Vidya Pratishthan's

Kamalnayan Bajaj Institute of Engineering and Technology, Baramati

(An Autonomous Institute)

M. Tech Computer Engineering

(Artificial Intelligence and Data Science)

Department of Computer Engineering

(With effect from June 2026)
[2026 pattern]

A.Y. 2026-2027

VP's Kamalnayan Bajaj Institute of Engineering and Technology, Baramati
(An Autonomous Institute)
Department of Computer Engineering
M. Tech- Computer Engineering
(Artificial Intelligence and Data Science) [2026 pattern]
(with effect from A.Y. 2026-27)

Semester I

Course Code	Course Category	Course	Teaching Scheme (Hrs/Week)		Examination Scheme and Marks							Credit Scheme	
			TH	PR	CA A	In-Sem	End-Sem	TW	PR	OR	Total	TH	PR
MAI26101	PCC	Artificial Intelligence	04		20	30	70				120	04	
MAI26102	PCC	Mathematical Foundation for Data Science	04		20	30	70				120	04	
MAI26103	PCC	Data Preparation and Analysis	03		20		70				90	03	
MAI26104	MDM	MDM	02		10		50				60	02	
MHS26101	Exp. Learn.	Research Methodology	03		30		70				100	03	
MAI26105	**VSEC**	**Skill development lab -1**	-	**04**				**30**		**30**	**60**		**02**
MHS26102	HSSM	Indian Knowledge System	02		20	30					50	02	
		Total	**18**	**04**	**120**	**90**	**330**	**30**		**30**	**600**	**18**	**02**
Total Credits												**20**	

MDM Basket

MAI26104-A	Information Systems Management	MAI26104-B	Advanced IoT Design and Applications
MAI26104-C	Advanced Software Engineering	MAI26104-D	Quantum computing
MAI26104-E	Image Processing		

Semester II

Course Code	Course Category	Course	Teaching Scheme (Hrs./Week)		Examination Scheme and Marks							Credit Scheme	
			TH	PR	CA A	In-Sem	End-Sem	TW	PR	OR	Total	TH	PR
MAI26111	PCC	Advance Machine Learning	04		20	30	70				120	04	
MAI26112	PCC	Scalable data science	04		20	30	70				120	04	
MAI26113	PCC	Advance Computing Intelligence	04		20	30	70				120	04	
MAI26114	PEC	Program Elective - I	04		20	30	70				120	04	
MAI26115	**VSEC**	**Skill development lab -2**	-	**04**				**30**		**30**	**60**		**02**
MSE26116	VEC	Environmental studies	02		20	30					50	02	
MHS26[illegible]	**HSSM**	**Human rights**	02		30	30					**60**	**02**	
MH526111		**Total**	**20**	**04**	**130**	**180**	**280**	**30**		**30**	**650**	**20**	**02**
Total Credits													**22**

Program Elective- I Basket

MAI26114-A	**Business Analytics and Intelligence**	MAI26114-B	**Computer Vision**
MAI26114-C	**Digital forensics**	MAI26114-D	**Augmented Reality & Virtual Reality**
MAI26114-E	**Blockchain Technology**		

25/03/2026

Dr. G.J. Chhajed, P.G. Coordinator
Dr. M. D. Shelar, Academic Coordinator
Dr. A. M. Jagtap, Head of Department
Head of Department, Computer Engineering, VPKBIET, Baramati - 413133
Dr. S. M. Bhosle, Dean Academics
Dr. A. H. Kolekar, Controller of Examination

Dr. S. B. Lande
Principal
Principal
Vidya Pratishthan's
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Engineering & Technology, Bara...
Vidyanagari, Baramati-41313...

VPKBIET BARAMATI
Affiliated to S.P.P.U. Pune Id No./PU/PN/Engg./152/2000
PUNE (MS.)

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Semester III

Course Code	Course category	Course	Teaching Scheme (Hrs./Week)		Examination Scheme and Marks							Credit Scheme	
			TH	PR	CAA	In-Sem	End-Sem	TW	PR	OR	Total	TH	PR
MAI26201	PCC	Deep Learning	04		20	30	70				120	04	
MAI26202	PCC	Natural Language Processing	04		20	30	70				120	04	
MAI26203	PEC	Program Elective-II	04		20	30	70				120	04	
MAI26204	Exp. Learn	Dissertation Stage I		08	**20**			**50**		**50**	120		04
MHS26201	AEC/ VAC	Introduction to Constitution of India	02		30	30					**60**	**02**	
MRA26205	SEC	Industrial Management	02		30	30					60	02	
MAI26205	SEC	Seminar		04				25		25	50		02
		Total	**16**	**12**	**140**	**150**	**210**	**75**		**75**	**650**	**16**	**06**
												Total Credit	**22**

Program Elective II

MAI26203-A	Data Modelling and Visualization	MAI26203-B	Product Life Cycle Management
MAI26203-C	GPU Computing	MAI26203-D	Data Mining and Analysis

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Semester IV

Course Code	Course category	Course	Teaching Scheme (Hrs./Week)		Examination Scheme and Marks							Credit Scheme	
			TH	PR	CAA	In-Sem	End-Sem	TW	PR	OR	Total	TH	PR
MAI26211	Internship /OJT	Industry Internship / In-house research project		20	100			100		100	300		10
MAI26212	Exp. Learn	Dissertation Stage- II		16	50			100		100	250		08
		Total		**36**				200		**200**	550		**18**
	SEC	Introduction to Cyber Security (Online to be taken from the SPPU Portal)	**04**										**04**
												Total Credit	**22**

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SEMESTER - I

MAI26101: Artificial Intelligence					
Teaching Scheme:		**Credits:**	**04**	**Examination Scheme:**	
				Continuous Activity:	**20 Marks**
TH:	**04 Hrs./Week**			**In-Semester Exam:**	**30 Marks**
				End-Semester Exam:	**70 Marks**

Prerequisite Courses:

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

Companion Course, if any: Professional Core Lab-I

Course Objectives:

1.	To establish theoretical knowledge and understanding in the field of Artificial Intelligence and identify its possible applications.
2.	To plan and formulate a non-trivial problem as a state space and apply intelligent search algorithms to identify optimal solutions.
3.	To develop and design methods to make decisions in complex uncertain environments.
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 foundation of AI and apply various search algorithms to identify optimal solutions in state spaces.
CO2:	Formulate plan as a state space and apply algorithms to find solutions.
CO3:	Represent and reason with knowledge and uncertainty to identify solutions for real world problems.
CO4:	Analyze uncertainty in complex scenarios and contribute to informed decision-making processes.
CO5:	Understand and apply learning techniques.
CO6:	To develop data driven learning agents.

Course Contents

Unit I: Intelligent Agents and Uninformed Search	**(6 Hrs)**

Foundations of Artificial Intelligence - Definitions - Evolution of AI - Applications of AI - Intelligent Agents - Agents and Environments - Nature of Environments - Structure of Agents- Solving Problem by Searching- Blind Search Techniques – Breadth First Search, Depth First Search, Uniform Cost Search, Iterative Deepening Search, Bidirectional search.

Unit II: Informed Search Algorithms	**(6 Hrs)**

Informed Search - Introduction to Heuristics – Greedy Breadth First Search, A* - Local Search Optimization Algorithms - Hill Climbing, Simulated Annealing.

Optimal Search Algorithms: Global optimization algorithms - Genetic Algorithms, Particle Swarm Optimization Algorithm, Ant Colony Optimization,

Games - Optimal Decisions in Games-Minimax Algorithm, Alpha-Beta Pruning, Algorithm.	
Unit III: Knowledge Representation and Reasoning	**(7 Hrs)**
Logical systems – Knowledge Based systems - Representing knowledge using Propositional Logic – Inference in Propositional Logic using Laws of Inference, Forward Chaining, Backward Chaining, Resolution. Representing knowledge using First Logic Order Logic Inference in First Order Logic using Unification, Forward Chaining, Backward Chaining, and Resolution.	
Unit IV: Quantifying Uncertainty	**(6 Hrs)**
Acting under Uncertainty, -Conditional Independence- Bayes Rule –Naïve Bayes Classifier - Bayesian Belief Network- Inference in Bayesian Belief Network- Making Decisions in Complex Environments- Markov Decision Processes.	
Unit V: Classical Planning	**(6 Hrs)**
Planning Problem –STRIPS representation- Complexity of planning- Algorithms for Planning as State Space Search – Partial order Planning –Hierarchical Planning.	
Unit VI: Data Driven Learning Agents	**(7 Hrs)**
Forms of learning – Supervised Learning - Decision Trees – CART - Univariate Linear Regression, Multivariate Linear Regression. Unsupervised Learning- K-means Clustering,	
Books & Other Resources:	
Textbooks:	
1.	Russell, S and Norvig, P, 2015, Artificial Intelligence – A Modern Approach, 3rd Edition, Prentice Hall.
2.	Artificial Intelligence, George F Luger, Pearson Education Publications
Reference Books:	
1.	Min Xin-She Yang., “Nature-Inspired Computation and Swarm Intelligence Algorithms, Theory and Applications”, Elsevier, Academic Press, 2020.
2.	Elaine Rich, Kevin Knight, Shivashankar B Nair., “Artificial Intelligence”, 3rd Edition, McGraw Hill Education, 2017.
3.	Charu C. Aggarwal, “Data Classification: Algorithms and Applications”, CRC Press, 2014.
E-books:	
1.	https://people.engr.tamu.edu/guni/csce625/slides/AI.pdf
2	https://mpbou.edu.in/uploads/files/MCA-AI.pdf
Important links: **https://www.cse.iitd.ac.in/~mausam/courses/cs/333/spring2014/**	

MAI26102: Mathematical Foundation for Data Science					
Teaching Scheme:		**Credits:**	**04**	**Examination Scheme:**	
				Continuous Activity:	**20 Marks**
TH:	**04 Hrs/Week**			**In-Semester Exam:**	**30 Marks**
				End-Semester Exam:	**70 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 (MTDS), 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.

Course Outcomes:

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

CO1:	Apply measures of central tendency to analyze a payroll 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	**(6 Hrs)**

Concept of set, cardinality of set, finite, infinite and countably 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 Distributions, Binomial, Poisson, and Hypergeometric Distribution, Normal Distribution, Distribution 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, 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 Association: Percentile, Z-score, Quartiles, Bayes' Theorem, Bayes Classifier, Bayesian network, Probabilistic models; with hidden variables.

Unit V: Linear Algebra and Calculus	**(6 Hrs)**

Linear Algebra: Matrix and vector algebra, systems of linear equations using matrices, linear independence, Matrix factorization concepts: 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.	Lju Chuang, "Elements of discrete mathematics", Tata McGraw-Hill Education, 1987

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

Important links: https://www.kaggle.com/
https://github.com/ https://towardsdatascience.com/
https://www.analyticsvidhya.com/

MAI26103: Data Preparation and Analysis					
Teaching Scheme:				**Examination Scheme:**	
				Continuous Activity:	**20 Marks**
TH:	**03 Hrs/Week**	**Credits:**	**03**	**End-Semester Exam:**	**70 Marks**

Prerequisite Courses:

Students are expected to have a good understanding of Machine learning, Business Intelligence, Statistics, 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.

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 & Wayne P. Johnson, 'Making Sense of Data I: A Practical Guide to Exploratory Data Analysis and Data Mining', John Wiley & Sons (Wiley), ISBN: 978-1-118- 40741-7 (paperback)
2.	Salvador García, Julián Luengo, Francisco Herrera, "Data Preprocessing in Data Mining", Springer International Publishing (Intelligent Systems Reference Library), ISBN: 978-3- 319-10246-7
Reference Books:	
1.	Mark Gardner, "Beginning R: The Statistical Programming Language", Wrox Publication, ISBN: 978-1-118-16430-3
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", Packt Publishing, ISBN: 978-1-78328-908-0
E-books:	
1.	Jacqueline Kazil, Katharine Jarmu, "Data Wrangling with Python: Tips and Tools to Make Your Life Easier"
2	Hector Cuesta and Dr. Sampath Kumar, "Practical Data Analysis", 2nd Edition
Important links: **https://www.techtarget.com/searchbusinessanalytics/resources/Business-intelligence-management** **https://openrefine.org/** **https://www.youtube.com/playlist?list=PLh2mXjKcTPSACrQxPM2_1Ojus5HX88ht7**	

MAI26104-A: Information System Management					
Teaching Scheme:				**Examination Scheme:**	
				Continuous Activity:	**10 Marks**
TH:	**02 Hrs/Week**	**Credits:**	**02**	**End-Semester Exam:**	**50 Marks**

Prerequisite Courses: Basic knowledge of Computer Fundamentals, Programming Concepts, and Business Mathematics.

Companion Course, if any:

Course Objectives:

1.	To provide foundational understanding of Information Systems and their role in digital organizations.
2.	To develop financial and accounting literacy required for managing and evaluating Information Systems.
3.	To analyze architectures of enterprise systems such as ERP, CRM, and Business Intelligence platforms.
4.	To understand governance, security, risk management, and emerging trends in Information System Management.

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

CO1:	Analyze components and architectures of Information Systems in organizations..
CO2:	Apply financial principles for evaluating IT investments and enterprise systems.
CO3:	Examine ERP, CRM, and BI architectures and their integration mechanisms.
CO4:	Evaluate information security, governance frameworks, and risk management practices in IS.
CO5:	Identify challenges and failure factors in Information Systems implementation.
CO6:	Assess emerging technologies such as AI and Blockchain in enterprise IS environments.

Course Contents

Unit I: Foundations of Information Systems and Digital Organizations	(5 Hrs)

Introduction to Information Systems, Types of IS (TPS, MIS, DSS, ESS), Role of IS in Organizations, Data–Information–Knowledge concepts, IS Components, Client–Server Architecture, Three-Tier Architecture, Distributed Systems, Common IS Problems and Failures.

Unit II: Financial and Accounting Foundations for IS Management	(5 Hrs)

Basic Accounting Concepts, Financial Statements (Balance Sheet, Income Statement, Cash Flow), Time Value of Money, Simple and Compound Interest, Loan and EMI Calculations, NPV, ROI, IRR, IT Investment and Cost-Benefit Analysis, Financial Risks in IT Projects.

