science is essential

Objectives:
1. To learn the data analytics for biomedical images
2. To learn different clinical Prediction models and real time applications in the healthcare sector.

Outcomes:
By the end of the course, students should be able to
1. Describe the basics of healthcare data analytics.
2. Use biomedical image features and perform data analytics.
3. Apply natural language processing for data analytics
4. Use prediction models for healthcare data analytics.
5. Interpret genomic and clinical data for healthcare data analytics.
6. Explain data analytics applications for healthcare.

Detailed Syllabus

Unit	Description	Duration Hrs
1.	**Introduction** Introduction to Healthcare Data Analytics- Electronic Health Records–Components of EHR- Coding Systems- Benefits of EHR- Barrier to Adopting HER, Challenges- Phenotyping Algorithms.	7
2.	**Biomedical Image Analysis** Biomedical image modalities, Object detection, image segmentation, image registration, feature extraction **Genomic Data Analysis for Personalized Medicine** Genomic data generation, methods for data analysis, types of computational genomics studies towards personalized medicine	8
3.	**Data Analysis using Natural language Processing for healthcare** Natural Language Processing, Mining information from Clinical Text, challenges of processing clinical reports, applications, Social Media Analytics for healthcare.	8
4.	**Clinical Prediction Models and Data Mining for Healthcare data** Basic Statistical Prediction Models, Alternative Clinical Prediction Models, Survival Models. Association Analysis, Temporal Pattern Mining: Sequential Pattern Mining, Time-Interval Pattern Mining.	8
5.	**Visual Analytics and Integrating data for Healthcare-** Medical data visualization, visual analytics for public health and population research, clinical workflow, clinicians, patients. Predictive Models for Integrating Clinical and Genomic Data	7
6.	**Applications** Applications and Practical Systems for Healthcare– Data Analytics for Pervasive Health- Fraud Detection in Healthcare- Data Analytics for Pharmaceutical Discoveries- Clinical Decision Support Systems, Analysis of Data from Online Doctor and Patient Communities.	7
	Total	45

Text Books:

1. Chandan K. Reddy and Charu C Aggarwal, "Healthcare data analytics", Taylor & Francis, 2015

2. Hui Yang and Eva K. Lee, "Healthcare Analytics: From Data to Knowledge to Healthcare Improvement, Wiley, 2016.

Reference Books:

1. Tinglong Dai, Sridhar Tayur , "Handbook of Healthcare Analytics", Wiley, 2018.

2. Anand J Kulkarni, Patrick Siarry,"Big Data Analytics in healthcare",Springer,Studies in Big Data

Program:	M. Tech. (Artificial Intelligence and Data Science)		Semester : II	
Course :	Healthcare Data Analytics Lab		Code : MDS2506B	
Teaching Scheme			**Evaluation Scheme**	

Practical	Hours	Credit	TW	PR	OR	Total
2	2	1	50	-	50	100

Prior Knowledge of
Foundations of data science
is essential.

Objectives:
1. To apply visual data analytics and text mining on any healthcare dataset.
2. To perform Genomic data analysis for personalized medicine.

Outcomes:
After learning the course, the students should be able to:
 1. Apply healthcare data Analytics on image dataset.
 2. Apply data mining algorithms on facebook or twitter data.
 3. Apply mining task of information on clinical text data.

Detailed Syllabus

Expt.	Problem Statement	Duration (Hrs)
1.	Write a program for data visual analytics using any healthcare image dataset.	2
2.	Write a program to perform Genomic Data Analysis for Personalized Medicine	3
3.	Write a program for Clinical Text data mining	2
	Total	**7**

Text Books:
1.   Chandan K. Reddy and Charu C Aggarwal, "Healthcare data analytics", Taylor & Francis, 2015
2.   Hui Yang and Eva K. Lee, "Healthcare Analytics: From Data to Knowledge to Healthcare Improvement, Wiley, 2016.

 Reference Books:

  1. Tinglong Dai, Sridhar Tayur , "Handbook of Healthcare Analytics", Wiley, 2018

  2. Anand J Kulkarni, Patrick Siarry,"Big Data Analytics in healthcare",Springer,Studies in Big Data

Program:	M. Tech. (Artificial Intelligence and Data Science)				Semester : II	
Course :	Advanced Data Visualization and Analytics – Elective III				Code :MDS2504C	
	Teaching Scheme			Evaluation Scheme		
Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Pre-requisite:
1. Basics of Machine Learning
2. Python Programming Language
3. Basics of Probability

Objectives:
1. This course will provide knowledge on visualization design principles and deciding the type of visualization chart to choose for the given sets
2. This course will teach on creating simple to advanced chart types using python modules and libraries.
3. This course will explore, visualize and analyze various types of data sets such as time series, Geospatial and multimodal data.
4. This course helps the students to work on visualization tools and enable the students tounderstand the visual analytics such as dashboards and storytelling with a hands-on tutorial ontableau and PowerBI.

Outcomes:
After learning the course, the students should be able to:
1. Explain the importance of Data Visualization
2. Describe how to create basic charts by applying visualization design principles
3. Interpret the advanced visualization of time series data
4. Explore and Analyse Time series, Geospatial and multimodal data
5. Build interactive/animated dashboards and construct data stories.
6. Summarize important trends/patterns in the datasets

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	**Overview of Data Visualization** Importance and benefits of good data visualization– Design principles - Introduction to python libraries for visualization: seaborn, plotly express, pygal- Exploring Data – Reduce Items and Attributes: Filter and Aggregate.	8
2.	**Creation of basic visualization** Histogram, Bar (Vertical and Horizontal) and Line Chart, Box plot, Scatter plot (Examples and Exercises to be given for practice). Color palettes – Creation of 3D Charts. Creation of Advanced Visualization: Heat Map– Facet Grid – Interaction Techniques: Manipulate View – Creation of interactive Network topologies and Trees	8
3.	**Visualization of Time series data** Summary statistics and plotting aggregated views - Visualization of seasonality, trends and noise– working with multiple time series data.	7
4.	**Case study - Visualization of Geospatial data** spatial join - overlaying geospatial data to maps and adding special cues - Case Study-Visualization of multimodal data and analysis-case study sensor data and health care, genome and biomedical data.	8
5.	**Business Analytics and Visualization Tools** Tableau, PowerBI, Creating Interactive Dashboards and charts to organize data using visualization principles-	8
6.	**Data Storytelling** reading data in-depth, identifying critical, messages and communicating these messages in most effective way	6

Total	45

Text Books:
1. Tamara Munzner, Visualization Analysis and Design, A K Peters Visualization Series, CRC Press, 2014.
2. Scott Murray, Interactive Data Visualization for the Web, O'Reilly, 2013.
3. VanderPlas J. Python data science handbook: essential tools for working with data O'Reilly Media. Inc",2016

Reference Books:
1. Alberto Cairo, The Functional Art: An Introduction to Information Graphics and Visualization, New Riders, 2012
2. Nathan Yau, Visualize This: The Flowing Data Guide to Design, Visualization and Statistics, John Wiley & Sons, 2011.

Program:	M. Tech. (Artificial Intelligence and Data Science)		Semester : II		
Course :	Advanced Data Visualization and Analytics lab: Elective III		Code :MDS2506C		
Teaching Scheme			**Evaluation Scheme**			
Practical	Hours	Credit	TW	PR	OR	Total
2	2	1	50	-	50	100

Pre-requisite:
1. Basics of Machine Learning
2. Python Programming Language

Objectives:
1. To learn visual analytics with a hands-on tutorial using Tableau, a leading self-service data visualization tool.
2. Learn to create effective charts and interactive dashboards

Outcomes:
After learning the course, the students should be able to:
1. Describe the main concepts of data visualization
2. Create ad-hoc reports, data visualizations, and dashboards using Tableau Desktop
3. Publish the created visualizations to Tableau Server and Tableau Public.

Detailed Syllabus(Any Three)

Expt.	Description	Duration Hrs
1.	Create common visualizations (bar charts, line charts etc. Pie Charts ,Scatter Plots ,Heat maps)	02
2.	Implement binning visualizations for any real time dataset, Implement linear regression techniques	02
3.	Visualize the clusters for any synthetic dataset, Implement the program for converting the clusters into histograms	02
4.	Write a program to implement agglomerative clustering technique, write a program to implement divisive hierarchical clustering technique	03
	Total	07

Text Books:
1. Visualization Analysis & Design by Tamara Munzner (2014) (ISBN 9781466508910)
2. VanderPlas J. Python data science handbook: essential tools for working with data O'Reilly Media. Inc",2016

Program:	M. Tech. (Artificial Intelligence and Data Science)			Semester : II			
Course :	Video Analytics using AI – Elective IV			Code :MDS2505A			
	Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total	
3	3	3	20	30	50	100	

Pre-requisite: Mathematics fundamentals, data structures in CPP

Objectives:
1. To learn computer video fundamentals knowledge
2. To know about video types and its analysis
3. To know video coding standards
4. To learn AI based video analytics examples.

Outcomes:
After learning the course, the students should be able to:
1. Discuss video formation and representation
2. Interpret the video coding standards and compression techniques
3. Explain concepts of vector quantization
4. Apply video analytics for AI application
5. Apply video analytics for object detection and recognition in video.
6. Apply video analytics for video surveillance system.

Detailed Syllabus

Unit	Description	Duration (Hrs.)
1.	**Video Formation, Perception, and Representation** Color Perception and Specification. Video Capture and Display. Analog Video Raster. Analog Color Television Systems. Digital Video. Video Sampling- Basics of the Lattice Theory. Sampling over Lattices. Sampling of Video Signals. Filtering Operations in Cameras and Display Devices	8
2.	**Video Analytics** Analog Video signal, Analog video standards, Analog video equipment, Digital Video Signal, Digital video Standards, digital Video Processing. Video Compression: Basic Concepts and Techniques of Video Coding and the H.264 Standard, MPEG1and MPEG-2Video Standards.	8
3.	**Vector Quantization, Subband Coding** Structure of vector quantizer, VC Codebook Design, Practical VQ Examples, Fractal Compression, Subband Coding: sub band decomposition, coding of subbands.	6
4.	**AI Based Application of Video Analytics** Object Tracking , object detection, Loitering detection, People counting, Automatic number plate detection, motion detection, Automatic number plate recognition , crowd detection, Facial detection and recognition, optical character recognition	7
5.	**Object Detection and Recognition in Video** Texture models Image and Video classification models- Object tracking in Video. Applications and Case studies- Industrial- Retail-Transportation& Travel Remote sensing. Video Analytics for business Intelligence using AI.	8
6.	**Intelligent Video Surveillance Systems** Basics of Video Processing and Motion Analysis, Background Modeling. Object Classification and Detection. Human Activity Recognition. Object Tracking. Camera Networks for Surveillance. Surveillance Systems and Applications. Emerging Techniques in Visual Surveillance System	8
	Total	**45**

Text Books:
1. Video Processing and Communications, Yao Wang, J. Osternann and QinZhang, Pearson Education
2. A.M. Dhake, Television and video Engineering, TMH Publication, 2nd Edition
3. A.M. Tekalp,Digital Video, PrenticeHall, 1995

Reference Books:
1. R.G.Gupta, Audio and Video Systems, McGraw Hill l Education (India), 2nd Edition,2010.
2. Kelthjack, Video Demystified: A Handbook for the Digital Engineer,5th Edition, Newnes, 2007.
3. Intelligent Video Surveillance Systems Jean-Yves Dufour
4. Akramullah, S. (2014). Video Coding Standards. In: Digital Video Concepts, Methods, and Metrics. Apress, Berkeley, CA. https://doi.org/10.1007/978-1-4302-6713-3_3
5. Maheshkumar H Kolekar , Intelligent Video Surveillance Systems An Algorithmic Approach , Chapmanand Hall/CRC208 Pages 94 B/W Illustrations, ISBN 9781498767118, 2018

Program:	M. Tech. (Artificial Intelligence and Data Science)			Semester : II			
Course :	Video Analytics using AI Lab – Elective IV			Code : Code :MDS2506A			
Teaching Scheme			**Evaluation Scheme**				
Practical	**Hours**	**Credit**	**TW**	**PR**	**OR**	**Total**	
2	2	1	50	--	50	100	

Pre-requisite:
1. Mathematics fundamentals,
2. Data structures in CPP

Objectives:
1. To learn Computer video fundamentals knowledge
2. To know about video types and its analysis
3. To know video coding standards
4. To learn AI based video analytics examples.

Outcomes:
After learning the course, the students should be able to:
1. Interpret video analytics based application
2. Apply video analytics for object detection and recognition in video.
3. Apply video analytics for video surveillance system.

Detailed Syllabus

Expt.	Description	Duration Hrs
1.	Case study on AI Based Application of Video Analytics	**02**
2.	Design and Implementation of Face Recognition	**02**
3.	Design and implement object detection as a task in computer vision	**04**
	Total	**08**

Text Books:
1. Visualization Analysis & Design by Tamara Munzner (2014) (ISBN 9781466508910)
2. Vander Plas J. Python data science handbook: essential tools for working with data O'Reilly Media. Inc",2016

Program:	M. Tech. (Artificial Intelligence & Data Science)			Semester : II		
Course :	Recommender System – Elective IV			Code:MDS2505B		
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
3	3	3	20	30	50	100

Prerequisite:
1. Linear Algebra
2. Machine Learning Crash Course

Objectives:
1. Understand the basics of information retrieval and recommender system.
2. Introduce the techniques for collaborative filtering and content-based recommendation.
3. Impart the knowledge on design approaches for hybrid recommendation system.
4. Evaluate the recommender system to provide quality recommendation.
5. Learn the recent developments of recommender systems.

Outcomes:
After learning the course, the students should be able to:
1. Explain the concept of information retrieval and recommender systems.
2. Analyze and Apply the techniques for collaborative filtering
3. Analyze and apply the content-based recommendation system
4. Analyze and apply the hybrid approaches of recommendation system
5. Evaluate the recommendation system to provide quality recommendation
6. Identify the recent developments of recommender systems

Detailed Syllabus

Unit	Description	Duration (Hrs)
1.	**Introduction** Introduction: Overview of Information Retrieval, Retrieval Models, Relevance Feedback, User Profiles, Understanding ratings, Matrix Operations, Recommender system functions, Covariance matrices, Applications of recommendation systems, Issues with recommender system	8
2.	**Collaborative Filtering** Collaborative Filtering: User-based nearest neighbor recommendation, Item-based nearest Neighbor recommendation, Model based and pre-processing based approaches, Attacks on collaborative recommender systems.	8
3.	**Content-based recommendation** Content-based recommendation: High level architecture of content-based systems, Content Representation and Content Similarity, Similarity based retrieval, Classification algorithms, Advantages and drawbacks of content based filtering, Knowledge based recommendation: Knowledge representation and reasoning, Constraint based recommenders, Case based recommenders.	8
4.	**Hybrid approaches** Hybrid approaches: Opportunities for hybridization, Monolithic hybridization design: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching, Mixed, Pipelined hybridization design: Cascade Meta-level, Limitations of hybridization strategies	8
5.	**Evaluation** Evaluating Recommender System: Introduction, General properties of evaluation research, Evaluation designs, Evaluation on historical datasets, Error metrics, Decision-Support metrics, User-Centered metrics	6

6.	**Recent Developments of Recommender Systems** Recommender Systems and communities: Communities, collaboration and recommender systems in personalized web search, Social tagging recommender systems, Trust and recommendations, Group recommender system	7
	Total	**45**

Text Books:
1. Jannach D., Zanker M. and FelFering A., "Recommender Systems: An Introduction", Cambridge University Press(2011), 1st ed.
2. Ricci F., Rokach L., Shapira D., Kantor B.P., "Recommender Systems Handbook", Springer(2011), 1st ed.

Reference Books:
1. Manouselis N., Drachsler H., Verbert K., Duval E., "Recommender Systems For Learning", Springer (2013), 1st ed.

Program:	M. Tech (Artificial Intelligence and Data Science)		Semester :II	
Course :	Recommender System Lab : Elective IV		Code: MDS2506B	
Teaching Scheme			**Evaluation Scheme**			

Practical	Hours	Credit	TW	PR	OR	Total
2	2	1	50	--	50	100

Prerequisite:
- Python
- Tensorflow

Objectives:
1. Apply the collaborative filtering and content-based recommendation for real life application.
2. Apply the hybrid approaches for real life application.

Outcomes:
After learning the course the students should be able to:
1. Design and apply collaborative filtering and content-based recommendation.
2. Design and apply hybrid approaches for recommendation.
3. Design and apply recommendation techniques for real life problems.

Detailed Syllabus:

Recommender System (ANY Three)		
Expt.	**Description**	**Duration Hrs**
1.	Demonstrate collaborative filtering to recommend movies to the user.	2
2.	Demonstrate content-based recommendation to recommend books to the user.	2
3.	Demonstrate hybrid approach recommendation to provide personalized recommendation to the user.	2
4.	Mini Project	4
Total		8

Text Books:
1. Ricci F., Rokach L., Shapira D., Kantor B.P., "Recommender Systems Handbook", Springer(2011), 1st ed. 1

Reference Books:
2. Manouselis N., Drachsler H., Verbert K., Duval E., "Recommender Systems For Learning", Springer (2013), 1st ed.

Program:	M. Tech. (Artificial Intelligence and Data Science)			Semester : II			
Course :	Computer Vision:- Elective IV			Code :MDS2505C			
	Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total	
3	3	3	20	30	50	100	

Pre-requisite:
Linear Algebra, Artificial Intelligence Fundamentals

Objectives:
1. To introduce students to the state of the art algorithms in the area of image analysis and object recognition
2. Give an exposure to video analysis techniques for object tracking and motion estimation
3. To build good understanding on the computer vision concepts and techniques to be applied for robotic vision applications
4. Enable students to apply the vision algorithms and develop applications in the domain of image analysis, robotic navigation

Outcomes:
After learning the course, the students should be able to:
1. Identify detailed models of image formation
2. Explore the techniques of image analysis through image feature extraction and object recognition.
3. Introduce fundamental algorithms for video analysis such as object tracking, motion segmentation etc.
4. Explore major technical approaches involved in image registration, camera calibration, pose estimation, stereo vision.
5. Apply computer vision algorithms for robotic applications.

