Vidya Pratishthan's
Kamalnayan Bajaj Institute of Engineering and Technology

Vidyanagari, Baramati, Dist. – Pune 413133
An Autonomous Institute Approved by AICTE and affiliated to SPPU,Pune

VPKBIET

Curriculum Structure and Syllabus of

M. Tech. Computer Engineering (Artificial Intelligence and Data Science)

Department of Computer Engineering

(Course 2023)

With effective from June 2023

VP's Kamalnayan Bajaj Institute of Engineering and Technology, Baramati.

(An Autonomous Institute)

Department of Computer Engineering

M. Tech- (Artificial Intelligence and Data Science)

(with effect from A.Y. 2023-24)

Semester I

Course Code	Course	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks						Credit Scheme	
		TH	PR	Activity	In Sem	End Sem	TW	PR	OR	Total	TH	PR
MAI23101	Data Preparation and Analysis	04		20	30	60				110	04	
MAI23102	Mathematical Foundation For Data Science	04		20	30	60				110	04	
MAI23103	Artificial Intelligence	03		20	30	60				110	03	
MAI23104	MDS	02		10	20	40				70	02	
MAI23105	Research Methodology	03		10	30	60				100	03	
MAI23106	Laboratory Proficiency I		08				50		50	100		04
MSE23107	Indian Knowledge System	02		20					30	50	02	
	Total	**18**	**08**	**100**	**140**	**280**	**50**		**80**	**650**	**18**	**04**
Total Credit											**22**	

MDS

MAI23104-A	Information Systems Management	MAI23104-B	Advanced IoT Design and Applications
MAI23104-C	Computational Linguistic Analytics	MAI23104-D	Distributed Databases

Mrs. Pawar S.D.

Dr. C.S. Kulkarni
Head of Department
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Id No./PU/PN/Engg./132/2000
PUNE (MS.)

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Semester II

Course Code	Course	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks						Credit Scheme	
		TH	PR	Activity	In Sem	End Sem	TW	PR	OR	Total	TH	PR
MAI23111	Advance Machine Learning	04		20	30	60				110	04	
MAI23112	Scalable Data Science	04		20	30	60				110	04	
MAI23113	Advance Computing Intelligence	04		20	30	60				110	04	
MAI23114	Program Elective - I	04		20	30	60				110	04	
MAI23115	Laboratory Proficiency -II		08				50		50	100		04
MSE23116	Environmental studies	02		30					30	60	02	
	Total	**18**	**08**	**110**	**120**	**240**	**50**		**80**	**600**	**18**	**04**
Total Credit											**22**	

Program Elective I

MAI23114-A	Business Intelligence	MAI23114-C	Advance Image Processing
MAI23114-B	Cryptography and Cryptanalysis	MAI23105-D	Virtual Reality Augmented Reality

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Semester III

Course Code	Course	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks						Credit Scheme	
		TH	PR	Activity	In Sem	End Sem	TW	PR	OR	Total	TH	PR
MAI23201	Deep Learning	04		20	30	60				110	04	
MAI23202	Natural Language Processing	04		20	30	60				110	04	
MAI23203	Program Elective-II	04		20	30	60				110	04	
MAI23204	Dissertation Stage- I		08				100		50	150		04
MHS23201	Constitution of India	02		10					25	35	02	
MRA23205	Industrial Mgmt.	02		10					25	35	02	
	Total	**16**	**08**	**80**	**90**	**180**	**100**		**100**	**550**	**16**	**04**
Total Credit											**20**	

Program Elective II

MAI23203-A	Data Modeling and Visualization	MAI23203-C	Product Life Cycle Management
MAI23203-B	GPU Computing	MAI23203-D	Data Mining and Analysis

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Semester IV

Course Code	Course	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks						Credit Scheme	
		TH	PR	Activity	In Sem	End Sem	TW	PR	OR	Total	TH	PR
MAI23211	Seminar		04				50		50	100		02
MAI23212	Industry Internship / Inhouse research project		20				150		100	250		10
MAI23213	Dissertation Stage- II		16				100		100	200		08
	Total		**40**				**300**		**250**	**550**		**20**
Total Credit											**20**	

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SEMESTER-I

MAI23101: Data Preparation and Analysis					
Teaching Scheme:		**Credits:**	**04**	**Examination Scheme:**	
TH:	**04 Hrs/Week**			**Activity marks**	**20 Marks**
				In-Semester Exam:	**30 Marks**
				End-Semester Exam:	**60 Marks**

Prerequisite Courses:

Introduction to Probability theory, statistics, Python/R , Database management system

Companion Course, if any: Professional Core Lab-I

Course Objectives:

1.	To understand the importance of data and data preprocessing
2.	To understand data cleaning and conditioning
3.	To understand an ETL – Extract, Transform and Load – process and ETL tools
4.	To get acquainted with data visualization techniques for exploratory analysis.

Course Outcomes:

On completion of the course, learner will be able to –

CO1:	Apply strategy for successful data preparation initiatives
CO2:	Identify potential data sources and discover the data
CO3:	Prepare conditioned and preprocessed datasets using normalization method for data
CO4:	Apply ETL process with ETL tools to datasets for data processing
CO5:	Draw insights into the datasets using exploratory mechanisms.
CO6:	Demonstrate use of visualization tools for data preparation and analysis Apply various skills in problem solving.

Course Contents

Unit I: Fundamentals of Data preparation	**(6 Hrs)**

Data preparation definition, purpose, benefits, Steps in data preparation process, challenges of data preparation, Data preparation tools, core features of self-service data preparation tools , data preparation trends, Strategy for successful data preparation initiatives.

Unit II: Data Gathering and Data Discovery	**(6 Hrs)**

Identifying potential data sources, gathering data, Data discovery- understanding the data, assessing data, data formats, Parsing, Selecting features, Transformation, Scalability, and real-time issues.

Unit III: Cleaning and Conditioning Data	**(7 Hrs)**

Data Preparation Basic Models: Data Integration, Data Cleaning, Data Normalization, Min- Max Normalization, Z-score Normalization, Decimal Scaling Normalization, Consistency

checking, Heterogeneous and missing data, Dealing with missing values, Duplicate values, Noise, Inconsistent data, Outliers.	
Unit IV: Extract, Transform, Load tools	**(6 Hrs)**
Transform and enrich data: Data Transformation, Linear Transformations, Quadratic Transformations, Non-polynomial Approximations of Transformations, Polynomial Approximations of Transformations, Rank Transformations, Transformations via Data Reduction, ETL tools	
Unit V: Exploratory Analysis and Data Visualization	**(6 Hrs)**
Formulating Hypothesis, Data Terminology, Data Exploration, Data Exploration through Summary Statistics, Data Exploration through Plots, Feature Engineering, Feature selection, Feature transformation, Dimensionality reduction, Visualization techniques, Different types of plots	
Unit VI: Advanced Tools for Data Preparation	**(7 Hrs)**
Web scraping, Data from social networks, Open-source tools for data preparation: Open Refine, R/Python libraries for data preparation and visualization	
Books & Other Resources:	
Textbooks:	
1.	Glenn J. Myatt, "Making Sense of Data I: A Practical Guide to Exploratory Data Analysis and Data Mining"
2.	Salvador García, Julián Luengo, Francisco Herrera, "Data Preprocessing in Data Mining"
Reference Books:	
1.	Mark Gardner, "Beginning R: The Statistical Programming Language", Wrox Publication, ISBN: 978-1-118-16430-3 2. 3.
2.	David Dietrich, Barry Hiller, "Data Science and Big Data Analytics", EMC education services, Wiley publications, 2012, ISBN0-07-120413-X
3.	Ruben Verborgh ; Max De Wilde, "Using OpenRefine : the essential OpenRefine guide that takes you from data analysis and error fixing to linking your dataset to the Web
E-books:	
1.	Jacqueline Kazil, Katharine Jarmu, "Data Wrangling with Python: Tips and Tools to Make Your Life Easier"
2	Hector Cuesta and DrSampath Kumar, "Practical Data Analysis", 2nd Edition
Important links: https://www.techtarget.com/searchbusinessanalytics/definition/data-preparation https://www.ibm.com/garage/method/practices/code/data-preparation-ai-data- science/ **https://openrefine.org** **https://www.youtube.com/playlist?list=PLh2mXjKcTPSACrQxPM2_1Ojus5HX88ht7**	

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MAI23102: Mathematical Foundation for Data Science					
Teaching Scheme:		**Credits:**	**04**	**Examination Scheme:**	
TH:	**04 Hrs/Week**			**Activity marks**	**20 Marks**
				In-Semester Exam:	**30 Marks**
				End-Semester Exam:	**60 Marks**

Prerequisite Courses:

Students are expected to have a good understanding of basics of the python/R programming language and knowledge of the basics of mathematics.

Companion Course, if any: Professional Core Lab-I **(MFDS),** Basics of Artificial intelligence and Data Science.

Course Objectives:

1.	To understand the role of discrete mathematics in data science.
2.	To learn probability and apply it for real life problems in Artificial Intelligence and Data Science.
3.	To understand the basis of descriptive statistics, measures and hypotheses.
4.	To learn linear algebra and calculus concepts and applicability in Artificial Intelligence and Data Science.
5.	To learn different linear regression methods used in machine learning.

Course Outcomes:

On completion of the course, learner will be able to –

CO1:	Apply measures of central tendency to analyze a payrll dataset.
CO2:	Apply a probabilistic model for credit card fraud detection.
CO3:	Evaluate covariance and correlation between two variables.
CO4:	Demonstrate the use of eigenvalues and eigenvectors for a reducing dimension of a healthcare dataset.
CO5:	Apply a simple regression model to predict the near future sales based on a time series data.

Course Contents

Unit I: Discrete mathematics for Data Science	**(7 Hrs)**

Concept of set, cardinality of set, finite, infinite and uncountably infinite sets, Basic set operations, Principal of inclusion Exclusion, Graph: Basic terminologies, representation of graph, path and circuit, graph traversal, traveling salesperson problem, Trees: Basic terminologies, search tree: Binary & M-ary tree.

Unit II: Data Analysis & Probability Theory	**(6 Hrs)**

Data Representation, Average, Spread, Experiments, Outcomes, Events, Probability, Permutations and Combinations, Random Variables, Probability Distributions, Mean and Variance of a Distribution, Binomial, Poisson, and Hypergeometric Distributions, Normal Distribution, Distributions of Several Random Variables.	
Unit III: Statistical Inference	**(7 Hrs)**
Types of Statistical Inference, Descriptive Statistics, Inferential Statistics, Importance of Statistical Inference in Machine Learning, Descriptive Statistics, Measures of Central Tendency: Mean, Median, Mode, Midrange, Measures of Dispersion: Range, Variance, Mean Deviation, Standard Deviation. Coefficient of variation: Moments, Skewness, Kurtosis, One sample hypothesis testing, hypothesis, Testing of Hypothesis, Binomial distribution and normal distribution, Chi-Square Tests, t-test, ANOVA. Pearson Correlation.	
Unit IV: Statistical Inference II	**(6 Hrs)**
Measure of Relationship: Covariance, Karl Pearson's Coefficient of Correlation, Measures of Position: Percentile, Z-score, Quartiles, Bayes' Theorem, Bayes Classifier, Bayesian network, Probabilistic models with hidden variables	
Unit V: Linear Algebra and Calculus	**(7 Hrs)**
Linear Algebra: Matrix and vector algebra, systems of linear equations using matrices, linear independence, Matrix factorization concept/LU decomposition, Eigen values and eigenvectors, Understanding of calculus: concept of function and derivative, Multivariate calculus: concept, Partial Derivatives, chain rule, the Jacobian and the Hessian	
Unit VI: Regression Model	**(7 Hrs)**
Introduction, types of regression. Simple regression- Types, Making predictions, Cost function, Gradient descent, Training, Model evaluation. Multivariable regression: Growing complexity, Normalization, making predictions, initialize weights, Cost function, Simplifying with matrices, Bias term, Model evaluation. Case Studies.	
Books & Other Resources:	
Textbooks:	
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
3.	T.Veerarajan, "Probability and Statistics", Tata McGraw-Hill New Delhi, 2008.
4.	Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2012.
5.	Practical Statistics for Data Scientists: 50+ Essential Concepts Using R and Python, Bruce, Peter, Andrew Bruce, and Peter Gedeck, O'Reilly Media, 2020.
6.	Liu, Chung Laung. "Elements of discrete mathematics" ,Tata McGraw-Hill Education, 1987.
7.	"Introduction to Statistics and Data Analysis With Exercises", Solutions and Applications in R Authors: Heumann, Christian, Schomaker, Michael, Shalabh, Publisher" Springer 2016
Reference Books:	

1.	Applied Statistics and Probability for Engineers, Douglas C. Montgomery, George C. Runger, 2018, Wiley (Low price edition available)
2.	Introduction to. Mathematics. Statistics. Robert V. Hogg. Allen T. Craig, Low price Indian edition by Pearson Education
3.	Probability and Statistics for Engineers. Richard A. Johnson, Irwin Miller, John Freund
4.	Mathematical Statistics with Applications. Irwin Miller, Marylees Miller, Pearson Education
5.	The R Software-Fundamentals of Programming and Statistical Analysis -Pierre Lafaye de Micheaux, RémyDrouilhet, Benoit Liquet, Springer 2013

Link for Reference :

1. **https://www.kaggle.com/**
2. **https://github.com/**
3. **https://towardsdatascience.com/**
4. **https://www.analyticsvidhya.com/**

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MAI23103: Artificial Intelligence					
Teaching Scheme:		**Credits:**	**03**	**Examination Scheme:**	
TH:	**03 Hrs/Week**			**Activity marks:**	**20 Marks**
				In-Semester Exam:	**30 Marks**
				End-Semester Exam:	**60 Marks**

Prerequisite Courses:

Discrete Structure and Theory of Logic, Probability and statistics, Data Structures, Familiarity with Python Programming

Companion Course, if any:

Course Objectives:

1.	To Understand AI Foundations.
2.	To apply AI techniques and algorithms to solve real-world problems
3.	To analyze and apply real world problems using AI approaches
4.	To Analyze Ethical and Social Implications of AI technologies.