Unit III: ERP Systems and Enterprise Architecture	(5 Hrs)

ERP Concepts and Evolution, ERP Modules, Modular Architecture, SOA-based ERP, Database Architecture, Cloud ERP, ERP Implementation Lifecycle, ERP Security Architecture, Overview of SAP, Oracle ERP, Odoo

Unit IV: Business Intelligence and Analytics Systems Architecture	(5 Hrs)
Business Intelligence Concepts, BI Architecture (ETL, Data Warehouse, Data Mart, OLAP), Star and Snowflake Schema, KPI and Dashboard Design, Power BI Architecture, Tableau Overview, Data Governance and Security in BI Systems.	
Unit V: CRM, SCM and Enterprise Integration Architecture	(5 Hrs)
CRM Architecture, SCM Systems Architecture, Enterprise Application Integration (EAI), Middleware and APIs, Micro services Architecture, Cloud Integration, Data Privacy and Compliance Issues, System Integration Challenges	
Unit VI: IT Governance, Risk Management and Emerging Enterprise Technologies	(5 Hrs)
IT Governance (COBIT Overview), ITIL Concepts, Information Security Management Systems (ISMS), Risk Management Framework, Business Continuity Planning (BCP), Disaster Recovery Planning (DRP), AI in Enterprise Systems, Blockchain in IS, Ethical and Regulatory Issues.	
Activities:	
1. Case Study Analysis: Evaluation of ERP or BI implementation success/failure in a real-world organization. 2. Financial Evaluation Exercise: Perform NPV/ROI analysis for a proposed IT/ERP investment project	
Books & Other Resources:	
Textbooks:	
1	Laudon, Kenneth C., and Laudon, Jane P., Management Information Systems: Managing the Digital Firm, 16th Edition, Pearson, 2020. ISBN-13: 978-0136971276.
2	Monk, Ellen, and Wagner, Bret, Concepts in Enterprise Resource Planning, 5th Edition, Cengage Learning, 2022. ISBN-13: 978-0357134245.
3	Hall, James A., Information Technology Auditing and Assurance, 4th Edition, Cengage Learning, 2015. ISBN-13: 978-1305080577.
4	Casey, Eoghan, Digital Evidence and Computer Crime: Forensic Science, Computers, and the Internet, 3rd Edition, Academic Press, 2011. ISBN-13: 978-0123742681.
Reference Books:	
1	Turban, Efraim, Pollard, Carol, and Wood, Gregory, Information Technology for Management, 11th Edition, Wiley, 2018. ISBN-13: 978-1118890790.
2	O'Brien, James A., and Marakas, George M., Management Information Systems, 10th Edition, McGraw- Hill Education, 2011. ISBN-13: 978-0078023941.
3	Romney, Marshall B., and Steinbart, Paul J., Accounting Information Systems, 14th Edition, Pearson, 2017. ISBN-13: 978-0134475585.
E-books:	
1	NIST Publications on Information Security and Risk Management – https://www.nist.gov
2	SAP ERP and Architecture Documentation – https://help.sap.com
3	Microsoft Power BI Documentation – https://learn.microsoft.com/power-bi

MAI26104-B: Advanced IoT Design and Applications					
Teaching Scheme:		**Credits:**	**02**	**Examination Scheme:**	
				Continuous Activity:	**10 Marks**
TH:	**02 Hrs/Week**			**End-Semester Exam:**	**50 Marks**

Prerequisite Courses:

Basic knowledge of programming (C/Python), embedded systems, and electronics including sensors and microcontrollers.

Companion Course, if any: Professional Core Lab-I

Course Objectives:

1.	Understand core and advanced concepts of IoT architecture and design.
2.	Analyze IoT communication protocols and networking models.
3.	Explore IoT system development using embedded platforms.
4.	Apply data analytics and cloud integration in IoT systems.

Course Outcomes:

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

CO1:	Explain IoT architecture and system components.
CO2:	Analyze communication protocols used in IoT.
CO3:	Design basic IoT systems using hardware platforms.
CO4:	Apply data analytics and cloud services in IoT.

Course Contents

Unit I: IoT Fundamentals	**(6 Hrs)**

Introduction to IoT and evolution, IoT architecture (physical & logical) , Sensors, actuators, smart devices , IoT reference models : Edge, Fog, and Cloud computing

Unit II: IoT Communication & System Design	**(8Hrs)**

IoT communication models Protocols: MQTT, CoAP, HTTP, AMQP , Wireless technologies: ZigBee, BLE, 6LoWPAN M2M communication and SDN in IoT , Network architectures and IoT gateways

Unit III: Data Analytics & Cloud in IoT	**(6 Hrs)**

IoT data lifecycle, Cloud platforms (AWS IoT, Azure IoT) Big Data basics in IoT , Introduction to Machine Learning in IoT , Data visualization tools

Unit IV: Security & Applications	**(6 Hrs)**

IoT security challenges Encryption and authentication Privacy issues Applications:

- Smart cities
- Healthcare
- Agriculture
- Industrial IoT

Books & Other Resources:

Textbooks:

1.	Olivier Hersent, David Boswarthick, Omar Elloumi – *The Internet of Things: Key Applications and Protocols*
2.	Raj Kamal – *Internet of Things: Architecture and Design Principles*

E-books:

1.	Adrian McEwen & Hakim Cassimally – *Designing the Internet of Things*
2	Samuel Greengard – *The Internet of Things*

Important links:

- NPTEL IoT Course: https://nptel.ac.in
- IoT Standards: https://www.ietf.org
- Arduino Official: https://www.arduino.cc
- Raspberry Pi: https://www.raspberrypi.org
- AWS IoT Core: https://aws.amazon.com/iot

MAI26104-C : Advanced Software Engineering					
Teaching Scheme:		**Credits:**	**02**	**Examination Scheme:**	
				Continuous Activity:	**10 Marks**
TH:	02Hrs/Week			**End-Semester Exam:**	**50 Marks**

Prerequisite Courses:

Basic knowledge of Software Engineering concepts, programming methodologies, and object-oriented design principles.

Course Objectives:

1.	Introduce advanced software engineering principles and modern software development methodologies used in large-scale systems
2.	Provide knowledge of software architecture styles and design patterns for designing scalable and maintainable software systems.
3.	Develop understanding of advanced requirements engineering techniques and software Modeling using UML.
4.	Familiarize students with modern software quality assurance practices and advanced testing methodologies.
5.	Introduce DevOps culture, tools, and continuous integration and continuous delivery (CI/CD) practices in modern software development.
6	Expose students to emerging trends in software engineering including software evolution, refactoring, AI-assisted development, and ethical considerations

Course Outcomes:

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

CO 1:	Analyze advanced software engineering principles and modern development methodologies used in large-scale systems.
CO 2:	Apply software architecture styles and design patterns to design scalable and maintainable software systems.
CO 3:	Evaluate software requirements and construct appropriate UML models for system design.
CO 4:	Apply advanced software testing and quality assurance techniques in software development
CO 5:	Analyze DevOps practices and implement CI/CD concepts in modern software development environments
CO 6:	Examine emerging trends and research directions in software engineering including AI-assisted development and software evolution.

Course Contents

Unit I: Advanced Software Engineering Fundamentals	**(4 Hrs)**

Evolution of software engineering; challenges in developing large-scale and complex software systems; modern software development paradigms; software development life cycle (SDLC) models; Agile software development methodologies including Scrum and Extreme Programming (XP); Lean software development principles; introduction to DevOps culture, practices, and principles in modern software development.

Unit II: Software Architecture and Design Patterns	**(5 Hrs)**
Concept and importance of software architecture; architectural styles and architectural patterns; layered architecture, micro-services architecture, and service-oriented architecture (SOA); software design principles including SOLID principles; introduction to software design patterns; classification of design patterns including creational, structural, and behavioural design patterns	
Unit III: Requirements Engineering and Software Modeling	**(4 Hrs)**
Advanced requirements engineering concepts; requirements elicitation techniques; requirements specification, validation, and traceability; introduction to UML modeling including use case diagrams, class diagrams, sequence diagrams, and activity diagrams; domain modeling in software system design.	
Unit IV: Software Quality Assurance and Testing	**(5 Hrs)**
Software quality models and standards; software verification and validation techniques; test planning and test case design; levels of testing including unit testing, integration testing, and system testing; automated testing techniques; test-driven development (TDD); static and dynamic analysis in software quality assurance.	
Unit V: DevOps and Continuous Integration	**(5 Hrs)**
Introduction to DevOps culture and practices; concepts of Continuous Integration and Continuous Delivery/Deployment (CI/CD); CI/CD pipeline and its stages; configuration management in DevOps environments; containerization concepts using Docker; overview of cloud-based application deployment.	
Unit VI: Emerging Trends in Software Engineering	**(5 Hrs)**
Concepts of software maintenance and software evolution; refactoring techniques for improving software design; component-based software engineering and software reuse; security considerations in software engineering; introduction to AI-assisted software development tools and techniques; ethical considerations and professional responsibilities in software engineering.	
Course Activity: The course coordinator should identify relative and innovative activities for course activity. Below are some Suggested course activity for course coordinator. 1. Seminar on emerging software engineering technologies 2. Case study analysis of modern software architecture 3. Implementation of selected design patterns 4. Mini project demonstrating DevOps pipeline .	

Books & Other Resources:	
Textbooks:	
1.	Roger S. Pressman, Software Engineering: A practitioners approach, TMH, Seventh Edition, ISBN 978–0–07–337597–7, ISBN 0–07–337597–7.
2.	Ian Sommerville, Software Engineering, Addison-Wesley, Tenth Ed. ISBN-13: 978-0133943030 ISBN-10: 0133943038
Reference Books:	
1.	Len Bass, Paul Clements, Rick Kazman – Software Architecture in Practice.
2.	Jez Humble and David Farley – Continuous Delivery.
3	Martin Fowler – Refactoring: Improving the Design of Existing Code.
E-books:	
1	Software Engineering – Ian Sommerville
2	Software Engineering: A Practitioner's Approach – Roger S. Pressman
3	Clean Code: A Handbook of Agile Software Craftsmanship – Robert C. Martin

Important links:

- **National Programme on Technology Enhanced Learning (NPTEL)** – Online courses related to Software Engineering, Software Architecture, Agile Development and Project Management.
  Link: https://nptel.ac.in
- **Carnegie Mellon University Software Engineering Institute (SEI)** – Resources on software architecture, process improvement, and software quality.
  Link: https://www.sei.cmu.edu
- IEEE Software Engineering Standards – Documentation and standards for software lifecycle processes.
  Link: https://standards.ieee.org
- Agile Software Development Manifesto – Principles and practices of agile development.
  Link: https://agilemanifesto.org
- Git Documentation – Version control system resources and tutorials for collaborative software development.
  Link: https://git-scm.com/docs

MAI26104-D: Quantum Computing					
Teaching Scheme:				**Examination Scheme:**	
				Continuous Activity:	**10 Marks**
TH:	**02 Hrs/Week**	**Credits:**	**02**	**End-Semester Exam:**	**50 Marks**

Prerequisite Courses:

Prerequisite: Students are expected to have a good understanding of Linear Algebra, Classical Computing

Companion Course, if any: Professional Core Lab-I

Course Objectives:

1.	Introduce the fundamentals of quantum computing, including qubits, superposition, and entanglement.
2.	Explain the mathematical foundations used in quantum computing.
3.	Understand quantum gates, circuits, and measurement principles.
4.	Study important quantum algorithms such as Deutsch–Jozsa, Grover's, QFT, and Shor's algorithm.
5.	Explore hybrid quantum–classical computing and practical challenges.
6.	Understand applications of quantum computing in cryptography, optimization, and AI.

Course Outcomes:

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

CO1:	Explain basic concepts of quantum computing and quantum systems.
CO2:	Apply mathematical foundations to represent quantum states and operations.
CO3:	Analyze quantum gates, circuits, and measurement techniques.
CO4:	Implement basic quantum algorithms.
CO5:	Understand practical issues such as noise and hybrid quantum computing.
CO6:	Identify applications of quantum computing in different domains.

Course Contents

Unit I: Introduction to Quantum Computing	**(7 Hrs)**

Overview of Quantum Computing and its significance , Limitations of Classical Computing , Qubits and Quantum States , Superposition and Entanglement, Quantum Parallelism, Physical Realization of Qubits , Types of Qubits (Superconducting, Ion Trap, Photonic etc.) , Global quantum platforms: IBM Q, Google Sycamore, IonQ.

Unit II: Mathematical Foundations for Quantum Computing	**(7 Hrs)**

Complex Vector Spaces , Linear Algebra Basics, State Vectors and Hilbert Space , Dirac Notation,Inner Product and Tensor Product, Linear Operators, Eigenvalues and Eigenvectors, Hermitian Operators and Observables

Unit III: Quantum Mechanics and Quantum Circuits	**(7 Hrs)**
Schrödinger Equation and Unitary Evolution , Quantum Interference, No-Cloning Theorem, Quantum Gates (Pauli Gates, Hadamard, Phase Gates), Universal Gate Sets, Quantum Circuits and Circuit Depth, Gate Decomposition, Reversible Computation	

Unit IV: Quantum Measurement and Information Extraction	**(7 Hrs)**
Quantum Measurement Concepts, Measurement Basis (Computational & Pauli Basis), Collapse of Wavefunction, Probability Amplitudes and Born Rule, Measurement Operators and POVM, Quantum State Tomography, Measurement-Induced Disturbance, Qubit Readout Errors.	

Unit V: Quantum Algorithms	**(7 Hrs)**
Deutsch–Jozsa Algorithm, Simons's Algorithm, Grover's Search Algorithm ,Quantum Fourier Transform (QFT), Shor's Algorithm for Integer Factorization, Performance comparison with classical algorithms.	

Unit VI: Quantum Computing Applications	**(7 Hrs)**
Quantum-Classical Hybrid Algorithms , Variational Quantum Algorithms, Noise in Quantum Systems Error Mitigation Techniques, Resource Estimation (Qubits, Time, Depth), Applications in Cryptography, Optimization Applications (Logistics, Supply Chain), Quantum AI / Machine Learning applications	

Books & Other Resources:

Textbooks:

1.	Quantum Computation and Quantum Information by Michael Nielsen and Isaac Chuang, Publisher: Cambridge University Press.
2.	Quantum Computing for Everyone by Chris Bernhardt.
3.	"Quantum Algorithms via Linear Algebra", by Richard J. Lipton and Kenneth W.Regan.

Reference Books:

1.	Introduction to Quantum Computing by Phillip Kaye, Raymond Laflamme, and Michele Mosca.
2.	Quantum Algorithms Via Linear Algebra: A Primer by Richard J. Lipton and Kenneth W. Regan

E-books:

1.	Jacqueline Kazil, Katharine Jarmu, "Data Wrangling with Python: Tips and Tools to Make Your Life Easier"
2	Hector Cuesta and Dr. Sampath Kumar, "Practical Data Analysis", 2nd Edition

MAI26104-E: Image Processing					
Teaching Scheme:		**Credits:**	**02**	**Examination Scheme:**	
				Continuous activity :	**10 Marks**
TH :	**02 Hrs/Week**				
				End-Semester Exam:	**50 Marks**

Prerequisite Courses:

Basic knowledge of Digital Image Processing, Linear Algebra, Probability, Signal Processing, and programming in Python/MATLAB.