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	**Image Formation** Geometric premitives and transformation-2D transformation, 3D transformation, Radiometry-Measuring Light, Sources, Shadow & Shading, Image Models, Photometric Image Formation-Lighting, Reflectance and Shading.	7
2.	**Analytical Image Features** Image Segmentation, Feature Extraction-Detection, Edge operators, Local Processing, Global Processing, Elements of Analytical Euclidean Geometry, Geometric Camera Parameters, Calibration Methods, Feature analysis and Extraction, Color.	8
3	**Early Vision: One Image** Linear Filters-Linear Filters and Convolution, Shift Invarient Linear System, Sampling and aliasing, Local Image Feature-Neighborhoods with SIFT and HOG features, Textures, Edge Detection, Filters & Features, Texture	8
4	**Mid-Level Vision** Segmentation using Clustering methods-Applications, Segmentation by Clustering Pixel, Using K-Means, Model Fitting-The Hough Transform, Fitting Lines and Planes, Robustness Tracking-Simple tracking Strategies, Matching.	8
5	**High-Level Vision** Smooth Surface and their Outlines, Range Data, Correspondence and Pose Consistency, Finding templates using classifiers, Classifying Images, Recognition by Relations between templates	7
6	**Computer Vision Application** Range Data, Finding in digital Library, Image-based rendering, Visual Hulls, Image Search and Retrieval-Basic Technology from information retrieval, Image as Documents, The state of Art of Word Prediction.	7
	Total	45

Text Books:
1. Forsyth, David A., and Jean Ponce. Computer Vision: a Modern Approach. Upper Saddle River, NJ: Prentice Hall, 2003. ISBN: 0130851981.
2. Textbook: Duda, Richard O., Peter E. Hart, and David G. Stork. Pattern classification. 2nd ed. New York, NY: Wiley, 2001. ISBN: 0471056693.

Reference Books:
1. Mallot, Hanspeter A. Computational Vision: Information Processing in Perception and Visual behavior. Translated by John S. Allen. Cambridge, MA: MIT Press, 2000. ISBN: 0262133814.

Program:	M. Tech (Artificial Intelligence and Data Science)		Semester :II	
Course :	Computer Vision Lab:-Elective4		Code: MDS2506C	

Teaching Scheme			Evaluation Scheme			
Practical	Hours	Credit	TW	PR	OR	Total
2	2	1	50	--	50	100

Prerequisite:
1. Python
2. Tensorflow

Objectives:
1. To introduce students to the state of the art algorithms in the area of image analysis and object recognition
2. Give an exposure to video analysis techniques for object tracking and motion estimation
3. To build good understanding on the computer vision concepts and techniques to be applied for robotic vision applications
4. Enable students to apply the vision algorithms and develop applications in the domain of image analysis, robotic navigation

Outcomes:
After learning the course the students should be able to:
1. Apply Image processing techniques for image formation
2. Explore the techniques of image analysis through image feature extraction for Image segmentation
3. Develop for robotic applications using computer vision algorithms

Detailed Syllabus:

Elective 4- Recommender System (ANY Three)		
Expt.	Description	Duration Hrs
1.	Perform Basic Image handling and Preprocessing operations on image.	2
2.	Write a program to compute the SIFT feature descriptors of the image.	2
3.	Write a Program for Edge Detection	2
4.	Mini Project- Object detection	4
Total		**8**

Text Books:
1. Forsyth, David A., and Jean Ponce. Computer Vision: a Modern Approach. Upper Saddle River, NJ: Prentice Hall, 2003. ISBN: 0130851981.
2. Textbook: Duda, Richard O., Peter E. Hart, and David G. Stork. Pattern classification. 2nd ed. New York, NY: Wiley, 2001. ISBN: 0471056693.

Reference Books:
1. Mallot, Hanspeter A. Computational Vision: Information Processing in Perception and Visual Behavior. Translated by John S. Allen. Cambridge, MA: MIT Press, 2000. ISBN: 0262133814.

Program:	M. Tech (Artificial Intelligence and Data Science)		Semester : II			
Course:	Skill Development Lab - II (Oral and written communication)		Code: M_2101			
Teaching Scheme			**Evaluation Scheme**			
Practical	Hours	Credit	TW	PR	OR	Total
2	2	1	50	--	--	50

Pre-requisite: Basic Communications skills

Objectives:
1. To facilitate holistic growth.
2. To make the students aware about the significance of Soft Skills and English Aptitude.
3. To develop the ability of effective communication through individual and group activities.
4. To expose students to right attitude and behavioral aspects and build the same through various activities.

Outcomes:
After learning the course the students should be able to:
1. Express effectively through verbal/oral communication skills.
2. Prepare for group discussions/meetings/interviews and presentations.
3. Operate effectively in multi disciplinary and heterogeneous teams through the knowledge of team work, inter personal relationships, conflict management and leadership activities.

Guidelines :
* Total experiments to be conducted are Six out of eight.
* Total : 6 experiments 12hours.

Detailed Syllabus:

Skill Development Lab (ANY Six)		
Expt.	Description	Duration (Hrs.)
1.	**Group Discussion:** Make students aware of proper and globally accepted ethical way to handle work, colleagues and clients. Develop group communication skills. Learn to speak up one's opinion in a forum. Cultivate the habit of presenting solution-driven analytical arguments making them contributors in any team.	2
2.	**Public Speaking:** Any one of the following activities may be conducted : **1. Prepared speech** (Topics are given in advance, students get 10 minutes to prepare the speech and 5 minutes to deliver.) **2. Extempore speech** (Students deliver speeches spontaneously for 5 minutes each on a given topic)	2
3.	**Writing An Article On Any Social Issue:** Build writing skills, improve language and gain knowledge about how to write an article/ report	2
4.	**Reading and Listening skills:** The batch can be divided into pairs. Each pair will be given an article by the facilitator. Each pair would come on the stage and read aloud the article one by one. After reading by each pair, the other students would be asked questions and needful corrections in the article. The facilitator can evaluate the students for reading and listening skills.	4
5.	**Debate On Current Affairs/ Social Relevance Topics:** Cultivate the habit to present forceful arguments while respecting the opponent's perspective and enhance verbal skills.	2

6.	**Telephonic etiquettes:** To teach students the skills to communicate effectively over the phone. Students will be divided into pairs. Each pair will be given different situations, such as phone call to enquire about job vacancy, scheduling a meeting with team members, phone call for requesting of urgent leave from higher authorities. Students will be given 10 min to prepare. Assessment will be done on the basis of performance during the telephone call.	3
7.	**Email etiquettes:** To provide students with an in-depth understanding of writing formal emails.	2
8.	**Mock interviews:** Guide students and conduct mock interviews	2
Total		**15**

Text Books:
- Barun Mitra, "Personality Development and SoftSkills"
- Stephen Lucas, "The Art of Public Speaking"

Reference Books:
- Marcia Weaver, "Empowering Employees Through Basic Skills"
- Gerald Ratigan, "Aced: Superior Interview Skills to Gain an Unfair Advantage to Land Your DREAMJOB!"

Program:	M. Tech (Artificial Intelligence and Data Science)				Semester : II	
Course :	Integrated Mini-Project				Code : MDS2701	
	Teaching Scheme			Evaluation Scheme		
Practical	Hours	Credit	IEI	IE2	OR	Total
6	6	3	--	50	50	100

Pre-requisite:
1. Basics of Software Engineering and Computer Programming Concepts.
2. Basics of Programming language such as Java, MATLAB, Pythonetc.

Objectives:
1. To understand the ―Product Development Process‟ including budgeting through Mini Project.
2. To plan for various activities of the project and channelize the work.
3. To build, design and implement real time application using available platforms

Outcomes:
After learning the course the students should be able to:
1. Plan and execute a Mini Project.
2. Design real time application.
3. Prepare a technical report based on the Miniproject.
4. Deliver technical seminar based on the Mini Project work carried out.
5. Learn publication and copyright process of research.

Guidelines : Total : 36 hours
1. Individual student need to design and demonstrate Mini-project under the guidance of allocated guide.
2. Students can choose platform of Information Technology considering their future implementation in Major Project in second year.
3. Implemented result of project or simulation is compulsory.
4. Mini-Project Report should be submitted as a compliance of term work associated with subject.
5. Paper publication associated with mini-project as research outcome is appreciable.
6. Mini-project work preferably should be completed in laboratory.

Detailed Syllabus:

	Integrated Mini-Project	
Sr. No.	Activity	Duration Hrs
1.	Week 1 &2 : Mini-project guide allotment, finalization of topic and platform, Planning of the work	8
2.	Week 3&4: Literature review and specification and Methodology Finalization, Review 1 for finalization of topic and specification.	8
3.	Week 5&6 : Simulation of Idea on appropriate software tools and finalization of hardware platform	8
4.	Week 7 & 8 : understanding platform implementation and related software flow and execute block level design , Review 2 to understand the progress of the project	8
5.	Week 9 & 10: Mini Project Report writing and publication or Copyright planning and execution.	7

6.	Week 11&12: Demonstration of Project work and Final Review for submission and term work compliances.		6
	Total		**45**

Course Syllabus

Semester-III

Program:	M.Tech. (Artificial Intelligence and Data Science)		Semester: III	
Course:	Dissertation Phase –I[Company/In-house project]		Code:MDS3702	

Teaching Scheme			Evaluation Scheme			
Practical	Hours	Credit	IE2	TW	OR	Total
20	20	10	-	100	100	200

Pre-requisite:
1. Basics of Software Engineering and Computer Programming Concepts
2. Basics of Programming Language suchas C, MATLAB, Python.

Objectives:
- To understand the—Product Development Process.
- To plan for various activities of the major project and channelize the work towards product development.
- To build, design and implement real time application using available platforms.
- To inculcate research culture in students for their technical growth.

Outcomes:
After learning the course the students should be able to:
1. Plan and execute the major Project with appreciable research outcomes.
2. Design real time application considering Emerging areas in technology
3. Prepare good quality technical report based on the project.
4. Demonstrate technical ideas and its relevance in recent technology
5. Publish good quality paper in reputed journal and present their work in reputed conferences.

Guidelines:
1. Individual student need to design and demonstrate project under the guidance of allocated guide.
2. Sponsored Projector Project Internship is acceptable considering postgraduate scope.
3. Students can choose project domain and problem statement as per latest research areas, recent technology trends and societal importance.
4. Project Report-1should be submitted as a compliance of term work associated with subject.
5. At least 2 Paper publications are expected as research outcome of Project Stage-I (Scopus indexed Conference or Journal) and 40% of planned project work should be completed for submission of Dissertation Phase-I
6. Total Duration: 120 hours are contact hours with guides and for reviews; 120 hours are expected to be spend by students to satisfy all project requirements and implementations.

Detailed Syllabus:

Dissertation Phase – I [Company/ In-house project]		
Sr. No.	Activity	Duration (Hrs.)
1.	Week1,2,3: Guide allotment, applying for sponsorship and project internship, finalization of topic and platform, Planning of the work.	30
2.	Week4,5:Literature review, Specification and Methodology Finalization, Review1for finalization of topic and specification.	20
3.	Week 6, 7, 8: Understanding platform for implementation and related software flow and execute block level design , Review 2 to understand the progress of the project	30
4.	Week9,10: Simulation of proposed methodology on appropriate software tools and finalization of hardware platform.	20
5.	Week 11, 12: Project Report writing and publication or copyright planning and execution. Demonstration of Project work and Final Review for submission and term work compliances	20
Total		**120**

Program:	M.Tech. (Artificial Intelligence and Data Science)				Semester: III	
Course:	Seminar				Code:MDS3703	
Teaching Scheme			Evaluation Scheme			
Practical	Hours	Credit	PR	TW	OR	Total
4	4	2	--	50	50	100

Pre-requisite:
1. Recent Development in the selected area and technology.

Objectives:
1. To study the recent technical ideas in the field of Information Technology.
2. To provide an opportunity to students to review the literature in the recent field of Information Technology and Computer Engineering.

Outcomes:
After learning the course the students should be able to:
1. Summarize the findings and scope of the problems identified in the literature review.
2. Present the findings of literature review by using presentation tools.
3. Prepare good quality technical report based on the literature review.

Guidelines:
1. Individual student need to study recent research topics in the field of Artificial Intelligence & Data Science under the guidance of allocated guide.
2. Students can choose topic related to Artificial Intelligence & Data Science considering recent trends and its societal importance and at least 5 latest research papers to be studied in seminar.
3. The extensive Literature Survey, Mathematical Modeling of particular method and valuable conclusion is expected from seminar study.
4. Seminar Report should be submitted as a compliance of term work associated with subject.
5. At least 1review paper publication is expected as research outcome of seminar.
6. Total Duration: 24 Contact Hours and 24 Hours should be spent by students on completion of related activities and requirements.

Detailed Syllabus:

	Seminar Activities	
Sr.No.	Activity	Duration Hrs
1.	Week 1, 2, 3: Guide allotment, Finalization of topic, Planning of the work. Review-1 conduction	6
2.	Week 4, 5: Literature review, Specification and Methodology Finalization of detail topic.	6
3.	Week 6,7,8:Detail Topic Mathematical model, methodology and findingsReview-2 conduction	6
4.	Week 9,10:Comparison of detail topic with other existing methods	6
5.	Week 11, 12: Seminar Report writing and publication or copyright planning Final Review conduction.	6
	Total	**30**

Program:	**M.Tech(Artificial Intelligence and Data Science)**			**Semester: III**		
Course:	**Internship[Company/In-house project]**			**Code:MDS3801**		
Teaching Scheme				**Evaluation Scheme**		
Practical	**Hours**	**Credit**	**IE2**	**TW**	**OR**	**Total**
4	**4**	**2**	-	**100**	-	**100**

Pre-requisite:
1. Basics of Software Engineering and Computer Programming Concepts
2. Knowledge about internship and program in which internship is interested.

Objectives:
1. To gain the employability-enhancing activities.
2. To get the competency in specific areas related to your academics.
3. To develop the project related skills.
4. To learn specific common job skills such as team work, communication skill etc.

Outcomes:
After learning the course the students should be able to:
1. Explore career alternatives prior to post graduation.
2. Develop work habits and attitudes necessary for the job success.
3. Bridge the gap of theory and its application.
4. Develop interpersonal communication, team work skills.

Guidelines:
1. Individual student need to attempt for internship with help of PCCoE T&P cell in the field of Artificial Intelligence & Data Science under the guidance of allocated guide.
2. If not get selected for any internships, students can choose extension of mini-project / opportunity of Entrepreneurship from PCCoE related to Information Technology considering recent trends and its societal importance.
3. The idea presentation is expected from the students based on their topics.
4. Internship Report should be submitted as a compliance of term work associated with subject.
5. Total Duration: 24 Contact Hours and 24 Hours should be spent by students on completion of related activities and requirements.

Detailed Syllabus:

Internship/In-house/Entrepreneurship activity		
Sr. No.	**Activity**	**Duration Hrs**
1.	Week1,2,3:Guide allotment, Application of internships, Finalization of topic, Planning of thework.Review-1 conduction	6
2.	Week4,5:Internship/Mini-project/Entrepreneurship activity implementation as per requirements	6
3.	Week6,7,8:Review-2 of Activities	6
4.	Week9,10:Interaction of Guides with Industry, Poster Presentation	6
5.	Week11,12: Internship Report writing and publication or copyright planning Final Review conduction.	6
	Total	**30**

Program:	M. Tech. (Artificial Intelligence and Data Science)		Semester : III			
Course :	MOOCs / Entrepreneurship		Code: MDS3981			
Teaching Scheme/week			Evaluation Scheme			
Practical	Hours	Credit	IE2	TW	OR	Total
4	4	2	-	100	-	100

Pre-requisite:

Any Engineering Graduate with Innovation and Design thinking knowledge

Objectives:
1. To acquaint with Entrepreneurial qualities.
2. To apply entrepreneurship in Engineering Courses.
3. To imbibe Entrepreneurial capabilities in engineering students.

Outcomes:

After learning the course, the students should be able to:
1. Motivate students to think about Entrepreneurship alternative to employment.
2. Registering students for Startup / Udyam registration of MSME.

Guidelines:
1. Individual student need to register for MOOC course or Entrepreneurship related trainings.
2. Week assignments need to be regularly completed as per requirement of course and to be submitted in file to Project Guide, which will be considered for internal assessment of course.
3. The certification of course or training is mandatory.
4. Oral and Presentation of course/training will be taken at the end of semester by Project Guide
5. Total Duration: 24 Contact Hours and 24 Hours should be spent by students on completion of related activities and requirements.

Detailed Syllabus:

Sr. No.	Description	Duration Hrs
1.	Introduction to Entrepreneurship and its importance	06
2.	Achievement Motivation. Case Studies of Indian Entrepreneurs	06
3.	Product Identification, Market Survey	06
4.	Whom to contact for what? Financial Management,	06
5.	Business Planning	06
6.	Project Report preparation	06
	Total	30

Reference Books:
1. Entrepreneurial Development by Vasant Desai, Himalaya publication
2. Entrepreneurship Development and Small Business Enterprise. Poornima M. Charantimath. Pearson Education India, 2005
3. Dynamics of entrepreneurial development and management: Entrepreneurship, project management, finances, programmes, and problems. by Vasant Desai.
4. Course Material by EDII, Ahmadabad

Experiment List: Project Report preparation for an Enterprise and Udyam Registration.