Course Outcomes:

On completion of the course, learner will be able to -

CO1	**Understand** the concepts, and techniques of artificial intelligence (AI), and apply them for effective problem-solving
CO2	**Apply** knowledge representation techniques and problem-solving strategies effectively in practical AI applications.
CO3	**Understand** the need of Intelligent agents in problem solving.
CO4	**Analyze** uncertainty in complex real-world scenarios and contribute to informed and effective decision-making processes.
CO5	**Understand and apply** learning techniques.
CO6	**Analyze** the applicability of AI to develop sustainable solutions of real world problems.

Course Contents

Unit I: Introduction of AI & Problem-Solving Method	**(7 Hrs)**

Introduction to Artificial Intelligence, Foundation and history of Artificial Intelligence, Future of Artificial Intelligence, Problem Solving Approach to Typical AI problems- Uninformed Search- Revision of BFS, DFS, Dijkstra's, Informed (Heuristic) Search- Greedy BFS, A*, AO*, Local Search Algorithms and Optimization Problems: Hill climbing Search, Evolutionary algorithms, Constraint Satisfaction, Means-Ends Analysis

Unit II: Knowledge Representation and Reasoning	**(7 Hrs)**

Representation and Reasoning using predicate logic, Inference in first order logic : forward chaining and backward chaining, resolution, Knowledge representation: categories, objects, events and ontologies: Mental object and model logic, reasoning, Reasoning Systems for Categories – Reasoning with Default Information, Natural Language Processing, NLTK

Unit III: Software Agents	**(7 Hrs)**

Software Agents: Typical Intelligent Agents, Characteristics of Intelligent Agents, Structure for Intelligent Agents, Agent communication – Negotiation and Bargaining, Argumentation among Agents, Trust and Reputation in Multi-agent systems

Unit IV: Uncertainty Reasoning	**(7 Hrs)**

Probabilistic Models, Fuzzy Logic, Bayesian Inference, Uncertainty Quantification, Monte Carlo Methods, Expert Systems, Fusion of Data Sources, Deep Learning with Uncertainty	
Unit V: Learning	**(7 Hrs)**
Learning from Examples, Forms of Learning- Supervised Learning, Unsupervised Learning, Reinforcement Learning etc. Inductive Learning, learning in -Problem Solving, Decision Tree, Probabilistic Models for Learning- Bayesian networks and Hidden Markov Models (HMMs), Learning in Neural and Bayesian Networks	
Unit VI: Applications	**(7 Hrs)**
AI Applications in various fields: Lifestyle- Autonomous Vehicles, Spam Filters, Facial Recognition, Recommendation System, Applications of AI in Navigation- Robotics, Healthcare, natural language processing, semantic web, AI-based programming Tools.	
Books & Other Resources:	
Textbooks:	
1.	Artificial Intelligence: A Modern Approach, S Russel and P Norvig, 3rd Edition, 2015 Prentice Hall
2.	Artificial Intelligence, George F Luger, Pearson Education Publications
Reference Books:	
1.	Introduction To Artificial Intelligence & Expert Systems, Patterson, PHI 2
2.	Luger G.F. and Stubblefield W.A. (2008). Artificial Intelligence: Structures and strategies for Complex Problem Solving. Addison Wesley, 6th edition
3.	Artificial Intelligence, Elaine Rich and Knight, Mcgraw-Hill Publications
Important links:	
https://www.cse.iitd.ac.in/~mausam/courses/csl333/spring2014/	

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MAI23104-A: Information System Management					
Teaching Scheme:		**Credits:**	**02**	**Examination Scheme:**	
				Activity marks:	**10 Marks**
TH:	**02 Hrs/Week**			**In-Semester Exam:**	**20 Marks**
				End-Semester Exam:	**40 Marks**

Prerequisite Courses:

1. Basics of Machine Learning
2. Python Programming Language
3. Basics of Probability.

Companion Course, if any: No

Course Objectives:

1.	To prepare the students for various forms of the Information Systems and its application in organizations.
2.	To Prepare engineering students to do economic analyses in the decision-making process to justify or reject alternatives / projects on an economic basis for an organization.
3.	To learn the skills to make the best use of Business Intelligence
4.	To learn the skills in building advanced Information Systems

Course Outcomes:

On completion of the course, learner will be able to –

CO1:	Understand the activities that are undertaken while managing, designing, planning, implementation, and deployment of computerized information systems in an organization.
CO2:	Perform and evaluate present worth, future worth and annual worth analyses on one of more economic alternatives.
CO3:	Evaluate the decisions using What-If Analysis, Sensitivity analysis, Goal-seeking analysis, Optimization analysis techniques of DSS
CO4:	Plan to implement a Business Intelligence Solution

Course Contents

Unit I : Management Information System (MIS)	**(4 Hrs)**

Managing Information Systems, Ethical and Social Issues, Information Technology Infrastructure and Choices, Information Systems Security and Control, Managing Data Resources, Business Process Integration and Enterprise Systems, ICT for Development and E-Governance.

Unit II: Business Intelligence	**(6 Hrs)**

Business Intelligence an Introduction: Introduction, Definition, History and Evolution, Difference between Information and Intelligence, Factors of Business Intelligence System - Business Intelligence Architecture, Real time Business Intelligence, Business Intelligence Applications, Business Intelligence Essentials: Introduction, Creating Business Intelligence Environment, Business Intelligence Landscape, Types of Business Intelligence, Business Intelligence Platform, Dynamic roles in Business Intelligence, Roles of Business Intelligence in Modern Business- Challenges of BI Business Intelligence User Model: Introduction, Evolution of Business Intelligence, Business Intelligence Opportunity Analysis Overview,

Business Intelligence, Business Intelligence Opportunity Analysis Overview, Content Management System, End User Segmentation, Basic Reporting	
Unit III: Building Advanced Information Systems	**(4 Hrs)**
Decision Support in Business, Decision Support Trends, Decision Support Systems, Management, Information Systems, Online Analytical Processing, Using Decision Support Systems, Executive Information Systems, Enterprise Portals and Decision Support, Knowledge Management Systems	
Unit IV: Economics and Management	**(4 Hrs)**
Engineering Economic Decisions, Time Value of Money, Understanding Money Management, Equivalence Calculations under Inflation, Present-Worth Analysis, Annual-Equivalence Analysis.	
Unit V: Applications of Business Intelligence	**(5 Hrs)**
Business Intelligence Strategy and Road Map: Introduction, planning to implement a Business Intelligence Solution, Understand Limitations of Business Intelligence, Business Intelligence Usage, how to make the best use of Business Intelligence? Implementing Business Intelligence: Implementation Strategy, Fundamental decisions, Business Intelligence Case Studies: Improving Operational Efficiency – Audi AG, Maximizing Profitability- The Frank Russell Company.	
Unit VI: Managing Information Systems Projects	**(5Hrs)**
The importance of project management, selecting projects, Establishing the business value of Information Systems, Managing project risk. Case Study: Hands on mini projects: Management Decision Problems, Improving Decision Making: Using Spreadsheet Software for Capital Budgeting for a New CAD System, Improving Decision Making: Using Web Tools for Buying and Financing a Home.	
Books & Other Resources:	
Textbooks:	
1.	Rahul De, —MIS: Management Information Systems in Business, Government and Society‖, Wiley India, ISBN: 13: 978-81-265-2019-0.
2.	Chan S. Park , "Fundamentals of Engineering Economics‖, 3rd Edition, Pearson Education, ISBN 13: 978-02-737-7291-0
3.	Kenneth C. Laudon, Jane P. Laudon, "Management Information Systems
4.	MANAGING THE DIGITAL FIRM", 12th Edition, Prentice Hall
Reference Books:	
1.	William G. Sullivan, Elin M. Wicks, C. Patrick Koelling, Engineering Economy, Pearson Education, ISBN13: 978-01-334-3927-4
2.	James A. O'Brien, George M. Marakas, "INTRODUCTION TO INFORMATION SYSTEMS", 15th Edition, McGraw-Hill
3.	Business-Intelligence-by-Michael-Luckevich-Elizabeth-Vitt-Stacia-Misner- Elizabeth-Vitt - Michael-Luc
4.	Definitive Guide to DAX, The: Business intelligence for Microsoft Power BI, SQL Server Analysis Services, and Excel, 2nd Edition
5.	Oracle Business Intelligence with Machine Learning : Artificial Intelligence Techniques in OBIEE for Actionable BIByRosendoAbelleraandLakshmanBulusu
6.	Business Intelligence Guidebook by Rick Sherman Released November 2014 Publisher(s): Morgan Kaufmann ISBN: 9780124115286
7.	Business Intelligence Strategy and Big Data Analytics by Steve Williams Released April 2016

	Publisher(s): Morgan Kaufmann ISBN: 9780128094891
Link for Reference: • https://www.managementstudyguide.com • https://www.coursera.org/specializations/information-systems	
MOOC Couses: "Information Systems Specialization", offered by University of Minnesota • https://www.coursera.org/specializations/information-systems "Enterprise Systems" by Jason Chan, Associate Professor, affiliated to University of Minnesota • https://www.coursera.org/learn/enterprise-systems "It Infrastructure and Emerging Trends" by SoumyaSen, Associate Professor, affiliated to ***University of Minnesota*** • https://www.coursera.org/learn/it-infrastructure-and-emerging-trends "Analysis for business systems" by Ken Reily, Associate Professor, affiliated to ***University of Minnesota*** • https://www.coursera.org/learn/analysis-for-business-systems "IS/IT Governance" by Gautam Ray, Associate Professor, affiliated to ***University of Minnesota*** • https://www.coursera.org/learn/is-it-governance	

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MAI23104-B: Advanced IoT Design and Applications

Teaching Scheme:		Credits:	02	Examination Scheme:	
TH:	02 Hrs/Week			Activity marks	10 Marks
				In-Semester Exam:	20 Marks
				End-Semester Exam:	40 Marks

Prerequisite Courses:

Basic knowledge of embedded systems, computer networks, and system programming.

Companion Course, if any: Professional Core Lab-I

Course Objectives:

1.	To understand the architectural overview of the Internet of Things IoT
2.	To acquire skills on data acquisition and communication in IoT.
3.	To understand the threats of IoT
4.	To acquire skills on data acquisition and communication in IoT

Course Outcomes:

On completion of the course, learner will be able to –

CO1:	Demonstrate the revolution of internet in mobile and cloud.
CO2:	Examine the architecture and operation of IoT.
CO3:	Explore various tools and programming paradigms for IoT applications
CO4:	Develop an IoT prototype for real time scenario.
CO5:	Analyze and select appropriate communication protocols for different IoT scenarios
CO6:	Evaluate the benefits and challenges of implementing edge and fog computing solutions

Course Contents

Unit I: Introduction to Advanced IoT Concepts	**(4 Hrs)**
Overview of IoT Evolution, Advanced IoT Architectures, Edge and Fog Computing in IoT Industry 4.0 and IoT.	
Unit II: Advanced Communication Protocols	**(4 Hrs)**
MQTT, CoAP, and AMQP, HTTP/2 for IoT, Lightweight protocols for constrained devices, Protocol selection for specific IoT use cases	
Unit III: IoT Security and Privacy	**(4 Hrs)**
Threats and vulnerabilities in IoT, Cryptographic techniques for IoT security, Secure device onboarding and communication, Privacy considerations in IoT applications	
Unit IV: Edge Computing and IoT	**(4 Hrs)**
Edge computing fundamentals, Edge analytics and decision-making, Implementing edge intelligence in IoT applications, Case studies of successful edge computing deployments	
Unit V: Machine Learning and AI in IoT	**(5 Hrs)**
Introduction to machine learning for IoT, Predictive analytics in IoT applications, Anomaly detection using machine learning, Integrating AI with IoT edge devices	
Unit VI: IoT Applications and Use Cases	**(6 Hrs)**
Smart Cities and Urban IoT, Industrial IoT (IoT), Agriculture and Environmental Monitoring, Home Automation and Consumer IoT	

Books & Other Resources:	
Textbooks:	
1.	Building the Internet of Things: Implement New Business Models, Disrupt Competitors, Transform Your Industry" by Maciej Kranz
2.	"Architecting the Internet of Things" by Dieter Uckelmann, Mark Harrison, and Florian Michahelles
3.	"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things" by David Hanes, Gonzalo Salgueiro, Patrick Grossetete

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MAI23104-C: Computational Linguistic Analytics					
Teaching Scheme:		**Credits:**	**02**	**Examination Scheme:**	
TH:	**02 Hrs/Week**			**Activity Marks**	**10 Marks**
				In-Semester Exam:	**20 Marks**
				End-Semester Exam:	**40 Marks**

Course Contents

Unit I : Computational Semantics	**(4 Hrs)**
Introduction: Classical Encryption Techniques – Substitution Techniques, Transposition Techniques; Symmetric Cipher Model: Feistel cipher structure, DES, Triple DES, Block Cipher Design Principles; AES	
Unit II: Advanced Machine Learning	**(6 Hrs)**
Supervised machine learning with focus on classification. K-NN, Decision trees, SVM, combining models via ensembling : boosting, bagging, random forests. Basic machine learning concepts: generalization error and overfitting. Introduction to optimization, Gradient Descent and Stochastic Gradient Descent. Roundoff error and finite differences. Clustering, association rules, model fitting via EM algorithm. Finding groups and other structures in unlabeled and high dimensional data	
Unit III: Computational Morphology and Machine Translation	**(4 Hrs)**
Public Key Cryptography: RSA – Algorithm & Computational Aspects, DiffieHellman Key Exchange; Elgamal Cryptographic System; Elliptic Curve Cryptography	
Unit IV: Advanced Computational Semantics	**(6 Hrs)**
Text corpora collection and curation. Methods to pull representative datasets from internet sources. Techniques for efficient and reliable annotation. Application of machine learning to various semantic tasks: Information extraction, semantic role labelling, semantic parsing, discourse parsing, question answering, summarization and natural language inference. Cutting edge techniques in natural language processing	
Unit V: Statistical NLP	**(4 Hrs)**
Text and document classification, Classification of selected words or phrases in sentential or broader contexts, Sequence labeling, Structure assignment to sentences, Sentence transduction, Knowledge transfer from other (related) languages	
Unit VI : Sentiment Analysis	**(4 Hrs)**
Sentiment identification and Analysis, Text polarity and emotion classification. Fine-grained mining, Sentiment in social networks, Legal, ethical and security issues concerning data, including aggregated data. Proactive compliance with rules and, in their absence, principles for the responsible management of sensitive data.	