Companion Course, if any: Machine Learning or Computer Vision

Course Objectives:

1.	To understand core and advanced image processing concepts
2.	To apply enhancement, compression, and segmentation techniques
3.	To develop solutions for real-world applications

Course Outcomes:

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

CO 1:	Understand image fundamentals and transforms
CO 2:	Apply enhancement and filtering techniques
CO 3:	Analyse compression and restoration methods
CO 4:	Implement segmentation and recognition techniques

Course Contents

Unit I: Fundamentals and Transform Techniques	**(7 Hrs)**

Digital Image Fundamentals: Sampling, Quantization, Resolution. Human Visual System & Image Representation, Image Processing System Components, Image File Formats, **Basic Transforms:** DFT, DCT, Wavelet (overview), Introduction to OpenCV / Python tools

Unit II: Image Enhancement and Filtering	**(7 Hrs)**

Spatial Domain Techniques: Image Negative, Contrast Enhancement, Histogram Equalization **Filtering Techniques:** Smoothing (Mean, Median), Sharpening (High-pass filters) **Frequency Domain Filtering:** Low-pass, High-pass, Butterworth. **Basic Edge Detection:** Sobel, Canny

Unit III: Image Compression and Restoration	**(7 Hrs)**

Image Compression: Redundancy & Fidelity, Lossless (Huffman, Run-length), Lossy (DCT, Wavelet). **Compression Standards:** JPEG, MPEG. **Image Restoration:** Noise Models, Mean, Wiener, Inverse Filtering

Unit IV: Segmentation and Applications	**(7Hrs)**
Segmentation Techniques: Thresholding (Global, Otsu), Edge & Region-based Methods **Morphological Operations:** Dilation, Erosion, Opening, Closing. Feature Extraction Basics. Object Recognition (Intro to Classifiers). **Applications:** Medical Imaging, Remote Sensing, Biometrics	

Books & Other Resources:

Textbooks:

1.	Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, Pearson, Third Edition, 2010.
2.	Anil K. Jain, Fundamentals of Digital Image Processing, Pearson, 2002.

Reference books:

1.	Kenneth R. Castleman, Digital Image Processing, Pearson, 2006.
2.	Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, Digital Image Processing using MATLAB, Pearson Education, Inc., 2011.
3.	William K. Pratt, Digital Image Processing, John Wiley, New York, 2002
4.	Milan Sonka et al Image processing, analysis and machine vision, Brookes/Cole, Vikas Publishing House, 2nd edition, 1999.
5.	Pratt W.K, "Digital Image Processing", Third Edition, John Wiley & Sons, 2001

Important links:

1. Digital Image Processing, IIT Kharagpur ,Prof. P.K. Biswas

Link: https://nptel.ac.in/courses/117105079

2. NPTEL Video Course : NOC: Digital Image Processing

Link: https://www.digimat.in/nptel/courses/video/117105135/L02.html

MHS26101 : Research Methodology

Credits: 03 (Theory)

Teaching Scheme:	**Examination Scheme:**
	CAA : 30 Marks
Theory : 03 hrs. /week	In-semester : -----
	End semester : 70 Marks

Prerequisites:

Fundamental laws and principles of all subjects, Soft and communication skills.

Course Objectives:

The course has been developed with orientation towards research related activities and recognizing the ensuing knowledge as property.

Course Outcomes:

On completion of the course, the students will be able to:
1. Formulate a research problem for engineering and technology domain.
2. Analyze the available literature for given research problem and understand different techniques of data collection.
3. Investigate the statistical and reliability methods of preliminary data analysis and present the results in graphical form.
4. Learner will be able to understand the preliminary data analysis techniques.
5. Learner will be able to understand the advanced data analysis techniques.
6. Understand the importance of technical writing and presentation skills.

Course Contents

Unit 1: Introduction (7)

Definition and Characteristics of Research: Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Philosophy and validity of research. Objective of research. Various functions that describe characteristics of research such as systematic, valid, verifiable, empirical and critical approach.

Unit 2: Literature Review (7)

Definition of literature and literature survey, Significance of literature survey, Sources of literature, Elements and objectives of literature survey, Styles of literature survey, Strategies of literature survey, Searching the existing literature, Reviewing the selected literature, Writing about the literature reviewed and gap identified, literature analysis, data collection, and interpretation.

Unit 3: Data collection, Measuring, Sampling and Scaling (7)

Classification of data, benefits and drawbacks of data, evaluation of data, qualitative methods of data collection, methods of qualitative research, Sampling, sample size, sampling strategy, attitude measurement and scaling, types of measurements, criteria of good measurements, classification of scales.

Unit 4 Preliminary data analysis (6)

Testing of hypothesis- concepts and testing, analysis of variance techniques, introduction to non-parametric tests. Validity and reliability, Approaches to qualitative and quantitative data analysis.

Unit 5: Advanced data analysis techniques (6)

Correlation and regression analysis, Introduction to factor analysis, discriminant analysis, cluster analysis, multidimensional scaling, Descriptive statistics, inferential statistics, Multi-dimensional measurement and factor analysis

Unit 6 Technical Writing and Presentation (6)

Effective technical writing, thesis writing, research proposal writing, research paper writing. Significance of report writing, Different steps in writing report, Layout of the research report, Types of reports, Mechanics of writing a research report, Precautions for writing research reports, Presentation skills, tools for technical writing and presentation. Plagiarism, avoiding plagiarism, Research ethics, Tools for plagiarism checking, technical writing and presentation.

Books

Text books:

1. Ranjit Kumar (2005), 2nd edition, Research Methodology: A Step by Step Guide for beginners (Pearson Education).
2. C. K. Kothari (2004), 2nd edition, Research Methodology Methods & Techniques (New Age International, New Delhi).
3. T. Ramappa (2016), 2nd edition, Intellectual Property Rights-Law in India (Asia Law House, Hyderbad).

Reference Books:

1. Louis Cohen, Manion, Morrison and Routledge (2017), 8th edition, Research Methods in Education (Taylor & Francis Group- Cambridge University Press India Pvt. Ltd.).
2. John Best and James Kahn (1998), 8th edition, Research in Education (Prentice Hall of India Pvt. Ltd.).
3. Stuart Melville and Wayne Goddard (2001), Research Methodology: An Introduction for Science and Engineering Students. (Juta & Co Ltd.).
4. Benjamine Niebel and Alan Draper (1974), Product Design and Process Engineering, (McGraw Hill International Publishers).
5. Halbert D. J. (2007), 2nd edition, Resisting Intellectual Property (Taylor and Francis Ltd.).
6. Robert P. Merges, Peter S. Menell, Mark A. Lemley (2016), Intellectual Property in New Technological Age (Stanford Public Law Working Paper No. 2780190, Elsevier Publishers).

Activity

Activity shall consist of the following

An activity can be designed such as to enhance students learning experience. The students need to submit assignment on each unit as part of activity:

1. **Literature Review:** Collect the existing literatures on any research idea in engineering/technology and find out the research gap**. (Performed by a single student).**
2. **Report and Seminar Presentation:** Prepare the research proposal based on the earlier identified research gap (Report should check in plagiarism and grammarly) and present the idea. **(Performed by a single student).**
3. **Blank format of research proposal:** Identify the national and international funding agencies and prepare/print the blank format of research proposal of any one funding agency. **(Performed by a single student).**
4. Write a report on different citation style and reference style adopted by different publishers.
5. Write a report on case study of any existing patent/copy right/trademark.

6. Collect the information of any one referred peer reviewed journal and write a report based on Abstracting and indexing, H Index, SJR rating, Impact factor, Aims and Scope of the Journal, Guidelines for paper submission etc.

MAI26105: Skill Development Lab-I

Teaching Scheme:		Credits:	02	Examination Scheme:	
PR:	04 Hrs/Week			Term Work	25 Marks
				Oral	25 Marks

Prerequisite Courses:

Linear Algebra (vectors, matrices),Probability & Statistics, Calculus (derivatives, gradients), Optimization basics, Python/ R Language

Companion Course:

MAI26101: Artificial Intelligence

MAI26102: Mathematical Foundation for Data Science

MAI26103: Data Preparation and Analysis

All assignments are compulsory. Each student should implement assignment individually.

List Of Practical Assignments

MAI26101: Artificial Intelligence

1. Building and evaluating a small-scale LLM pipeline
   Objective: Give students hands-on experience with modern large-language-model workflows, including data preparation, fine-tuning, evaluation, and prompt-engineering.
2. Design and deploy an AI agent system
   Objective: Explore agent-based reasoning, tool use, planning, and real-world integration of AI models.

MAI26102: Mathematical Foundation for Data Science

1. Write a Python program to implement simple statistical measures and probability simulations in Python.
2. Write a Python program to solve the system of linear equations.

MAI26103: Data Preparation and Analysis

1. Scale and transform dataset attributes using normalization techniques (Min-Max and Z-Score) to bring them to a common range for effective data analysis.
2. Convert continuous numerical attributes in a dataset into discrete categorical bins using appropriate discretization techniques for easier analysis and mining.

MHS26102- Indian Knowledge System		
Teaching Scheme: **Theory: 2 Hours/Week**	**Credits: 02**	**Examination Scheme:** **In-Semester Exam: 30 Marks** **CAA: 20 Marks** **Total: 50 Marks**

Course Objectives:

1. To create awareness about the history and rich cultural heritage of Bharata.
2. To introduce the principles of Vedic mathematics for faster calculations.
3. To explore the contributions of traditional Bharatiya knowledge in science and astronomy.
4. To understand the contributions of traditional Bharatiya knowledge in engineering and technology.

Course Outcomes: Students will be able to

1. Understand the antiquity of Bharatiya civilization, traditional knowledge systems, ancient education institutions, and contributions to life sciences, healthcare, and philosophy.
2. Apply the principles of Vedic mathematics for efficient problem-solving in arithmetic, algebra, geometry To explore the contributions of traditional Bharatiya knowledge in science and astronomy.
3. Analyze the scientific and astronomical advancements of ancient Bharata, including concepts of matter, gravity, aeronautics, and cosmology, and their relevance to modern science.
4. Explore the engineering, technological, and architectural innovations of ancient Bharata,

Course Syllabus

UNIT -I: Indian Civilization and Development, Philosophy: **(7 hours)**

Geological formation of land, Early History of civilization, the Saraswati-Sindhu Civilization, Traditional Knowledge System, The Vedas,Upanishadas,Vedanga,Aranyakas, Main Schools of Philosophy,Gurukul Parampara, the Takṣaśila University, the Nālandā University., Agriculture, Ecology and Environment, Sushrut Samhita,Charak Samhita , Integrated Approach to Healthcare, Medicine, Microbiology, Surgery, and Yoga. Life and work of Rishi's, Brahmavadini.Vedangas Information " Shiksha ,Kalpa,Vyakaran,Nirukta , Chandas,Jyotish" .

UNIT-II: Advanced technique in Vedic Mathematics: **(7 hours)**

The Great Indian Mathematicians, Introduction to sutras, and sub sutras. Methods for squaring and square roots, cube and cube roots, factorization. Differentiation and Integration methods. Easy Solution of linear equations, quadratic equations, high-Speed Matrix, Algebra.
Vedic Geometry: Different forms of straight lines, The Triangle, The Cyclic Quadrilateral, Squares, and the Circle, Geometrical constructions (such as Altars), Transformation of simple shapes, Kalpa Sutras,Srauta Sutras and Sulbha Sutras.

UNIT-III: Ancient Astronomy and Science: **(7 hours)**

Concepts of Samkhya and Universe, Gravity, Sage Agastya's Innovation in Electricity , Ancient Physics: Big Bang Theory , Vimāna: Aeronautics (Sundar Vimana,Rukma Vimana,Tripur Vimana Vedic Cosmology and Modern Concepts, Bhāratīya Kāla-gaṇanā, History and Culture of Astronomy, Sun, Earth, Moon, and Eclipses, Earth is Spherical and Rotation of Earth, Archeoastronomy,Raja Bhoja Robotics And Automation.

UNIT-IV: Engineering Technology and Architecture of Ancient India: **(7 hours)**

Ancient Rasayanshastra: Laboratory and Apparatus, Juices, Dyes, Paints and Cements, Glass and pottery, Metallurgy, Engineering Science and Technology in the Vedic Age and Post-Vedic Records, Iron Pillar of Delhi, Rakhigarhi, Mehrgarh, Sindhu Valley Civilization, Marine Technology, and Bet-Dwārkā. Vastu Shastra,Architecture the Root of Civilization and Art work of Bharatiya Knowledge Metals and Metalworking: 1. The rise and fall of a great Indian technology 2. Mining and ore extraction 3. Zinc extraction 4. Copper and it"s alloys 5. Iron and steel in ancient India 6. Lost wax casting of idols and artefacts 7. Apparatuses used for extraction of metallic components Engineering and Technology, Town Planning and Architecture: 1. Perspective of Arthaśāstra on town planning 2. Vedic Vāstu-śāstra – The science of architecture 3. Eight limbs of Vāstu 4. Town planning 5. Temples in India: Marvellous stone architecture for eternity 6. Temple architecture in India 7. Iconography Knowledge Framework and classifications.

Textbooks:

1. Textbook on The Knowledge System of Bharata by Bhag Chand Chauhan,
2. Engineering and Technology in Ancient India by Ravi Prakash Arya
3. History of Science in India Volume-1, Part-1, Part-II, Volume VIII, by Sibaji Raha, et al. National Academy of Sciences, India and The Ramakrishna Mission Institute of Culture, Kolkata (2014).
4. Science and Technology in Ancient Indian Texts by Bal Ram Singh, Nath Girish. Umesh Kumar Singh
5. Vedic Mathematics, Swami Bharati Krishna Trithaji, Motilal Banarsidass, New Delhi.

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. Rigvedadi Bhashya Bhumika: Swami Dayananda Saraswati publisher Arya samaj, Vedic Mission West Midlands.

Course Activity: Test, Poster Presentation, Model Makin

Course Coordinator

Dean Academics

Principal

VPKBIET BARAMATI Affiliated to S.P.P.U. Pune Id No./SU/PN/Engg./152/2000 PUNE (MS)

Vidya Pratishthan's Kamalnayan Bajaj Institute of Engineering & Technology, Baramati Vidyanagari, Baramati-413133

SEMESTER - II

MAI26111: Advance Machine Learning					
Teaching Scheme:		**Credits:**	**04**	**Examination Scheme:**	
				Continuous Activity:	**20 Marks**
TH:	**04 Hrs/Week**			**In-Semester Exam:**	**30 Marks**
				End-Semester Exam:	**70 Marks**

Prerequisite Courses:

Data Mining, 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 :	Apply advanced supervised learning algorithms for prediction tasks.
CO2 :	Implement probabilistic and graphical models for inference and learning.
CO3 :	Perform clustering and dimensionality reduction for data analysis.
CO4 :	Apply optimization and scalable learning techniques for large datasets.
CO5 :	Implement explainable AI methods and deploy ML models.
CO6 :	Explore emerging ML trends, AutoML, and ethical considerations.

Course Contents

Unit I: Advanced Supervised Learning	**(7 Hrs)**

Review of regression and classification; Support Vector Machines (SVM) and Kernel Trick; Soft-margin SVM; Kernel Ridge Regression; Decision Trees and Random Forests; Gradient Boosting Machines (GBM); XGBoost and LightGBM; bias-variance tradeoff in ensemble models.

Unit II: Probabilistic Models and Graphical Models	**(7 Hrs)**

Bayesian learning framework; Maximum Likelihood and MAP estimation; Expectation-Maximization (EM) algorithm; Gaussian Mixture Models (GMM); Hidden Markov Models (HMM); Bayesian Networks; Markov Random Fields; inference techniques including Variable Elimination and Belief Propagation.