Course Syllabus

Semester-IV

Program:	M. Tech. (Artificial Intelligence and Data Science)		Semester: IV	
Course:	Dissertation Phase–II[Company/In-house project]		Code: MDS4704	

Teaching Scheme			Evaluation Scheme			
Practical	Hours	Credit	TW	PR	OR	Total
24	24	12	200	--	200	400

Pre-requisite:
1. Basics of Software Engineering and Computer Programming Concepts
2. Basics of Programming Language such as C, MATLAB, Python.

Objectives:
1. To understand the Product Development Process.
2. To plan for various activities of the major project and channelize the work towards product development.
3. To build, design and implement real time application using available platforms.
4. To inculcate research culture in students for their technical growth.

Outcomes:
After learning the course the students should be able to:
1. Plan and execute the major Project with appreciable research outcomes.
2. Design real time application considering emerging areas in technology
3. Prepare good quality technical report based on the project.
4. Demonstrate technical ideas and its relevance in recent technology
5. Publish good quality paper in reputed journal and present their work in reputed conferences.

Guidelines:
1. Semester III major project is continued to be completed in this section under the guidance of same project guides.
2. Students need to implement the project using suitable hardware and software platforms
3. Final Project Report including all process of project should be submitted as a compliance of term work associated with subject and permission to appear for examination.
4. Total 3 Paper publications are expected as research outcome of Dissertation Phase - I and II (Scopus Indexed Conference or Journal) and 100% of planned project work should be completed for submission of Dissertation Phase-II
5. Total Duration: 144 hours are contact hours with guides and for reviews; 144 hours are expected to be spent by students to satisfy all project requirements and implementations.

Detailed Syllabus:

	Dissertation Phase–II[Company/In-house project]	
Sr. No.	Description	Duration Hrs
1.	Week1, 2:60 %Work should be completed.	24
2.	Week3, 4: Software Simulation and Hardware Implementation should be completed.Review1conduction.	24
3.	Week5,6: Paper Publication should be in process or completed during this week,80%work should be completed.	24
4.	Week7,8: Compliance of 100% work. Review-2 will be conducted	24
5.	Week9,10: Department Reviews will be conducted to check the quality of project and requirements fulfilment to permit project submission.	24
6.	Week11,12: Project Report writing and copyright planning and execution. Demonstration of Project work and Final Research Review Committee (RRC) reviews will be conducted for submission and term work compliances.	24
	Total	**144**

Program:	M.Tech. (Artificial Intelligence and Data Science)			Semester: IV		
Course:	MOOCs			Code:MDS4982		
Teaching Scheme			**Evaluation Scheme**			
Practical	Hours	Credit	IE2	TW	OR	Total
4	4	2	-	100	-	100

Objectives:
1. To apply the knowledge of specific concept.
2. To synthesize the knowledge of specific concept.

Outcomes:
After learning the course the students should be able to:
1. Rate their learning gains in the specific concepts.
2. Get the certificate for the specific concept.

Guidelines:
1. Individual student need to register for MOOC course of their interest.
2. Week assignments need to be regularly completed as per requirement of course and to be submitted in file to Project Guide, which will be considered for internal assessment of course.
3. The certification of course or training is mandatory.
4. Termwork of course/training will be taken at the end of semester by Project Guide
5. Total Duration: 30 Contact Hours and 30 Hours should be spend by students on completion of related activities and requirements.

Program:	M. Tech (Artificial Intelligence and Data Science)		Semester : I			
Course :	Constitution of India		Code :M_1961A			

Teaching Scheme and **Evaluation Scheme**

Lecture	Hours	Credit	IE1	IE2	ETE	Total
1	1	-	--	-	--	--

Objectives:
1. To understand the constitution and the centre-state relations and functioning.
2. To understand the rules and regulations under which public and private sector work.
3. To understand E-governance through computers and knowledge of cyber laws.

Outcomes:

After learning the course, the students should be able to:

1. Explain the functions of the Indian government and identify and explore the basic features, modalities about Indian constitution and assessment of the Parliamentary System in India.
2. Differentiate the functioning of Indian Political system at Central and State level and comprehend the fundamental rights and abide the rules of the Indian constitution.

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	**Introduction to Constitution & System of Government:** Meaning of the constitution law and constitutionalism, making of constitution, Salient features and characteristics of the Constitution of India, Preamble, Fundamental Rights, Directive Principles of State Policy, Fundamental Duties and it's legal status, Citizenship. Structure and Function of Central Government, President, Vice President, Prime Minister, Cabinet, Parliament, Supreme Court of India, Judicial Review, Federal structure and distribution of legislative and financial powers between the Union and the States, local self-government	7
2.	**Judiciary and Constitution Functions:** Governor, Chief Minister, Cabinet, State Legislature Judicial System in States, High Courts and other Subordinate Courts, Parliamentary Form of Government in India. Constitution Functions: Indian Federal System and it's characteristics, Center& State Relations, President's Rule, Constitutional Amendments and powers, Constitutional Function	8
	Total	15

Text Books:
1. **Durga Das Basu, "Introduction to the Constitution of India ", Prentice Hall of India, New Delhi,24th edition, 2020, ISBN-109388548868**
2. **Clarendon Press, Subhash C, Kashyap, "Our Constitution: An Introduction to India's Constitution and constitutional Law", NBT, 5th edition, 2014, ISBN-9781107034624**

Reference Books:
1. Dr J N Pandey : Constitutional Law ofIndia
2. https://www.meity.gov.in/divisions/national-e-governance-plan
3. https://www.meity.gov.in/DeitY_e-book/e-gov_policy/download/Policy%20Document.pdf
4. http://www.iibf.org.in/documents/cyber-laws-chapter-in-legal-aspects-book.pdf
5. **Maciver and Page, "Society: An Introduction Analysis ", Laxmi Publications, 4th edition, 2007, ISBN-100333916166**
6. **PM Bhakshi, "The constitution of India", Universal Law Publishing - An imprint of Lexis Nexis, 14th edition, 2017, ISBN-108131262375**

Program:	M. Tech (Artificial Intelligence and Data Science)		Semester : I	
Course :	Value Education		Code : M_1961B	
Teaching Scheme			Evaluation Scheme	

Lecture	Hours	Credit	IE1	IE2	ETE	Total
1	1	-	--	--	--	--

Objectives:
1. To identify and develop Attitude and Core Faith values.
2. To expose students to Family Relations.
3. To enable student to understand Creative Thinking and Problem solving.
4. To enable students to understand Humanistic Education.

Outcomes:
After learning the course the students should be able to:
1. Change in awareness levels, knowledge and understanding of student.
2. Change in attitudes / behavior of students with regards to their education improved teamwork, institutional leadership and other lifeskills
3. Improvement in social health and attitude.

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	Why Human Relations are so important? Understanding Behavior, Human Relations, and Performance, Personality, Stress, Learning, and Perception, Attitudes, Self-Concept, Natural acceptance of human values, and Ethics, Dealing with Conflict, Leading and Trust	8
2.	Justice in Humankind, Nurturing and Exploitation, Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order, Competence in professional ethics	7
	Total	15

Text Books:
1. R R Gaur, R Sangal, G P Bagaria, "A Foundation Course in Human Values and Professional Ethics", Excel Books, New Delhi and Teacher's Manual

Reference Books:
1. Robart Lussier , "Human Relations in Organizations Applications and Skill Building", eighth edition, McGraw-Hill(2014).
2. Atkinson and Hilgard's, "Introduction to psychology", Nolen-Hoeksema,, Cengage Learning EME.

Program:	M. Tech (Artificial Intelligence and Data Science)				Semester : I		
Course :	Stress Management				Code : M_1961C		
Teaching Scheme				**Evaluation Scheme**			
Lecture	Hours	Credit	IE1	IE2	ETE	Total	
1	1	-	--	--	--	--	

Objectives:
1. To overcome stress.
2. To achieve overall health of body and mind.
3. To learn to achieve the highest goal happily.
4. To become a person with stable mind, pleasing personality and determination.

Outcomes:
Students will be able to:
1. Develop healthy mind in a healthy body thus improving social health also
2. Improve efficiency

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	Definitions of Eight parts of Yog. (Ashtanga) Yam and Niyam.Do`s and Don't's in life.	7
2.	Pranayam ,Regularization of breathing techniques and its effects- Types of pranayama Approach to day to day work and duties, wisdom	8
	Total	**15**

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

Reference Books:
1.Swami Vivekananda , "Rajayoga or conquering the Internal Nature", Advaita Ashrama (Publication Department),Kolkata
2.Wendelin Küpers, David J. Pauleen , "A Handbook of Practical Wisdom Leadership, Organization and Integral Business Practice",· 2016
3. A Foundation Course in Human Values and Professional Ethics Presenting a Universal Approach to Value Education - ThroughSelf-exploration

Program: M. Tech. (Artificial Intelligence and Data Science)					Semester: II	
Course: Team Building & Leadership					Code: M_2962A	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
1	1	-	--	--	--	--

Objectives:
1. Develop and strengthen interpersonal skills.
2. Become familiar with and discuss different leadership models.
3. Familiarize students with the characteristics of teambuilding.

Outcomes:
After learning the course, the students should be able to:
1. Use leadership and teamwork knowledge to develop projects.
2. To develop the capacity to work collaboratively in a team.

Detailed Syllabus:		
Unit	Description	Duration Hrs
1.	**Leadership:** Will and motivation, Personal leadership, self-knowledge, and self- control, using power responsibly and respectfully: the leader as a team-builder, Ability to plan future actions and transmit that vision to others. Taking the initiative and stimulate others. What the word "leader" means, Types of leadership, Traditional, legal, and legitimate leader. Categories: autocratic, democratic, charismatic, paternalistic, authentic, spiritual, dictatorial, etc	7
2.	**Team work** Why is teamwork important? The evolution from group to team: development stages. Advantages and disadvantages of teamwork. How to determine roles in a team. Traditional vs. virtuoso teams, forming effective and balanced teams, Strengthening teams within the organization. Creating a friendly and collaborative environment. Strategies to develop the team's mission, vision, values, and objectives. Shared objectives vs. personal motivation. Distinguishing purpose and tasks in the team. Encouraging participation. Creating team identity, creating high-performing teams.	8
	Total	15

Text Books
1. Stephen Covey, "The Seven Habits of Highly Effective People", Free Press, 1989
2. Ronald A. Heifetz, "Leadership without Easy Answers", Belknap Press, 1994.
3. Michael E. Porter, "Competitive Strategy", Free Press, 1980.

Reference Books:
1. John Kotter, Leading Change, " Why Transformation Efforts Fail", IkujiroNonaka, The Knowledge-Creating Company
2. Michael West, "The Secrets of Successful Team Management", Chap. 2, "Self-Management," pgs. 32- 61

Program:	M. Tech (Artificial Intelligence and Data Science)		Semester :II
Course :	English For Research Paper Writing		Code : M_2962B

Teaching Scheme			Evaluation Scheme			
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
1	1	-	--	--	--	--

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.
4. Ensure the good quality of paper at very first-time submission.

Outcomes:
After learning the course the students should be able to:
1. Develop the ability to plan and prepare and research papers and reports
2. Write a research article, review article, thesis chapter and other related academic research text effectively.

Detailed Syllabus:

Unit	Description	Duration (Hrs.)
1.	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness, Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	8
2.	Key skills are needed when writing a Title, Abstract, Introduction, Review of the Literature, Methods, Results, Discussion, Conclusions useful phrases, how to ensure paper is as good as it could possibly be the first-time submission	7
	Total	15

Text Books:
1. Day R, "How to Write and Publish a Scientific Paper", Cambridge University Press, 2006

Reference Books:
1. Goldbort R ,"Writing for Science", Yale University Press (available on GoogleBooks), 2006
2. Highman N, "Handbook of Writing for the Mathematical Sciences", SIAM. Highman'sbook, 1998.
3. Adrian Wallwork , "English for Writing Research Papers", Springer New York Dordrecht Heidelberg London,2011

Program:	M. Tech (Artificial Intelligence and Data Science)		Semester : II			
Course :	Disaster Management		Code :M_2962C			
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
1	1	-	--	--	--	--

Objectives:
1. To orient engineers about various natural and manmade disasters.
2. To teach the concept of Disaster management and measures to be taken at different stages of disaster management.
3. To provide insight about global, national and regional level scenario of disaster management.

Outcomes:
After learning the course the students should be able to:
  1. Learn different disasters and measures to reduce the risk due to these disasters.
  2. Learn institutional frame work for disaster management at national as well as global level.

Detailed Syllabus:

Unit	Description	Duration (Hrs.)
1.	**Introduction** – Hazard and Disaster. Concepts of Hazard, Vulnerability, Risks. Different Types of Disaster : A) Natural Disaster: such as Flood, Cyclone, Earthquakes, Landslides etcB) Man-made Disaster: such as Fire, Industrial Pollution, Nuclear Disaster, Biological Disasters, Accidents (Air, Sea, Rail & Road), Structural failures(Building and Bridge), War & Terrorism etc. Slow Disasters (famine, draught, epidemics)andRapidOnsetDisasters(AirCrash,tidalwaves,Tsunami)Causes, effects and practical examples for all disasters.	8
2.	**Natural disasters**- Earthquakes, Tsunami, Floods, Drought, Landslides, Cyclones and Volcanic eruptions. Their case studies. Coastal disasters. Coastal regulation Zone. **Disaster Prevention and Mitigation**. Refugee operations during disasters, Human Resettlement and Rehabilitation issues during and after disasters, Inter-sectoral coordination during disasters, Models in Disasters. **Disaster Management:** Role of Government, International and NGO Bodies. Role of IT in Disaster Preparedness Role of Engineers on Disaster Management.	7
	Total	15

Reference Books:
1. Pandey, M., "Disaster Management", Wiley India Pvt. Ltd.,240p., 2014
2. Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill Education (India) Pvt.Ltd
3. JagbirSingh, "Disaster Management: Future Challenges and Opportunities", K W Publishers Pvt.Ltd.
4. J.P. Singhal, "Disaster Management", LaxmiPublications
5. C. K. Rajan, NavalePandharinath, "Earth and Atmospheric Disaster Management : Nature and Manmade, B S Publication
6. Shailesh Shukla, Shamna Hussain, Biodiversity, "Environment and Disaster Management", UniquePublications

Text Books:
1. SL Goel,"Disaster Administration and Management, Text & Case studies", Deep and DeepPublications
2. G.K Ghosh , "Disaster Management", A.P.H. Publishing Corporation
3. S.K.Singh, S.C. Kundu, Shobha Singh , "Disaster management", A – 119, William Publications, NewDelhi.
4. Vinod K Sharma , "Disaster Management", IIPA, NewDelhi,1995
5. Goel S.L, "Encyclopedia of Disaster Management", Deep and Deep Publications, New Delhi,2006.

Annexure II

Open Electives Syllabus

Program:	M. Tech. (Artificial Intelligence and Data Science)		Semester : I	
Course :	R Programming		Code :MDS1601A	
Teaching Scheme			**Evaluation Scheme**	

Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	-	30	50

Pre-requisite:
1. Knowledge of Statistics in Mathematics
2. Prior Knowledge of any programming

Objectives:
1. To use R and R Studio Environment
2. To understand different data types and control structures in R
3. To interface R with other languages.
4. To understand the use of R for Big Data analytics.

Outcomes:
After learning the course, the students should be able to:
1. Explain the basics in R programming in terms of constructs, control statements, string functions.
2. Apply the use of R for Big Data analytics.
3. Learn to apply R programming for Text processing.
4. Able to appreciate and apply the R programming from a statistical perspective.

	Detailed Syllabus:	
Unit	**Description**	**Duration (Hrs.)**
1.	**Getting Started with R Programming** Introduction to the R-Studio, user-interface, Basic commands, Data Structures in R, Reading data into R Subsetting	7
2.	**Matrices, Arrays And Lists** Creating matrices ,Matrix operations ,Applying Functions to Matrix Rows and Columns, Adding and deleting rows and columns, Vector/Matrix Distinction, Avoiding Dimension Reduction, Higher Dimensional arrays, Lists, Creating lists, General list operations,– Accessing list components and values, Applying functions to lists, Recursive lists	8
3.	**Data Frames** Creating Data Frames, Matrix-like operations in frames, Merging Data Frames, Applying functions to Data frames, Factors and Tables: factors and levels, Common functions used with factors, Working with tables, Other factors and table related functions, Control statements: Arithmetic and Boolean operators and values, Default values for arguments, Returning Boolean values, Environment and Scope issues: Writing Upstairs - Recursion ,Replacement functions, Tools for composing function code, Math and Simulations in R	8
4.	**Interfacing** Interfacing R to other languages, Parallel R, Basic Statistics, Linear Model, Generalized Linear models, Non-linear models, Time Series and Auto-correlation – Clustering	7
	Total	30

Text Books:
1. Mark Gardener, " Beginning R – The Statistical Programming Language", Wiley,2013
2. Norman Matloff , "The Art of R Programming: A Tour of Statistical Software Design", No Starch Press,2011

Reference Books:
1. Jared P. Lander, "R for Everyone: Advanced Analytics and Graphics", Addison-Wesley Data & Analytics Series, 2013
2. Robert Knell, "Introductory R: A Beginner's Guide to Data Visualization, Statistical Analysis and Programming in R", Amazon Digital South Asia Services Inc,2013.

Program:	M. Tech. (Artificial Intelligence and Data Science)			Semester :	I	
Course :	Business Analytics			Code :	MDS1601B	
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
2	2	2	20	-	30	50

Pre-requisite: 1. Machine Learning
2. Data Science

Objectives:
1. Understand the different basic concept / fundamentals of business statistics
2. Understand the concept of Probability and its usage in various business applications.
3. Understand the practical application of Descriptive and Inferential Statistics concepts and their uses for Business Analytics.
4. Evaluate different data analytics tools.

Outcomes:
After learning the course, the students should be able to:
1. Gaining Knowledge of basic concept / fundamentals of business analytics.
2. Evaluating basic concepts of probability and perform probability theoretical distributions.
3. To perform practical application by taking managerial decision and evaluating the Concept of Business Analytics.
4. Evaluate different tools.