Books & Other Resources:

Textbooks:

1.	Dan Jurafsky and James H. Martin. Speech and Language Processing (3rd ed. draft), Prentice-Hall, 2000

2.	Igor A. Bolshakov and Alexander Gelbukh, Computational Linguistics :Models, Resources, Applications
3.	Database system Concept by Silberschatz And Korth 6th Edition,Tata Mcgraw Hill Education Private Limited, ISBN - 9789332901384

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MAI23104-D: Distributed Databases					
Teaching Scheme:		**Credits:**	**02**	**Examination Scheme:**	
TH:	**02 Hrs/Week**			**Activity Marks:**	**10 Marks**
				In-Semester Exam:	**20 Marks**
				End-Semester Exam:	**40 Marks**

Prerequisite Courses:

Database Management Systems

Companion Course, if any: Laboratory Proficiency-I

Course Objectives:

1.	Understand the various aspects in Distributed Data.
2.	Understand query processing and optimization in Distributed Database.
3.	Management of distributed data with different levels of transparency.
4.	Understand how to use database management tools in resolving deadlock situations.

Course Outcomes:

On completion of the course, learner will be able to –

CO1:	Design distributed database for any real-world application.
CO2:	Write query for data manipulation on Distributed Database.
CO3:	Manage Transaction using fragmentation.
CO4:	Handle deadlock situation in Distributed Database.
CO5:	Apply security policies on Distributed Databases.
CO6:	Manage data from Heterogeneous databases.

Course Contents

Unit I: Overview of Distributed Database Design	**(6 Hrs)**

What is Distributed Database System (DDBS), Features of DDBS, promises of DDBS, Design issue in DDBS, Distributed DBMS architecture:- Client/server System, Peer-to- Peer, Multi-Database system, Levels of distribution transparency : Reference Architecture for Distributed Databases, Types of Data Fragmentation, Integrity Constraints in Distributed Databases Framework of Distributed Databases Design, Design of Database Fragmentation, Allocation of fragments, Transparencies in Distributed Database Design.

Unit II: Distributed Query Processing And Optimization	**(4 Hrs)**

Concept, objective, and phases of distributed query processing, Translation of global queries to fragment queries, Query optimization in centralized databases, framework for query optimization in Distributed databases, join queries, general queries.

Unit III: Transactions Management	**(6 Hrs)**

FRAGMENT QUERIES: Equivalence Transformations For Queries, Transforming Global Queries into Fragment Queries, Distributed Grouping and Aggregate Function Evaluation, Parametric Queries. THE MANAGEMENT OF DISTRIBUTED TRANSACTIONS: A Framework for Transaction Management, Supporting Atomicity of Distributed Transactions, Concurrency Control for Distributed Transactions, Architectural Aspects of Distributed Transactions

Unit IV: Concurrency Control and Reliability	(6 Hrs)
CONCURRENCY CONTROL: Foundations of Distributed Concurrency Control, Distributed Deadlocks, Concurrency Control Based on Timestamps, Optimistic Methods for Distributed Concurrency Control. Introduction to Deadlock, Distributed Deadlock prevention, avoidance, detection and recovery, Two-Phase and Three-Phase Commit Protocol. RELIABILITY: Basic Concepts, Non Blocking Commitment Protocols, Reliability and Concurrency Control, Determining a Consistent View of the Network, Detection and Resolution of Inconsistency, Checkpoints And Cold Restart. Catalog Management in Distributed Databases, Authorization and Protection.	
Unit V: Security Aspects in DDBMS	**(4 Hrs)**
Study of a variety of attacks on the components of system (such as on routing protocols in ad hoc networks), privacy issues in Peer to Peer systems, trusted collaboration and dissemination of data among cooperative entities, Security problems, security policies, DAC methods, MAC methods, security models for DDBMS	
Unit VI: Heterogeneous Database	**(4 Hrs)**
Architecture of Heterogeneous Database, Interface Standards for Relational Database :ODBC ODBC architecture, functionality and usage of ODBC Database Integration:- Schema Translation and schema Integration, Query processing issues in Heterogeneous database.	

Books & Other Resources:

Text Books:

1.	Distributed Databases principles & systems by Stefano Ceri, Giuseppe Pelagatti, 2nd edition, McGraw-Hill, New York, 1985, ISBN 0-07-010829-3.
2.	N.TamerOzsu, Patrick Valduriez, "Principles of Distributed Database Systems", 2nd , Illustrated Edition, Prentice Hall International Inc., 1999, ISBN 0136597076, 9780136597070.
3.	Database system Concept by Silberschatz And Korth 6th Edition,Tata Mcgraw Hill Education Private Limited, ISBN - 9789332901384

Reference Books:

1.	Database Systems: A Practical Approach to Design, Implementation and ManagementThomas Connolly, Carolyn Begg, Pearson Publisher, 4th Edition.
2.	Database Management Systems - Raghu Ramakrishnan and Johannes Gehrke, McGraw-Hill Education publisher, illustrated Edition,2003,ISBN0072465638, 9780072465631.
3.	Carlo Zaniolo, Stefano Ceri, Christos Faloustsos, R.T.Snodgrass, V.S.Subrahmanian, "Advanced Database Systems", Morgan Kaufman, 1997.

E-books-

Distributed Database Management Systems: A Practical Approach Kindle Edition by Saeed K. Rahimi, Frank

S. Haug, 1st Edition, Wiley-IEEE Computer Society, ASIN: B005CDYQSC

Distributed Database Management Systems: A Practical Approach - Saeed K. Rahimi, Frank S. Haug - Google Books

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MAI23105: Research Methodology					
Teaching Scheme:		**Credits:**	**03**	**Examination Scheme:**	
TH:	**03 Hrs/Week**			**Activity Marks**	**10 Marks**
				In-Semester Exam:	**30 Marks**
				End-Semester Exam:	**60 Marks**

Course Contents

Unit I: Introduction	**(7 Hrs)**
Nature and objectives of research. Methods of Research: historical, descriptive and experimental, research process, research approaches, criteria for good research, problems faced by researchers	
Unit II: Research Design	**(7 Hrs)**
Meaning of research design, need of research design, features of good design, different research designs, basic principles of experimental designs, design of experiments.	
Unit III: Data Collection	**(7 Hrs)**
Types of data, methods and techniques of data collection, primary and secondary data, meta analysis, historical methods, content analysis, devices used in data collection, pilot study and pretest of tools, choice of data collection methods.	
Unit IV: Processing and Analysis of Data	**(7 Hrs)**
Use of statistics for data analysis, measures of central tendency, dispersion, skewness and relationship. Sampling distributions, sampling theory, determination of sample size, chi-square test, analysis of variance, multiple regression analysis, neural networks.	
Unit V: Decision Making Techniques	**(7 Hrs)**
Multi-attribute decision making techniques: Analytical Hierarchy Process (AHP), TOPSIS, Data Envelope Analysis (DEA), graph theory and matrix approach. Multi-objective decision making techniques: Simulated annealing, Genetic algorithms.	
Unit VI: Interpretation and Report Writing	**(7 Hrs)**
Techniques of interpretation, precautions in interpretation, significance of report writing, different steps in report writing, layout of research report, mechanics of writing research report.	

Reference Books:

1.	C.R Kothari "Research Methodology" Wishwa Prakashan, ISBN: 8173280363
2.	P.G Triphati "Research Methodology" Sultan Chand & Sons, New Delhi.
3.	J. W Barnes, "Statistical Analysis for Engineers and Scientists" McGraw Hill, New York.
4.	Ranjit Kumar "Research Methodology" Pearson Education, ISBN: 9788131704967
5.	Rao R. V. "Decision making in the manufacturing environment using graph theory and fuzzy multiple attribute decision making" Springer-Verlag, London. ISBN: 1846288193

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MAI23106: Laboratory Proficiency - I		
Teaching Scheme:	**Credit**	**Examination Scheme:**
PR:08 Hr/Week	**04**	**Term Work:50 Marks** **Oral : 50 Marks**
Prerequisite Courses: Knowledge of programming languages, Basics of Python/R		
Companion Courses: MAI23101-Data Preparation and Analysis MAI23102 - Mathematical Foundation for Data Science MAI23103 – Artificial intelligence		
All assignments are compulsory. Each student should implement the assignment individually. Laboratory teachers should make sure that the dataset/code/writeup is not the same. Laboratory teacher can add more assignments as per requirement.		

MAI23101-Data Preparation and Analysis

LIST OF PRACTICALS

1	a) Use ETL tools/R/Python for applying various transformations on free datasets available. b) Use Open Refine to preprocess raw data from websites
2	Use the following covid_vaccine_statewise.csv dataset and perform following analytics on the given dataset https://www.kaggle.com/sudalairajkumar/covid19-in-india?select=covid_vaccine_statewise.csv a. Describe the dataset b. Number of persons state wise vaccinated for first dose in India c. Number of persons state wise vaccinated for second dose in India d. Number of Males vaccinated d. Number of females vaccinated
3	Write a case study to process data driven for Digital Marketing **OR** Health care systems with Hadoop Ecosystem components as shown. (Mandatory) • HDFS: Hadoop Distributed File System • YARN: Yet Another Resource Negotiator • MapReduce: Programming based Data Processing • Spark: In-Memory data processing • PIG, HIVE: Query based processing of data services • HBase: NoSQL Database (Provides real-time reads and writes) • Mahout, Spark MLLib: (Provides analytical tools) Machine Learning algorithm libraries Solar, Lucene: Searching and Indexing
4	Develop a movie recommendation model using the scikit-learn library in python. Refer dataset https://github.com/rashida048/Some-NLP-Projects/blob/master/movie_dataset.csv
5	**Data Visualization** Download the Iris flower dataset or any other dataset into a DataFrame. (e.g.,https://archive.ics.uci.edu/ml/datasets/Iris). Scan the dataset and give the inference as: 1. List down the features and their types (e.g., numeric, nominal) available in the dataset. 2. Create a histogram for each feature in the dataset to illustrate the feature distributions. 3. Create a box plot for each feature in the

	dataset. Compare distributions and identify outliers.
6	**Mini Project:-**

MAI23102 - Mathematical Foundation for Data Science	
Sr. No.	**Problem Statement**
1.	Choose a dataset from UCI Machine Learning repository (e.g. Cleveland). 1. Compute and display summary statistics for each feature available in the dataset. (eg. minimum, maximum, mean, range, standard deviation, variance and percentiles). Use a bar-graph to demonstrate your results. 2. Data Visualization-Create a histogram for each feature in the dataset to illustrate the feature distributions. Plot each histogram. c)Create a boxplot for each feature in the dataset. All of the boxplots should be combined into a single plot. Compare distributions and identify outliers.
2.	**Mercari price prediction.** Perform following tasks: 1. Pre-process the dataset. 2. EDA, Try to understand the overall dataset which includes gathering initial stats about the raw data like the shape or the data types. 3. Identify outliers. 4. Check the correlation. 5. Univariate analysis and Bivariate analysis 6. Implement linear regression or any suitable technique on it to build a better model. 7. Evaluate the models and compare their respective scores like R2, RMSE, etc. Dataset Link: https://www.kaggle.com/datasets/bharathsaiellanti/mercari?resource=download
3.	1. Take any dataset from UCI repository (like air quality dataset) and perform regression analysis on it. Demonstrate your results using appropriate visualization techniques for numerical and categorical features (e.g. histogram, scatter plot, heat map, box plot). 2. Compute Eigenvalues and Eigen vectors for dataset in part a.
4.	Given a bank customer, build a neural network-based classifier that can determine whether they will leave or not in the next 6 months. Dataset Description: The case study is from an open-source dataset from Kaggle.The dataset contains 10,000 sample points with 14 distinct features such as CustomerId, CreditScore, Geography, Gender,