Unit III: Unsupervised and Representation Learning	**(7 Hrs)**
K-Means and Hierarchical Clustering; Spectral Clustering; Density-Based Clustering (DBSCAN); Principal Component Analysis (PCA); Kernel PCA; Independent Component Analysis (ICA); t-SNE and UMAP; manifold learning concepts.	
Unit IV: Optimization and Large-Scale Learning	**(7 Hrs)**
Convex optimization fundamentals; Lagrangian duality; Stochastic Gradient Descent; Coordinate Descent; Online learning algorithms; Passive-Aggressive algorithms; Distributed machine learning; Spark ML concepts; handling imbalanced and large-scale datasets.	
Unit V: Explainable AI and Deployment	**(6 Hrs)**
Explainable AI (XAI), SHAP, LIME, Model Interpretability, Saving and Loading Models, Model Deployment using Flask, Introduction to MLOps.	
Unit VI: Emerging Trends	**(7 Hrs)**
Meta-learning and few-shot learning; Transfer learning in classical ML; AutoML concepts; Hyperparameter optimization (Grid Search, Random Search, Bayesian Optimization); Explainable Machine Learning techniques (LIME, SHAP); Fairness and ethical considerations; MLOps and ML pipeline deployment.	
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

MA26112: Scalable Data Science					
Teaching Scheme:		**Credits:**	**04**	**Examination Scheme:**	
				Continuous Activity:	**20 Marks**
TH:	**04 Hrs/Week**			**In-Semester Exam:**	**30 Marks**
				End-Semester Exam:	**70 Marks**

Prerequisite Courses:

Students are expected to have a good understanding of basics of the Data 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.

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	**(6 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, k-d 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	**(6 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:	
Textbooks:	
1.	Leskovec, A., Rajaraman and JD Ullman, "Mining of Massive Datasets", Cambridge University Press, 3rd Ed.
2.	Mohammad 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 Bukkirusamy Bikkariyya Singhal, "Spark for Data Science", Packt Publishing, ISBN: 9781785885565
Important links: Sketching as a Tool for Numerical Linear Algebra (link provided in syllabus) https://www.oreilly.com/library/view/spark-for-data/9781785885565/ https://www.amazon.in/Big-Data-Analytics-Spark-Practitioners/dp/1484209566	

MAI26113: Advance Computing Intelligence					
Teaching Scheme:		**Credits:**	**04**	**Examination Scheme:**	
				Continuous Activity:	**20 Marks**
TH:	**04 Hrs/Week**			**In-Semester Exam:**	**30 Marks**
				End-Semester Exam:	**70 Marks**

Prerequisite Courses:

- Basic knowledge of Artificial Intelligence and Machine Learning
- Understanding of Probability and Statistics
- Fundamentals of Linear Algebra and Optimization
- Programming knowledge in Python
- Basic understanding of Neural Networks and Data Structures

Companion Course, if any: Skill development lab -2

Course Objectives:

1.	To understand the advanced concepts and techniques of computational intelligence.
2.	To study nature-inspired optimization algorithms used in intelligent systems.
3.	To explore neural networks, fuzzy systems, and evolutionary computing techniques.
4.	To analyze hybrid computational intelligence models for complex problem solving.
5.	To develop intelligent systems using metaheuristic optimization algorithms.
6.	To apply computational intelligence methods to real-world AI and data science problems

Course Outcomes:

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

CO1:	Understand the fundamental principles of computational intelligence techniques.
CO2:	Apply neural networks and deep learning models for complex AI tasks.
CO3:	Implement evolutionary algorithms and swarm intelligence techniques for optimization problems.
CO4:	Design and develop fuzzy logic-based intelligent systems.
CO5:	Develop hybrid intelligent systems combining multiple CI techniques.
CO6:	Analyze and solve real-world problems using computational intelligence approaches

Course Contents

Unit I: Introduction to Computational Intelligence	**(6 Hrs)**

Introduction to Computational Intelligence (CI), Characteristics of CI systems, CI vs Artificial Intelligence vs Machine Learning, Components of Computational Intelligence, Applications of CI in real-world problems, Overview of Neural Networks, Fuzzy Systems, and Evolutionary Computing

Unit II: Artificial Neural Networks (ANN)	**(6 Hrs)**

Biological inspiration of neural networks, Structure of Artificial Neural Networks, Perceptron and Multi-layer Perceptron (MLP), Activation functions, Backpropagation algorithm, Training and learning rules, Applications of ANN	
Unit III: Fuzzy Logic Systems	**(7 Hrs)**
Introduction to Fuzzy Logic, Crisp sets vs Fuzzy sets, Membership functions, Fuzzy rules and inference systems, Fuzzification and Defuzzification, Applications of fuzzy logic in decision-making systems.	
Unit IV: Evolutionary Algorithms	**(6 Hrs)**
Introduction to Evolutionary Computing, Genetic Algorithms (GA), Chromosome, representation, Selection, crossover, and mutation operators, Fitness evaluation, Applications of Genetic Algorithms	
Unit V: Swarm Intelligence	**(6 Hrs)**
Introduction to Swarm Intelligence, Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO), Bee Colony Optimization, Applications of swarm intelligence in optimization problems	
Unit VI: Hybrid Computational Intelligence and Applications	**(7 Hrs)**
Hybrid CI systems, Neuro-Fuzzy systems, Evolutionary neural networks, CI in data mining and big data analytics, CI applications in robotics, healthcare, and finance, Future trends in computational intelligence	
Books & Other Resources:	
Textbooks:	
1.	**Andries P. Engelbrecht**, *Computational Intelligence: An Introduction*, **John Wiley & Sons**, 2nd Edition, 2007.
2.	S. Rajasekaran and G. A. Vijayalakshmi Pai, *Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis and Applications*, PHI Learning Pvt. Ltd., New Delhi, 1st Edition, 2003.
3.	**Simon Haykin**, *Neural Networks and Learning Machines*, **Pearson Education**, 3rd Edition, 2008.
Reference Books:	
1.	**Rudolf Kruse, Christian Borgelt, Christian Braune, and Sanaz Mostaghim**, *Computational Intelligence: A Methodological Introduction*, **Springer**, 3rd Edition, 2022.
2.	**James Kennedy and Russell Eberhart**, *Swarm Intelligence*, **Morgan Kaufmann Publishers (Elsevier)**, 1st Edition, 2001.

3.	**Aurélien Géron**, *Hands-On Machine Learning with Scikit-Learn, Keras and TensorFlow*, **O'Reilly Media**, 2nd Edition, 2019.
4.	**Ian Goodfellow, Yoshua Bengio, and Aaron Courville**, *Deep Learning*, **MIT Press**, 2016.
E-books:	
1.	*Dive into Deep Learning*, Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, **Cambridge University Press / Open Source**, Available at: https://d2l.ai
2.	*Computational Intelligence: An Introduction, Andries P. Engelbrecht,* ***John Wiley & Sons****, Available at: https://onlinelibrary.wiley.com*
3.	*Deep Learning*, Ian Goodfellow, Yoshua Bengio, Aaron Courville, **MIT Press**, Available at: https://www.deeplearningbook.org
4.	*Machine Learning Open Course Materials,* ***MIT OpenCourseWare****, Available at: https://ocw.mit.edu*

MAI26114-A: Business Analytics and Intelligence					
Teaching Scheme:		**Credits:**	**04**	**Examination Scheme:**	
				Continuous Activity: :	**20 Marks**
TH:	**04 Hrs/Week**			**In-Semester Exam:**	**30 Marks**
				End-Semester Exam:	**70 Marks**

Prerequisite Courses:

Database management System, Data Visualization and statistics

Companion Course, if any: Professional Core Lab-I

Course Objectives:

1.	To introduce the concepts, scope, and drivers of Business Analytics and Intelligence (BAI)
2.	To develop an understanding of data management, data warehousing, and analytical architectures.
3.	To build analytical thinking using statistical learning, data mining, and machine learning techniques.
4.	To enable learners to apply analytics tools and techniques to real-world business problems.

Course Outcomes:

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

CO1:	Explain the concepts, architecture, and applications of Business Intelligence and Analytics.
CO2:	Design and manage databases and data warehouses for analytical purposes.
CO3:	Apply descriptive and predictive analytics techniques to business data.
CO4:	Build and evaluate classification, clustering, and regression models.
CO5:	Implement analytics models using Python and R for business decision-making.
CO6:	Interpret analytical results to derive actionable business insights.

Course Contents

Unit I: Introduction to Business Intelligence & Analytics	**(7 Hrs)**

Introduction to BI, **Evolution of BI**: DSS → EIS → BI → Analytics, Role of BI in strategic, tactical, and operational decision-making, BI vs Business Analytics vs Data Science, BI applications across functional domains (marketing, finance, HR, operations), Definition and scope of Business Analytics, Drivers of Business Intelligence & Analytics, Types of Analytics(Descriptive analytics, Diagnostic analytics, Predictive analytics, Prescriptive analytics)

Unit II: Data Management and BIA Architecture	**(7 Hrs)**
Types of data: transactional, master, reference, metadata, Internal vs external data sources, Data governance and data stewardship, **Technical Architecture of BIA**: Operational systems, Data integration layer (ETL/ELT), Data warehouse and data marts, Analytics and presentation layer, BI tools and reporting platforms, **Data modeling** concepts, Entity–Relationship (ER) modeling, Keys, constraints, and relationships, **Online Transaction Processing (OLTP):** Characteristics of OLTP systems, Normalized database structures, ACID properties, OLTP vs OLAP comparison	

Unit III: Data Warehousing and OLAP	**(7 Hrs)**
Data Warehousing: Need for data warehouses, Characteristics: subject-oriented, integrated, time- variant, non-volatile, Star schema and snowflake schema, Fact tables and dimension tables, **Online Analytical Processing (OLAP):**OLAP operations: roll-up, drill-down, slice, dice, pivot, Multidimensional data model, Data cubes.	
Unit IV: Descriptive Analytics and Customer Analytics	**(7 Hrs)**
Descriptive analytics: Summary statistics, Frequency distributions, Cross-tabulation, Data aggregation, **Customer Analytics:** Customer acquisition, retention, and churn, Customer segmentation, Behavioral analytics, **Survival Analysis:** Time-to-event data, Censoring, Kaplan–Meier estimator, Business interpretation of survival curves, **Customer Lifetime Value (CLV):** Definition and importance, Deterministic and probabilistic CLV models, CLV for strategic decision-making	
Unit V: Predictive Analytics and Data Mining	**(7 Hrs)**
Data Mining Process: Business understanding, Data understanding, Data preparation, Modeling, Evaluation, Deployment (CRISP-DM), **Statistical Learning:** Supervised vs unsupervised learning, Bias–variance trade-off, Training, validation, and test data, **Data Preprocessing and Quality:** Missing value treatment, Outlier detection, Data transformation and scaling, Feature selection, **Regression Analysis:** Simple and multiple linear regression, Model assumptions, Interpretation of coefficients, Regression diagnostics, Business case study, **Classification:** Introduction to classification problems, Binary and multiclass classification, Scoring models, **Model Performance Evaluation:** Confusion matrix, Accuracy, precision, recall, F1-score, ROC curves and AUC, Precision–Recall curves	

Unit VI: Advanced Analytics and Applications	**(7 Hrs)**
Decision Trees: Tree structure and terminology, Tree induction algorithms, Measures of impurity (Gini, entropy), Overfitting and underfitting , **Ensemble Methods:** Bagging, Boosting, Random forests, Model comparison, **Cluster Analysis:** Clustering concepts, Distance measures, K-means algorithm, Cluster validation techniques, **Customer Segmentation:** Store and customer segmentation, Cluster profiling and interpretation, RFM (Recency, Frequency, Monetary) analysis, Actionable insights for loyalty management, **Text Mining:** Text analytics process, Text preprocessing, Sentiment analysis	
Books & Other Resources:	
Textbooks:	
1.	Han, J., Pei, J. & Tong, H. (2023). *Data Mining: Concepts and Techniques*, 4th Edition. Elsevier.
2.	James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). *An Introduction to Statistical*
	Learning with Applications in R. Springer
Reference Books:	
1.	Kaastra, I., & Boyd, M. (1996). Designing a neural network for forecasting financial and economic time series. *Journal of Neural Computing*.
2.	Silge, J., & Robinson, D. *Text Mining with R: A Tidy Approach*. O'Reilly.
3.	Gartner Insights – Customer Lifetime Value (CLV).
E-books:	
1.	SQL Tutorial: https://www.mysqltutorial.org
2	Scikit-learn Documentation: https://scikit-learn.org
3.	ISL Resources: http://www-bcf.usc.edu/~gareth/isl/
Data Sources:	
• **Adventure Works Cycles (SQL Server sample database)** • **Retail Sense transaction data (fashion retailer)** • **UCI Machine Learning Repository: http://archive.ics.uci.edu/ml/** • **Financial and capital market data: Yahoo! Finance** • **Text data: Twitter** • **Kaggle datasets: https://www.kaggle.com**	
Important links: **https://www.mysqltutorial.org** **https://scikit-learn.org** **https://www.kaggle.com** **http://archive.ics.uci.edu/ml/**	

MAI26114-B: Computer Vision					
Teaching Scheme:		**Credits:**	**04**	**Examination Scheme:**	
				Continuous Activity: :	**20 Marks**
TH:	**04 Hrs/Week**			**In-Semester Exam :**	**30 Marks**
				End-Semester Exam:	**70 Marks**

Prerequisite Courses:

Linear Algebra, Probability & Statistics, Machine Learning, Deep Learning

Companion Course, if any: Advanced Computer Vision Laboratory

Course Objectives:

1.	To understand advanced image formation and multi-view geometry concepts.
2.	To design and implement deep learning architectures for computer vision.
3.	To develop robust object detection, segmentation and tracking systems.
4.	To explore 3D reconstruction and motion estimation techniques.
5.	To analyze recent research trends and real-world vision applications.

Course Outcomes:

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

CO1:	Analyze mathematical foundations and image formation models for computer vision.
CO2:	Design and implement deep convolutional neural networks for vision tasks.
CO3:	Develop advanced object detection and segmentation models.
CO4:	Apply 3D reconstruction and motion estimation techniques.
CO5:	Evaluate recent research literature in computer vision.
CO6:	Develop optimized real-time computer vision systems.

Course Contents

Unit I: Advanced Image Formation and Feature Extraction	**(7 Hrs.)**

Image formation models, Radiometry and reflectance, Camera calibration, Multi-view geometry, Epipolar geometry, Feature descriptors (SIFT, SURF, ORB), Optimization basics for vision.

Unit II: Deep Learning Architectures for Vision	**(7 Hrs.)**

Convolutional Neural Networks (CNN), Residual learning, Transfer learning, Self-supervised learning, Architectures:ResNet, VGG, AlexNet, Large-scale dataset concept – ImageNet, Vision Transformers (ViT).