Detailed Syllabus:

Unit	Description	Duration (Hrs.)
1.	**Introduction** What is business analytics?, Business Analytics process: problem framing, Data modeling, model building, Deployment, Different types of business analytics, application of business analytics, current trends, roles within data analytics team.	8
2.	**Analytics Techniques** Optimization techniques: Linear Programming, Goal Programming, Integer Programming, Non –linear programming, Predictive modelling :- regression, multiple linear regression for predictive analysis, logistic regression, linear discriminate analysis, Data Mining: Introduction to supervised and unsupervised learning, clustering	8
3.	**Probability Theory & Distribution** Probability: Theory of Probability, Addition and Multiplication Law, Baye's Theorem Probability Theoretical Distributions: Concept and application of Binomial; Poisson and Normal distributions. Concept of Business Analytics- Meaning types and application of Business Analytics, Use of Spread Sheet to analyze data-Descriptive analytics and Predictive analytics	8
4.	**Data analytics tools** Data Visualization using Tableau/Python/R/SQL. Case study.	6
	Total	30

Text Books:
• R.N. Prasad , Seema Acharya, "Fundamentals of business analytics", Wiley

Reference Books:
1. James Evans, Business Analytics, 2nd Edition, Pearson

Program:	M. Tech. (Artificial Intelligence and Data Science)		Semester :	II	
Course :	Python for Data Science		Code :	MDS2602A	

Teaching Scheme			Evaluation Scheme			
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
2	2	2	20	-	30	50

Pre-requisite: 1. Python basics ; 2.Statistical and numerical methods

Objectives:
1. Apply various Python data structures to effectively manage various types of data.
2. Explore various steps of data science pipeline with role of Python
3. Design applications applying various operations for data cleansing and transformation.
4. Use various data visualization tools for effective interpretations and insights of data.

Outcomes:
After learning the course, the students should be able to:
1. Gain an in-depth understanding of data science processes and the basics of statistics.
2. Explain the essential concepts of Python programming.
3. Perform high-level mathematical computations.
4. Perform data analysis and manipulation.

Detailed Syllabus:

Unit	Description	Duration (Hrs.)
1.	**Overview of Python and Data Structures** Basics of Python including data types, variables, expressions, objects and functions. Python data structures including String, Array, List, Tuple, Set, Dictionary and operations them	6
2.	**Data Science and Python** Discovering the match between data science and python: Outlining the core competencies of a data scientist, Linking data science, big data, and AI , Understanding the role of programming, Creating the Data Science Pipeline, Preparing the data, Performing exploratory data analysis, Learning from data, Visualizing, Obtaining insights and data products, Understanding Python's Role in Data Science Introducing Python's Capabilities and Wonders: Why Python?, Grasping Python's Core Philosophy, Contributing to data science, Discovering present and future development goals, Working with Python, Getting a taste of the language, Understanding the need for indentation, Working at the command line or in the IDE, Performing Rapid Prototyping and Experimentation, Considering Speed of Execution, Visualizing Power, Using the Python Ecosystem for Data Science, Accessing scientific tools using SciPy, Performing fundamental scientific computing using NumPy, Performing data analysis using pandas, Implementing machine learning using Scikit-learn, Going for deep learning with Keras and TensorFlow, Plotting the data using matplotlib, Creating graphs with NetworkX, Parsing HTML documents using Beautiful Soup.	9
3.	**Data Visualization** Visualizing Information: Starting with a Graph, Defining the plot, Drawing multiple lines and plots, Saving your work to disk, Setting the Axis, Ticks, Grids, Getting the axes, Formatting the axes, Adding grids, Defining the Line Appearance, Working with line style, Using colors, Adding markers, Using Labels, Annotations, and Legends, Adding labels, Annotating the chart, Creating a legend.	7
4.	**Data Wrangling** Wrangling Data: Playing with Scikit-learn, Understanding classes in Scikit-learn, Defining applications for data science, Performing the Hashing Trick, Using hash functions, Demonstrating the hashing trick, Working with deterministic selection, Considering Timing and Performance, Benchmarkin, with,timeit, Working with the memory profiler, Running in Parallel on Multiple Cores, Performing multicore parallelism, Demonstrating multiprocessing.	8

Total	30

Text Book

1. Python for data science for dummies 2nd Edition, John Paul Mueller, Luca Massaron, Wiley
2. Programming through Python, M. T. Savaliya, R. **K. Maurya**, G. M. Magar, STAREDU Solutions
3. Pandas for everyone :Python Data Analysis, Daniel Y. Chen, Pearson

Reference Book

1. Introducing Data Science: Big Data, Machine Learning, and More, Using Python Tools Davy Cielen, Arno D.B. Meysman, Mohamed Ali

Program:	M. Tech. (Artificial Intelligence & Data Science)		Semester : II	
Course :	Introduction to Neural Networks		Code : MDS2602B	

Teaching Scheme | | | **Evaluation Scheme** | | | |

Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	-	30	50

Prerequisite:
1. Linear Algebra
2. Mathematics

Objectives:
1. The main objective of this course is to provide the student with a basic understanding of neural networks fundamentals
2. Program the related algorithms and Design the required and related systems

Outcomes:
After learning the course, the students should be able to:
1. Demonstrate ANN structure and activation Functions
2. Define foundations and learning mechanisms and state-space concepts
3. Identify structure and learning of perceptions
4. Explain Feed forward, multi-layer feed forward networks and Back propagation algorithms
5. Analyze Radial Basis Function Networks, Regularization and RBF networks
6. Explain the Self Organizing Map

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	**Introduction to Neural Networks:** Introduction and ANN Structure, Biological neurons and artificial neurons. Model of an ANN. Activation functions used in ANNs. Typical classes of network architectures.	6
2.	**Mathematical Foundation** Mathematical Foundations and Learning mechanisms. Re-visiting vector and matrix algebra, State-space concepts, Concepts of optimization, and Error-correction learning. Memory-based learning, Hebbian learning. Competitive learning.	8
3.	**Perceptrons** Single-layer perceptrons, Structure and learning of perceptrons, Pattern classifier, introduction and Bayes' classifiers, Perceptron as a pattern classifier, Perceptron convergence. Limitations of a perceptrons.	7
4.	**Feed Forward and Backpropagation NN:** Feed forward ANN, Structures of Multi-layer feed forward networks. Back propagation algorithm, Back propagation - training and convergence, Functional approximation with back propagation. Practical and design issues of back propagation learning	9
	Total	30

Text Books:
1. Introduction to Artificial Neural Systems, Jacek Zurada, West Publishing Company
2. Simon Haykin, "Neural Networks: A comprehensive foundation", Second Edition, Pearson Education Asia.
3. Satish Kumar, "Neural Networks: A classroom approach", Tata McGraw Hill, 2004

Reference Books:
1. Neural Networks: A Systematic Introduction, Raúl Rojas, 1996
2. Pattern Recognition and Machine Learning, Christopher Bishop, 2007

MOOC Courses-
3. 1. Deep Learning Part-I, Swayam Prof.Mitesh M. Khapra
4. 2. Neural Networks and Deep Learning, Coursera, Andrew Ng
5. 3. Deep Learning for Computer Vision, Prof. Vineeth N Balasubramanian

Program:	M. Tech. Mechanical (Design Engineering)		Semester : I	
Course :	Advanced Materials		Code: MMD1601A	

Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	--	30	50

Pre-requisite:
 Chemistry, Physics, Material Science, Metallurgy

Objectives:
1. To introduce advanced and exotic materials.
2. To familiarize students with structure and properties of materials.
3. To establish significance of material selection in engineering design.
4. To explore new design opportunities.

Outcomes:
After learning the course, the students should be able to:
1. Student will be able to analyze of different materials in advanced engineering application.
2. Student will be able to relate structure and properties of new materials in engineering applications
3. Student will be able to evaluate and select materials for advanced engineering applications

Detailed Syllabus:

Unit	Description	Duration Hrs
1	Advanced and exotic materials – ceramics and Plastics, Biomaterials, Aerogels, Superconductors, Carbon nano tubes	8
2	Mechanical, electrical, optical and magnetic properties of materials.	6
3	Smart materials, Piezoelectricity, Magnetostriction, smart polymers, Shape memory alloys	8
4	Introduction to nano, Nano-biomimicry, Synthesis of nanomaterials by physical and chemical methods, Synthesis of nanomaterials by biological methods, Characterizations of nanomaterials.	8
	Total	**30**

Text Books:
• W.D. Callister Material Science and Engineering: An Introduction, Wiley publication.

Reference Books:
• Malsch, N.H., "Biomedical Nanotechnology", CRC Press. (2005).
• L.F. Pease, R.M. Rose and J. Wulff, Electronic Properties (Volume IV: Structure and Properties of Materials)

Program:	M. Tech. Mechanical (Design Engineering)		Semester : I	
Course :	Optimization Methods		Code: MMD1601B	

Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	--	30	50

Pre-requisite: Engineering Mathematics

Objectives:
1. To introduce students to the modeling of constrained decision-making problems and optimization.
2. Provide students with the basic mathematical concepts of optimization.
3. Provide students with the modelling skills necessary to describe and formulate optimization problems.
4. Provide students with the skills necessary to solve and interpret optimization problems in engineering.

Outcomes:
After learning the course, the students should be able to:
1. Formulate mathematical programs in various practical systems
2. Understand basic optimization techniques
3. interpret the results of a model and present the insights (sensitivity, duality)
4. Know the limitations of different solution methodology
5. Use software to solve problems

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	**Classical Optimization Techniques** Introduction to Mathematical Modeling, Single variable optimization and multi variable optimization, with constraints and without constraints	7
2.	**Linear and non-Linear Programming** Simplex Methods, Elimination and iterative methods for one-dimensional minimization.	8
3.	**Simulation Modeling** Introduction, definition and types, limitations, various phases of modeling, Monte Carlo method, applications, advantages and limitations of simulation	8
4.	**Modern Methods of Optimization** Genetic algorithms, Simulated Annealing, Particle Swarm Optimization, Ant Colony Optimization, etc.	7
	Total	30

Text Books:
- Engineering Optimization: Theory and Practice, Singiresu S. Rao, John Wiley & Sons
- Practical Optimization Methods with Mathematical Applications, M. Asghar Bhatti, Springer
- Optimization for engineering design, K. Deb, PHI

Reference Books:
- Topology Optimization – Theory, Methods and Applications, M. P. Bendse, Q. Sigmund
- Evolutionary Topology Optimization of Continuum Structures, Methods and Applications, X. Huang, Y.M. Xie, Wiley
- Structural Optimization, Raphael T. Haftka and Zafer Gurdal, Kluwer Academic Publishers
- Mathematical Modelling, J N Kapur, New age international publication
- Optimization concepts and applications in engineering, Belegundu, Chandrupatla, Pearson Education

Program:	M. Tech. Mechanical (Design Engineering)		Semester : I		
Course :	Modeling and Simulation of Dynamic systems		Code: MMD1601C		
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	--	30	50

Pre-requisite: Engineering Mathematics

Objectives:
1. Students able to model any physical system for real-time applications
2. Students able to simulate any physical system for real-time applications

Outcomes:
After learning the course, the students should be able to:
1. Develop mathematical model for practical problem
2. Develop Bond Graph model for system
3. Apply transfer function and State space model techniques
4. Simulate the system using suitable software and Estimate parameters by optimization

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	Introduction to Modelling and Simulation, Basic systems, Introduction and Types of Mathematical modelling, Basic building blocks Mechanical, Electrical, Thermal systems.	7
2.	Bond Graph Modelling of Dynamic Systems: Representation,Elements, Single, Two and multiport Causality, Application to basic Mechanical, Electrical and Electromechanical system	8
3.	Dynamic Response and System Transfer Function: Poles, Stability Block diagram/Signal flow diagram/State Space formulation and Frequency response	8
4.	Simulation and Simulation application Parameter Estimation, System Identification and Optimization	7
	Total	**30**

Reference Books:
1. Brown, Forbes T. , "Engineering System Dynamics.", New York, NY: CRC, 2001. ISBN: 9780824706166.

Program:		M. Tech. Mechanical (Design Engineering)			Semester : II	
Course :		Room Acoustics			Code :MMD2602A	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	--	30	50

Pre-requisite: Engineering Mathematics, Physics,

Objectives:
The course includes sound fields in rooms with wave theoretical methods, geometrical acoustics methods Acoustical measurement techniques, sound absorption for evaluation of room acoustic quality

Outcomes:
After learning the course, the students should be able to:
Understand Basic principals in acoustics, measurement of sound Power and apply to analyze effectiveness in compliance to noise regulations.

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	**Basics of acoustics** – Terminologies speed of sound, wavelength, frequency, and wave number, acoustic pressure, acoustic intensity and acoustic energy density, spherical wave, **Acoustic measurement** Directivity factor and directivity index, levels and the decibel, combination of sound sources, octave bands, weighted sound levels. Sound power measurement	7
2.	**Transmission of Sound:** changes in media with normal incidence, changes in media with oblique incidence, sound transmission through a wall, transmission loss for walls - stiffness-controlled region- mass-controlled region - damping-controlled region,	8
3.	**Sound Absorption:** General description of acoustical materials - acoustical tiles, fiberboard, resonator absorption unit absorber, carpets, acoustical plaster, resilient packing composite materials, etc. Their use, selection criteria and construction.	8
4.	**Room acoustics -** surface absorption coefficients, steady-state sound level in a room, Behaviour of sound in an enclosed space. Concept of reverberation and reverberation time effect of energy absorption in the air, noise from an adjacent room, acoustic enclosures, acoustic barriers.	7
	Total	30

Text Books:
- Randell Barron, "Industrial Noise Control", Marcel Dekker, Inc.

Reference Books:
- G.Ambekar, "Mechanical Vibrations & Noise Engineering", Prentice Hall of India, New-Delhi.

Program:		M. Tech. Mechanical (Design Engineering)			Semester : II	
Course :		Design Thinking			Code: MMD2602B	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	--	30	50

Pre-requisite:
    Any Engineering Graduate

Objectives:
1. To acquaint with concepts of Design Thinking.
2. To apply design thinking tools in every field of Engineering.

Outcomes:
After learning the course, the students should be able to:
1. Use Design Thinking tools.
2. Create simple Products using design thinking tools

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	Introduction to Design thinking and its importance. Steps in Design Thinking	05
2.	Empathize Phase	05
3.	Define Phase	05
4.	Ideate Phase	05
5.	Prototype Phase	05
6.	Test Phase. One simple Product development using Design thinking tools	05
	Total	30

Reference Books:
- EmrahYayici, "Design Thinking methodology " , Publisher EmrahYayici, 2016
- Tim Ogilvie,"Designing for Growth: A design thinking toolkit for managers" ,Columbia Business School Publishing

Program:	M. Tech. Mechanical (Design Engineering)		Semester : II		
Course :	Reliability Engineering		Code: MMD2602C		
Teaching Scheme			Evaluation Scheme		
Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	--	30	50

Pre-requisite: Engineering Mathematics

Objectives:
1. To perform reliability engineering analysis.
2. To compute reliability engineering parameters and estimates for applications in mechanical devices and manufacturing environments.

Outcomes:
After learning the course, the students should be able to:
1. Identify the possible faults in systems and their impacts to the overall system reliability.
2. Develop fault trees for a sub-system and apply various reliability models on fault analysis.
3. Evaluate maintenance schedules and assess the corresponding risk with appropriate techniques and tools.

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	**Fundamental concepts - I** Failure density, failure rate, hazard rate, MTTF, MTBF, pdf, cdf, modes of failure, Areas of reliability, Quality and reliability assurance rules, product liability, probability distributions binomial, normal, Poisson.	7
2.	**System reliability** Series, parallel, mixed configuration, k- out of n structure, complex systems-enumeration method, conditional probability method, cut set and tie set method,	8
3.	**Redundancy** Element redundancy, unit redundancy, standby redundancy- types of stand by redundancy, parallel components single redundancy, multiple redundancy. Markov analysis.	8
4.	**System reliability Analysis** Reliability apportionment, Reliability apportionment techniques – equal apportionment, AGREE, ARINC, feasibility of objectives apportionment.	7
	Total	30

Text Books:

1. L.S. Srinath, "Concepts of Reliability Engg"., Affiliated East-Wast Press (P) Ltd., 1985.
2. E. Balagurusmy, "Reliability Engineering", Tata McGraw-Hill Publishing Co. Ltd., 1984.