	Age, Tenure, Balance, etc. Link to the Kaggle project: https://www.kaggle.com/barelydedicated/bank-customer-churn-modeling Perform following steps: 1. Read the dataset. 2. Distinguish the feature and target set and divide the data set into training and test sets. 3. Normalize the train and test data. 4. Initialize and build the model. Identify the points of improvement and implement the same. Print the accuracy score and confusion matrix (5 points).
5.	Use the following dataset to analyze ups and downs in the market and predict future stock price returns based on Indian Market data from 2000 to 2020. Dataset Link: https://www.kaggle.com/datasets/sagara9595/stock-data
4.	**Mini Project**
	Useful links: https://archive.ics.uci.edu/ml/datasets/heart+disease https://archive.ics.uci.edu/ml/datasets/breast+cancer+wisconsin+(original) https://archive.ics.uci.edu/ml/datasets/Air+Quality

MAI23103 – Artificial intelligence	
Sr. No.	**Problem Statement**
1.	Implement 3 missionaries and 3 cannibal problems depicting appropriate graphs. Use A* algorithm.
2.	Implement any one of the following Expert Systems, i. Medical Diagnosis of 10 diseases based on adequate symptoms ii. Identifying birds of India based on characteristics
3	Implement Greedy search algorithm for any of the following application: I. Selection Sort II. Minimum Spanning Tree III. Single-Source Shortest Path Problem IV. Job Scheduling Problem V. Prim's Minimal Spanning Tree Algorithm VI. Kruskal's Minimal Spanning Tree Algorithm VII. Dijkstra's Minimal Spanning Tree Algorithm
4	Implement a solution for a Constraint Satisfaction Problem using Branch and Bound andBacktracking for n-queens problem or a graph coloring problem.
5	Implement any one of the following Expert System I. Information management II. Hospitals and medical facilities III. Help desks management IV. Employee performance evaluation V. Stock market trading Airline scheduling and cargo schedules

6	**Mini Project**

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MHS23101: Indian Knowledge System		
Teaching Scheme: **TH: 02 Hr./Week**	**Credit: 02**	**Examination scheme:** **Activity: 20 Marks** **Oral Exam: 30 marks**

Course Objectives:

1. To create awareness about the history and rich culture of the Bharata.
2. To introduce Vedic mathematics principles for faster calculations.
3. To know the science and Astronomy contributions of the traditional knowledge of Bhārata;
4. To learn engineering and technology contributions of the traditional knowledge of Bhārata;
5. To convert the Bhāratīya wisdom into the applied aspect of the modern scientific paradigm

Course Outcomes:

Students will be able to

CO1: Explain the historicity of Indian Knowledge System and the broad classification of Indian philosophical systems.

CO2: Apply Vedic Mathematics for faster calculations.

CO3: Understand the importance of science and astronomy concepts developed Bhārata;

CO4: To understand the contributions in the science, engineering & technology heritage of ancient and medieval India.

UNIT -I: Bhāratīya Civilization and Development of Knowledge System (4 hours)

Genesis of the land, Antiquity of civilization, the Saraswatī-Sindhu Civilization, Traditional Knowledge System, The Vedas, Main Schools of Philosophy, Ancient Education System, the Takṣaśilā University, the Nālandā University, Knowledge Export from Bhārata. Ethnic Studies, Life Science studies, Agriculture, Ecology and Environment, Āyurveda, Integrated Approach to Healthcare, Medicine, Microbiology, Surgery, and Yoga.

UNIT-II: Vedic Mathematics (8 hours)

Indian Mathematicians, Varahmihir, Brahmagupta, Srinivasa Ramanujan, Neelkanth Somayya, Bharti Krishna Tirtha, Introduction to sutras, and sub sutras,

Reference Books:

1. Pride of India- A Glimpse of India's Scientific Heritage edited by Pradeep Kohle et al. Samskrit Bharati (2006).

2. Vedic Physics by Keshav Dev Verma, Motilal Banarsidass Publishers (2012).

3. India's Glorious Scientific Tradition by Suresh Soni, Ocean Books Pvt. Ltd. (2010).

4. Modern Introduction to Ancient Indian Mathematics, T S Bhanumurthy, Wiley Eastern Limited, New Delhi

5. Advance Vedic Mathematics, Rajkumar Thakur, Rupa Publications India Pvt. Ltd 2019

6. Arihant Vedic Mathematics Made Easy - Pt. Ramnandan Shastri

7. Magical World of Mathematics, VG Unkalkar, Vandana publishers, Bangalore

8. Vedic Geometry Course, S. K. Kapoor, Lotus Press

9. Rigvedadi-Bhashya-Bhumika) by Swami Dayanand Saraswati (Author) Translation by Premananda, Swadeshi Store.

10. NPTEL Course: Indian Knowledge System (IKS): Concepts and Applications in Engineering https://onlinecourses.swayam2.ac.in/imb23_mg53/preview

Guidelines for Evaluation:

Activity: A group of 2 students will be assigned a topic related to Indian Knowledge System. Students will explore the topic and will present a poster. The work will be evaluated through presentation of their exploration of the topic.

Oral Examination: The oral examination will be conducted by external examiner on the complete syllabus to evaluate the learning of students on Indian Knowledge Systems.

Kalyani
(Kalyani Kulkarni)

Prof. R.K. Shastri
Subject Co-ordinator

Principal
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SEMESTER II

MAI23111: Advanced Machine Learning

Teaching Scheme:		Credits:	04	Examination Scheme:	
				Activity Exam:	20 Marks
TH:	04 Hrs/Week			In-Semester Exam:	30 Marks
				End-Semester Exam:	60 Marks

Prerequisite Courses:

1. Data Mining
2. Machine Learning

Course Objectives:

1.	To understand nature of problems solved with machine learning
2.	To apply classification algorithms for suitable machine learning problems.
3.	To understand reinforcement learning method and its applications
4.	To apply advanced machine learning methods for suitable applications

Course Outcomes:

On completion of the course, learner will be able to –

CO1:	Design and evaluate various machine learning algorithms
CO2:	Use machine learning methods for data analysis in various scientific fields
CO3:	Choose and apply appropriate Machine Learning techniques for analysis, forecasting and categorization of data
CO4:	Understand reinforcement learning and its applications

Course Contents

Unit I: Introduction to Machine Learning	**(6 Hrs)**

Types of learning: Supervised, Unsupervised and semi-supervised, reinforcement learning techniques;
Models of Machine learning:
Geometric model, Probabilistic Models, Logical Models, Grouping and grading models, Parametric and non-parametric models, Predictive and descriptive learning

Unit II: Classification	**(7 Hrs)**

Basic Concepts, Decision Tree Induction, Attribute Selection Measures, Tree Pruning, Rule Extraction from a Decision Tree; Multiclass Classification; Naive Bayesian Classification; Rule-Based Classification; Metrics for Evaluating Classifier Performance

Unit III: Support Vector Machine	**(6 Hrs)**

Artificial Neural Network and Recurrent Neural Networks: Mathematical foundation, Design and implementation study of neural network systems to solve real world problems

Unit IV: Genetic Algorithms	**(7 Hrs)**

Genetic Algorithms, Fuzzy Set Approaches; k-Nearest-Neighbor Classifiers, Case- Based Reasoning, , Holistic learning and multi-perspective learning

Unit V: Reinforcement learning	**(6 Hrs)**

The Reinforcement Learning Problem; History of Reinforcement Learning; Elements of Reinforcement Learning; Example: Tic-Tac- Toe; Transfer learning;

Unit VI: Advanced Machine Learning Applications:		(7 Hrs)
Advanced Machine Learning Applications: Beyond machine learning-deep learning and bio inspired adaptive systems; Machine learning and Big data; Natural Language Processing; Healthcare Decision Support System; Computer Vision		
Books & Other Resources:		
Textbooks:		
1.	Peter Flach, Machine Learning: The Art and Science of Algorithms that make sense of data, Cambridge University Press, 1st Edition, 2012, ISBN No.: 978-1-316-50611-0	
2.	Parag Kulkarni, "Reinforcement and Systemic Machine Learning for Decision Making" Wiley-IEEE Press, ISBN: 978-0-470-91999-6.	
3.	Han, Jiawei Kamber, Micheline Pei and Jian, "Data Mining: Concepts and Techniques" Elsevier Publishers Third Edition, ISBN: 9780123814791, 9780123814807.	
Reference Books:		
1.	Ethem Alpaydin, Introduction to Machine Learning, PHI, 2nd edition, 2013, 978-0-262-01243-0	

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MAI23112: Scalable Data Science

Teaching Scheme:		Credits:	04	Examination Scheme:	
				Activity Marks:	20 Marks
TH:	04 Hrs/Week			In-Semester Exam:	30 Marks
				End-Semester Exam:	60 Marks

Prerequisite Courses, if any:

Data Structures, Basics of Statistics & Data Science, Big Data.

Course Objectives:

1.	To learn the memory-efficient data structures and concepts
2.	To study different APIs provided by Apache Spark for parallel computation
3.	To learn the concepts of machine learning pipelines with Apache Spark

Following Fields are applicable for courses with companion Laboratory course

Course Outcomes:

On completion of the course, learner will be able to –

CO1:	**Identify** the memory-efficient data structures and scalability problems
CO2:	**Analyze** the solutions to the scalability problems
CO3:	**Understand** how switching to Apache Spark improves performance for large scale data science applications.
CO4:	**Implement** machine learning algorithms using SparkML and SparkR.
CO5:	**Understand & Apply** the GraphX API for graphs and graph-parallel computation

Course Contents

Unit I : Introduction to Scalability problems **(7 Hrs)**

Introduction of scalable machine learning: need and current scenario, Challenges with big data analytics- Computational and Analytical challenges, Memory-efficient data structures: Hash functions, universal / perfect hash families, Bloom filters, Sketches for distinct count, Misra-Gries sketch, Count Sketch, Count-Min Sketch. Approximate near neighbors search: Introduction, kd-trees. LSH families, MinHash for Jaccard, SimHash for L2.

Unit II : Apache Spark for Scalability **(6 Hrs)**

Introduction to Apache Spark, what is big data, data storage solutions, Parallel data processing strategies of Apache Spark, Programming language options on ApacheSpark and choosing the right language, the RDD API, Functional programming basics, RDDs transformations and actions – ApacheSparkSQL. Introduction to DataFrames- The DataFrame API, DataFrame basics, RDDs versus DataFrames, Creating DataFrames from- RDDs, JSON, databases using JDBC.

Unit III : Scaling Math for Statistics on Apache Spark **(7 Hrs)**

Use of Apache Spark RDD API to achieve parallelism in applying basic statistical calculations- Averages, Standard deviation, skewness, Kurtosis, Covariance, Covariance matrices, correlation, Plotting with ApacheSpark and python's matplotlib, Dimensionality reduction.

Unit IV : Apache SparkML **(6 Hrs)**

How ML Pipelines work, Introduction to SparkML, MLlib and the Pipeline API- Extract - Transform – Load, Using K-Means in Apache SparkML, Linear Regression with Apache SparkML, Logistic Regression with Apache SparkML

Unit V : Graph Processing with Spark	(7 Hrs)
Introduction to Graphs, Introduction to GraphX API, Data Abstractions, Creating a Graph, Graph Properties, Graph Operators.	
Unit VI : Extending Spark with SparkR	**(7 Hrs)**
SparkR basics- Accessing SparkR from the R environment, RDDs and DataFrames, Advantages and limitations. Programming with SparkR- Function name masking, Subsetting data, Column functions, Grouped data. SparkR DataFrames- SQL operations, Set operations, Merging DataFrames.	

Books & Other Resources:

Text Books:

1.	J. Leskovec, A. Rajaraman and JD Ullman, "Mining of Massive Datasets", Cambridge University Press, 3rd Ed.
2.	Mohammed Guller, "Big Data Analytics with Spark: A Practitioner's Guide to Using Spark for Large Scale Data Analysis", Apress

Reference Books:

1.	Mitzenmacher, Michael, and Eli Upfal, " Probability and computing: Randomized algorithms and probabilistic analysis", Cambridge University Press, 2005
2.	Srinivas Duvvuri, Bikramaditya Singhal, "Spark for Data Science", Packt Publishing, ISBN: 9781785885655

Link for Reference :

1.	Sketching as a Tool for Numerical Linear Algebra (unit-1): https://arxiv.org/abs/1411.4357
2.	https://www.oreilly.com/library/view/spark-for-data/9781785885655/
3.	https://www.amazon.in/Big-Data-Analytics-Spark-Practitioners/dp/1484209656

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MAI23113: Advanced Computing Intelligence

Teaching Scheme:		Credits:	04	Examination Scheme:	
				Activity Exam:	20 Marks
TH:	04 Hrs/Week			In-Semester Exam:	30 Marks
				End-Semester Exam:	60 Marks

Prerequisite Courses:

1. Mathematics
2. Data Mining Concepts
3. Machine Learning

Course Objectives:

1.	To Explain details on Introduction to Computational Intelligence
2.	To explain the feed-forward neural networks and its learning methods.
3.	To explain feed-back neural networks and its learning methods.
4.	To summarize the Evolutionary Computation and Swarm Intelligent Systems.
5.	To interpret different hybrid intelligent systems
6.	To discuss the different applications of Computational Intelligence

Course Outcomes:

On completion of the course, learner will be able to –

CO1:	Interpret the importance of Computational Intelligence for solving the different problems
CO2:	Select the appropriate type of neural network architecture and learning method.
CO3:	Optimize the solutions by using different optimization techniques.
CO4:	Evaluate the importance of different hybrid intelligent systems.
CO5:	Formulate the solution to the different real-world problems with the use of advanced computing techniques.

Course Contents

Unit I : Introduction to Computational Intelligence	**(7 Hrs)**

Cognitive Computing: Foundation of Cognitive Computing, its uses, AI as the foundation of Cognitive Computing, Elements of Cognitive System, Cognitive Applications, Design Principles of Cognitive System. Introduction to Computational Intelligence, from conventional AI to computational Intelligence, Computational Intelligence Paradigms: Artificial Neural Networks, Fuzzy System, Genetic Algorithms and Evolutionary Programming, Swarm Intelligent Systems.