Unit III: Object Detection, Segmentation and Tracking	**(7 Hrs.)**
Region proposal networks- Concept of anchor boxes, region proposal generation and bounding box regression, Faster R-CNN- Two-stage object detection architecture with region proposal and classification., YOLO, Mask R-CNN, U-Net- Encoder–decoder architecture for semantic segmentation with skip connections, Multi-object tracking, Evaluation metrics (IoU, mAP).	
Unit IV: 3D Vision and Motion Estimation	**(7 Hrs.)**
Stereo Reconstruction: Depth estimation using stereo image pairs, disparity computation and triangulation principles, Structure from Motion (SfM):3D structure recovery from multiple images using feature matching and camera pose estimation, Bundle Adjustment**:** Non-linear optimization technique for refining 3D structure and camera parameters. SLAM Fundamentals (Simultaneous Localization and Mapping), Optical Flow**:** Estimation of pixel-wise motion between consecutive frames using differential methods, Visual Odometry, Pose Estimation	
Unit V: Image Restoration and Reconstruction	**(7 Hrs.)**
Advanced image degradation modeling including spatial and frequency domain representations; statistical noise models (Gaussian, Poisson, Speckle) and parameter estimation; deterministic and stochastic approaches to image restoration; inverse filtering and regularized reconstruction techniques; Wiener filtering and Minimum Mean Square Error (MMSE) estimation; iterative restoration methods including Lucy–Richardson algorithm and constrained optimization-based deconvolution; blind deconvolution and Bayesian restoration frameworks; performance evaluation using PSNR, SSIM and perceptual quality metrics.	
Unit VI: Application of Computer Vision in Medical and Satellite Image Processing.	**(7 Hrs.)**
Medical Image Processing: Advanced medical imaging modalities (MRI, CT), deep learning-based image enhancement and segmentation, quantitative analysis for Brain MRI, Cardiac MRI and Breast Cancer detection. Satellite Image Processing Advanced remote sensing principles, radiometric and geometric corrections, integration of GPS and GIS, multispectral and hyper spectral image analysis, land-use classification and environmental monitoring applications.	
Books & Other Resources:	
Textbooks:	
1.	Computer Vision: Algorithms and Applications – Richard Szeliski.
2.	Deep Learning – Goodfellow, Bengio, Courville.
3.	Multiple View Geometry in Computer Vision – Hartley & Zisserman, Cambridge University Press.
Reference Books:	
1.	Computer Vision: Models, Learning, and Inference – Simon Prince.
2.	Feature Extraction and Image Processing for Computer Vision – Nixon & Aguado.
3.	Deep Learning for Computer Vision – Adrian Rosebrock.

E-books:

1.	NPTEL Computer Vision Course
2	Stanford CS231n Course
3.	Computer Vision: A Modern Approach – Forsyth & Ponce.

Important links:

- **Stanford CS231n – Convolutional Neural Networks for Visual Recognition**
https://cs231n.stanford.edu/

- **NPTEL – Computer Vision (IIT Courses)**
https://onlinecourses.nptel.ac.in/

- **PyTorch Official Documentation**
https://pytorch.org/docs/

- **TensorFlow Official Documentation**
https://www.tensorflow.org/tutorials

- **OpenCV Official Documentation**
https://docs.opencv.org/

- **COCO Dataset (Object Detection & Segmentation)**
https://cocodataset.org/

- **ImageNet Dataset**
https://www.image-net.org/

- **KITTI Dataset (Stereo & Visual Odometry)**
http://www.cvlibs.net/datasets/kitti/

- **IEEE Xplore Digital Library**
https://ieeexplore.ieee.org/

- **arXiv – Computer Vision and Pattern Recognition (cs.CV)**
https://arxiv.org/list/cs.CV/recent

MAI26114-C : Digital Forensics					
Teaching Scheme:		**Credits:**	**04**	**Examination Scheme:**	
				Continuous Activity:	**20 Marks**
TH:	**04 Hrs/Week**			**In-Semester Exam :**	**30 Marks**
				End-Semester Exam:	**70 Marks**

Prerequisite Courses:

Knowledge of Internet, Computer Network , Cyber security

Companion Course, if any: Cryptography & Network Security.

Course Objectives:

1.	To understand the fundamentals of cybercrime and digital forensics.
2.	To develop skills in incident response and forensic investigation processes.
3.	To apply techniques for evidence acquisition, preservation, and analysis.
4.	To analyze system, network, and mobile artifacts for forensic investigations.
5.	To interpret digital evidence and prepare professional forensic reports.

Course Outcomes:

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

CO1:	Understand cybercrime concepts, digital forensics principles, and legal aspects.
CO2:	Apply incident response methodologies and forensic investigation procedures.
CO3:	Analyze and acquire digital evidence using forensic tools and imaging techniques.
CO4:	Examine Windows, memory, network, and mobile forensic artifacts.
CO5:	Investigate email and internet-based evidence and correlate findings.

Course Contents

Unit I: Introduction to Digital Forensics.	**(7 Hrs.)**

Introduction to Cybercrime: Cyber Crime Attack mode, How are Computers used in Cyber Crimes? Types of Cyber Crime, Cybercrime Statistics in India Prevention of Cybercrime Introduction to Digital Forensics: Introduction to Digital Forensics Objective and need of Digital Forensic Types of Digital Forensics Digital Forensic Investigations Process Locard's Exchange Principle, Daubert's Rule Digital Evidences: Type , Role of Digital evidence and Rules , sources of Digital Evidences

Unit II: Forensic Investigation Process and Incident Response	**(7 Hrs.)**

Introduction, People Involved in Incident Response Process, Incident Response Process, Incident Response Methodology, Activities in Initial Response, Phases after Detection of an Incident Pre-investigation considerations: The forensic workstation, The response kit, Forensic software, Forensic investigator training, Understanding case information and legal issues, Understanding data acquisition, Chain of custody, Understanding the analysis process, Dates and time zones

Hash analysis , File signature analysis, Reporting your findings, Details to include in your report, Document facts and circumstances, The report conclusion.	
Unit III: Computer Forensics: Evidence Acquisition and Imaging	**(7 Hrs.)**
Exploring evidence, Understanding the forensic examination environment, Tool validation, Creating sterile media, Understanding write blocking, Hardware write blocker, Software write blocker, Rules of Forensic duplication, Defining forensic imaging: DD image, Encase evidence file, SSD device. Imaging tools: FTK Imager, PALADIN.	
Unit IV: Windows Artifact Analysis in Digital Forensics	**(7 Hrs.)**
Windows Artifact Analysis: Understanding user profiles, Understanding Windows Registry, Determining account usage, Last login/last password change, Determining file knowledge: Exploring the thumb cache, Exploring Microsoft browsers, Determining most recently used/recently used, Looking into the Recycle Bin, Understanding shortcut (LNK) files, Deciphering Jump Lists, Opening shellbags, Understanding prefetch dentifying physical locations: Determining time zones, Exploring network history, Understanding the WLAN event log, Exploring program execution, Determining User Assist, Exploring the Shimcache RAM Memory Forensic Analysis: Identifying sources of memory, Capturing RAM, Preparing the capturing device, Exploring RAM capture tools, Exploring RAM analyzing tools, Using Bulk Extractor.	
Unit V: Network and Mobile Forensics	**(7 Hrs.)**
Introduction to Network Forensic: Understanding Password Cracking, Understanding Technical Exploits, Analyzing Network Traffic, Collecting Network-Based Evidence, Evidence Handling, Investigating Routers, Handling Router Table Manipulation Incidents, Using Routers as Response Tools Mobile Forensics : Definition, Information available in Mobile Phones, identification, isolation of mobile devices, search and seizure of mobile devices, acquisition methods (physical, logical, file system, JTAG, Chip off), Analysis of mobile images, understanding a mobile forensic report	
Unit VI: Internet and Email Evidence Analysis with Reporting	**(7 Hrs.)**
Email Forensics – Investigation Techniques, Understanding web -based email, Decoding email, Understanding the email message format, Email attachments, Understanding clientbased email analysis, Exploring Microsoft Outlook/Outlook Express, Exploring Microsoft Windows Live Mail, Mozilla Thunderbird Understanding Web Mail analysis, E -mail Investigations Challenge Internet Artifacts: Understanding browsers, Exploring Internet Explorer/Microsoft Edge (Old Version),Exploring Firefox, Social media,P2P file sharing, Investigative Report Template, Layout of an Investigative Report, Guidelines for Writing a Report.	
Books & Other Resources:	
Textbooks:	
1.	Digital Forensics and Incident Response – by Gerard Johansen
2.	Guide to Computer Forensics and Investigations – by Bill Nelson, Amelia Phillips, Christopher Steuart
3.	Computer Forensics: Investigating Network Intrusions and Cyber Crime – by EC-Council

Reference Books:	
1.	Bill Nelson, Amelia Phillips, Christopher Steuart – *Guide to Computer Forensics and Investigations*
2.	Eoghan Casey – *Digital Evidence and Computer Crime*
3.	Jason T. Luttgens – *Incident Response & Computer Forensics*
E-books:	
1.	Forensic Discovery, Dan Farmer & Wietse Venema
2	Digital Forensics Basics: A Practical Guide, Nihad A. Hassan

Important links:

Unit I: Cybercrime & Digital Forensics

https://ncrb.gov.in
https://www.cert-in.org.in
https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-86.pdf
https://www.sans.org

Unit II: Investigation & Incident Response

https://www.sans.org/dfir
https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-61r2.pdf

Unit III: Evidence Acquisition & Imaging

https://accessdata.com/product-download/ftk-imager-version-4-5
https://sumuri.com/software/paladin/
https://www.dfir.training

Unit IV: Windows & Memory Forensics

https://www.autopsy.com
https://www.volatilityfoundation.org
https://digitalcorpora.org/downloads/bulk_extractor/

Unit V: Network & Mobile Forensics

https://www.wireshark.org
https://www.oxygen-forensic.com
https://cellebrite.com

Unit VI: Email & Internet Forensics

https://mxtoolbox.com
https://www.thunderbird.net

Reporting & Practice

https://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication800-86.pdf
https://tryhackme.com
https://www.cybrary.it

MAI26114-D: Augmented Reality and Virtual Reality					
Teaching Scheme:		**Credits:**	**04**	**Examination Scheme:**	
				Continuous Activity: :	**20 Marks**
TH:	**04 Hrs/Week**			**In-Semester Exam:**	**30 Marks**
				End-Semester Exam:	**70 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.
4.	To develop hands-on skills in designing, implementing, and evaluating immersive AR and VR experiences, with an emphasis on user interaction and real-world problem solving.

Course Outcomes:

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

CO1:	**Identify** the most suitable immersive technology technique for a given use case by understanding the similarities and differences between virtual, augmented, and mixed reality.
CO2:	**Understand** the system of human vision and its implications on perception, depth, and rendering in AR/VR environments.
CO3:	**Understand** core computer vision concepts and software frameworks used for AR, and explain various AR techniques.
CO4:	**Create** interactive 3D scenes using Unity IDE and experiment with different user interface (UI) techniques used in VR applications.
CO5:	**Design** and develop functional AR applications using Unity IDE and supporting SDKs.
CO6:	**Develop**, integrate, and demonstrate complete AR and VR applications while evaluating performance, usability, and user experience.

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 World 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 and 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 and AR Software	**(7 Hrs)**

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. Packet publishing, 9th October 2017. ISBN-13:978-1787286436
E-books:	
1.	**Augmented and Virtual Reality in the Metaverse** Explores AR/VR within the emerging *metaverse* context — research and future perspectives. https://link.springer.com/book/10.1007/978-3-031-57746-8?utm_source=chatgpt.com
2	**Virtual and Augmented Reality (VR/AR): Foundations and Methods of Extended Realities (XR)** A foundational academic e-book covering core concepts and methods of AR/VR/XR systems. https://www.kobo.com/in/en/ebook/virtual-and-augmented-reality-vr-ar?utm_source=chatgpt.com
Important links: **http://lavalle.pl/vr/book.html https://www.amazon.in/Augmented-Reality-Virtual-Business-Progress/dp/3030062457**	

MAI26114-E: Blockchain Technology					
Teaching Scheme:		**Credits:**	**04**	**Examination Scheme:**	
				Continuous Activity:	**20 Marks**
TH:	**04 Hrs/Week**			**In-Semester Exam:**	**30 Marks**
				End-Semester Exam:	**60 Marks**

Prerequisite Courses: Computer Network, Cryptography / Network Security, Operating Systems

Companion Course, if any: Professional Core Lab-I

Course Objectives:

To equip students with the architectural knowledge and hands-on programming skills required to design, develop, and secure decentralized systems on both Bitcoin and EVM-compatible platforms

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

CO1:	Implement and verify cryptographic foundations including Hashing, ECC, and Merkle structures.
CO2:	Analyze the architectural components of Bitcoin, including the UTXO model and Nakamoto Consensus.
CO3:	Deconstruct the Ethereum Virtual Machine (EVM) architecture and its gas-based execution model.
CO4:	Design, write, and secure complex Smart Contracts using the Solidity programming language.
CO5:	Build and deploy full-stack decentralized applications (dApps) using professional engineering tool chains.
CO6:	Evaluate advanced scaling solutions and the role of AI in securing decentralized ecosystems.

Course Contents

Unit I: Cryptographic Foundations & Distributed Systems	(8 Hrs)

Security Principles: CIA, AAA, and Threat Modeling in decentralized ecosystems, **Mathematical Foundations**: Modular arithmetic, Prime numbers, and Elliptic Curve Cryptography, **Cryptographic Primitives**: SHA-256 (Double Hashing), HMAC. **Data Structures**: Merkle Trees, Patricia Tries (Ethereum state), and Hash Pointers. **Distributed Systems**: Byzantine Generals Problem, CAP Theorem, and Sybil Attacks.

Unit II: Blockchain Fundamentals and Bitcoin	(8 Hrs)

Evolution of DLT: History from Blockchain 1.0 to 3.0, **Block Anatomy**: Header (Version, Prev Hash, Merkle Root, Nonce, Difficulty) vs. Block Body, **The UTXO Model**: Unspent Transaction Outputs, ScriptPubKey, and ScriptSig, **Consensus Mechanisms**: Nakamoto Consensus (PoW), Difficulty Adjustment, and Mining incentives, **Network Dynamics**: P2P Topology, Node types (Full, Light, SPV), and Propagation, **Forks**: Soft Forks (SegWit) vs. Hard Forks (Bitcoin Cash).