Reference Books:
A.K. Govil, "Reliability Engineering", Tata McGraw-Hill Publishing Co. Ltd., 1983.
B.S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
M.L. Shooman, "Probabilistic Reliability", McGraw-Hill Book Co., 1968.
P.D.T. Conor, "Practical Reliability Engg"., John Wiley & Sons, 1985.
K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons, 1977.
A. Birolini , "Reliability Engineering, Theory and Practice", Third Edition, Springer, 1999

Program:	M. Tech (E&TC)-VLSI and Embedded Systems		Semester: I	
Course:	Automotive Electronics and its Applications		Code:	MET1601A
Teaching Scheme			**Evaluation Scheme**			
Lecture		Hours	Credit	IE1	IE2	ETE	Total

Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	--	30	50

Prior Knowledge of Electronics & electrical, instrumentation, control systems, and IC engine operation, **is essential.**

Objectives:

1. To explain the various application of electronics systems and ECU in automotive.
2. To deliver knowledge about principles and applications of sensors and actuators in automotive electronics systems.
3. To explore various control systems in automotive

Outcomes:

After learning the course, the students should be able to:

1. Acquire an overview of automotive components, subsystems, and basics of electronic control in today's automotive industry.
2. Understand the available automotive sensors and actuators in various electronic control systems.
3. Understand components of engine control system in automotive design.
4. Analyze the safety systems in automotive application

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	**Automotive Systems Overview:** Automotive vehicle technology, Present trends in automobiles with emphasis on increasing role of electronics and software, Overview of typical automotive subsystems and components, Body, Chassis, and Powertrain Electronics	7
2.	**Sensors and Actuators:** Basic sensor arrangement, Types of sensors such as oxygen sensors, Crank angle position sensors, Fuel metering/ vehicle speed sensors, Flow sensor, Temperature, EGO, Air mass flow sensors, Throttle position sensor, Solenoids, Stepper Motors, Relays, etc.,	8
3.	**Engine Control System:** Algorithms for engine control including open loop and closed loop control system, Electronic ignition, EGR for exhaust emission control. Look-up tables and maps, Need of maps, Procedure to generate maps, Engine calibration, Torque table, Dynamometer testing	8
4.	**Active and passive safety systems:** Body electronics including lighting control, Remote keyless entry, Immobilizers etc., Electronic instrument clusters and dashboard electronics, Antilock braking system, Electronic stability program, Air bags, Computer vision based ADAS	7
	Total	30

Text Books:

- William B. Ribbens, "Understanding Automotive Electronics- An Engineering Perspective", 7th edition, Butterworth-Heinemann Publications, 2017.
- Ronald K. Jurgen, "Automotive Electronics Handbook", Mc-Graw Hill, 1999

Reference Books:
- Robert Bosch, "Automotive Hand Book", 10th edition, Wiley Publications, 2018
- Kiencke, Uwe, Nielsen & Lars, "Automotive Control Systems for Engine, Driveline and Vehicle", 2nd edition, Springer Publication, 2005.
- Tom H. Denton , "Automobile Electrical and Electronic Systems", 3rd Edition, Elsevier, 2004
- John F. Kershaw, James D. Halderman, "Automotive Electrical and Electronic Systems", 5th Edition, Pearson Prentice Hall, 2007

Program:	M.Tech.(E&TC)-VLSI and Embedded Systems		Semester: I			
Course:	Industrial Drives			Code:	MET1601B	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	--	30	50

Pre-requisite:
Electrical Drives, Dynamics of Electrical drives, Control Systems

Objectives:
- To define electric drive, its parts, advantages and explain choice of electric drive.
- To explain dynamics and modes of operation of electric drives.
- To explain selection of motor power ratings and control of dc motor using rectifiers.
- To explain the control of induction motor, synchronous motor and stepper motor drives.
- To discuss typical applications electrical drives in the industry

Outcomes:
After learning the course, the students should be able to:
- Analyze the performance of induction motor drives under different conditions.
- Control induction motor, synchronous motor and stepper motor drives.
- Suggest a suitable electrical drive for specific application in the industry
- To analyze the performance of induction motor drives under different conditions.

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	**Selection of Motor Power Ratings:** Thermal Model of Motor for Heating and Cooling, Classes of Motor Duty, Determination of Motor Rating. **Direct Current Motor Drives:** Controlled Rectifier Fed dc Drives, Single and three Phase Half and Fully Controlled Rectifier Control of dc Separately Excited Motor, Rectifier Control of dc Series Motor, Supply Harmonics, Power Factor and Ripple in Motor Current, Chopper Control of Separately Excited dc Motor, Chopper Control of Series Motor.	7
2.	**Induction Motor Drives:** Analysis and Performance of Three Phase Induction Motors, Analysis of Induction Motor Fed from Non-Sinusoidal Voltage Supply, Starting, Braking, Transient Analysis. Speed Control Techniques-Stator Voltage Control, Variable Voltage Frequency Control from Voltage Sources.	8
3.	Voltage Source Inverter (VSI) Control, Cyclo-converter Control, Closed Loop Speed Control and Converter Rating for VSI and Cyclo-converter Induction Motor Drives, Variable Frequency Control from a Current Source, Current Source (CSI) Control, current regulated voltage source inverter control, speed control of single phase induction motors.	8
4.	**Synchronous Motor Drives:** Operation from fixed frequency supply-starting, synchronous motor. Self-controlled synchronous motor drive employing load commutated thruster inverter, Permanent Magnet ac (PMAC) Motor Drives, Sinusoidal PMAC Motor Drives, Brushless dc Motor Drives. **Stepper Motor Drives:** Variable Reluctance, Permanent Magnet, Important Features of Stepper Motors, Torque Versus Stepping Rate Characteristics, Drive Circuits for Stepper Motor. **Industrial Drives:** Textile Mills, Steel Rolling Mills, Cranes and Hoists, Machine Tools.	7
	Total	30

Text Books:
- Gopal K Dubey , Fundamentals of the electrical drives Narosa publication
- N. Mohan T.M. udeland&W.P.Robbins , Power Electronics converter application J.Wiley& sons

• VedamSuryavanshi**,** Electrical Drives Concept and application • B.K. Bose, Advanced power Electronics & A.C. Drives • S.K.Pillar, Analysis of thyristor power conditioned motors
Reference Books: • N.K De,P.K. Sen , Electric Drives PHI Learning 1 st Edition, 2009 • GobalK.Dubey, Fundamentals of Electrical Drives- Alpha Science Int. Ltd., • Shepherd Hullay&Liag, Power Electronics & Motor Control -, Cambridge Univ. Press • Gopal K Dubey, Power Semiconductor controlled Drives, - Prentice Hall pub. • R. Krishnan, Electric Motor Drives–Modelling, Analysis and Control, - Pearson Education, 2003 • P.C. Sen , Thyristorised DC Drives -, Krieger pub. • S.B.Dewan, G.R.Slemon&A.Stranghan; Power Semi conductor controlled Drives - John-Willey pub.

Program:	M.Tech. (E&TC)-VLSI and Embedded Systems				Semester : I		
Course :	Basic of FPGA and CPLD				Code :		MET1601C
Teaching Scheme				**Evaluation Scheme**			
Lecture	Hours	Credit	IE1	IE2	ETE	Total	
2	2	2	20	--	30	50	

Pre-requisite: Fundamentals of digital electronics, Knowledge of one hardware description language

Objectives:
1. To make students familiar with programmable logic devices and its architectures.
2. To understand the architecture and features of FPGA and CPLD .
3. To make the students familiar with the design process and how the design is mapped to the existing hardware in FPGA and CPLD.

Outcomes:
After learning the course the students should be able to:
1. To understand the depth of CPLD and FPGA architectures.
2. To design a system using FPGAs.
3. To demonstrate an understanding of interfacing of different external devices with FPGA/CPLD.
4. To apply the complete design flow of FPGA and CPLD   for the specific application.

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	**Introduction:** Introduction to Hardware Description language, Need of Programmable logic devices, PLA PAL, CPLD, FPGA: General Architecture, features CPLD Architecture: overview, specification and applications, Features of XC9500 series of CPLD family.	7
2.	**FPGA Architecture:** Xilinx Logic Cell Array, Configurable Logic Block, I/O Block, Programmable Interconnects, Programming methods, Advanced features of Xilinx 4000 series Technology Trends: Device capacity, Utilization and Gate Density, Programming methods, General Design Flow, General Design Guidelines.	8
3.	**Interfacing with FPGA/CPLD:** The purpose of interfacing, interfacing of external devices such as WiFi Module, Bluetooth Module, GPS Module, Zigbee Module, Different types of display devices with FPGA/CPLD	8
4.	**Case Studies-FPGA/CPLD:** Xilinx Virtex-6, Spartan-6, Z-board Advanced features in FPGA based on Case studies. **Logical Design by FPGA/CPLD:** Complete design of any combinational circuit by gates, Boolean Algebra, Design of sequential circuits	7
	Total	30

Text Books:
- P.K.Chan& S. Mourad, Digital Design Using Field Programmable Gate Array, Prentice Hall (Pte), 1994
- Ronald Sass and Andrew G. Schmidt, "Embedded systems design with platform FPGAs: Principles and practices", Morgan Kaufmann, 2010.
- Design manuals of Altera, Xilinx and Actel.

Reference Books:
- S. Trimberger, Edr. Field Programmable Gate Array Technology, Kluwer Academic Publications, 1994.
- Ronald J Tocci, Neal S. Widmer, Gregory L. Moss, "Digital Systems: Principles & Applications", 10thEdition, Pearson, 2009
- J. Old Field, R. Dorf, Field Programmable Gate Arrays, John Wiley & Sons, Newyork, Reprint 2008.
- S. Brown, R. Francis, J. Rose, Z. Vransic, Field Programmable Gate Array, BSP, 2007.
- S. Brown and J. Rose, "Architecture of FPGAs and CPLDs: A Tutorial", IEEE Design & Test of Computers, Vol. 13, No. 2, pp. 42-57, 1996.
- Stephen Brown ZvonkoVranesic – Fundamentals of Digital Logic with VHDL design,   McGraw Hill – 2000

Program:	M. Tech. (E&TC)-VLSI and Embedded Systems		Semester : I	
Course :	Robotics		Code : MET1601D	

Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	--	30	50

Prior Knowledge of is essential.
1. Sensors and actuators
2. Programming language 'C', MATLAB

Objectives: To impart knowledge on
1. Electromechanical elements of robots
2. Control system for robot automation
3. Existing robots designed for various applications

Outcomes:
After learning the course the students should be able to:
1. Understand kinematics, statistics and dynamic of robots
2. Apply concepts of industrial automation and communication for selection of robots
3. Select sensing and actuating elements for designing robots as per applications requirements
4. Integrate and design control system and information system for various applications.

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	**Introduction to robotics** Evolution of Robotics, Elements of robots; Kinematics of serial and parallel robots; Velocity and static analysis of robots; Dynamics of robots; Motion planning and control; Flexible manipulators; Wheeled mobile robots, classification of Robots	7
2.	**Advanced concepts in robotics** Introduction to Cloud and Fog robotics; Basic concepts of industrial automation and communication protocols for PLC, DCS, SCADA systems; Introduction to Internet of Things, Protocols and real time applications.	8
3.	Sensing Elements **for robots** Classification of Sensors, Encoders and Dead Reckoning Infrared Sensors, Ground-based RF Systems, Active Beacons, Ultrasonic Transponder Trilateration, Accelerometers, Gyroscopes, Laser Range Finder, Vision-based Sensors, Color-tracking Sensors, safety and motion sensors, Force/ Torque Sensors , Tactile Sensors, DC Motors, Controlling a DC Motor, Pulse Width Modulation, Stepper Motors, Servo Motor.	8
4.	**Control System of Robots** Automatic-Feedback Control System, Control Elements, Control System Design, A Robot's System Dynamics, Sensory Feedback, Control Algorithms and Performances, Space Control, Introduction to Information System of Robots.	7
	Total	30

Text Books:
- John J C, Introduction to Robotics: Mechanics and Control , Addison-Wesley (1989).
- Appin Knowledge Solutions, Robotics (2007)
- Ming Xie, Fundamentals of Robotics - Linking Perception to Action (2003)

Reference Books:
- Thomas Bräunl, Embedded Robotics - Thomas Braunl (2006)
- Bruno S and Sciavicco L, Robotics: Modelling, Planning and Control, Springer (2009).
- Fu K S, Ralph G and Lee C S G, Robotics: Control Sensing. Vision, and Intelligence , Tata McGraw-Hill (1987).
- Mukhopadhyay S, Sen S and Deb A K, Industrial Instrumentation, Control and Automation, Jaico (1999).
- Rajkumar B and Dastjerdi A V, Internet of Things: Principles and Paradigms , Morgan Kaufmann (2016).

Program:	M.Tech. (E&TC)-VLSI and Embedded Systems		Semester:II			
Course:	Drone Programming for Beginners			Code:		MET2602A
Teaching Scheme			Evaluation Scheme			
Lecture	**Hours**	**Credit**	**IE 1**	**IE 2**	**ETE**	**Total**
2	2	2	20	--	30	50

Pre-requisite: Basic understanding of physics (Force, Velocity, Acceleration, etc), Understanding of sensors and actuators, Control systems, Modelling Basics –MATLB & SIMULINK, Programming in python

Objectives:
1. To understand the physics behind drones
2. To create the mathematical model of quadcopter drone from simple mathematics & Experimental data
3. To implement model into Simulink & check it against real life performance

Outcomes:
After learning the course, the students should be able to:
1. Identify & select different accessories of Drones as per applications
2. Establish the mathematical model & the Physics behind Quadcopter drone
3. Design Simulink model simulating the complete dynamics of quadcopter drone.

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	**Introduction to drones:** Unmanned Aerial Systems (UAS), Basics of drones, Introduction to Drones programming and Development Tools, Current rules and regulations governing owning and operating a UAS, concerns surrounding UAS safety, security and privacy issues	7
2.	**Drone accessories and Applications:** Sensors, Motors, Propellers, Battery, Concept of propulsion, Forces working on a Flight, Principal axes and rotation of aerial systems, Stable, unstable and neutral systems, Control drone (roll, pitch and yaw), Application of drones.	8
3.	**Drone control system development in Simulink:** Control system architecture, Quadcopter with actuator & propellers functionality block, Sensing & estimation functionality block, controller functionality block, Motor mixing algorithm (RPYT) functionality block	8
4.	**Modelling, Simulation & Flight control design:** Dynamic quadcopter system Model, flight control design, 3D visualization, testing & Tuning the model, Flight operations, Applicable software for data collection, processing, and analysis	7
	Total	30

Text books:
- John Baichtal ,Building your own drones, a beginner's guide to drones, UAVS, and ROVs
- Muhammad Usman , Quadcopter modelling and control with Matlab/Simulink implementation
- Ryan Gordon , Model based design of a quadcopter
- K.S.Fu, R.C.Gonzalez, C.G.Lee , Robotics control, sensing, vision and intelligence

Reference Books:
- - R.K.Mittal , I.J.Nagrath,Robotics and control
- Ben Rupert , Drones (The ultimate guide), , CreateSpace Independent Publishing Platform
- Agam Kumar Tyagi Matlab and Simulink for engineers, , Oxford University Press, 2012

Program:	M. Tech (E&TC)-VLSI and Embedded Systems		Semester:	II	
Course :	Instrumentation and Measurements		Code:	MET2602B	

Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	--	30	50

Pre-requisite: Basics of sensors and Actuators, Basic of Electronics, Analog and Digital Systems

Objectives:
To impart knowledge on the following Topics -
1. Basic functional elements of instrumentation
2. Fundamentals of electrical and electronic instruments
3. Comparison between various measurement techniques
4. Various storage and display devices
5. Various transducers and the data acquisition systems

Outcomes:
After learning the course, the students should be able to:
1. Analyse different measuring parameters of any electronics/mechatronics system
2. Design and evaluate characteristics of different types of mechatronics/ electrical/ electronic system
3. Understand different types of wave/spectrum analyzer.
4. Interface various system components and analyse its data using data acquisition system.

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	Basics of Measurements: Accuracy, Precision, resolution, reliability, repeatability, validity, Errors and their analysis, Standards of measurement. Bridge Measurement: DC bridges-wheatstone bridge, AC bridges – Kelvin, Hay, Maxwell, Schering and Wien bridges, Wagner ground Connection. Electronic Instruments for Measuring Basic Parameters: Amplified DC meter, AC Voltmeter, True- RMS responding Voltmeter, Electronic multi-meter, Digital voltmeter, Vector Voltmeter.	7
2.	Oscilloscopes: Cathode Ray Tube, Vertical and Horizontal Deflection Systems, Delay lines, Probes and Transducers, Specification of an Oscilloscope. Oscilloscope measurement Techniques, Special Oscilloscopes – Storage Oscilloscope, Sampling Oscilloscope. Signal Generators: Sine wave generator, Frequency – Synthesized Signal Generator, Sweep frequency Generator. Pulse and square wave generators. Function Generators.	8
3.	Signal Analysis: Wave Analyzer, Spectrum Analyzer. Frequency Counters: Simple Frequency Counter; Measurement errors; extending frequency range of counters Transducers: Types, Strain Gages, Displacement Transducers	8
4.	Digital Data Acquisition System: Interfacing transducers to Electronics Control and Measuring System. Instrumentation Amplifier, Isolation Amplifier. An Introduction to Computer-Controlled Test Systems.IEEE-488 GPIB Bus	7
	Total	30

Text Books:
1. Albert D.Helstrick and William D.Cooper, Pearson Education , Modern Electronics Instrumentation & Measurement Techniques, . Selected portion from Ch.1, 5-13.
2. by JoshphJ.Carr ,Elements of Electronics Instrumentation and Measurement-3rd Edition.Pearson Education. Selected portion from Ch.1,2,4,7,8,9,13,14,18,23 and 25.

Reference Books:
1. Electronics Instruments and Instrumentation Technology – Anand, PHI
2. Doebelin, E.O., Measurement systems, McGraw Hill, Fourth edition, Singapore, 1990.

Program:	M.Tech. (E&TC)-VLSI and Embedded Systems		Semester : II			
Course :	Microcontrollers and Microprocessors applications		Code : MET2602C			
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	-	30	50

Prior Knowledge of
Digital Electronics **is essential.**

Objectives:
1. To understand architecture and features of typical Microcontroller.
2. To understand need of microcontrollers in real life applications.
3. To learn interfacing of real-world peripheral devices
4. To study various hardware and software tools for developing applications.
5. To learn the architecture and programmer's model of advanced processor and microcontroller
6. To acquaint the learner with application instruction set and logic to build assembly language programs.