Unit II: Neural Networks - Basic Concepts	**(7 Hrs)**

Biological Neurons and artificial neuron models, Classification of Artificial Neural Networks, Perceptron Networks and its limitations, Multi-Layer Feed Forward Neural Networks and Error Backpropagation Learning Algorithm, Performance issues in Error Back Propagation algorithm, Fast Learning Algorithms.	
Unit III: Advanced Neural Networks	**(7 Hrs)**
Kohonen Neural Networks, Hopfield Networks, Boltzmann Machines, Radial Basis Function networks, Adaptive Resonance Theory, Support Vector Machines. Spikes Neuron Models and Networks.	
Unit IV: Fuzzy Logic and Hybrid Techniques	**(7 Hrs)**
Fuzzy Set Theory: Fuzzy Sets, Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems Hybrid Techniques: Neuro-Fuzzy Systems, Adaptive Neuro-Fuzzy Inference System (ANFIS), Fuzzy Genetic Algorithms.	
Unit V: Evolutionary Computation and Swarm Intelligent System	**(7 Hrs)**
Genetic Algorithms (GAs) and Evolutionary Programming: Introduction to GA, Genetic Algorithms, Procedures of GAs, Working of GAs. Applicability of GAs, Evolutionary Programming, Working of Evolutionary Programming Swarm Intelligent System: Introduction to Swarm Intelligence, Background Of Swarm Intelligent systems, Ant Colony System, Working of Ant Colony Optimization, Ant Colony Optimization for TSP, Unit Commitment Problem, Particle Swarm Intelligent System, Artificial BeeColony System, Cuckoo Search Algorithm.	
Unit VI: Applications of Computational Intelligence	**(7 Hrs)**
Soft Computing in Database and Information management(R3 pp 295-309), Application of Fuzzy Techniques to Autonomous Robots(R3 pp 313-324), Computational intelligence in Industrial application(R3 pp 1143-1155), Knowledge discovery in Bioinformatics(R3 pp 1211-1220).	
Books & Other Resources:	
Textbooks:	
1.	S. P. Simon, N. P. Padhye, Soft Computing with Matlab Programming, OXFORD UNIVERSITY PRESS, 1st Edition, ISBN No. 978-0-19-945542-3.
2.	Cognitive Computing and Big Data Analytics, John Wiley and Sons.
Reference Books:	
1.	Andries P. Engelbrecht, Computational Intelligence: An Introduction, PHI, 2nd Edition ISBN No.978-0-470-03561-0.
2.	J.-S. R. Jang, C.-T. Sun, E. Mizutani, Neuro-fuzzy and Soft Computing A Computational Approach to Learning and Machine Intelligence, PHI, 2nd Edition, ISBN-978-81-203-2243-1
3.	Kacprzyk,Pedrycz Editors, Springer Handbook of computational intelligence, Springer series,ISBN-13: 978-3662435045.

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MAI23114-A: Business Intelligence

Teaching Scheme:		Credits:	04	Examination Scheme:	
				Activity Marks:	20 Marks
TH:	04 Hrs/Week			In-Semester Exam:	30 Marks
				End-Semester Exam:	60 Marks

Prerequisite Courses:

Students are expected to have a good understanding of Data Mining Knowledge.

Students are expected to have a good understanding of Machine Learning Knowledge.

Companion Course, if any: Advance Machine Learning, Data preparation and Analysis

Course Objectives:

1.	To get the students acquainted with the fundamentals of Business Intelligence
2.	To illustrate the core concepts and design issues of Decision support system and BI Infrastructure.
3.	To emphasize the importance of Data Preprocessing and Data Warehousing techniques for providing solution to the real time BI problems
4.	To comprehend and analyze Business and Data Analytics techniques for solving BI problems.
5.	To get the students acquainted with Pattern Evaluation and Visualization techniques for BI applications
6.	To acquaint myself with the use and benefits of Business Intelligence tools.

Course Outcomes:

On completion of the course, learner will be able to –

CO1:	Differentiate different BAI components such as BI, BA, DSS, and Operational data and Informational data
CO2:	Apply the knowledge of mathematics for data pre-processing techniques to solve BI problems.
CO3:	Use Data Warehouse techniques to design BI systems.
CO4:	Apply the knowledge of mathematics with Data Mining techniques for analytics to develop DSS
CO5:	Use performance evaluation metrics for pattern evaluation
CO6:	Analyze data sets and present analytical findings in reports, summaries, and dashboards.

Course Contents

Unit I: Introduction	**(7 Hrs)**

Introduction to data, Information and knowledge, Decision Support System, Theory of Operational data and informational data, Introduction to Business Intelligence, Defining BI Cycle, BI Environment and Architecture, Identify BI opportunities, Benefits of BI. Role of Mathematical model in BI, Factors Responsible for successful BI Project.

Unit II: Decision Making Concepts	**(7 Hrs)**
Concepts of Decision Making, Structure of Decision Support System (DSS), Development of Decision Support System (DSS), Applications of DSS, Role of Business Intelligence in DSS. Determining BI infrastructure requirements, planning for scalability and availability, managing and maintenance of BI systems, managing BI operations for business continuity	
Unit III: Data Preprocessing and Data Warehousing	**(7 Hrs)**
Data preparation, Preprocessing requirements, data cleaning, data integration, data reduction, data transformation, Data discretization and concept hierarchy generation; Data warehouse Modeling, data warehouse design, Distributed data warehouse.	
Unit IV: Business and Data Analytics	**(7 Hrs)**
Data analytics, business analytics, Data Analytics life cycle, Types of Analytics: Descriptive, Predictive, Prescriptive; Model Planning, Model building, Communicating Results & Findings, Operationalizing; Data Mining techniques for Business Analytics	
Unit V: Pattern Evaluation and Visualization	**(7 Hrs)**
Metrics for performance evaluation: Accuracy, Error Rate, precision, Recall, Fmeasure, Sensitivity, Specificity; Prescriptive Analytical techniques for Optimization, Dashboard, BI metrics on Dashboard, Need of Visualization, Pattern visualization tools and techniques	
Unit VI: BI Tools and Applications	**(7 Hrs)**
Tools for Business Intelligence, Role of analytical tools in BI, Case study of Analytical Tools: WEKA/ KNIME/ Rapid Miner/ R;Case Study of BI applications: ERP and Business Intelligence, BI Applications in Marketing, Role of BI in Finance, BI Applications in Banking, BI Applications in Fraud Detection	

Books & Other Resources:

Textbooks:

1.	R. Sharda, D. Delen, & E. Turban, Business Intelligence and Analytics. Systems for Decision Support, 10th Edition. Pearson/Prentice Hall, 2015. ISBN-13: 978-0-13-305090- 5, ISBN-10: 0-13- 3050904;
2.	Business unintelligence: Insight and Innovation Beyond Analytics and Big Data by Barry Devlin 2017
3.	Business Intelligence – Data Mining and Optimization for Decision Making – Carlo Vercellis – Wiley Publications

Reference Books:

1.	Introduction to business Intelligence and data warehousing, IBM, PHI
2.	Data mining concepts and techniques, Jawai Han, Michelline Kamber, Jiran Pie, Morgan Kaufmann Publishers 3rd edition.
3.	EMC Educational Services, Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, Wiley ISBN-13 978 1118876138
4.	Ken W. Collier, Agile Analytics: A value driven Approach to Business Intelligence and Data Warehousing, Pearson Education,2012, ISBN-13 978 2131786826

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MAI23114-B: Cryptography and Cryptanalysis					
Teaching Scheme:		**Credits:**	**04**	**Examination Scheme:**	
				Activity Marks:	**20 Marks**
TH:	**04 Hrs./Week**			**In-Semester Exam:**	**30 Marks**
				End-Semester Exam:	**60 Marks**

Course Contents

Unit I : Introduction	**(7 Hrs)**
Introduction: Classical Encryption Techniques – Substitution Techniques, Transposition Techniques; Symmetric Cipher Model: Feistel cipher structure, DES, Tripple DES, Block Cipher Design Principles; AES	
Unit II: Number Theory	**(7 Hrs)**
Number Theory: Divisibility and the division Algorithm, The Euclidean Algorithm, Modular Arithmetic, Fermat's and Euler's Theorems, The Chinese remainder Theorem	
Unit III: Public Key Cryptography	**(7 Hrs)**
Public Key Cryptography: RSA – Algorithm & Computational Aspects, DiffieHellman Key Exchange; Elgamal Cryptographic System; Elliptic Curve Cryptography	
Unit IV: Key management and distribution	**(7 Hrs)**
Key management and distribution: Symmetric key distribution using symmetric & asymmetric encryption, distribution of public keys, X.509 certificates, PKI	
Unit V: Cryptographic Hash Functions	**(7 Hrs)**
Cryptographic Hash Functions: Applications, SHA, MD5; Message Authentication Codes: requirements, function, security, HMAC; Digital signatures - introduction.	
Unit VI: Cryptanalysis	**(7 Hrs)**
Cryptanalysis, Cryptanalysis on Substitution Cipher (Frequency Analysis), Cryptanalysis on Stream Cipher, Modern Stream Ciphers, Time-Memory Trade-off Attack, Linear Cryptanalysis, Differential Cryptanalysis	

Books & Other Resources:

Reference Books:

1.	William Stallings, Lawrie Brown "Computer security -Principles and Practices", Pearson publication.
2.	John F. Dooley, History of Cryptography & Cryptanalysis-Codes, Ciphers & Algorithms, Springer
3.	W. Mao, "Modern Cryptography – Theory and Practice", Pearson Education.
4.	A. Forouzan, "Cryptography & Network Security", Tata Mc Graw Hill. A. Forouzan, "Cryptography & Network Security", Tata Mc Graw Hill.

Head of Department
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MAI23114-C: Advanced Image Processing					
Teaching Scheme:		**Credits:**	**04**	**Examination Scheme:**	
				Activity Marks:	**20 Marks**
TH:	**04 Hrs./Week**			**In-Semester Exam:**	**30 Marks**
				End-Semester Exam:	**60 Marks**

Course Contents

Unit –I Digital image fundamentals	**(7 Hrs)**
Digital Image Processing (DIP), Origin of DIP, Fundamental steps in Digital Image Processing (DIP), Componen of digital image processing system, Digitization, Elements of visual perception, Structure of the human eye, Imag formation in the eye, Brightness adaptation and discrimination, light, Image sensing and acquisition, Image formation model. Sampling and Quantization.	
Unit –II: Image Enhancement in spatial domain	**(7 Hrs)**
Gray level transformations, DIP Operations –Point Operations i.e Histogram processing, enhancement using Arithmetic/logic operations, Basics of spatial filtering, Local operations - Windows Operators, Convolution, Smoothing and sharpening spatial filters, Combining Spatial Enhancement methods.	
Unit-III: Frequency Domain	**(7 Hrs)**
Global operations – Relationship to neighborhood operations, Energy Compaction in transform domain. Two dimensional Discrete Cosine Transform (DCT), Discrete Haar Transform, Haar Wavelet Pyramid, Discrete Sine Transform, Discrete Walsh Transform, Discrete Hadamard Transform	
Unit-IV: Feature Descriptors	**(7 Hrs)**
Basics of Feature Descriptor, Color Feature Descriptors: Histograms, Bins, Block Truncation Coding, Sorted Block truncation Coding, Shape Feature Descriptors: TopHat Transformation, Bottom hat Transformation, Texture Shape Descriptors: GLCM, Texture Patterns, Local Binary Pattern (LBP)	
Unit-V: Color Spaces	**(7 Hrs)**
RGB, YCbCr, CIE LUV, Kekre LUV, YUV, HSI, HSV, color space conversions and applications Image Morphology: Erosion, Dilation, Opening, Closing	
Unit-VI: Advanced Image Processing Algorithms	**(7 Hrs)**
Grayscale Image colorization, Image In painting, Content based Image Classification Histogram Equalization Based Contrast Enhancement, Hit and Miss Morphological Algorithm, Image Stitching, PCA based face Recognition.	
Books & Other Resources:	
Reference Books:	

1.	S.Sridhar, Digital Image Processing, Oxford University Press
2.	B.Chanda, D. DuttaMajumder, "Digital Image Processing and Analysis", 2nd Edition, Phi learning
3.	William K Pratt , "Digital Image Processing" 4 Edition, Wiley

Dr. C. S. Kulkarni.

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MAI23114-D: Virtual Reality Augmented Reality					
Teaching Scheme:		**Credits:**	**04**	**Examination Scheme:**	
				Activity Marks:	**20 Marks**
TH:	**04 Hrs./Week**			**In-Semester Exam:**	**30 Marks**
				End-Semester Exam:	**60 Marks**

Prerequisite Courses:

Computer Graphics

Companion Course, if any: Laboratory Proficiency-II

Course Objectives:

1.	To introduce the fundamentals of sensation, perception, technical and engineering aspects of virtual reality systems
2.	To introduce the fast-growing field of AR and make the students aware of the various AR concepts and applications.
3.	To learn basic principles of VR applications and encourage students to build various AR & VR apps using Unity.