Unit III: Ethereum Architecture & EVM Mechanics	(8 Hrs)
The World Computer: Ethereum's State Machine and Global State transitions, **EVM Deep Dive**: Stack-based architecture, Memory vs. Storage vs. Calldata, and Opcodes, **Gas Economics**: Opcode costs, Gas Limit vs. Gas Price, and the EIP-1559 Fee Market, **Accounts**: Externally Owned Accounts (EOA) vs. Contract Accounts (CA), **Nodes & Clients**: JSON-RPC API, interacting with Geth or Erigon nodes.	
Unit IV: Smart Contract Engineering with Solidity	(8 Hrs)
Solidity Fundamentals: Data types (address, mapping, struct, enum), visibility (public/private/internal/external), **Advanced Logic**: Function modifiers, Events (Logs), Inheritance, and Interfaces, **Error Handling**: require, assert, and revert patterns, **Contract Interaction**: Calling other contracts (call vs. delegatecall) and sending Ether, **Standards**: Implementing ERC-20 (Fungible) and ERC-721 (NFT) standards.	
Unit V: The Blockchain Development Workflow	(8 Hrs)
Toolchains: Setting up development environments (Hardhat, Foundry, or Truffle), **Unit Testing**: Writing robust tests in JavaScript/TypeScript or Solidity, **Deployment & Debugging**: Deploying to Testnets (Sepolia/Holesky), Etherscan verification, and using Debuggers, **Security Patterns**: Identifying and preventing Reentrancy, Front-running, and Integer Overflow, **Frontend Integration**: Connecting dApps to the browser using Ethers.js or Web3.js.	
Unit VI: Scalability, Enterprise & AI Integration	(8 Hrs)
Scaling Solutions: Layer 2s (Optimistic vs. ZK-Rollups), Sidechains, and Sharding, **Enterprise Frameworks**: Hyperledger Fabric (Private channels, MSP) and Corda, **DeFi Ecosystem**: Automated Market Makers (AMM), Liquidity Pools, and Flash Loans, **AI in Blockchain**: AI-driven smart contract auditing, decentralized AI model training, and ML for chain analysis.	
Books & Other Resources:	
Textbooks:	
1	Subramanian, Chandramouli et al., Blockchain Technology, 1st Edition, Gandhi Institute of Technology and Management, 2019. ISBN-13: 978-9389583946.
2	Antonopoulos, Andreas M., Mastering Bitcoin: Programming the Open Blockchain, 3rd Edition, O'Reilly Media, 2024. ISBN-13: 978-1098150105.
3	Modi, Ritesh, Solidity Programming Essentials: A beginner's guide to build smart contracts for Ethereum and blockchain, 2nd Edition, Packt Publishing, 2022. ISBN-13: 978-1803231181.
4	Stallings, William, Cryptography and Network Security: Principles and Practice, 8th Edition, Pearson Education, 2023. ISBN-13: 978-9357059718.
Reference Books:	
1	Narayanan, Arvind et al., Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, 1st Edition, Princeton University Press, 2016. ISBN-13: 978-0691171692.

2	Prusty, Narayan, Building Blockchain Projects, 1st Edition, Packt Publishing, 2017. ISBN-13: 978-1787122147.
3	Solorio, Kevin et al., Hands-On Smart Contract Development with Solidity and Ethereum, 1st Edition, O'Reilly Media, 2019. ISBN-13: 978-1492045267.
E-books:	
1	Antonopoulos, Andreas M., Mastering Bitcoin, 2nd Edition, O'Reilly Media, 2017
2	Antonopoulos, Andreas M. and Wood, Gavin, Mastering Ethereum, O'Reilly Media, 2018.
3	NIST Publications, Guide to Integrating Forensic Techniques into Incident Response (SP 800-86), National Institute of Standards and Technology.

MAI26115: Skill Development Lab-II					
Teaching Scheme:		**Credits:**	**02**	**Examination Scheme:**	
PR:	**04 Hrs/Week**			**Term Work**	**30 Marks**
				Oral	**30 Marks**

Prerequisite Courses:

Linear Algebra (vectors, matrices),Probability & Statistics, Calculus (derivatives, gradients), Optimization basics, Python/ R Language

Companion Course:

MAI26111: Advanced Machine Learning

MAI26112: Scalable Data Science

MAI26113: Advanced Computing Intelligence

MAI26114-A: Business Analytics and Intelligence

MAI26114-B: Computer Vision

MAI26114-C: Digital Forensics

MAI26114-D: Augmented Reality and Virtual Reality

MAI26114-E: Blockchain Technology

All assignments are compulsory. Each student should implement assignment individually.

List Of Practical Assignments

MAI26111: Advanced Machine Learning

1. Implement Machine Learning-Based Crop Yield Prediction and Fertilizer Recommendation System. Crop Yield Prediction Dataset (Kaggle) : https://www.kaggle.com/datasets/patelris/crop-yield-prediction-dataset
2. Implement Early Disease Risk Prediction using Ensemble Machine Learning on Clinical Data. Pima Indians Diabetes Dataset (Kaggle): https://www.kaggle.com/datasets/uciml/pima-indians-diabetes-database

MAI26112: Scalable Data Science

1. A company wants to analyse large sales data to understand product performance and customer behaviour. The dataset is large, so traditional processing is slow. Use PySpark to perform scalable data analysis.
2. Build a scalable machine learning pipeline to predict customer churn using a large dataset.

MAI26113: Advanced Computing Intelligence

1. Design of membership functions and fuzzy inference system.
2. Development of a Neuro-Fuzzy system for prediction problems.

MAI26114 A: Business Analytics and Intelligence(Program Elective – I)
1. Design a Data warehouse for sales analysis using MS Access and MS Excel .Analyse the sales and generate different reports and graphs for visualizing different OLAP operations like Pivot, Dice, Slice, Roll-up, Drill-down for decision making like offering discounts ,providing schemes. 2. Design interactive dashboard with data visualization (charts, graphs, maps) using Power BI tool for any business application (eg. Sales analysis etc.).
OR
MAI26114 B: Computer Vision (Program Elective – I)
1. Design, implement, and comparatively evaluate deep learning-based object detection and segmentation models using real-world datasets. The study must include training, testing, performance evaluation, and analytical comparison of results. 2. Design and implement a complete stereo vision pipeline for 3D scene understanding. The system shall accept a pair of stereo images (left and right views) and compute the disparity map using Block Matching or Semi-Global Matching techniques in OpenCV. The computed disparity must be converted into depth information to estimate scene distance. Using the depth data, reconstruct the 3D point cloud of the scene. Further, implement feature-based visual odometry to estimate camera motion between frames and plot the camera trajectory.
OR
MAI26114 C: Digital Forensics (Program Elective – I)
1. Create a forensic image of a given storage device using appropriate digital forensic tools and verify its integrity using hash values. Perform analysis on the acquired image to identify files, including deleted data and metadata, and document the findings. Ensure proper evidence handling procedures are followed to maintain data integrity and support forensic investigation.Design and Implement an Intelligent Digital Forensic Investigation System for Evidence Acquisition, Data Recovery, Timeline Reconstruction, and AI-Based Anomaly Detection. 2. Analyze a given Windows system or forensic image to examine system artifacts such as registry entries, recent files, login information, and system logs. Reconstruct user activity and identify any suspicious actions or usage patterns. Document the findings in a structured forensic report, ensuring proper analysis and interpretation of digital evidence.
OR
MAI26114 D: Augmented Reality and Virtual Reality(Program Elective – I)
1. Design and develop an Augmented Reality (AR) application that detects real-world objects or visual markers using a camera and overlays relevant virtual information such as 3D models, text, or animations in real time. The system should ensure accurate tracking, proper alignment of virtual content, and smooth interaction under varying environmental conditions.

2. Design and implement an interactive Virtual Reality (VR) environment that allows users to navigate and interact with virtual objects. The environment should include intelligent behaviors or adaptive interactions using AI-based logic to enhance user immersion and decision-making within the virtual space.
OR
MAI26114-E: Blockchain Technology (Program Elective – I)
1. Implementation of a Decentralized Voting System using Solidity and EVM 2. Design and Deployment of a Standardized Asset Token (ERC-20) with Access Control

MSE26116 TH-Environmental Studies

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 2 hrs./week	TH:2	CAA-20 Marks
		ISE-30 Marks

Course objectives: The Objective of this course is to impart knowledge of environment and ecosystems. It also creates awareness among the students about conservations of the resources, pollutions and different environmental acts.

Course Outcomes: After completion of this course, students will able to,

1. Understand importance of environment and natural resources.
2. Study different ecosystems and prepare a detailed report.
3. Identify the causes of pollution and suggest remedial actions.
4. Address social issues and understand the various environmental acts.

Unit I: Introduction

Multidisciplinary nature of environmental studies: [7 Hours]

Definition, scope, and importance, Need for public awareness.

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

Unit II: Ecosystems & Biodiversity [7 Hours]

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 ecosystems. Biodiversity: 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, India as a mega-diversity nation.

Unit III: Environmental Pollution [7 Hours]

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 IV: Social Issues and the Environmental acts [7 Hours]

Urban problems related to energy, Water conservation, rainwater 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.

References:

1. Suman Gupta, 2024. Environmental studies, S. Chand publication.

2.Gadgil, M., & Guha, R. 1993. This Fissured Land: An Ecological History of India. Univ. of California Press.

3. Odum, E.P., Odum, H.T. & Andrews, J. 1971. Fundamentals of Ecology. Philadelphia: Saunders.

4.Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.

5. Rosencranz, A., Divan, S., & Noble, M.L. 2001. Environmental law and policy in India. Tripathi 1992.

6. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014.Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.

Important Note:

CAA:

Report writing and Poster making & presentation:
Students are required **to prepare one report** and **one poster** with presentation on **two** different activities selected from the list given below. **The report and poster should not be based on the same activity.**

i) Record the **biodiversity of any visited area** and prepare a detailed report.
ii) Identify the **natural resources and ecosystems** of your area and prepare a detailed report.
iii) Identify the **sources of pollution** in your area and prepare a detailed report.
iv) Study **environmental ethics and environmental acts**.

ISE:

The In-Semester Examination (ISE) will be conducted in an **MCQ-based test pattern.**

MHS26111- Human Rights		
Teaching Scheme: **Theory: 2 Hours/Week**	**Credits: 02**	**Examination Scheme:** **In-Semester Exam: 30 Marks** **CAA: 30 Marks** **Total: 60 Marks**

Course Objectives:

To introduce students to the concept and evolution of human rights. Understand constitutional provisions related to human rights in India. Develop awareness about human rights in professional and technical environments. Analyze contemporary human rights issues in science, technology, and industry.

Course Outcomes: After successful completion of the course, students will be able to:

CO1: Explain the concept, historical development and classification of human rights, including the principles of the Universal Declaration of Human Rights (UDHR).

CO2: Interpret the human rights provisions in the Indian Constitution and evaluate the role of institutions such as NHRC and human rights courts in protecting vulnerable groups.

CO3: Apply human rights principles in technical and professional settings, including workplace ethics, labor rights, environmental sustainability, and AI/data privacy issues.

CO4: Analyze contemporary human rights issues in the global and digital context, including cyber security, intellectual property rights, refugees, and the role of international organizations.

Course Contents

Unit 1: Introduction to Human Rights **[07 Hours]**

Meaning, Nature and Scope of Human Rights, Evolution and Historical Development Universalism vs Cultural Relativism, Classification: Civil, Political, Economic, Social and Cultural Rights, International Bill of Human Rights, Universal Declaration of Human Rights (UDHR)

Unit 2: Human Rights and Indian Constitution **[07 Hours]**

Fundamental Rights under Constitution of India, Directive Principles of State Policy, Fundamental Duties, Kinds of Writ Petition, Role of National Human Rights Commission (NHRC), Human Rights Courts in India, Rights of Women, Children, SC/ST and Minorities

Unit 3: Human Rights in Technical and Professional Environment **[07 Hours]**

Right to Equality and Non-Discrimination in Workplace, Labor Rights and Industrial Safety, Right to Information and Transparency, Environmental Protection and Sustainable Development, National Institutions for the Protection and Promotion of Human Rights, National Human Rights Commission, -Corporate Social Responsibility (CSR), Ethical issues in Engineering, AI & Data Privacy

Unit 4:Contemporary Issues and Global Perspective **[07 Hours]**

Globalization, Multinational Corporations and Human Rights, Rights in the Digital Era, Cyber Security and Privacy Rights, Implications of Technological Advancements on Society, Expectations from the Technocrats, Effects of Robotics, Automation, and Artificial Intelligence on Daily Life, Surveillance Capitalism, Need of Code of Ethics for Engineers, Content Policing, Content Moderation, Effect of Emergence of Engineering and Technology on Human Rights in Warfare and Correctional Services

Text Books:

1. Human Rights Law and Practice –By Jatindra Kumar Das, PHI Learning, New Delhi
2. International Law and Human Rights, By Dr. S.K. Kapoor, Published by central law agency, 22nd edition - 2021

Reference Books:

1. Human Rights in Constitutional Law By D.D. Basu, (3rd ed., 2008) published by LexisNexis
2. International Law & Human Rights by Dr. H.O. Agarwal is published by Central Law Publications.
3. Human Rights and Law Justice P.S. Narayana –

Activity:

1. Case study on data privacy in AI systems/ content moderation on social media platforms and freedom of expression
2. Analysis of industrial safety standards/social dilemma critically reflecting working of digital platform
3. Report on environmental compliance of industries
4. Study of CSR initiatives of technical companies
5. Assignments on case studies related to technology abuse.
6. Poster designing or Seminars on specific rights.

Course Coordinator Bhoite G.G. | Autonomy Coordinator (Dean) | Dean Academics | Principal

Vidya Pratishthan's
Kamalnayan Bajaj Institute of
Engineering & Technology, Baramati
Vidyanagari, Baramati-413133

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PUNE (MS)

SEMESTER – III

MAI26201: Deep Learning					
Teaching Scheme:		**Credits:**	**04**	**Examination Scheme:**	
				Continuous Activity:	**20 Marks**
TH:	**04 Hrs/Week**			**In-Semester Exam:**	**30 Marks**
				End-Semester Exam:	**70 Marks**

Prerequisite Courses:

Linear Algebra, Probability and Statistics, Machine Learning, Python Programming

Course Objectives:

1.	To develop theoretical foundations of deep neural networks and representation learning.
2.	To study modern deep learning architectures used in vision, language and generative modeling.
3.	To analyze optimization strategies and scalability issues in deep networks.
4.	To understand recent research trends and deployment considerations in deep learning.

Course Outcomes:

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

CO1 :	Design and implement deep neural network architectures.
CO2 :	Apply optimization and regularization techniques effectively.
CO3 :	Develop CNN and Transformer-based models for real-world applications.
CO4 :	Analyze sequence models including LSTM and attention-based systems.
CO5 :	Implement generative and self-supervised learning models.
CO6 :	Deploy efficient, scalable and responsible deep learning systems

Course Contents

Unit I: Foundations of Deep Learn	**(7 Hrs)**

Introduction to Artificial Intelligence, Machine Learning and Deep Learning; biological neuron versus artificial neuron; perceptron and multilayer perceptron; activation functions; loss functions; gradient descent variants; backpropagation; computational graphs; vanishing and exploding gradient problems; introduction to automatic differentiation frameworks such as PyTorch and TensorFlow.