Outcomes:
After learning the course the students should be able to:
1. Learn importance of microcontroller and microprocessor in designing embedded application
2. To apply the programming skills to develop real-life embedded application.
3. Learn use of hardware and software tools.
4. Develop interfacing to real world devices

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	**Introduction to single chip Microcontrollers:** Intel MCS-51 family features, 8051/8031-architecture, 8051 assembly language programming, addressing modes, Programming interrupts, timers and serial communication	7
2.	**Microcontrollers and system design:** Assembly vs High-Level language programming, System Development Environment: assembler, compiler and integrated development environment, Debugging and Simulation, system design with 8051.	8
3.	**System level interfacing design;** Advanced Microprocessor Architectures- 286, 486, Pentium; Introduction to RISC processors; ARM microcontrollers; Embedded system design methodologies, embedded controller design for communication, digital control	8
4.	**Microcontroller & Processors Applications:** Interfacing with display devices, Sensors, actuators, and memory devices. Case Study on real time embedded system.	7
	Total	30

Text Books:
- Barry B Brey, The intel microprocessor: architecture, programming and interfacing, Prentice hall of India, New Delhi, 2003.ISBN-0138027455, 4th Edition
- Mohammad Ali Mazidi and Janice GillispieMaszidi "The 8051 Microcontroller and Embedded Systems" Pearson education, 2003, ISBN- 9788131710265, 2nd Edition

Reference Books:
- Chris H. Pappas, William H. Murray, —80386 Microprocessor Handbooks‖, McGraw-Hill Osborne Media, ISBN-10: 0078812429, 13: 978-0078812422.
- Walter A. Triebel, —The 80386Dx Microprocessor: Hardware‖, Software, and Interfacing, Pearson Education, ISBN: 0137877307, 9780137877300.
- Mohammad Rafiquzzaman, —Microprocessors: Theory and Applications: Intel and Motorola", Prentice Hall, ISBN: -10:0966498011, 13:978:0966498011.
- K. Bhurchandi, A. Ray, —Advanced Microprocessors and Peripherals, McGraw Hill Education, Third Edition, ISBN: 978-1-25-900613-5

Program:	M. Tech(VLSI & Embedded Systems)		Semester:		II	
Course:	Electronics Implementation Platform		Code: MET2602D			
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	--	30	50

Pre-requisite: Knowledge of C language, Python, electronic circuits.

Objectives:
1. Explain about the Arduino, Raspberry Pi, PLDs and all other associated platforms
2. Understand of the importance of micro controllers and computers in science and technology.
3. Discuss basic programming and structures required for basic operation of the platform,
4. Describe how to recognize functions, operations and syntax of Python, C and C++

Outcomes:
After learning the course, the students should be able to:
1. Apply logical thinking and problem-solving skills with Arduino platform.
2. Acquire knowledge about Raspberry pi for implementation of applications
3. Understand Digital Signal processing implantation basics
4. Understanding rapid prototyping using PLDs.

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	Arduino: A open-source Hardware, Working, Interfacing, Coding basics and small applications and Debugging.	7
2.	Raspberry pi : Working, Interfacing, Coding basics and small applications and Debugging.	8
3.	DSP processor for Real time Video and Inage Processing. : Working, Interfacing, Coding basics and small applications and Debugging.	8
4.	Programmable Logic devices: FPGA: Working, Interfacing, Coding basics and small applications and Debugging.	7
	Total	30

Text Books:
- Ryan Turner, Arduino Programming: The Ultimate Beginner's & Intermediate Guide to Learn Arduino Programming Step by Step, 2019
- Derek Molloy Exploring Raspberry Pi: Interfacing to the Real World with Embedded Linux 1st Edition,2006
- Avtar Singh , Digital Signal Processing Implementations : Using DSP Microprocessors (with examples from TMS320C54XX),2003
- Roger Woods, HYPERLINK "https://onlinelibrary.wiley.com/action/doSearch?ContribAuthorRaw=McAllister%2C+John"John McAllister, HYPERLINK "https://onlinelibrary.wiley.com/action/doSearch?ContribAuthorRaw=Yi%2C+Ying"Ying Yi, HYPERLINK "https://onlinelibrary.wiley.com/action/doSearch?ContribAuthorRaw=Lightbody%2C+Gaye"Gaye Lightbody, FPGA-based Implementation of Signal Processing Systems, Second Edition, 2017

Reference Books:
- Mark Torvalds ARDUINO - ARDUINO PROGRAMMING - ARDUINO FOR BEGINNERS,Second Edition June 7, 2018
- Eben Upton Raspberry Pi User Guide 4th Edition 2019
- Sen M. Kuo ,Real-Time Digital Signal Processing, : Implementations, Application and Experiments with the TMS320C55X, 2001
- CemUnsalan, Bora Tar ,Digital System Design with FPGA: Implementation Using Verilog andx VHDL ,2017

Program:		M.Tech. (Computer Engineering)			Semester : I	
Course :		Programming with Python			Code :MCE1601A	
Teaching Scheme				Evaluation Scheme		
Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	--	30	50

Pre-requisite: . Basics of Programming

Objectives:

- To acquire knowledge in Python and R programming.

- To develop Python programs with conditionals and loops and data structures.

- Acquire skills to apply data analysis methods to a problem.

Outcomes:

After learning the course the students should be able to:

1.Describe the Numbers, Math functions, Strings, List, Tuples and Dictionaries in Python

2.Interpret Object oriented programming in Python

3. Apply a solution clearly and accurately in a program using Python.

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	**Introduction to Python Programming** Python Introduction, Installing and setting Python environment in Windows and Linux, basics of Python interpreter, Execution of python program, Editor for Python code, syntax, variable, Data types. Flow control if if else, for, while, range() function, continue, pass, break. Strings: Sequence operations, String Methods.	7
2.	**Lists** Basic Operations, List slices, listmethods, list and strings **Dictionaries:**looping and dictionaries, dictionaries & lists. **Tuples and Files:** reading and writing Functions: Definition, Call, Arguments , Input output file handling.	8
3.	**Object Oriented Programmingfeatures in Python** Classes, Objects, Inheritance, Errors and Exceptions: try, except and else statements, Exception Objects, Regular expressions.	8
4.	**Numpy and Matplotlib** Array operations, Numpy Side Effects, 2D Numpy Arrays , Numpy Basic Statistics. Matplotlib: Introduction, Simple plots, Line API, Legend API, Figures, Subplots. **Pandas:** Look Ups, Selections and Indexing, Filling Methods, Series operation, Handling NaN values, Mapping, Data Frames, Reading Files, Plotting, Joins, Correlation, Histograms, Rolling calculation.	7
	Total	30

Text Books:

1. Allen B Downey, ―Think PYTHON‖, O‘Rielly, ISBN: 13:978-93-5023-863-9, 4th Indian Reprint 2015
2. Peng, Roger D and Elizabeth Matsui, ―The Art of Data Science." A Guide for Anyone Who Works with Data. Skybrude Consulting 200 (2015): 162

Reference Books:

1. Zed A. Shaw,Learn Python the Hard Way

Program:	M.Tech. (Computer Engineering)		Semester : I			
Course :	Software Engineering Basics		Code :MCE1601B			
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
2	2	2	20	--	30	50

Pre-requisite:- None

Objectives:
1. To learn and understand the principles of Software Engineering
2. To be acquainted with methods of capturing, specifying, visualizing and analyzing software requirements.
3. To apply Design and Testing principles to S/W project development.
4. To understand project management through life cycle of the project.
5. To understand software quality attributes.

Outcomes:
After learning the course the students should be able to:
1. Decide on a process model for a developing a software project
2. Classify software applications and Identify unique features of various domains
3. Design test cases of a software system.
4. Understand basics of IT Project management.
5. Plan, schedule and execute a project considering the risk management.
6. Apply quality attributes in software development life cycle.

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	**Introduction to Software Engineering and Software Process Models:** Software Engineering Fundamentals: Nature of Software, Software Engineering Principles, The Software Process, Software Myths. Process Models : A Generic Process Model, Prescriptive Process Models: The Waterfall, Incremental Process(RAD), Evolutionary Process, Unified Process, Concurrent. Advanced Process Models & Tools: Agile software development: Agile methods, Plan-driven and agile development.	7
2.	**Software Requirements Engineering and Analysis:** Requirements Engineering: User and system requirements, Functional and non-functional requirements, Types & Metrics, A spiral view of the requirements engineering process. Software Requirements Specification (SRS): The software requirements Specification document, The structure of SRS, Ways of writing a SRS, Requirements elicitation & Analysis: Process, Requirements validation, Requirements management.	8
3.	**Design Engineering:** Design Process & quality, Design Concepts, The design Model, Pattern-based Software Design. Architectural Design :Design Decisions, Views, Patterns, Application Architectures, Modeling Component level Design: component, Designing class based components, conducting component-level design, User Interface Design: The golden rules, Interface Design steps & Analysis, Design Evaluation	8
4.	**Project Risk Management:** Risk Analysis & Management: Reactive versus Proactive Risk Strategies, Software Risks, Risk Identification, Risk Projection, Risk Refinement, Risk Mitigation, Risks Monitoring and Management, The RMMM plan for case study project	7
	Total	30

Text Books:
1. Roger Pressman, ―Software Engineering: A Practitioner 's Approach‖, McGraw Hill, ISBN 0–07–337597

2. Ian Sommerville, ― Software Engineering‖, Addison and Wesley, ISBN 0-13-703515-2

Reference Books:
1. Carlo Ghezzi, ―Fundamentals of Software Engineering", Prentice Hall India, ISBN-10: 0133056996

2. Rajib Mall, ―Fundamentals of Software Engineering‖, Prentice Hall India, ISBN-13: 978- 8120348981

3. Pankaj Jalote, ―An Integrated Approach to Software Engineering‖, Springer, ISBN 13: 9788173192715.

4. S K Chang, ―Handbook of Software Engineering and Knowledge Engineering‖, World Scientific, Vol I, II, ISBN: 978-981-02-4973-1

5. Tom Halt, ―Handbook of Software Engineering‖, Clanye International, ISBN10: 1632402939

6.Christine Bresnahan, Richard Blum –Linux command line and Shell Scripting Bible -Weilly , ISBN-978-0-470-25128-7

Program:	M.Tech. (Computer Engineering)		Semester : I			
Course :	Basics of Machine Learning		Code :MCE1601C			
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
2	2	2	20	--	30	50

Pre-requisite:
1.Linear Algebra, Statistics, Probability and Calculus
2. Basic Programming Skills

Objectives:
1. To master the concepts of supervised and unsupervised learning, recommendation engine, and time series modeling
2. To gain practical knowledge over principles, algorithms, and applications of Machine Learning through a hands-on approach and to validate Machine Learning models and decode various accuracy metrics. Improve the final models using another set of optimization algorithms, which include Boosting & Bagging techniques
3. To acquire thorough knowledge of the statistical and heuristic aspects of Machine Learning and To comprehend the theoretical concepts and how they relate to the practical aspects of Machine Learning.
4. To implement models such as support vector machines, kernel SVM, naive Bayes, decision tree classifier, random forest classifier, logistic regression, K-means clustering

Outcomes:
After learning the course the students should be able to:
1. Understand machine learning techniques and computing environment that are suitable for the applications under consideration.
2. Solve problems associated with batch learning and online learning, and the big data characteristics such as high dimensionality, dynamically growing data and in particular scalability issues.
3. Develop scaling up machine learning techniques and associated computing techniques and technologies for various applications.
4. Implement various ways of selecting suitable model parameters for different machine learning techniques.

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	**Foundations for Machine Learning [ML]:** ML Techniques overview: Supervised; Unsupervised, Reinforcement Learning, Validation Techniques (Cross-Validations)**;**Feature Reduction/Dimensionality reduction; Principal components analysis (Eigen values, Eigen vectors, Orthogonality)	7
2.	**Clustering:** Distance measures; Different clustering methods (Distance, Density, Hierarchical); Iterative distance-based clustering; Dealing with continuous, categorical values in K-Means; Constructing a hierarchical cluster; K-Medoids, k-Mode and density-based clustering; Measures of quality of clustering	8
3.	**Classification: Naïve Bayes Classifier** Model Assumptions; Probability estimation; Required data processing; M-estimates;, Feature selection: Mutual information; Classifier **K-Nearest Neighbors:** K-Nearest Neighbor algorithm; Aspects to consider while designing K-Nearest Neighbor Support Vector Machines; SVM for classification and regression problems.	8
4.	**Association Rule mining:** The applications of Association Rule Mining: Market Basket, Recommendation Engines, etc. ; A mathematical model for association analysis; Large item sets; Association Rules; Apriori: Constructs large item sets with mini sup by iterations; Interestingness of discovered association rules; Application examples; Association analysis vs. classification ; FP-trees **Research Aspects: Application of ML in various domains-**Research Paper Publication in Quality Indexed International Journals/ Conferences; Practical Implementation of Industry Projects/Applications**;** IPR	7

	Total	**30**

Text Books:
1. T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2e, 2008.
2. Christopher Bishop. Pattern Recognition and Machine Learning. 2e.

Reference Books:
- EthemAlpaydin, Introduction to Machine Learning

Program:	M.Tech.(Computer Engineering)			Semester : II		
Course :	Image Processing with MATLAB			Code :MCE2602A		
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
2	2	2	20	--	30	50
Pre-requisite: Programming Basics						

Objectives:
1. Develop an overview of the field of image processing.
2. Cover the basic theory and algorithms that are widely used in digital image processing.
3. Develop hands-on experience in using computers to process images.
4. Familiarize with MATLAB Image Processing Toolbox Course

Outcomes:
After learning the course the students should be able to:
• Understand the need for image transforms different types of image transforms and their properties.
• Learn different techniques employed for the enhancement of images.
• Understand the need for image compression and to learn the spatial and frequency domain techniques of image compression.
• Learn different feature extraction techniques for image analysis and recognition.
• Develop any image processing application.

	Detailed Syllabus:	
Unit	**Description**	**Duration Hrs**
•	**Introduction** What is image processing?, What are the fundamental issues? , What is the role of perception? Image sampling and quantization, Basic relationship between pixels, MATLAB orientations. **Image Transformations** Discrete Fourier transform, Properties of 2D DFT, FFT, Convolution, Correlation, Discrete cosine transform, Discrete Wavelet transform.	7
•	**Image Enhancement Techniques** Spatial Domain Techniques: Basic gray level transformations, Histogram processing, Image subtraction, Image averaging, Spatial filtering, Smoothing filters, Sharpening filters. Frequency Domain Techniques: Frequency domain filtering, Image smoothing and Image sharpening using frequency domain filters.	8
•	**Color image processing:** Color fundamentals, Color models, Color transformation, Smoothing and Sharpening **Image Compression:** Fundamentals, Encoder-Decoder model, Types of redundancies, Lossy and Lossless compression, Huffman coding, Arithmetic coding, Golomb coding, LZW coding, Block transform coding, Run-length coding, JPEG Lossless predictive coding, Lossy predictive coding, Wavelet coding.	8
•	**Morphological Image processing:** Basics, Erosion, Dilation, Opening, Closing, Hit-or-Miss transform, Boundary Detection, Hole filling, Connected components, Convex hull, Thinning, Thickening, Skeletons, Pruning. **Image Segmentation and Representation:** Point, Line and Edge detection, Edge linking and Boundary detection, Thresholding, Basic global tresholding, Otsu's method, Region based segmentation, Use of motion in segmentation	7
	Total	30

Text Books:

1. R. C.Gonzalez, R.E.Woods," Digital Image processing", Pearson edition, Inc3/e,2008.

2. A.K.Jain," Fundamentals of Digital Image Processing", PHI,1995

Reference Books:

1. J.C. Russ," The Image Processing Handbook", (5/e), CRC, 2006

2. R.C.Gonzalez& R.E. Woods; "Digital Image Processing with MATLAB", Prentice Hall, 2003

3.W. K. Pratt, *Digital Image Processing,* John Wiley & Sons, 2006.

4.S. Ahmed, *Image Processing,* McGraw -Hill, 1994.

5.S. J. Solari, *Digital Video and Audio Compression,* McGraw-Hill, 1997

Program:	M.Tech. (Computer Engineering)		Semester : II		
Course :	Linux Essentials		Code :MCE2602B		

Teaching Scheme | | | **Evaluation Scheme** | | | |

Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	--	30	50

Pre-requisite:

Objectives:
  1.To acquire knowledge of basic Linux OS, commands, and terminologies
  2.To develop programs using Shell scripting
  3.To acquire skills related to Linux file system

Outcomes:
After learning the course the students should be able to:
  1. Use common and simple Linux commands
  2. Demonstrate programming ability using Unix Shell
  3. Develop collaboratively using GIT and write research-papers using LaTex 4.
  4. Apply a solution clearly and accurately in Linux environment

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	**Introduction to Linux:** Linux introduction; Understanding philosophy of Linux; Understanding Software Licensing and Linux Distributions; Architecture of Linux OS; Installation of Linux OS (direct and using virtual machine); Using common Linux programs: Linux desktop environment, working with different productivity software; Understanding and managing hardware: CPU, Disk issues, Device drivers, Display etc.;	7
2.	**Basic Commands and Shell Scripting:** Introduction to Linux commands, concept of shell, shell variables, getcwd() and pwd; Introduction to shell programming features: Variables declaration &scope, test, return value of a program, if-else and useful examples, for and while loop, switch case; Shell functions, pipe and redirection, wildcards, escape characters; Awk script: Environment and workflow, syntax, variables, operators, regular expressions, arrays, control flows, loops, functions, output redirections	8
3.	**Linux File System and Networking:** File System - Manipulating Files: creating, deleting, copying, moving, renamingetc; Using absolute and relative path; Manipulating Directories: Creating, Deleting and Managing; Basic File and Directory commands; Understanding Linux file system; Networking - Understanding network features; Configuring a network connection; Testing a network connection;	8
4.	**Essential System Administration** **Users and Group Management:** Users and Group management: Creation, Updating, Deletion of user and group; Commands –shadow, useradd, usermod, userdel, groupadd, groupmod, groupdeletc; Managing ownership and permission. **Process and Package Management:** Understanding package management,package management commands like rpm, yum, apt; Understanding Process hierarchy and identifying running processes; Log files. **Or** **Introduction to GIT and LaTEX:** LaTEX:Basic syntax, compiling and creating documents; Document structure including sections and paragraphs; Adding Images, Table of contents, Source code, graphs; Adding references, and Bibliography; Installation and Hands-on of LaTEX. GIT: Creating a project using GIT locally, add, commit; Branch and Merge; Cloning a remote repo, working with a remote repo; Working on a project in a distributed	7

	fashion; Hands-on of GIT.	
	Total	**30**

Text Books:

1. Christine Bresnahan, Richard Blum ―Linux Essentials, Sybex, ISBN 9781119092063

2. Sumitava Das, Unix Concepts and Applications, Tata-McGraw Hill, ISBN 0-07-063546-3

Reference Books:

1.Christine Bresnahan, Richard Blum –Linux command line and Shell Scripting Bible -Weilly , ISBN-978-0-470-25128-7

Program:	M.Tech (Computer Engineering)				Semester : II	
Course :	Design with UML				Code: MCE2602C	
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
2	2	2	20	--	30	50

Pre-requisite:
.Basic understanding of computer programming and related programming paradigms.