Course Outcomes:

On completion of the course, learner will be able to –

CO1:	**Identify** the most suitable technique for a given use case based on the understanding of the similarities and differences between virtual, augmented, and mixed reality
CO2:	**Understand** the system of human vision and its implication on perception and rendering.
CO3:	**Understand** the computer vision concepts and software's for AR and describe AR techniques
CO4:	**Create** 3D scenes with Unity IDE and experiment with various user interface (UI) techniques that are used in VR applications
CO5:	**Understand, develop,** and **demonstrate** AR and VR apps in Unity IDE

Course Contents

Unit I : Introduction to AR, VR and MR	**(7 Hrs)**

Differentiation, Features, use-cases and examples. Milgram's Reality-Virtuality continuum: Reality, Augmented Reality, Augmented Virtuality, Virtual Environment and Mixed Reality.
Taxonomy of Mixed Reality: real, virtual, Extent of Work Knowledge (EWK),
Reproduction Fidelity (RF), Extent of Presence Metaphor (EPM). Geometry of Virtual World and Illumination: Birds- Eye View. Geometric Modeling. Matrix algebra and 2D rotations. 3D rotations and Yaw, Pitch and Roll. Axis angle representation. Quaternions. Converting and multiplying rotations. Homogeneous transforms. The chain of viewing transforms. Eye transforms. Viewport transforms.
Three interpretations of light.

Unit II: Visual Perception & Rendering	**(6 Hrs)**

Visual Perception - Perception of Depth, Perception of Motion, Perception of Color, Combining Sources of Information.
Visual Rendering -Ray Tracing and Shading Models, Rasterization, Correcting Optical Distortions, Improving Latency and Frame Rates

Unit III: Computer Vision for Augmented Reality & AR software	**(7 Hrs)**

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Marker creation and marker tracking. Multiple-Camera Infrared Tracking, Natural Feature Tracking by Detection, Simultaneous Localization and Mapping, Outdoor Tracking
Augmented Reality Software - Introduction, Major Software Components for Augmented Reality Systems, Software used to Create Content for the Augmented Reality Application.

Unit IV: AR Techniques- Marker based & Marker less tracking	**(7 Hrs)**

Marker-based approach- Introduction to marker-based tracking, types of markers, marker camera pose and identification, visual tracking, mathematical representation of matrix multiplication. **Marker types-** Template markers, 2D barcode markers, imperceptible markers. **Marker-less approach-** Localization based augmentation, real world examples. **Tracking methods-** Visual tracking, feature based tracking, hybrid tracking, and initialization and recovery.

Unit V: Virtual Reality for Game Development	**(7 Hrs)**

What is virtual reality?, Types of head-mounted displays, How virtual reality really works, Types of VR experiences, Technical skills that are important to VR, High-Level Concepts of Content Creation, Environmental Design, Affecting Behavior, Transitioning to VR Content Creation, Content Creation: Design Guidelines, Human-Centered Interaction, VR Interaction Concepts, Input Devices, Interaction Patterns and Techniques, Interaction: Design Guidelines, Overview of game development in Unity IDE, Building Your Project and Character, Getting Animated, The Town View, Working with Unity's UI System.

Unit VI: Application Development Using Augmented Reality and Virtual Reality	**(6 Hrs)**

VR SDK's – VR SDK'S and Frameworks – OpenVR SDK, StreamVR SDK, VRTK, Oculus SDK, Google VR SDK. **VR Concept Integration-** Motion Tracking, Controllers, Camera , Hardware and Software requirements **Setting up Unity with VR-** Framework/SDK Integration with Unity, Debugging VR projects,**Working with AR Tools– ARCore, ARToolkitx ARCore** - Features of ARCore, integration with Unity/Unreal/iOS/Android Studio, augmented reality applications with ARCore. **ARToolkit** – Features of ARToolkit, setting up the environment for application development. **Vuforia-** Features of Vuforia, setting up the environment for application development.

Books & Other Resources:

Textbooks:

1.	Tom Dieck, M. Claudia & Timothy Jung "Augmented Reality and Virtual Reality The Power of AR and VR for Business" Springer; 1st ed. 2019 edition ISBN-13: 978-3030062453
2.	Jason Jerald "The VR Book: Human- Centered Design for Virtual Reality, Association for Computing Machinery", Morgan & Claypool Publishers.
3.	Steven M. LaValle, "Virtual Reality", Cambridge University Press, 2016
4.	William R Sherman and Alan B Craig, "Understanding Virtual Reality: Interface, Application and Design", (The Morgan Kaufmann Series in Computer Graphics)". Morgan Kaufmann Publishers, San Francisco, CA, 2002
5.	Allan Fowler "Beginning iOS AR Game Development Developing Augmented Reality Apps with Unity and C#", 1st Edition, Apress Publications, 2018, ISBN 978-1484236178

Reference Books:

1.	Tony Parisi, Learning Virtual Reality, O'Reilly Media, Inc., 2015, ISBN- 9781491922835
2.	Jonathan Linowes, Krystian Babilinski, Augmented Reality for Developers: Build practical augmented reality applications with Unity, ARCore, ARKit, and Vuforia. Packt publishing, 9th October 2017. ISBN- 13: 978-1787286436

Link for Reference :
http://lavalle.pl/vr/book.html
https://www.amazon.in/Augmented-Reality-Virtual-Business-Progress/dp/3030062457
https://www.amazon.in/Beginning-iOS-Game-Development-Developing-ebook/dp/B07G2LT4PW

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MAI23115: Laboratory Proficiency - II		
Teaching Scheme:	**Credit**	**Examination Scheme:**
PR:08 Hr/Week	**04**	**Term Work: 50 Marks** **Oral: 50 Marks**
Prerequisite Courses: Knowledge of programming languages, Basics of Python/R		
Companion Courses: MAI23111-Advanced Machine Learning MAI23112 – Scalable Data Science MAI23113 – Advance Computing Intelligence		
All assignments are compulsory. Each student should implement the assignment individually. Laboratory teachers should make sure that the dataset/code/write-up is not the same. Laboratory teacher can add more assignments as per requirement.		

MAI23111-Advanced Machine Learning	
LIST OF PRACTICALS	
1	Hypothesis Formulation and Dataset Exploration- Optimize the hyper parameters of a deep learning model for image classification on the CIFAR-10 dataset. Compare the performance of the tuned model with a baseline model.
2	Transfer Learning- Apply transfer learning to improve the performance of a pre-trained language model (e.g., BERT) on a domain-specific text classification task, such as sentiment analysis of customer reviews.
3	Ensemble Learning- Build an ensemble of machine learning models to predict stock prices. Explore different algorithms (e.g., Random Forest, Gradient Boosting) and evaluate the ensemble's performance against individual models.
4	Advanced Neural Network Architectures- Implement convolutional neural network (CNN) architecture for medical image segmentation. Evaluate the model's accuracy in segmenting tumors in MRI images compared to traditional segmentation methods.
5	**Mini Project-** Define the scope of the project, including the boundaries and limitations. Be realistic about what can be accomplished within the given timeframe.

MAI23112 – Scalable Data Science	
LIST OF PRACTICALS	
1	Implement a distributed computing solution for analyzing a large-scale dataset, such as the analysis of a massive log file or a dataset with billions of records. Utilize Apache Spark to parallelize data processing.
2	Train a machine learning model on a massive dataset, like the Image Net dataset, using distributed training techniques. Explore frameworks such as Tensor Flow or PyTorch with distributed computing support.
3	Perform scalable sentiment analysis on a vast collection of text data, such as Twitter feeds or news articles. Implement distributed NLP algorithms and explore cloud-based solutions for efficient processing.

4	Build a scalable recommender system capable of handling a large number of users and items. Utilize collaborative filtering or matrix factorization techniques and consider distributed computing for real-time recommendations.
5	**Mini Project-** Define the scope of the project, including the boundaries and limitations. Be realistic about what can be accomplished within the given timeframe.

MAI23113 – Advance Computing Intelligence	
LIST OF PRACTICALS	
1	Apply an evolutionary algorithm (e.g., Genetic Algorithm) to optimize the parameters of a complex mathematical function. Evaluate the algorithm's performance in finding the global optimum and compare it with traditional optimization methods.
2	Apply reinforcement learning to dynamically allocate resources in a cloud computing environment. Develop an agent that learns to optimize resource allocation based on changing workloads and demands.
3	Build a hybrid intelligent system that combines machine learning and expert systems for predictive maintenance in manufacturing. Predict equipment failures and recommend maintenance actions based on historical data and domain knowledge.
4	Explore the application of quantum computing algorithms (e.g., Shor's algorithm) for the factorization of large integers. Compare the efficiency of quantum algorithms with classical algorithms.
5	**Mini Project-** Define the scope of the project, including the boundaries and limitations. Be realistic about what can be accomplished within the given timeframe.

Mrs. Pawar.S.D
Subject - Incharge
PG. Coordinator.

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MSE23116-Environmental Studies

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 2 hrs./week	TH:2	Activity Marks = 30
		Oral -30 Marks

Unit 1 : Multidisciplinary nature of environmental studies: 4Hrs

Definition, scope and importance, Need for public awareness.

Unit 2 : Natural Resources : 4Hrs

Renewable and non-renewable resources, Role of an individual in conservation of natural resources, Equitable use of resoureces for sustainable lifestyles.

Unit 3 : Ecosystems 4Hrs

Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids, Introduction, types, characteristic features, structure and function of the various ecosystem.

Unit 4 : Biodiversity and its conservation 4Hrs

Introduction – Definition : genetic, species and ecosystem diversity, Biogeographical classification of India, Value of biodiversity : consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, National and local levels, India as a mega-diversity nation

Unit 5 : Environmental Pollution 4Hrs

Definition, Cause, effects and control measures of a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f. Thermal pollution g. Nuclear hazards, Solid waste Management, Pollution case studies.

Unit 6 : Social Issues and the Environment 4Hrs

Urban problems related to energy, Water conservation, rain water harvesting, watershed management, Environmental ethics : Issues and possible solutions, Environment Protection Act. , Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act.

Mr. U. T. Jagadale
PG Coordinator

Dr. C. B. Nayak
Head, Civil Engg. Dept.

SEMESTER III

MAI23201: Deep Learning

Teaching Scheme:		Credits:	04	Examination Scheme:	
				Activity Marks:	20 Marks
TH:	04 Hrs/Week			In-Semester Exam:	30 Marks
				End-Semester Exam:	60 Marks

Prerequisite Courses:

Students are expected to have knowledge of Statistics and Calculus, Machine Learning, Artificial Intelligence.

Companion Course, if any: Advance Machine Learning

Course Objectives:

1.	Introduce major deep neural network frameworks and issues in basic neural networks
2.	To solve real-world applications using Deep learning
3.	Providing insight into recent Deep Learning architectures
4.	Identify and analyze the various types of neural networks and models of neurons and apply accordingly.
5.	Introduce the concept of deep learning and its types.
6.	Explore the concepts of applications of deep learning

Course Outcomes:

On completion of the course, learner will be able to –

CO1:	Understand the methods and terminologies involved in deep neural networks, differentiate the learning methods used in Deep-nets.
CO2:	Identify and improve Hyper parameters for better Deep Network Performance
CO3:	To understand and visualize Convolutional Neural Network for real-world applications
CO4:	To demonstrate the use of Recurrent Neural Networks and Transformer based for language modeling
CO5:	To distinguish different types of Advanced Neural Networks
CO6:	Apply the deep learning techniques for various applications

Course Contents

Unit I : Neural Networks and Neural Learning **(7 Hrs)**

The Neuron –Expressing Linear Perceptrons as Neurons – Feed-Forward Neural Networks – Linear Neurons and their Limitations – Sigmoid, Tanh and Relu Functions – Softmax Output Layers
Measuring Errors - Gradient Descent – Delta Rule and Learning Rate – Backpropagation – Stochastic and Minibatch Gradient – Test Sets, Validation Sets and Overfitting – Preventing Overfitting in Deep Neural Networks – Other Optimization Algorithms: Adagrad, RMSProp, Adadelta, Adam

Unit II: Convolution Neural Networks and Pre-Trained Models **(8 Hrs)**

Neurons in Human Vision – Shortcomings of Feature Selection –Scaling Problem in Vanilla Deep Neural Networks – Filters and Feature Maps – Description of Convolutional Layer – Max Pooling – Convolutional Network Architecture – Image Classification
Self-Supervised Pre Training, AlexNet, VGG, NiN, GoogleNet, Residual Network (ResNet), DenseNet, Region-Based CNNs (R-CNNs) – Transfer Learning - FSL

Unit III: Recurrent Neural Networks **(8 Hrs)**

Sequence-to-Sequence Modeling – Embedding - Recurrent Neural Networks - Bidirectional RNNs, Analyzing Variable Length Inputs – Tackling seq2seq Problem – Beam Search and Global Normalization – Recurrent Neural Networks (RNN)– Hidden States – Perplexity – Character-level Language Models –Modern RNNs: Gated Recurrent Units (GRU), Long Short Term Memory (LSTM), Bidirectional Long Short Term Memory

(BLSTM), Deep Recurrent Neural Network, Bidirectional RNN	
Unit IV: Attention Models and Transformers	**(7 Hrs)**
Attention Mechanism: Attention Cues, Attention Pooling, Scoring Functions, Self-Attention and Positional Encoding;–Bidirectional Encoder Representations from Transformers (BERT) – Generative Pre-trained Transformers.	
Unit V: Advanced Neural Networks	**(6 Hrs)**
Generative Adversarial Networks – Generator, Discriminator, Training, GAN variants; Auto encoder: Architecture, Denoising and Sparcity; DALL-E, DALL-E 2 and IMAGEN	
Unit VI: Practical methodology and applications	**(6 Hrs)**
Performance metrics, default baseline models, determining whether to gather more data, selecting hyper parameters, debugging strategies, multi-digit number recognition, large scale deep learning, applications in computer vision and NLP	
Books & Other Resources:	
Text Books:	
1.	Fundamentals of Deep Learning, Nikhil Buduma and Nicholas Locasio, O-Reilly, 2017
2.	Dive into Deep Learning, Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, Amazon Senior Scientists – Open source and Free Book, March 2022
3.	"Deep Learning", Ian Goodfellow, YoshuaBengio and Aaron Courville, published by MIT Press,UK, 2017 Series
4.	Deep Learning with Keras: The Textbook by Antonio Gulli and Sujit Pal, PacktPublishing Ltd, Birmingham, UK, April 2017
5.	Neural Networks and Deep Learning, Michael Nielsen,, Determination Press
Reference Books:	
1.	Deep Learning with TensorFlow, The Textbook by Giancarlo Zaccone, Md. Rezaul Karim, and Ahmed Menshawy, Packt Publishing Ltd, Birmingham, UK, April 2017.
2.	Deep Learning: A Practitioner's Approach, Josh Patterson, Adam Gibson, O'Reilly Media, 2017
3.	Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks, Umberto Michelucci, Apress, 2018.