Unit II: Optimization and Regularization Techniques	**(7 Hrs)**

Advanced optimization algorithms including Momentum, RMSProp, Adam and AdamW; learning rate scheduling; weight initialization (Xavier and He initialization); batch normalization and layer normalization; dropout; early stopping; bias-variance tradeoff; hyperparameter tuning; mixed precision training and basics of distributed data parallel training

Unit III: Convolutional Neural Networks and Modern Vision Models	**(7 Hrs)**
Convolution operation, padding, stride and pooling; classical CNN architectures including LeNet-5, AlexNet, VGG16 and ResNet-50; transfer learning and fine-tuning; Vision Transformer (ViT-Base); contrastive learning approaches including SimCLR and MoCo; multimodal vision-language models such as CLIP and BLIP (conceptual overview).	
Unit IV: Sequence Models and Transformer Architectures	**(7 Hrs)**
Recurrent neural networks; Backpropagation Through Time; LSTM and GRU architectures; encoder- decoder models; attention mechanism; Transformer architecture; multi-head attention and positional encoding; pretrained language models including BERT and GPT-2; overview of large language models and prompt engineering concepts	
Unit V: Generative and Representation Learning	**(6 Hrs)**
Autoencoders and Variational Autoencoders (VAE); Generative Adversarial Networks (GAN), DCGAN and Wasserstein GAN; diffusion models including Denoising Diffusion Probabilistic Models (DDPM); Graph Convolutional Networks (GCN); Deep Q-Network (DQN) for reinforcement learning (conceptual introduction).	
Unit VI: Advanced Topics, Model Efficiency and Deployment	**(7 Hrs)**
Model compression techniques including pruning and quantization; knowledge distillation with example of DistilBERT; Neural Architecture Search (NASNet overview); adversarial attacks including Fast Gradient Sign Method (FGSM); explainable AI; fairness and bias; edge AI concepts; MLOps fundamentals; model serving and deployment using APIs and ONNX.	
Books & Other Resources:	
Textbooks:	
1.	Goodfellow, I., Bengio, Y., Courville, A. – Deep Learning, MIT Press
2.	**Aggarwal, Charu C.** *Neural Networks and Deep Learning: A Textbook*, Springer, 2018. **Publisher:** Springer **ISBN-13:** 978-3319944630
3	**Chollet, François.** *Deep Learning with Python*, 2nd Edition, Manning Publications, 2021. **Publisher:** Manning Publications **ISBN-13:** 978-1617296864
Reference Books:	
1.	**Zhang, Aston; Lipton, Zachary C.; Li, Mu; Smola, Alexander J.** *Dive into Deep Learning*, Cambridge University Press, 2023 (Print Edition). **Publisher:** Cambridge University Press **ISBN-13:** 978-1108470049
2	**Géron, Aurélien.** *Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow*, 2nd Edition, O'Reilly Media, 2019. **Publisher:** O'Reilly Media **ISBN-13:** 978-1492032649

MAI26202: Natural Language Processing					
Teaching Scheme:		**Credits:**	**04**	**Examination Scheme:**	
				Continuous Activity:	**20 Marks**
TH:	**04 Hrs/Week**			**In-Semester Exam:**	**30 Marks**
				End-Semester Exam:	**70 Marks**

Prerequisite Courses:

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

Companion Course, if any: Professional Core Lab-I

Course Objectives:

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:	Apply fundamental linguistic concepts, empirical laws, and text preprocessing techniques using Python-based NLP libraries for structured text analysis.
CO2:	Design and evaluate statistical and probabilistic models including N-gram models, Hidden Markov Models (HMM), and Conditional Random Fields (CRF) for sequence labeling and language modeling tasks
CO3:	Implement syntactic parsing methods and structured prediction techniques for NLP tasks.
CO4:	Analyze lexical semantic relationships and implement word representation techniques including WordNet and word embeddings.
CO5:	Apply transformer-based pre-trained language models such as BERT, GPT, and related architectures for advanced NLP applications.
CO6:	Evaluate NLP systems using appropriate datasets and performance metrics and analyze ethical considerations including bias and fairness in NLP models.

Course Contents

Unit I: Foundations of NLP and Text Processing	**(7 Hrs)**

Introduction to Natural Language Processing (NLP): problems, applications and challenges, stages of NLP, levels of linguistic analysis, empirical laws including Zipf's Law and Heaps' Law, text pre-processing techniques such as tokenization, normalization and case folding, stop-word removal, stemming and lemmatization, spelling correction using edit distance and dynamic programming, corpora construction and annotation, introduction to Python NLP libraries such as NLTK and spaCy.

Unit II: Statistical NLP and Sequence Labeling	**(7 Hrs)**

Statistical NLP and Sequence Labeling: probability review for NLP, N-gram language models, smoothing techniques including Laplace smoothing, Good-Turing smoothing and Kneser-Ney smoothing, Hidden Markov Models including Forward algorithm, Backward algorithm, Viterbi algorithm and Baum–Welch algorithm, part-of-speech (POS) tagging, sequence labeling models such as Maximum Entropy and Conditional Random Fields (CRF), evaluation metrics including perplexity, accuracy and F1-score.

Unit III: Syntactic Parsing and Structured Prediction	**(7 Hrs)**

Context-free grammar (CFG), constituency parsing, dependency parsing, CKY algorithm, probabilistic parsing, transition-based dependency parsing, graph-based dependency parsing, parsing ambiguities and issues, co-reference resolution, named entity recognition (NER).

Unit IV: Lexical Semantics and Word Representations	**(7 Hrs)**

Lexical semantics, word senses and word similarity, word sense disambiguation (supervised and unsupervised approaches), WordNet and knowledge bases, distributional semantics, one-hot encoding, word embeddings including Word2Vec (CBOW and Skip-Gram), GloVe and FastText, evaluation of word embeddings, limitations of static embeddings.

Unit V: Neural Network and Transformer Models for NLP	**(7 Hrs)**

Recurrent neural networks (RNN) for language modeling, backpropagation through time (BPTT), long short-term memory (LSTM), gated recurrent unit (GRU), transformer architecture, self-attention mechanism, positional encoding, encoder–decoder architecture, pre-trained language models such as Google's BERT, OpenAI's GPT and RoBERTa.

Unit VI: Advanced NLP Applications.	**(7 Hrs)**

Text classification; sentiment analysis; machine translation; question answering; summarization; dialogue systems; evaluation metrics such as BLEU, ROUGE and F1-score; ethical considerations and bias in NLP.

Books & Other Resources:	
Textbooks:	
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/Cummings
Reference Books:	
1.	Conferences: Annual Meeting of the Association for 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.
E-books:	
1.	Speech and Language Processing – Daniel Jurafsky and James H. Martin
2	Natural Language Processing with Python – Steven Bird, Ewan Klein
3	Neural Network Methods in Natural Language Processing – Yoav Goldberg

Important links:

1. Stanford NLP Course – https://web.stanford.edu/class/cs224n/
2. NPTEL Natural Language Processing – https://onlinecourses.nptel.ac.in/noc26_cs45
3. NLP Specialization – https://www.coursera.org/specializations/natural-language-processing
4. NLTK Library – https://www.nltk.org
5. spaCy NLP Library – https://spacy.io
6. HuggingFace Transformers – https://huggingface.co

MAI26203-A: Data Modelling and Visualization					
Teaching Scheme:		**Credits:**	**04**	**Examination Scheme:**	
				Continuous Activity:	**20 Marks**
TH:	**04 Hrs/Week**			**In-Semester Exam:**	**30 Marks**
				End-Semester Exam:	**70 Marks**

Prerequisite Courses:

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

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: Introduction and Data Fundamentals	**(6 Hrs)**

Concepts: Information visualization, data types, and data quality.

Data Preparation: Connecting to data sources, cleaning, transforming, blending, and shaping data.

Unit II: Data Modeling Techniques	**(6 Hrs)**

Modeling Concepts: Entity-Relationship (ER) diagrams, supertypes/subtypes, and hierarchical data. **Dimensional Modeling:** Star schema, snowflake schema, fact tables, and dimension tables. **Advanced Modeling:** Recursive relationships, historical data, and stochastic processes (Markov chains).

Unit III: Statistical & Machine Learning Modeling	(7 Hrs)
Regression: Linear & Logistic Regression, **Tree Models:** Regression Trees & Random Forest., **SVR:** Support Vector Regression with kernels. **Clustering:** K-Means & Hierarchical Clustering. **Association Rules:** Apriori Algorithm. **Model Issues:** Bias-Variance, Overfitting & Underfitting. **Metrics:** RMSE, MAE, R^2 Score. **Validation:** K-Fold Cross-Validation.	
Unit IV: Visualization Principles & Techniques	**(6 Hrs)**
Principles of Information Visualization: Visual perception, cognitive aspects, and design principles. **Core Visualization Techniques:** Bar, Line, Scatter plots, Heatmaps. **Advanced Visualizations:** Geospatial and Temporal visualization. **Dimensionality Reduction:** PCA and t-SNE for visualization.	
Unit V: Advanced Visualization Tools & Analytics	**(6 Hrs)**
Tools: Python libraries (Matplotlib, Seaborn, Plotly) or BI tools (Tableau, Power BI). Interactive Dashboards and Storytelling with Data. Visualizing geospatial, temporal, and hierarchical data. **Big Data Visualization Concepts:** Handling large-scale datasets , Sampling & aggregation techniques, Distributed data visualization	
Unit VI: Data Modeling in Practice	**(7 Hrs)**
Data Wrangling/Cleaning techniques using Python (Pandas). Handling Missing Values, Data Transformation, and Normalization. **Case studies:** Customer Churn Analysis, Sales Forecasting, and Time Series Data analysis	

Books & Other Resources:

Textbooks:

1.	Ralph Kimball and Margy Ross, *The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling*, John Wiley & Sons, 3rd Edition, 2013.
2.	Gareth James, Daniela Witten, Trevor Hastie and Robert Tibshirani, *An Introduction to Statistical Learning*, Springer, 2013.
3.	Cole Nussbaumer Knaflic, *Storytelling with Data: A Data Visualization Guide for Business Professionals*, Wiley, 2015.

Reference Books:

1.	Jiawei Han, Micheline Kamber and Jian Pei, *Data Mining: Concepts and Techniques*, Morgan Kaufmann, 3rd Edition, 2011.
2.	Christopher M. Bishop, *Pattern Recognition and Machine Learning*, Springer, 2006.
3.	Ramez Elmasri and Shamkant B. Navathe, *Fundamentals of Database Systems*, Pearson, 7th Edition, 2016
4.	Wes McKinney, *Python for Data Analysis*, O'Reilly Media, 2nd Edition, 2017.

E-books/Online Resources:

1.	Gareth James et al., *An Introduction to Statistical Learning with Python*, Springer

2	Allen B. Downey, *Think Stats*, O'Reilly Media, 2nd Edition, 2014

Important links:

1. An Introduction to Statistical Learning: https://www.statlearning.com
2. **Microsoft Power BI Documentation:** https://learn.microsoft.com/power-bi
3. **Scikit-learn Official Documentation:** https://scikit-learn.org

MAI26203-B: Product Life Cycle Management					
Teaching Scheme:		**Credits:**	**04**	**Examination Scheme:**	
				Continuous Activity:	**20 Marks**
TH:	**04 Hrs./Week**			**In-Semester Exam:**	**30 Marks**
				End-Semester Exam:	**70 Marks**

Prerequisite Courses: Software Engineering

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

Companion Course, if any: no

Course Objectives:

1.	To understand history, concepts and terminology of PLM
2.	To understand functions and features of PLM/PDM
3.	To understand different modules offered in commercial PLM/PDM tools
4.	To demonstrate PLM/PDM approaches for industrial applications

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:	Implement PLM/PDM approaches for industrial applications.
CO5:	Use different modules offered in commercial PLM/PDM tools.
CO6:	Integrate PLM/PDM with legacy data bases, CAx & ERP systems.

Course Contents

Unit I: Introduction to Product Life Cycle Management **(7 Hrs)**

Definition, PLM Life cycle model, Threads of PLM, Need for PLM, Opportunities and benefits of PLM, Views, Components and Phases of PLM, PLM feasibility study, PLM visioning. Characteristics of PLM, Environment driving PLM, PLM Elements, Drivers of PLM, Conceptualization, Design, Development, Validation, Production, Support of 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, 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)**
PDM systems and importance, reason for implementing a PDM system, financial justification of PDM implementation. Versioning, check-in and checkout, views, Metadata, Lifecycle, and workflow. Applied problems and solution on PDM processes and workflow.	
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: ROLE OF PLM ININDUSTRIES	**(7 Hrs)**
Case studies on PLM selection and implementation (like auto, aero, electronic) – other possible sectors, PLM visioning, PLM strategy, PLM feasibility study, change management for PLM, financial justification of PLM, barriers to PLM implementation. **Basics On Customization/Integration Of PDM/PLM Software:** PLM Customization, use of EAI technology (Middleware), Integration with legacy data base, CAD, SLM and ERP.	
Books & Other Resources:	
Textbooks:	
1.	Product Lifecycle Management: Grieves, Michael, McGraw-Hil, Edition 2006.ISBN0071452303
2.	PDM: Product Data Management: Burden, Rodger, Resource Pub, 2003. ISBN0970035225.
Reference Books:	
1.	Fabio Guidice, Guido La Rosa, Product Design for the environment A life cycle approach, Taylor and Francis2006.
2.	Robert J. Thomas, “NDP: Managing and forecasting for strategic processes”.
3.	Stark, John,” Product Life cycle Management: Paradigm for 21st Century Product Realization “, Springer-Verlag, 2004. ISBN1852338105
E-books:	
1.	https://nitsri.ac.in/Department/Mechanical%20Engineering/MSD_201_Product_Lifecycle_Manage ment_pateiktys.pdf
2	https://edurev.in/courses/14588_product-management-books-notes-and-tests
Important links: **https://studylib.net/doc/25818926/plm-notes**	

MAI26203-C GPU Computing					
Teaching Scheme:		**Credits:**	**04**	**Examination Scheme:**	
				Continuous Activity: :	**20 Marks**
TH:	**04 Hrs/Week**			**In-Semester Exam:**	**30 Marks**
				End-Semester Exam:	**70 Marks**

Prerequisite Courses: High Performance Computing, Data Structure, Object Oriented Programming, Operating System

Companion Course, if any: Professional Core Lab-I

Course Objectives:

1.	To provide foundational understanding of parallel and heterogeneous computing architectures with emphasis on GPU systems.
2.	To develop proficiency in GPU programming models, memory hierarchy, and performance optimization techniques using CUDA and related frameworks.
3.	To design and implement parallel algorithms on GPU for computationally intensive applications.
4.	To explore advanced GPU computing frameworks and real-world applications in scientific computing, machine learning, and high-performance systems.

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

CO1:	Analyze parallel computing principles and GPU architectural components to evaluate performance characteristics.
CO2:	Design and implement GPU kernels using CUDA/OpenCL programming models.
CO3:	Apply memory optimization and concurrency techniques to improve GPU program efficiency.
CO4:	Develop and evaluate parallel algorithms such as reduction, scan, sorting, and matrix operations on GPU platforms.
CO5:	Utilize GPU libraries and frameworks for accelerating machine learning and scientific computing applications.
CO6:	Assess scalability, performance trade-offs, and energy considerations in advanced GPU-based computing systems.