Objectives:
1. To introduce the concept of Object-oriented design
2. To understand and differentiate Unified Process from other approaches
3. To design static and dynamic UML diagrams

Outcomes:
After learning the course the students should be able to:
1. Understand Basic features and elements of the object-oriented approach
2. Identify, analyze, and model structural and behavioral concepts of the system.
3. Apply the concepts of architectural design for deploying the code for software.

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	Introduction to UML: Importance of modeling, principles of modeling, object-oriented modeling, conceptual model of the UML, Architecture, Software Development Life Cycle	7
2.	Basic Structural Modeling: Classes, Relationships, common Mechanisms, and diagrams. Advanced Structural Modeling: Advanced classes, advanced relationships, Interfaces, Types and Roles, Packages. Class & Object Diagrams	8
3.	Basic and Advanced Behavioral Modeling: Interactions, Interaction diagrams. Use cases, Use case Diagrams, Activity Diagrams. Advanced Behavioral Modeling Events and signals, state machines, processes and Threads, time and space, state chart diagrams.	8
4.	Architectural Modeling: Component, Deployment, Component diagrams and Deployment diagrams. Common modeling techniques	7
	Total	30

Text Books:
- Grady Booch, -The unified modeling language user guide. Pearson Education India, ISBN: 0-201-57168

- James Rumbaugh. Micheal Blaha- Object-Oriented Modeling and Design with UML: Pearson Education India, ISBN-13: 978-0130159205

Reference Books:
- Charles Ritcher - Designing Flexible Object-Oriented systems with UML. New Riders Publishing.
- Jackson, Burd Thomson - Object Oriented Analysis & Design. Thomson Course Technology.
- Mike O'Docherty - Object-Oriented Analysis and Design: using UML. Wiley Publication
- Joseph Schmuilers - Teach Yourself UML in 24 Hours. Sams publishing.

Program:	M. Tech. (Civil) Construction Management			Semester : I		
Course :	Project Management and Finance			Code :		MCI1601A
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
2	2	2	20	--	30	50

Pre-requisite: Basics of Management, Basics of Finance

Objectives:

After Completing this course, student will have adequate background to understand and solve the problem involving: Outline the principles followed in carrying out a project.
- To demonstrate knowledge and understanding of engineering and management principles.
- To function effectively as an individual, and as a member or leader in diverse teams.
4. To understand the concepts of finance and accounts carried out in project management.

Outcomes:

After learning the course, the students should be able to:
1. Study the current market trends and choose projects.
2. Prepare project feasibility reports.
3. Ability to implement the project effectively meeting government norms and conditions.
4. Ability to understand the role and responsibility of the Professional Engineer.
5. Ability to choose projects which benefit the society and organization.

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	**Introduction to Management** What is Management? It's Need ,Importance& Purpose, Evolution of Managements thought, Different Schools/ approaches to Management: Behavioral, Quantitative, Systems, Contingency Approach	7
2.	**Project Implementation, Monitoring and Control** Project representation: Role of project managers, relevance with objective of organization, preliminary manipulations, Basic Scheduling concepts: Resource levelling, Resource allocation, Setting a base line, Project management information system: Importance of contracts in projects: Team work in Project Management: Formation of Effective terms.	8
3.	**Organizing** Organizing as a Management process, Principles of Organization, Different Structures of organizations such as line, Line & Staff, Functional, Matrix or project Organization: Characteristics, Features, their Merits and Limitation, Ownerships of Organization: Sole Proprietorship, Partnership, Private Ltd., Public Ltd., Introduction to Organizational climate, Decision Making, Group Decision Making, Staffing: What is Staffing? Steps involved in Staffing, Recruitment, Staffing, Performance Appraisal Development	8
4.	**Financial Statements and Their Analysis** Understanding of Financial Statements and Their Analysis, Like Balance Sheet, Profit & Loss Account ,Ratio Analysis, Fund Flow Analysis, Statement of Changes In Financial Position.	7
	Total	30

Text Books:
1. Project Management Institute A Guide to the Project Management Body of Knowledge PMBOK Guide (Sixth Edition), Sept 2017.
2. James C.Van Horne, Fundamentals of Financial Management, Person Education 2004.
3. Khanna, R.B.,Project Management, PHI 2011.

Reference Books:
1. Kuster J., Huber, E., Lippmann, R., Schmid, A., Schneider, E., Witschi, U., Wust, R. Project Management Handbook, 2015.
2. Prasanna Chandra, Financial Management, Tata McGraw-Hill, 2008.
3. Carl S. Warren, James M. Reeve, Jonathan Duchac.
4. Financial and Managerial Accounting, 2016
   5. Paneer Selvam, R., and Senthilkumar, P., Project Management, PHI, 2011.

Program:	M. Tech. (Civil) Construction Management		Semester :I			
Course :	Green Technology		Code :MCI1601B			
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	--	30	50

Pre-requisite:
- Environmental study, Types of pollution

Objectives:

After Completing this course, student will have adequate background to understand and solve the problem involving:
1. To learn about Global warming and its effect
2. To demonstrate knowledge in the reduction of global warming.
3. To learn the control measures of carbon emission and accumulation.
4. To learn high tech measures for Reducing Carbon Emissions.

Outcomes:

After learning the course, the students should be able to:
1. Study the effects of Global warming
2. Implement the concept of reduction of global warming
3. Understand the remedial action for the carbon emission and accumulation.
4. Apply high tech measures for Reducing Carbon Emissions.

	Detailed Syllabus:	
Unit	Description	Duration Hrs
1.	**Global Warming and its effect:-**Introduction and physical definition of global warming, the New Carbon Problem: Accumulation, Long Half-Life, Heating Potential, Carbon Emission Factors, Carbon Absorption in Nature, The Global Emission Situation and its effect in India, The Kyoto and Other Protocols and its view in India, Effect of climate change and its impact. **Planning for the Future to reduce global warming:-**Steps taken to Control Carbon Emissions universally, Use of Promotional and Punitive Mechanisms for Reducing Carbon in Atmosphere, The General Approach in Planning for the Future, Developing Countrywide Adaptive Measures for Safety of Local People, Developing Mitigative Measures for Global Reduction of Carbon, India's National Action Plan on Climate Change (NAPCC) till date, National Mission for a Green India, The MRV Debate.	7
2..	**Opportunities in Control of Carbon Emissions and Accumulation:-** Essential Steps for Control of Carbon Emissions and Accumulation, Procedure to develop own Priorities and Business Opportunities in India for control of carbon emissions and accumulation, Needs a Mix of Green and Traditional Power Sources in India, A Logical Approach for Carbon Reduction, Need in India —More Forests, Less Deforestation and payment rates procedure for controlling carbon emissions and its Promotional Mechanisms at India**. Green Technologies for Energy Production:-**Various Technologies Available for Energy Production, Cost Comparison of a Few Typical Systems for Power Generation, Sources of Energy Production Already in Use, Alternative Methods Ready for Use, Green Technologies Needing some Prior R&D Work.	8
3.	**Green Technologies for Personal and Citywide Application :-** Measures to be taken for Green city, Carbon Emission Reduction at Personal Level, Carbon Emission Reduction at Local Authority and Citywide Level, Carbon Emissions from Imports. **Green Technologies for Specific Applications:-** Promotion of 'Green' Buildings, Guidelines, The Energy Conservation Building Code (ECBC), Green Hotels and Hospitals, Green Technologies for Transport, Green Roads, Ports and Harbors, Industries, Carbon, Carbon Emissions from a Few Selected Industries in India, The Changing Scenario in Cities, Need for Wider Application to Town Planning and Area Re-Development Projects ,'Green' Infrastructure for Municipal Services, Bringing up Indian Villages, Green Services for Crematoria, Spreading Message to all Stakeholders.	8

4.	**Some High-tech Measures for Reducing Carbon Emissions :-** Use of Solar Power with Satellite-Based Systems ,Use of Carbon Capture and Storage (Sequestration) ,Microorganisms, A Quick SWOT Analysis. **Recommended Plan of Action :-** India's National Action Plan Take Us to a Low-Carbon Path, The Missions Help Develop Awareness, Few case studies on Projects undertaken by Various Countries, Adaptive Measures Essential for Indian People to Cope with Climate Change	7	
	Total		30

Text Books:
1. Green Technologies, Soli J. Arceivala, Mc Graw Hill Education.

Reference Books
1. Green Technologies and Environmental Sustainability edited by Ritu Singh, Sanjeev Kumar
2. http://cpcbenvis.nic.in/greentechnology.html

Program:	M. Tech. (Construction Management)				Semester :II	
Course :	Contracts, Tendering & Arbitration				Code :MCI2602A	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	--	30	50

Pre-requisite: None

Objectives:
1. 1. To equipped with knowledge of contracts system.
2. 2. To study principles and specifications for making tender documents
3. 3. To learn basic principles of Arbitration in the context of various construction aspects.

Outcomes:
After learning the course, the students should be able to:
4. Adopting the ethical knowledge for making construction contracts & Tenders.
5. Prepare Tendering documents as per conditions of contract.
6. Exhibit concept of Arbitration to resolution of disputes in construction projects.

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	**Construction Contracts:** Indian Contract Act (1872): Definition of the contract as per the ACT. Valid, Voidable, Void contracts, Objectives of the act. Introduction: To law, Indian legal system, Laws governing structure & Working of Construction Organization Firms, Laws of Tort.	7
2.	**Construction Contract Documents:** Evaluation of contract documents, need for documents, present stage of national and international contract documents, types of construction contracts, roles and functions of parties to the contract. Contract Formation.	8
3.	**Stages in Contracting:** Preparation of tender documents estimating, pre - qualification, bid evaluation, award of contract, project financing and contract payments, contracts close out and completion.	8
4.	**Arbitration:** Comparison of Actions and Laws - Agreements, subject matter-Violations- Appointment of Arbitrators-Conditions of Arbitrations-Powers and duties of	7
	Total	30

Text Books:
1. Civil Engineering Contracts and Estimates - B.S.Patil – Universities Press- 2006 Edition,reprinted in 2009.
2. The Indian Contract Act (9 of 1872), 1872- Bare Act- 2006 edition, Professional Book Publishers.
3. The Arbitration and Conciliation Act,(1996), 1996 (26 of 1996)- 2006 Edition, Professional Book Publisher.

Reference Books:
1. Law of contract Part I and Part II, Dr. R.K. Bangia- 2005 Edition, Allahabad Law Agency.
2. Arbitration, Conciliation and Alternative Dispute Resolution Systems- Dr. S.R. Myneni-2004 Edition, reprinted in 2005- Asia Law House Publishers.
3. The Workmen's Compensation Act, 1923 (8 of 1923) Bare Act- 2005- Professional Book Publishers.
4. Standard General Conditions for Domestic Contracts- 2001 Ministry Of Statistics and Program Implementation, Government of India.FIDIC Document (1999).
5. Dispute Resolution Board foundation manual-www.drbf.org. 30 Edition

Program:	M. Tech. (Civil) Construction Management		Semester :II	
Course :	Total Quality Management in Construction		Code :MCI2602B	
Teaching Scheme			Evaluation Scheme	

Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	--	30	50

Pre-requisite: TQM & MIS at UG Level , Awareness of Quality Construction Aspects

Objectives:
- To understand the need of QM in construction and apply necessary tools to achieve
- To apply necessary trainings for the effective utilization of resources
- To apply effectively the eight principles of ISO for quality processes in construction
- To apply Six Sigma tool for TQM in construction project

Outcomes:
After learning the course, the engineers should be able to:
- Understand and apply the TQM phylosophy in construction
- Able to use effectively QC tools.
- Apply ISO principles for effective Quality processes in construction
- Able to apply Six Sigma effectively.

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	**Concepts of Quality** A) Definition of quality as given by Deming, Juran, Crosby, difference between Quality control, Quality Assurance (QA/QC). Total quality control (TQC) and Total Quality Management (TQM), Need for TQM in construction industry. Organization necessary for implementation of quality, Quality manual-Contents, data required, preparation, responsibility matrix, monitoring for quality- PDCA Cycle. Quality aspects in every phase in the life cycle of Construction project.	7
2.	**Quality Control Tools** Histogram, Pareto diagram, Fish-bone diagram, Quality control chart-Testing required for quality control of construction material used in RCC Work- destructive and Non destructive Test (NDT).Statistical Quality Control-Necessity, Benchmarking.	8
3.	**Study of ISO 9004- Quality System Standards.** Purpose of ISO Standards. Difference between ISO 9001 and ISO 9004. Certification process for ISO 9001. Certification bodies involved. Eight Principles of ISO-Basic meaning, applying these principles for an effective quality process in the organization. Management support and commitment necessary for achieving implementation for quality system standards. **Development** of quality circles, quality inspection team, inspection reports, monitoring and control, 360' feedback for quality.	8
4.	**A) Six Sigma** Definition of six sigma, evolution – Historical aspects, probability distribution Six sigma ratings, Six sigma training, six sigma as an effective tool in TQM. **B) Application of Six Sigma** i) RCC Work in building(ii) Assessment of overall construction process from concept to completion of a construction project.	7
	Total	30

Text Books:
1. Quality Control and Total Quality Management by P.L.Jain- Tata McGraw Hill Publ.Company Ltd
2.Total Engineering Quality Management – Sunil Sharma – Macmillan India Ltd.
3.Total Project Management – The Indian Context - P.K.Joy Macmillan India Ltd.

Reference Books:
1. International Standards Organization – ISO 9001 and ISO 9004
2. Mantri Handbook – A to Z of Construction – Mantri Publications
3. Juran's Quality Handbook – Joseph M. Juran, A. Blanton. Godfrey – Mcgraw Hill InternationalEdition (1998)
4. Management Information Systems – Gordon B. Davis, Margrethe H. Olson – Tata McGraw Hill Publ. Co.

Program:	M. Tech. (Civil) Construction Management			Semester :II		
Course :	Operation Research			Code : MCI2602C		
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
2	2	2	20	--	30	50

Pre-requisite: Applied Mathematics Including Calculus and Linear Algebra, Calculus-Based Probability/Statistics

Objectives: This course aims at enabling students,
1. To familiarize with concepts and techniques of Linear and Nonlinear Programming Problems.
2. To derive feasible and optimal solution for Transportation and Assignment Problem.
3. To apply various methods to select and execute various optimal strategies using decision theory.
4. To construct network diagrams with single and three time estimates of activities involved in the project.

Outcomes: After learning the course, the students should be able to:
1. Model and solve Linear and Nonlinear Programming Problems.
2. Model & Solve profit maximization Transportation and Assignment Problem.
3. Apply various methods to select and execute various optimal strategies using decision theory.
4. Calculate Project schedule and expected completion time for the project.

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	**Introduction to Operations Research** Introduction, operations research approach to problem solving, Models and Modelling in operations research, Advantages, Methods for solving operations research models, Methodology of operations research, Advantages. **Linear Programming** Introduction, Structure of Linear programming Model, Advantages, Limitations, Assumptions and Applications of Linear programming, Guidelines for Model Formulation, Solving Linear programming problems using Graphical Method and Simplex Method	8
2.	**Transportation and Assignment Problems** Mathematical Models of Transportation Problem, The Transportation Algorithm, Methods for Finding Initial Solution, Test for Optimality. Mathematical Models of Assignment Problem, Solution Methods of Assignment Problem.	7
3.	**Decision Theory and Games Theory** Steps of Decision-Making Process, Types of Decision-Making Environment, Decision Making Under Uncertainty, Games Theory: Introduction, Two Person Zero Sum Games, Pure Strategies (Minimax and Maximin Principles): Games with Saddle Point, Mixed Strategies: Games without Saddle Point, The Rules of Dominance, Solution Methods of Games without Saddle Point.	8
4.	**Project Management** Introduction, Basic Difference between PERT and CPM, Phases of Project Management, PERT/CPM Network Components and Precedence Relationships, Critical Path Analysis. Project scheduling with uncertain activity times, Estimation of project completion time.	7
	Total	30

Text Books:
1. J K Sharma, "Operations Research: Theory and Applications" , Trinity Press 5th Edition ISBN No. 9789350593363.
2. Frederick S. Hillier, Gerald Lieberman, "Introduction to Operations Research, McGraw Hill", 6th Edition ISBN No. 0071139893.

Reference Books:
1. Gerald Lieberman, "Operations Research: An Introduction", PHI, 9th Edition, ISBN No. 978- 9332518223.
2. Gupta Prem Kumar and Hira D.S, "Problems in Operations Research", S. Chand, ISBN No.978-8121909686.

3. Wayne L. Winston, "Operations Research Applications and Algorithms", Cengage Learning, 4th Edition, ISBN No. 978-8131501900.
4. P Sankara Iyer, "Operations Research", Sigma Series, TMH, 1st Edition, ISBN No.978-0070669024.