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MAI23202: Natural Language Processing					
Teaching Scheme:		**Credits:**	04	**Examination Scheme:**	
				Activity Exam:	**20 Marks**
TH:	**04 Hrs/Week**			**In-Semester Exam:**	**30 Marks**
				End-Semester Exam:	**60 Marks**

Prerequisite Courses:

Students are expected to have a good understanding of basics of Computational methods, language constructs

Companion Course, if any: Professional Elective Lab-I **(NLP).**

Course Objectives:

The Primary objective is to give students a basic introduction to programming with the computer language Python.

1.	To understand the basics of natural language processing
2.	To understand the syntax, semantics of the language
3.	To understand the sequence labeling task
4.	To be able to build and demonstrate language model
5.	To be able to implement different word embedding techniques

Course Outcomes:

On completion of the course, learner will be able to –

CO1:	Demonstrate the basics and applications of NLP
CO2:	Apply different text processing techniques of NLP
CO3:	Implement part-of-speech taggers and parsers for a language
CO4:	Build language models and demonstrate Word Sense Disambiguation using WordNet.
CO5:	Use different word embedding techniques.

Course Contents

Unit I : Introduction to Natural Language Processing	**(8 Hrs)**

Introduction to Natural Language Processing NLP, Basics of NLP, NLP Problems and prospective, stages of NLP, , Applications of NLP, Challenges in NLP, Overview of Probability Calculus, Empirical Laws of language, zipf's law, Heap's law, introduction to python library NLTK

Unit II: Basic Text Processing	**(7 Hrs)**

Concept of Tokenization, word token and type, feature extraction, Tokenization for different languages, text segmentation, normalization, case folding, Spelling Correction, Corpora and its construction, Stop word removal, Stemming, lemmatization, spelling correction - dynamic programming approach for finding edit distance, Regular Expressions, N-gram Language Modeling- context sensitive spelling correction, probabilistic language model, auto completion prediction, Basic text processing using python

Unit III: POS Tagging	(7 Hrs)
Sequence labeling, Tagging, POS tagging, Introduction to Hidden Markov Model Markov Processes, HMM characterization: Likelihood of a sequence (Forward Procedure, Backward Procedure), Best state sequence (Viterbi Algorithm), Re-estimation (Baum Welch - Forward-Backward Algorithm) Best state sequence, Re estimation, Models for Sequential tagging – Maximum Entropy, Conditional Random Field.	
Unit IV: Parsing	**(7 Hrs)**
Grammar for natural languages, Parsing, Context – free grammar, Constituency and dependency parsing, Syntactic structure, Parsing methodology, Different parsing algorithms, ambiguity in parsing , Probabilistic parsing, CKY algorithm, Issues in parsing, Dependency parsing- Syntactic structure, Parsing methodology, Transition-Based Dependency Parsing, Graph-Based dependency parsing, Evaluation, Co-reference resolution, Named-entity recognition	
Unit V: Knowledge Base and Semantics	**(7 Hrs)**
WordNet: Word Senses, Word relations, Word similarity and thesaurus methods, Word sense Disambiguation, Overlap based method, supervised method, unsupervised method, WordNet. Lexical and Distributional Semantics - Introduction, models of Semantics, applications	
Unit VI: Word Embedding	**(6 Hrs)**
Introduction, one-hot vectors, methods of generating word embeddings, Skip-gram, CBOW, Glove model, Fast Text model, evaluation measures-rough scores	
Books & Other Resources:	
Text Books:	
1.	"Speech and Language Processing", Daniel Jurafsky and James H. Martin, Second Edition, Prentice Hall, 2008, ISBN: 978-0131873216.
2.	"Natural Language Understanding", Allen James, Second Edition, Benjamin/Cumming
Reference Books:	
1.	Conferences: Annual Meeting of the Association of Computational Linguistics (ACL), Computational Linguistics (COLING), European ACL (EACL), Empirical Methods in NLP (EMNLP), Annual Meeting of the Special Interest Group in Information Retrieval (SIGIR), Human Language Technology (HLT).
2.	Journals: Computational Linguistics, Natural Language Engineering, Machine Learning, Machine Translation, Artificial Intelligence.

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MAI23203-A: Data Modelling and Visualization					
Teaching Scheme:		**Credits:**	**04**	**Examination Scheme:**	
				Activity Exam:	**20 Marks**
TH:	**04 Hrs/Week**			**In-Semester Exam:**	**30 Marks**
				End-Semester Exam:	**60 Marks**

Prerequisite Courses:

1. Basics of Machine Learning
2. Python Programming Language
3. Basics of Probability.

Companion Course, if any: No

Course 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 to understand the visual analytics such as dashboards and storytelling with a hands-on tutorial. On tableau and PowerBI.

Course Outcomes:

On completion of the course, learner will be able to –

CO1:	Explain the importance of Data Visualization.
CO2:	Describe how to create basic charts by applying visualization design principles.
CO3:	Interpret the advanced visualization of time series data.
CO4:	Explore and analyze Time series, Geospatial and multimodal data.
CO5:	Build interactive/animated dashboards and construct data stories.
CO6:	Summarize important trends/patterns in the datasets.

Course Contents

Unit I : Overview of Data Visualization	**(8 Hrs)**

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.

Unit II: Creation of basic visualization	**(8 Hrs)**

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.	
Unit III: Visualization of Time series data	**(7 Hrs)**
Visualization of Time series data, Summary statistics and plotting aggregated views - Visualization of seasonality, trends and noise– working with multiple time series data	
Unit IV: Pars Business Analytics and Visualization Tool	**(8 Hrs)**
Business Analytics and Visualization Tools, Tableau, PowerBI, Creating Interactive Dashboards and charts to organize data using visualization principles	
Unit V: Data Storytelling	**(6 Hrs)**
Data Storytelling, reading data in-depth, identifying critical, messages and communicating these messages in most effective way	
Unit VI: Case study	**(8 Hrs)**
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.	
Books & Other Resources:	
Textbooks	
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.

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MAI23203-B: GPU Computing

Teaching Scheme:		Credits:	04	Examination Scheme:	
				Activity Exam:	20 Marks
TH:	04 Hrs/Week			In-Semester Exam:	30 Marks
				End-Semester Exam:	60 Marks

Prerequisite Courses:

1. Basics of Machine Learning
2. Python Programming Language
3. Basics of Probability.

Companion Course, if any: No

Course Objectives:

1.	To understand the different approaches of parallel programming.
2.	To study massively parallel computing hardware and programming models.
3.	To study massively parallel computing hardware and programming models.
4.	To develop parallel programs in heterogeneous environments with OpenCL.
5.	To understand machine learning using GPU.

Course Outcomes:

On completion of the course, learner will be able to –

CO1:	**Analyze** and measure performance of modern parallel computing systems.
CO2:	**Design and implement** parallel programs on GPUs.
CO3:	**Develop** a high-performance parallel application in CUDA.
CO4:	**Build** parallel programming logic on current system architectures using OpenCL.
CO5:	**Implement** machine learning using GPU.

Course Contents

Unit I : Understanding Parallelism with GPUs.	**(7 Hrs)**

Review of traditional computer architecture – basic five stage RISC pipeline, cache memory, register file, SIMD instructions, and GPU architectures - streaming multi processors, cache hierarchy, the graphics pipeline, parallel programming languages and models. Understanding Parallelism with GPUs.

Unit II: Grids, Blocks, and Threads	**(7 Hrs)**

Grids, Blocks, and Threads Introduction to Data Parallelism and CUDA C, Data-Parallel Execution Model, CUDA Memories-Memory types and memory Access Efficiency, Performance Considerations- Warps ,Thread Execution, Global Memory Bandwidth, Dynamic Partitioning of Execution Resources, Instruction Mix and Thread Granularity, the CUDA extensions to the C language, and the basic programming/debugging tools.

Unit III: Memory Handling and Synchronization	**(7 Hrs)**

Memory Handling with CUDA- The basic CUDA memory/threading model, floating-point considerations in parallel computing and common data-parallel programming patterns needed to develop a high-performance parallel application. Programs for concurrent Data Structure such as Worklists, Linked-lists. Synchronization across CPU and GPU

Unit IV: Designing GPU-Based Systems	(7 Hrs)
Parallel Programming and Computational Thinking, MPI-CUDA programming in a heterogeneous computing cluster. Dynamic parallelism, Unified Virtual Memory, CPU vs GPU, GPU hardware overview, GPU memory architecture, GPU properties, compute capability of GPU, multi- GPU solution. Multi-GPU processing, Peer access, Heterogeneous processing.	
Unit V: Introduction to OpenCL	**(7 Hrs)**
Data Storytelling, reading data in-depth, identifying critical messages and communicating these messages in the most effective way.	
Unit VI: Machine learning applications with CUDA	**(7 Hrs)**
Containerization on GPU-Enabled Platforms, concept of Containerization, working of open and closed environments as local and cloud containers **Accelerated Machine learning on GPUS**, Exploring the Pytorch and Neural networks **Case Study:** GPU Enabled Machine Learning	
Books & Other Resources:	
Text Books:	
1.	"Programming Massively Parallel Processors" - David Kirk and Wen- meiHwu
2.	" Heterogeneous Computing with OpenCL" -- Benedict Gaster, Lee Howes, David R. Kaeli
3.	Hands-On GPU Computing with Python: (Kindle Edition) by Bandyopadhyay, Avimanyu
Reference Books:	
1.	Shane Cook, "CUDA Programming: A Developer's Guide to Parallel Computing with GPUs", Morgan Kaufmann Publishers Inc. San Francisco, CA, USA 2013 ISBN: 9780124159884
2.	CUDA BY EXAMPLE by Jason Sanders, Edvard Kandrot.
Link for Reference : http://www.cs.columbia.edu/~m-reed/gpu.html https://developer.nvidia.com/udacity-cs344-intro-parallel-programming	

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MAI23203-C: Product Life Cycle Management					
Teaching Scheme:		**Credits:**	**04**	**Examination Scheme:**	
				Activity Exam :	**20 Marks**
TH:	**04 Hrs/Week**			**In-Semester Exam:**	**30 Marks**
				End-Semester Exam:	**60 Marks**

Prerequisite Courses: Software Engineering

Companion Course, if any: No

Course Objectives:

1.	To familiarize the students with the needs, benefits, and components of PLM.
2.	To acquaint students with Product Data Management & PLM strategies.
3.	To give insights into new product development program and guidelines for designing and
4.	Developing a product.
5.	To familiarize the students with Virtual Product Development.

Course Outcomes:

On completion of the course, learner will be able to –

CO1:	Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
CO2:	Illustrate various approaches and techniques for designing and developing products.
CO3:	Apply product engineering guidelines / thumb rules in designing products for molding, machining, sheet metal working etc
CO4:	Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Course Contents

Unit I: Introduction to Product Lifecycle Management (PLM)	**(7 Hrs)**

Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications. PLM Strategies: Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy, Change management for PLM

Unit II: Product Design	**(7 Hrs)**

Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post

design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process.	
Unit III: Product Data Management (PDM)	**(7 Hrs)**
Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	
Unit IV: Virtual Product Development Tools	**(7 Hrs)**
For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies.	
Unit V: Integration of Environmental Aspects in Product Design	**(7 Hrs)**
Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	
Unit VI: Life Cycle Assessment and Life Cycle Cost Analysis	**(7 Hrs)**
Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis.	
Books & Other Resources:	
Reference Books:	
1.	John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realization", Springer-Verlag, 2004. ISBN: 1852338105.
2.	Fabio Giudice, Guido La Rosa, AntoninoRisitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3.	SaaksvuoriAntti, ImmonenAnselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4.	Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

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MAI23203-D: Data Mining and Analytics					
Teaching Scheme:		**Credits:**	**04**	**Examination Scheme:**	
				Activity Exam :	**20 Marks**
TH:	**04 Hrs/Week**			**In-Semester Exam:**	**30 Marks**
				End-Semester Exam:	**60 Marks**

Prerequisite Courses:

Students are expected to have a good understanding of basics of the Database Management Systems, Data Mining.

Companion Course, if any: Professional Core Lab-I

Course Objectives:

1.	To study necessity of Data mining and its continuous growth.
2.	To study Data Preprocessing and Data Reduction of Data mining.
3.	To Understand Mining Frequent Patterns, Associations in Data mining.
4.	To Study concept of classification & clustering in data mining
5.	Understand the Data Mining Trends and Research Frontiers

Course Outcomes: On completion of the course, learner will be able to –

CO1:	Understand the fundamentals of data mining
CO2:	Understand the fundamental concept data preprocessing and data reduction in data mining
CO3:	Understand the concept of Associations and Correlations
CO4:	Analyze and Apply advanced classifications techniques on applications
CO5:	Analyze and Apply advanced clustering techniques on real life applications
CO6:	Analyze Trends and Research Frontiers of Data Mining

Course Contents

Unit I : Introduction to Data Mining	**(7 Hrs)**

Introduction: Data mining, kinds of data mined, kinds of patterns mined, technologies used: statistics, Machine learning, Database systems and Data Warehousing, Information Retrieval, Major issues in Data Mining: Mining methodology, User Interaction, Efficiency and Scalability, Diversity and database types, Data Mining & society.