Program:	M. Tech. Mechanical (Heat Power Engineering)			Semester : I	
Course :	Electronic Cooling (OEI)			Code : MMH1601A	
Teaching Scheme			**Evaluation Scheme**		
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
2	2	2	20		30	50

Pre-requisite:
. Thermodynamics, Fluid Mechanics, Heat Transfer

Objectives:
1. To establish fundamental understanding of heat transfer in electronic equipment.
2. To select a suitable cooling process for electronic components and systems.
3. To increase the capabilities in design and analysis of cooling of electronic packages.
4. To analysis the thermal failure for electronic components and define the solution.

Outcomes: After learning the course, the students should be able to
1. Understand Heat transfer processes involved in electronics cooling.
2. Analyze thermal failure for electronic components and define the solution.
3. Assign the best cooling method for each individual application.
4. Design cooling system for any electronic device and select Best packaging approach for any design.

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	**Introduction to Electronics Cooling** Introduction, Packaging Trends and Thermal Management, Basics of Heat Transfer, Conduction Heat Transfer, Multi-Dimensional Conduction, Transient Conduction, Natural Convection in Electronic Devices, Forced Convection Heat Transfer, Radiation Heat Transfer, contact and spreading resistances.	7
2.	**Electronics Cooling Methods in Industry** Thermal interface and phase change materials, passive and novel air-cooling approaches, Heat Sinks, Heat Pipes in Electronics Cooling, Thermoelectric Cooling, Liquid Immersion Cooling (Single and Two-phase), Cooling Techniques for High Density Electronics	8
3.	**Packaging of Electronic Equipments** Components of Electronic Systems, Packaging of Electronic Equipment, Conduction Cooling for Chassis and Circuit Boards, Chip/circuit material for augmenting heat transfer.	8
4.	**Control Parameters Measurement and simulation** Temperature & humidity requirement, CFD analysis for Airflow & temperature evaluation, thermography etc	7
	Total	30

Text Books:
- Dave S. Steinberg," Cooling Techniques for Electronic Equipment ", Second Edition, John Wiley & Sons, 1991.
- Frank P. Incropera, "Introduction to Heat Transfer ", Fourth Edition, John Wiley, 2002.
- Sung Jin Kim and Sang Woo Lee, "Air cooling Technology for Electronic Equipment", CRC press, London, 1996.
- Frank P. Incropera, "Liquid Cooling of Electronic Devices by Single-Phase Convection", John Wiley& sons, inc, 1999.

Reference Books:
- Joel L. Sloan, "Design and Packaging of Electronic Equipment", Van Nostrand Reinhold Company, 1985.
- Belady C., "Standardizing Heat Sink Performance for Forced Convection, Electronics Cooling", Vol. 3, No. 3, September, 1997.
- Biber C., Wakefield Engineering, Wakefield, Massachusetts, "Characterization of the Performance of Heat Sinks,", Personal Communication, October 1997.
- A. B.-Cohen, "Encyclopedia of Thermal Packaging volume 1 to 6", February 2013, World Scientific Publication

Program:	M. Tech. Mechanical (Heat Power Engineering)		Semester : I	
Course :	Green Buildings		Code : MMH1601B	
Teaching Scheme			**Evaluation Scheme**	

Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	-	30	50

Pre -requisite:
1. Basics of air conditioning
2. Basics of building construction

Objectives:
1. To develop a multidisciplinary approach to the energy supply and use in new and existing buildings
2. To develop knowledge and understanding of system solutions that provide optimal indoor environment in buildings in an environmentally and cost-effective way
3. To create awareness of different building rating tools

Outcomes: After learning the course, the students should be able to:
1. Should be able to identify features of an energy efficient building system
2. Learner should be able to apply simulation programs of buildings to perform energy calculations, evaluate the relationship between energy use, indoor comfort
3. Learner should be able to evaluate and justify energy-saving measures in existing building on the basis of engineering and economic feasibility
4. Learner should be able to apply the principles of energy management to obtain buildings that can be certified

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	**Overview and comparison of green building rating systems** What is green building, conventional building practices versus integrated design process, comparison of USGBC LEED, IGBC, GRIHA, EDGE and other green building rating systems, Conducting feasibility studies, reference standards, key definitions, synergies between various credit categories, understanding building forms, site level features, microclimate features	6
2.	**Resource Efficiency** Energy efficiency in buildings, Water efficiency – indoor water use, rainwater harvesting, irrigation water use, wastewater systems, strategies for reducing water consumption Waste management – source reduction, reduce – recycle – reuse, strategies for waste management, construction waste management plan	6
3.	**Health and Wellness** Introduction to indoor air quality, ASHRAE 62.1 overview and requirements, ventilation rate procedure method, key parameters affecting indoor environment, IAQ management plan Daylight and views, strategies to enhance daylight availability, Overview of WELL standard for buildings, impact of VOCs and hazardous chemicals on human health	6
4.	**Site features** Erosion and sedimentation control, water efficient landscaping and irrigation practices, microclimate, heat island effect, exterior lighting pollution, Location and transportation, transportation management strategies and planning	6
5.	**Materials and resources** Low-embodied energy materials, environmental product declarations (EPDs), overview of material categories of IGBC, LEED & GRIHA, life cycle analysis and its application, overview of software tools for LCA,	6
6.	**Government schemes and incentive programs** Funding and Incentives for green building rating programs, requirements of NBC 2016 related to sustainability, local byelaws, model building code	6
	Total	30

Text Books:

1. Shahane, V. S, "Planning and Designing Building", Poona, Allies Book Stall, 2004. 2. Michael Bauer, Peter Mösle and Michael Schwarz "Green Building – Guidebook for Sustainable Architecture" Springer, 2010. 3. Tom Woolley, Sam Kimmins, Paul Harrison and Rob Harrison "Green Building Handbook" Volume I, Spon Press, 2001. 4.	
Reference Books: 1. Mili Majumdar, "Energy-efficient buildings in India" Tata Energy Research Institute, 2002. 2. TERI "Sustainable Building Design Manual- Volume I & II" Tata Energy Research Institute, 2009 3. Reference manuals of green building rating programs (LEED, WELL, IGBC, GRIHA) 4. ASHRAE Standard 62.1, Standard 55, Standard 90.1, and other standards referred by green building programs 5. EDGE App user manual 6. National Building Code of India – 2016 7. ECBC 2017	

Program:	M. Tech. Mechanical (Heat Power Engineering)		Semester : I			
Course :	System Modeling and Simulation		Code : MMH1601C			
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
2	2	2	20	-	30	50

Pre-requisite:
Objectives: 1. Students able to model any physical system for real-time applications   2. Students able to simulate any physical system for real-time applications
Outcomes: After learning the course, the students should be able to: 1. Develop mathematical model for practical problem   2. Develop Bond Graph model for system   3. Apply transfer function and State space model techniques   4. Simulate the system using suitable software and Estimate parameters by optimization

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	Introduction to Modeling and Simulation, Basic systems, Introduction and Types of Mathematical modeling, Basic building blocks Mechanical, Electrical, Thermal systems.	7
2.	Bond Graph Modeling of Dynamic Systems: Representation, Elements, Single, Two and multiport Causality, Application to basic Mechanical, Electrical and Electromechanical system	8
3.	Dynamic Response and System Transfer Function: Poles, Stability Block diagram/Signal flow diagram/State Space formulation and Frequency response	8
4.	Simulation and Simulation application Parameter Estimation, System Identification and Optimization	7
	Total	30

Reference Books:
• Brown, Forbes T. Engineering System Dynamics. New York, NY: CRC, 2001. ISBN: 9780824706166.

Program:	M. Tech. Mechanical (Heat Power Engineering)		Semester : I	
Course :	Waste Management for Smart Cities		Code : MMH2602A	
Teaching Scheme			**Evaluation Scheme**				

Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	-	30	50

Pre-requisite:

Course Objective:

1. To provides an in-depth understanding of Municipal waste characteristics and management.
2. To make aware about regulations in the area municipal waste management.
3. To equip with the methods of environment risk assessment of waste.
4. To provide an in-depth understanding of Physiochemical and biological treatment of Municipal waste.
5. To be able to design the land-fields for the smart cities.

Course Outcomes: The learners will be
1. Identify and evaluate the sources; composition; generation rates, methods of separation and collection methods of municipal waste treatment.
2. Evaluate and analysis the risk and methods of handling the hazardous and radioactive waste based on health effects.
3. Evaluate the Physiochemical and biological waste for its treatment and disposal
4. Design the land field for solid and hazardous wastes collection and removal.

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	**Municipal Solid Waste Management** Fundamentals Sources; composition, generation rates, collection of waste, separation, transfer and transport of waste, treatment and disposal options. Municipal waste management and handling rules for solid waste, hazardous waste, biomedical waste, fly ash, recycled plastics usage and batteries	7
2.	**Hazardous and Radioactive Waste Management** Fundamentals Characterization of waste, fate and transport of chemicals, health effects, Fundamentals sources, measures and health effects; nuclear power plants and fuel production; waste generation from nuclear power plants; disposal options.	8
3.	**Physiochemical Treatment of Solid waste** Physicochemical Treatment of Solid and Hazardous Waste Chemical treatment processes for MSW (combustion, stabilization and solidification of hazardous wastes); physicochemical processes for hazardous wastes (soil vapour extraction, air stripping, chemical oxidation); ground water contamination and remediation.	8
4.	**Biological Treatment of Solid waste and landfill design** Biological Treatment of Solid and Hazardous Waste Composting; bioreactors; anaerobic decomposition of solid waste; principles of biodegradation of toxic waste; inhibition; co-metabolism; oxidative and reductive processes; slurry phase bioreactor. Landfill design Landfill design for solid and hazardous wastes; leach ate collection and removal; landfill covers; incineration	7
	Total	30

Reference Books:
1. John Pichtel Waste Management Practices CRC Press, Taylor and Francis Group 2005.
2. LaGrega, M.D.Buckingham,P.L. and Evans, J.C. Hazardous Waste Management, McGraw Hill International Editions, New York, 1994.
3. Richard J. Watts, Hazardous Wastes - Sources, Pathways, Receptors John Wiley and Sons, New York, 1997.
4. KantiL.Shah, "Basics of Solid and Hazardous Waste Mgmt. Tech." 1999, Prentice Hall.
5. S.C.Bhatia,"Solid And Hazardous Waste Management", 2007 by Atlantic Publishers & Dist.

Program:	M. Tech. Mechanical (Heat Power Engineering)		Semester :I	
Course :	Battery management for Electric Vehicles		Code : MMH2602B	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	-	30	50

Pre-requisite: Basics of Electrical Engineering

Objectives:
1. To understand the various battery performance parameters and types of batteries used for EV applications
2. To understand the requirements of battery management system
3. To make the learners conversant with Equivalent Circuit Cell Modeling of Battery
4. To make the learners conversant with SOC estimation
5. To make the learners conversant with Battery Pack Balancing and Power Estimation
6. To make the learners aware of thermal issues of Lithium ion battery and thermal management system

Outcomes: After learning the course, Learners will be able to
1. Select battery for EV application and design battery pack.
2. Estimate available energy and power of battery pack.
3. Simulate charge discharge characteristics of a battery using equivalent circuit model
4. Estimate SOC and SOH of battery
5. Understand various methods of battery pack balancing
6. Estimate heat generation inside battery and propose cooling strategy for the battery pack.

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	**Introduction to battery-management systems** Battery terminology and performance parameters, Types of electrochemical cells , Lithium Ion Cells components, primary functions and components of BMS **BMS design requirements** Primary functions of BMS, sensing voltage, current and temperature of cell and battery pack, estimation of cell SOC and battery pack SOC, Estimation of available energy and power of cell and battery pack	7
2.	**Equivalent Circuit Cell Model (ECM)** Modeling OCV and SOC, Modeling voltage polarization, Warburg impedance, Estimation of Model parameter values: OCV, Columbic Efficiency, total capacity, temperature dependence of OCV, modeling hysteresis, using the ECM to simulate constant voltage/ power charge/ discharge characteristics	8
3.	**State-of-Charge (SOC) Estimation and Battery Pack Balancing** Different approaches to estimating battery cell SOC, Kalman-filter method of SOC estimation: linear Kalman filter , extended Kalman filter Reasons of battery pack unbalancing, criteria for specifying a balancing set point and when to balance a battery pack ,Passive balancing methods for battery packs, Active balancing methods for battery packs: capacitor-based circuits, transformer-based circuits, Estimation of available battery power using a simplified cell model	8
4.	**Battery Thermal Management** Heat Generation inside battery , Thermal issues of Lithium Ion Battery, Operating temperature range, Energy analysis and Thermal modeling of LIB, Cooling strategies in thermal management : Air cooling, liquid cooling, PCM based cooling , effect of parameters like cell arrangement, spacing, fluid velocity etc.	7
	Total	30

Reference Books:

1. Gregory L. Plett, Battery Management Systems, Volume I: Battery Modeling, Artech House, London
2. Gregory L. Plett, Battery Management Systems Volume II, Equivalent-Circuit Methods, Artech House, London
3. Gianfranco Pistoia, BoryannLiaw (eds.), Behaviour of Lithium-Ion Batteries in Electric Vehicles_ Battery

Health, Performance, Safety, and Cost, Springer International Publication
4. Reiner_Korthauer, Li-I Batteries Basics and Applications, Springer International Publication John Pichtel Waste Management Practices CRC Press, Taylor and Francis Group 2005.

Program:	M. Tech. Mechanical (Heat Power Engineering)				Semester : I	
Course :	Renewable Energy Sources				Code : MMH2602C	
Teaching Scheme				**Evaluation Scheme**		
Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	-	30	50

Pre-requisite: Thermodynamics; Fluid Mechanics; Heat Transfer; Elements of Electrical Engineering;

Objectives: Following concepts to be taught to the students,
1. Demonstrate significance of analysis solar and Wind Resources Sources and design technologies of their utilization
2. Expose them to conceptualize and design renewable energy appliances and equipment
3. Enable them to independently analyze, implement and asses the real-life systems
4. Develop a research insight about renewable technologies so as to motivate all concerned for their enhanced deployment.

Course Outcomes:
1. To be able to determine the fundamental performance of characteristics of solar thermal, photovoltaic and wind energy systems
2. Enable the students to estimate the potential of solar and wind resources
3. To be able to understand the fundamentals of energy conversion from biomass, geothermal, tidal and ocean thermal energy conversion systems
4. To be able to determine the economic feasibility of renewable energy technologies.

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	**Solar energy** Potential of Renewable energy sources (Flow & not stocks), Current scenario of worldwide installed capacity Solar- Earth Geometry for assessment of available solar radiation, Solar radiation estimation, instruments for measurement **Solar thermal collectors** – General description and characteristics: Flat plate collectors – Heat transfer processes – Short term and long-term collector performance. Solar concentrators – Aspects of Design, and performance evaluation. **Solar Photovoltaic Systems**– Working, Constructional details & Performance Assessment for Techno-economic evaluation / feasibility	7
2.	**Wind energy -** Principles of wind energy conversion – Site selection considerations, Wind resource / energy potential measurement, wind electric generator components, Wind power plant design – *Aerodynamics and performance,* vertical vs. Horizontal axis design, and energy wheeling and banking concepts. Types of wind power conversion systems – Operation, maintenance and economics	8
3.	**Energy from biomass -** Sources of biomass – Different species, Conversion of biomass into fuels – Energy through fermentation – Pyrolysis, gasification and combustion – Aerobic and anaerobic bio-conversion, Properties of biomass Biogas plants – Types of plants – Design and operation – Properties and characteristics of biogas. Biogas / Producer Gas Technology, Engines - Constructional, Operational & Performance aspects	8
4.	**Geothermal, Tidal and Wave Energy Conversion** Geothermal energy: hot springs and steam ejection site selection, power plants, and economics. Environmental impacts, Economic and social considerations,	7

	Availability, system development and limitations, Wave and tidal energy –Scope and economics, Introduction to integrated energy systems. Other plants: Fuel cell-based power plants, tidal and wave energy plant design	
	Total	**30**

Text Books
- S.P. Sukhatme, Solar Energy – Principles of thermal collection and storage, II edition, Tata McGraw Hill, New Delhi, 1996.
- Garg H.P., Prakash J., Solar energy Fundamentals and Applications, Tata Mc Graw Hill Publishing Company, New-Delhi, Latest Edition
- V.V. N. Kishore, Editor, Renewable Energy Engineering and Technology, A knowledge Compendium, The Energy and Resources Institute, New Delhi, 2008

Reference Books:
- J.A.Duffie and W.A.Beckman, Solar engineering of Thermal processes, II edition,
- John Wiley, New York, 1991.
- D.Y.Goswami, F.Kreith and J.F.Kreider, Principles of Solar Engineering, Taylor and
- Francis, Philadelphia, 2000.
- D.D.Hall and R.P.Grover, Biomass Regenerable Energy, John Wiley, New York,1987.
- Mukund R Patel, Wind and Solar Power Systems, CRC Press, 1999.
- J F Manwell, J.G.McGowan, A.L.Rogers, Wind Energy Explained: Theory, Design and Application, John Wiley and Sons, May 2002.
- R D Begamudre, Energy Conversion Systems, New Age International (P) Ltd., Publishers, New Delhi ,2000.
- Bureau of Energy Efficiency – Volume 1

VISION AND MISSION OF INFORMATION TECHNOLOGY DEPARTMENT

Vision

- To develop Information Technology professionals through Quality Education with dedicated faculty

Mission

- To foster the development of Information Technology professionals with focus on Excellent Academics, Research Aptitude, Overall Personality Development and Social Awareness.

Programme Outcomes:

- An ability to independently carry out research /investigation and development work to solve practical problems

- An ability to write and present a substantial technical report/document

- Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Programme Specific Outcomes:

- Students will be able to provide IT services, manage IT infrastructure, monitor and safeguard the data.

- Student will be able to apply standard practices and strategies using various programming paradigms to develop a quality product for business success.

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- Effective Course work conductions

"There are no secrets to success. It is the result of preparation, hard work, learning from failure."

– Colin Powell