Unit II: Data Preprocessing and Data Reduction	**(7 Hrs)**

Data Preprocessing: Data Quality, Major Tasks in Data Preprocessing, **Data Cleaning:** Missing Values, Noisy Data, Data Cleaning as a Process. **Data Integration:** Redundancy and Correlation Analysis, Tuple Duplication, Data Value Conflict Detection and Resolution. **Data Reduction:** Overview of Data Reduction Strategies, Wavelet Transforms, Principal Components Analysis, Attribute Subset Selection, Regression and Log-Linear Models: Parametric Data Reduction, Histograms, Clustering, Data Cube Aggregation. Data Transformation: Data Transformation Strategies Overview. Data Transformation by Normalization, Discretization by Binning.

Unit III: Mining Frequent Patterns, Associations, and Correlations	**(7 Hrs)**

Basic Concepts: Market Basket Analysis: A Motivating Example, Frequent Itemsets, Closed Itemsets, and Association Rules. Frequent Itemset Mining Methods: Apriori Algorithm: Finding Frequent Itemsets by Confined Candidate Generation, Generating Association Rules from Frequent Itemsets, Improving the Efficiency of Apriori. A Pattern-Growth Approach for Mining Frequent Itemsets, Mining Frequent Itemsets Using Vertical Data Format, Mining Closed and Max Patterns.	
Unit IV: Classification: Advanced Methods	**(7 Hrs)**
Bayesian Belief Networks: Concepts and Mechanisms, Training Bayesian Belief Networks. **Classification by Backpropagation:** A Multilayer Feed-Forward Neural Network, Defining a Network Topology, Backpropagation, Inside the Black Box: Backpropagation and Interpretability. Support Vector Machines: The Case When the Data Are Linearly Separable, The Case When the Data Are Linearly Inseparable. **Classification Using Frequent Patterns:** Associative Classification, Discriminative Frequent Pattern–Based Classification. Lazy Learners (or Learning from Your Neighbors) : k-Nearest-Neighbor Classifiers, **Other Classification Methods :** Genetic Algorithms, Rough Set Approach, Fuzzy Set Approaches	
Unit V: Advanced Cluster Analysis	**(7 Hrs)**
Cluster Analysis: Basic Concepts and Methods, Cluster Analysis **Probabilistic Model- Based Clustering:** Fuzzy Clusters, Probabilistic Model-Based Clusters, Expectation- Maximization Algorithm. **Clustering High-Dimensional Data:** Clustering High- Dimensional Data: Problems, Challenges, and Major Methodologies, Subspace Clustering Methods, Biclustering, **Clustering Graph and Network Data:** Applications and Challenges, Similarity Measures, Graph Clustering Methods. **Clustering with Constraints:** Categorization of Constraints, Methods for Clustering with Constraints	
Unit VI: Data Mining Trends and Research Frontiers	**(7 Hrs)**
Mining Complex Data Types Mining Sequence Data: Time-Series, Symbolic Sequences, and Biological Sequences, Mining Graphs and Networks. **Methodologies of Data Mining:** Statistical Data Mining, Visual and Audio Data Mining. **Data Mining Applications:** Data Mining for Financial Data Analysis, Data Mining for Retail and Telecommunication Industries, Data Mining for Intrusion Detection and Prevention, Data Mining and Recommender Systems. **Data Mining and Society:** Ubiquitous and Invisible Data Mining, Privacy, Security, and Social Impacts of Data Mining	
Books & Other Resources:	
Textbooks:	
1.	Data Mining – Concepts and Techniques - Jiawei Han & Micheline Kamber, Morgan Kaufmann Publishers, Elsevier,3rd Edition, 2012.
2.	Data Mining: Practical Machine Learning Tools and Techniques-by Ian H. Witten & Eibe Frank
Reference Books:	
1.	Data Mining: Practical Machine Learning Tools and Techniques-by Ian H. Witten & Eibe Frank
2.	Data Mining Techniques: For Marketing, Sales, and Customer Relationship Management by Gordon S. Linoff and Michael J. Berry (Apr 12, 2011)
3.	Data Mining: A Tutorial Based Primer by Richard Roiger and Michael Geatz (Oct 6, 2002).

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MOOC Courses:

Coursera 4 weeks course on " Data Warehouse Concepts, Design, and Data Integration"by University of Colorado System Instructor Name : Michael Mannino https://www.coursera.org/learn/dwdesign

Coursera 4 weeks course on " Relational Database Support for Data Warehouses", offered by University of Colorado System Instructor Name :Michael Mannino https://www.coursera.org/learn/dwrelational

NPTEL course on "Data Mining"offered by IIT Kharagpur Instructor Name: Prof.PabitraMitra https://nptel.ac.in/courses/106105174/

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MAI23204: **Dissertation Stage I**		
Teaching Scheme	**Credit Scheme**	**Examination Scheme**
Practical: 8 hrs/week	4	TW-100 Marks
		OR-50 Marks

Dissertation Stage–I is an integral part of the Dissertation work. In this, the student shall complete the partial work of the Dissertation which will consist of problem statement, literature review, design, scheme of implementation (Mathematical Model/ SRS/ UML/ ERD /block diagram/ PERT chart,) and Layout & Design of the Set-up. The student is expected to complete the dissertation at least up to the design phase. As a part of the progress report of Dissertation work Stage-I, the candidate shall deliver a presentation on the advancement in Technology pertaining to the selected dissertation topic. The student shall submit the duly approved and certified progress report of Dissertation Stage-I in standard format for satisfactory completion of the work by the concerned guide and head of the Department/ Institute. The examiner will be assessed by a panel of examiners of which one is necessarily an external examiner. The assessment will be broadly based on literature study, work undergone, content delivery, presentation skills, documentation and report. The students are expected to validate their study undertaken by publishing it at standard platforms. The investigations and findings need to be validated appropriately at standard platforms – conference and/or peer reviewed journal. The student has to exhibit the continuous progress through regular reporting and presentations and proper documentation of the frequency of the activities at the sole discretion of the PG coordination. The continuous assessment of the progress needs to be documented unambiguously. For standardization and documentation, it is recommended to follow the formats and guidelines circulated / as in the dissertation workbook approved by the Board of Studies.

Dr. C. [illegible]

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MHS23201- Constitution of India

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 2 hrs/week	TH:2	Activity Marks = 10 Marks
		Oral-25 Marks

Course Objectives:

- To realise the significance of constitution of India to students from all walks of life and help them to understand the basic concepts of Indian constitution.
- To identify the importance of fundamental rights as well as fundamental duties.
- To understand the functioning of Union, State and Local Governments in Indian federal system.
- To learn procedure and effects of emergency, composition and activities of election commission and amendment procedure.

Course Outcomes: At the end of the course the student should be able to:

CO1. Understand and explain the significance of Indian Constitution as the fundamental law of the land.

CO2. Utilize his fundamental rights in proper sense at the same time identifies his responsibilities in national building.

CO3. Analyse the Indian political system, the powers and functions of the Union, State and Local Governments in detail

CO4. Understand Electoral Process, Emergency provisions and Amendment procedure

UNIT-I Introduction to Constitution: **6 hours.**

Meaning and importance of the Constitution, salient features of Indian Constitution. Preamble of the Constitution. Fundamental rights. Directive principles of state policy and Fundamental duties

UNIT-II Union Government: **6 Hours.**

Union Executive, Union Legislature and Union Judiciary-Supreme Court of India – composition and powers and functions.

UNIT-III State and Local Governments: **6 hours**

State Executive- Governor, Chief Minister, Council of Ministers. State Legislature-State Legislative Assembly and State Legislative Council. State Judiciary-High court. Local Government-Panchayat raj system with special reference to 73rd and Urban Local Self Govt. with special reference to74th Amendment.

UNIT-IV Election provisions **6 hours.**

Election Commission of India-composition, powers, functions and electoral process. Types of emergency-grounds, procedure, duration and effects. Amendment of the constitution- meaning, procedure and limitations.

Textbooks

1. M.V.Pylee, "Introduction to the Constitution of India",4th Edition, Vikas publication, 2005.

2. Durga Das Basu(DD Basu) , "Introduction to the constitution of India",(Student Edition),19th edition,Prentice-Hall EEE, 2008.

Reference Book

1. Merunandan, "Multiple Choice Questions on Constitution of India", 2 nd Edition,Meraga publication,2007.

ASP. Anil Patil

M. S. Lande

MRA23205- Industrial Management

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 2 hrs/week	TH:2	Activity Marks = 10 Marks
		Oral=25 Marks

Course Objectives:

- Engineering disciplines are expected to work during most of their career at middle level. They are also expected to deal with workforce and management problems.
- In the present era of competition, optimum utilization of the resources with achieving higher productivity is essential for any industry to survive. Quality and cost controls are also other important factors which contribute to the day to day supervision issues.

Course Outcome-On completion of the course students will be able

Co1-To interpret and acquire major management skills, familiarize with different leadership styles

CO2-To acquire the knowledge of different types of plant layout, Production modes and PPC functions

CO3-To understand the need of Total Quality management and appreciate the usage of TQM tools in quality control

CO4-To acquire the knowledge of different types of Plant maintenance and measures and procedure observed in industry towards safety

Course Contents

Unit I: Basics of Management **06hrs**

Management - Definition – Administration- Definition – Henry-Fayol's principles of management- Business Organization-Types- Proprietorship-Partnership- Joint stock-Cooperative Society-Advantages and disadvantages -Functions of Management –

Organization-Definition- types of organization –Line-Functional-Line &staff-advantages and disadvantages- Leadership -Types –Quality of good leader

Text books and references

1. Industrial Organization and Engineering Economics T.R.Banga & S C Sharma Khanna.Publishers
2. Industrial management and organizational behavior K.K.Ahuja
3. Industrial management and engineering economics O.P.khanna Khanna publishers
4. Production and operations management -Dr .K.Aswathappa and Dr.Sreedhar Bhatt Himalaya publishers
5. Safety Management in Industry Krishnan.N V Jaico Publishing House, Bombay, 1997
6. Total Quality Management S Raja Ram, Shivashankar

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PG Coordinator

for

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SEMESTER IV

MAI23211: Seminar					
Teaching Scheme:		**Credits:**	**02**	**Examination Scheme:**	
				TW:	**50 Marks**
TH:	**4 Hrs /Week**			**OR:**	**50 Marks**

Course Objectives:

1.	To identify the domain of research
2.	To learn to communicate in a scientific language through collaboration with a guide
3.	To categorize the research material confined to the domain of choice
4.	To work in professional environment

Course Outcomes:

On completion of the course, learner will be able to –

CO1:	Conduct thorough literature survey confined to the domain of choice
CO2:	Critically analyze the results and their interpretation; infer findings
CO3:	Furnish the report of the technical research domain
CO4:	Analyze the findings and work of various authors confined to the chosen domain

Conduction guidelines

Each student select the topic in the area of computer engineering and AI&DS preferably keeping track with recent technological trends and development beyond scope of syllabus avoiding repetition in consecutive years.

Panel with guide would be assessing the seminar work. Students will prepare the seminar report.

The preferences/choices of the domain should be taken from the students. The guide needs to be allocated based on the preference/choices. The guide from college has to monitor and evaluate the progress of the student. The student has to exhibit continuous progress through regular reporting and presentations and proper documentation. The continuous assessment of the progress needs to be documented unambiguously.

MAI23212-Industry Internship / Inhouse research project		
Teaching Scheme	**Credit Scheme**	**Examination Scheme**
Practical: 20 hrs/week	10	TW-150 Marks
		OR-100 Marks

Conduction guidelines: Industry or research internship should include partial/ complete project implementation. Students should be allocated to the research guide in the first semester itself and the same guide should be continued for the: Industry Internship-II/ In house Research Project –II. Otherwise the preferences/ choices of the domain should be taken from the students. The guide needs to be allocated based on the preference/ choices. The research project should be assigned to students. In case of Industry Internship-I, the assigned guide from college has to monitor and evaluate the progress of the student. The student has to exhibit continuous progress through regular reporting and presentations and proper documentation. The continuous assessment of the progress needs to be documented unambiguously.

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MAI23213-Dissertation Stage II		
Teaching Scheme	**Credit Scheme**	**Examination Scheme**
Practical: 16 hrs/week	8	TW-100 Marks
		OR-100 Marks

Guidelines:

In Dissertation Work Stage–II, the student shall consolidate and complete the remaining part of the dissertation which will consist of Selection of Technology, Installations, implementations, testing, results, measuring performance, discussions using data tables per parameter considered for the improvement with existing/ known algorithms/ systems, comparative analysis, validation of results and conclusions. The student shall prepare the duly certified final report of Dissertation in standard format for satisfactory completion of the work by the concerned guide and head of the Department/ Institute. The students are expected to validate their study undertaken by publishing it at standard platforms. The investigations and findings need to be validated appropriately at standard platforms – conference and/or peer reviewed journal. The student has to exhibit continuous progress through regular reporting and presentations and proper documentation of the frequency ofthe activities in the sole discretion of the PG coordination. The continuous assessment of the progress needs to be documented unambiguously.

Dr. C.S. Kulkarni

Head of Department

Mrs. Pawar. S. D.