Course Contents

Unit I: Foundations of Parallel and Heterogeneous Computing	(8 Hrs)

Evolution of Parallel Computing, Flynn's Taxonomy, Multicore vs Manycore Architectures, CPU vs GPU Architecture Comparison Memory Hierarchy in Parallel Systems, Amdahl's Law and Gustafson's Law, Introduction to Heterogeneous Computing, Performance Metrics (Throughput, Latency, Speedup, Efficiency)

Unit II: GPU Architecture and Programming Model	(8 Hrs)

GPU Hardware Architecture, Streaming Multiprocessors (SM),CUDA Cores, Warps and Threads, SIMT Execution Model, Thread Hierarchy (Grid, Block, Thread),GPU Memory Architecture, Global Memory, Shared Memory, Constant & Texture Memory, Registers, Memory Coalescing, Occupancy and Latency Hiding

Unit III: CUDA Programming and Optimization Techniques	(8 Hrs)
CUDA Programming Model, Kernel Launch Configuration, Thread Synchronization, Shared Memory Usage Memory Transfers (Host ↔ Device), Streams and Concurrency, Optimization Techniques: Memory Coalescing, Loop Unrolling, Bank Conflict Avoidance, Warp Divergence Minimization. Profiling and Performance Analysis	
Unit IV: Parallel Algorithms on GPU	(8 Hrs)
Parallel Reduction, Parallel Scan (Prefix Sum),Matrix Multiplication, Sorting Algorithms (Bitonic Sort, Merge Sort), Graph Algorithms on GPU, Sparse Matrix Computations, Performance Comparison: CPU vs GPU,	
Unit V: GPU Computing Frameworks and Libraries	(8 Hrs)
OpenCL Programming Model, Thrust Library, cuBLAS, cuDNN, PyCUDA / Numba, TensorFlow & PyTorch GPU Acceleration, Multi-GPU Programming, Distributed GPU Systems	
Unit VI: Advanced Topics and Applications of GPU Computing	(8 Hrs)
GPU in Machine Learning and Deep Learning, High Performance Scientific Computing, GPU in Image and Signal Processing, GPU in Blockchain and Cryptography, Real-Time Rendering and Ray Tracing, Performance Tuning and Scalability, Energy Efficiency in GPU Systems	

Books & Other Resources:

Textbooks:

1	Kirk, David B., and Hwu, Wen-mei W., Programming Massively Parallel Processors: A Hands-on Approach, 4th Edition, Morgan Kaufmann, 2022. ISBN-13: 978-0323912310..
2	Sanders, Jason, and Kandrot, Edward, CUDA by Example: An Introduction to General-Purpose GPU Programming, Addison-Wesley Professional, 2010. ISBN-13: 978-0131387683.
3	Cook, Shane, CUDA Programming: A Developer's Guide to Parallel Computing with GPUs, Morgan Kaufmann, 2012.ISBN-13: 978-0124159334..

Reference Books:

1	Gaster, Benedict, Howes, Lee, Kaeli, David R., Mistry, Perhaad, and Schaa, Dana, Heterogeneous Computing with OpenCL,2nd Edition, Morgan Kaufmann, 2012. ISBN-13: 978-0124058941.
2	Farber, Rob, Parallel Programming with OpenACC, Morgan Kaufmann, 2016. ISBN-13: 978- 0124103979.

3	Nguyen, Hubert (Ed.), GPU Gems 2: Programming Techniques for High-Performance Graphics and General-Purpose Computation, Addison-Wesley Professional, 2005. ISBN-13: 978-0321335593.
E-books:	
1	NVIDIA, CUDA C Programming Guide (Latest Version), NVIDIA Corporation. https://docs.nvidia.com/cuda/
2	NVIDIA Developer Documentation and CUDA Toolkit Resources https://developer.nvidia.com/cuda-toolkit
3	Khronos Group, OpenCL Specification (Latest Version) https://www.khronos.org/opencl/
4	NVIDIA Nsight Systems & Nsight Compute Documentation https://developer.nvidia.com/nsight-tools
Activities (Any one)	
GPU Performance Optimization Study and Technical Report (20 Marks) Objective: To analyze GPU architecture, implement parallel algorithms, and evaluate performance improvements through optimization.	
GPU-Based Mini Project (Application-Oriented) (20 Marks) Objective: To design and develop a real-world GPU-accelerated application.	
Practical Assignments	
1	CUDA Environment Setup and Basic Parallel Kernel Implementation
2	GPU Memory Hierarchy and Optimization Study
3	Implementation of Parallel Algorithms on GPU
4	GPU-Accelerated Application using Libraries
5	Mini Project – Application-Based GPU Optimization

MAI26203-D: Data Mining and Analysis					
Teaching Scheme:		**Credits:**	**04**	**Examination Scheme:**	
				Continuous Activity:	**20 Marks**
TH:	**04 Hrs/Week**			**In-Semester Exam:**	**30 Marks**
				End-Semester Exam:	**70 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 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 Is 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, (μ, p)-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 – Ian H. Witten & Eibe Frank.
Reference Books:	
1.	Data Mining: Practical Machine Learning Tools and Techniques – Ian H. Witten & Eibe Frank.
2.	Data Mining Techniques: For Marketing, Sales, and Customer Relationship Management – Gordon S. Linoff and Michael J. Berry (Apr 12, 2011).
3.	Data Mining: A Tutorial Based Primer – Richard Roiger and Michael Geatz (Oct 6, 2002).
E-books:	
1.	https://myweb.sabanciuniv.edu/rdehkharghani/files/2016/02/The-Morgan-Kaufmann- Series-in-Data-Management-Systems-Jiawei-Han-Micheline-Kamber-Jian-Pei-Data- Mining.-Concepts-and-Techniques-3rd-Edition-Morgan-Kaufmann-2011.pdf
2	https://dataminingbook.info/book_html/

MAI26204: Dissertation Stage - I					
Teaching Scheme:		**Credits:**	**04**	**Examination Scheme:**	
				Term work :	**50 Marks**
PR:	**08 Hrs/Week**			**Oral:**	**50 Marks**

Course Objectives:

1.	Identify and define a suitable research domain aligned with the student's specialization.
2.	Develop the ability to communicate research ideas effectively using appropriate scientific and technical language in collaboration with the research guide.
3.	Understand different modes of technical publications such as journals, conferences, and workshops, along with common terminologies used in research dissemination
4.	Systematically collect, organize, and categorize research materials related to the selected domain.
5	Formulate a clear research problem and outline the proposed research methodology under the guidance of the mentor.
6	Acquire relevant information independently from scholarly sources and critically evaluate its suitability for addressing the research problem.

Course Outcomes:

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

CO1:	Conduct a comprehensive literature survey in the chosen research domain.
CO2:	Demonstrate effective presentation skills to communicate technical concepts and research progress.
CO3:	Prepare a structured technical report documenting the selected research domain and proposed work.
CO4	Critically analyze and compare existing research contributions related to the selected topic

Course Description

Dissertation Stage–I is an integral component of the M.Tech dissertation work. During this stage, the student is expected to identify a suitable research problem and perform preliminary work required for the dissertation. The work carried out in this phase generally includes problem definition, literature survey, analysis of existing research, and preparation of the initial design or methodology.

The student shall prepare a comprehensive review of relevant research papers, technical reports, and related literature in the selected domain. Based on the literature review, the student should clearly define the research problem and propose a suitable approach or methodology to address it.

The work completed during Dissertation Stage–I should include preparation of the proposed design and implementation framework. This may involve development of a mathematical model, Software Requirement Specification (SRS), UML diagrams, ER diagrams, block diagrams, system architecture, or a PERT chart describing the project plan and milestones. The layout and design of the proposed experimental or computational setup should also be presented.

As part of the evaluation process, the student must deliver a seminar presentation

describing the selected research topic, the state-of-the-art technologies related to the topic, and the progress achieved during this stage. The presentation should highlight the motivation, literature findings, research gap, proposed methodology, and expected outcomes of the dissertation work At the end of Dissertation Stage–I, the student must submit a progress report in a prescribed format. The report must be duly approved and certified by the research guide and the Head of the Department/Institute, confirming satisfactory progress.

The evaluation of Dissertation Stage–I shall be carried out by a panel of examiners, including at least one external examiner. The assessment will be based on the literature review, technical understanding of the topic, quality of the proposed methodology, presentation skills, documentation quality, and overall research preparedness.

Students are encouraged to validate their research ideas by preparing technical manuscripts and submitting them to reputed conferences and/or peer-reviewed journals.

Students must demonstrate continuous progress through periodic meetings with the research guide, progress presentations, and proper documentation of research activities as advised by the PG coordinator.

All documentation should follow the formats and guidelines specified in the Dissertation Workbook approved by the Board of Studies.

MHS26201- Introduction to Constitution of India		
Teaching Scheme: **Theory: 2 Hours/Week**	**Credits: 02**	**Examination Scheme:** **In-Semester Exam: 30 Marks** **CAA: 30 Marks** **Total: 60 Marks**

Course Objectives: To realize the significance of constitution of India to students from all walks of life and help them to understand the basic concepts of Indian constitution. Identify the importance of fundamental rights as well as fundamental duties. Understand the functioning of Union, State and Local Governments in Indian federal system. 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.

CO 2. Utilize his fundamental rights in proper sense at the same time identifies his responsibilities in national building.

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

CO 4. Understand Electoral Process, Emergency provisions and Amendment procedure

Course Contents

UNIT-I Introduction to Constitution: **[7 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: **[7 Hours]**

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

UNIT-III State and Local Governments: **[7 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 to 74th Amendment.

UNIT-IV Election Emergency and Amendment Provisions **[7 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. D.D. Basu, Introduction to the Constitution of India, LexisNexis, 25th Edition, 2021.

Reference Book:

1. D.D. Basu, Introduction to the Constitution of India, LexisNexis, 25th Edition, 2021.
2. Subhash Kashyap, Our Constitution: An Introduction to India's Constitution and Constitutional Law, National Book Trust, 2019.
3. Bare Act, Constitution of India, Government of India Publications.
4. Merunandan, "Multiple Choice Questions on Constitution of India", 2nd Edition, Meraga publication, 2007.

Activity:

1. Poster presentation /PPT Presentation
2. Case Study
3. Seminar

Course Coordinator Bhoite G. G

Autonomy Coordinator

Dean Academics

Principal

Vidya Pratishthan's
Kamalnayan Bajaj Institute of
Engineering & Technology, Baramati
Vidyanagari, Baramati-413133

VPKBIET BARAMATI
Affiliated to S.P.P.U. Pune
Id No.: PU/PN/
Engg./152/2008
PUNE (MS.)

MRA26205- Industrial Management

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 2 hrs/week	TH:2	Activity Marks = 30 Marks
		In Sem.=30 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 Content

Unit I: Basics of Management **6 Hrs**

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

Motivation - Maslow's Theory of Motivation -Hierarchy of needs- Communication - Process of Communication – Barriers for effective communication.

Unit II: Production Management **6 Hrs**

Concept of project work - Project planning -Market survey- Project capacity-selection of site for project Plant layout-Types of Plant layout

Product design-Stages in product design drawing-Specifications-Material requirement-operation-Planning-Production-definition-Job, Batch & Mass production with their advantages and disadvantages-

Productivity-definition factors to improve productivity- Production planning and Control (PPC)-definition-Functions of PPC- planning, routing, scheduling, dispatching and Inspection-

Unit III: Total quality management	**6 Hrs**

Quality–Concept-Quality control- Definition - Factors affecting quality- Advantages of quality control –Inspection-Different types of inspection

Total Quality Management-Meaning- Principles of total quality management-PDCA cycles Quality Circles-definition-Function.

TQM Tools- Flow charts, Control charts, Histograms, Pareto charts, Cause and effect diagram-5-S-Kaizen, and Six-sigma

Quality Certification Systems- ISO 9000 series quality standards

Unit IV: Plant maintenance and industrial safety	**6 Hrs**

Plant maintenance-Definition -Types of maintenance-Preventive maintenance- Break down maintenance-Advantages and disadvantages-

Total Productive Maintenance-Meaning benefits of TPM -Tools of TPM- planned maintenance and predictive maintenance.

Industrial safety –Meaning - Accident- causes for accident- Direct and indirect losses due to an accident-Personal protective devices for preventions of accidents

Safety department- role of safety officer – safety supervisor -safety committee – Fire prevention and Protection- Fire triangle-principles of fire extinguishing- various classes of fire- A, B,C, D types of fire extinguishers

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

Note: The **semester examination will be conducted in the form of objective questions.**

Total Quality Management-Meaning- Principles of total quality management-PDCA cycles Quality Circles-definition-Function.

TQM Tools- Flow charts, Control charts, Histograms, Pareto charts, Cause and effect diagram-5-S-Kaizen, and Six-sigma

Quality Certification Systems- ISO 9000 series quality standards

Unit IV: Plant maintenance and industrial safety **6 Hrs**

Plant maintenance-Definition -Types of maintenance-Preventive maintenance- Break down maintenance-Advantages and disadvantages-

Total Productive Maintenance-Meaning benefits of TPM -Tools of TPM- planned maintenance and predictive maintenance.

Industrial safety –Meaning - Accident- causes for accident- Direct and indirect losses due to an accident-Personal protective devices for preventions of accidents

Safety department- role of safety officer – safety supervisor -safety committee – Fire prevention and Protection- Fire triangle-principles of fire extinguishing- various classes of fire- A, B,C, D types of fire extinguishers

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

Note: The **semester examination will be conducted in the form of objective questions.**

MAI26205: Seminar					
Teaching Scheme:				**Examination Scheme:**	
				Term Work:	**25 Marks**
PR:	**04 Hrs/Week**	**Credits:**	**02**	**Oral:**	**25 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 selects the Seminar 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. Students should be allocated the seminar guide.

Panel and staff members along with guide would be assessing the seminar work.

The assigned guide 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.

SEMESTER-IV

MAI26211-Industry Internship / In-house research project			
Teaching Scheme	**Credit Scheme**	**Examination Scheme**	
Practical: 20 hrs/week	**10**	**Continuous Activity:**	**100 Marks**
		Term Work :	**100 Marks**
		Oral:	**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.

MAI26212: Dissertation Stage - II					
Teaching Scheme:		**Credits:**	**08**	**Examination Scheme:**	
				Continuous Activity:	**50 Marks**
PR:	**16 Hrs/Week**			**Term work:**	**100 Marks**
				Oral:	**100 Marks**

Course Objectives:

1.	To follow the Software Development Life Cycle (SDLC) systematically and achieve the objectives of the proposed research work.
2.	To rigorously test and verify the developed system or methodology before deployment or final evaluation.
3.	To validate the work undertaken through experimental analysis and performance evaluation.
4.	To compile, organize, and present the completed research work in the form of a structured technical report.

Course Outcomes:

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

CO1:	Demonstrate evidence of independent investigation and research capability.
CO2:	Critically analyze experimental results, interpret findings, and draw meaningful conclusions.
CO3:	Report and present original research results systematically while identifying open research problems.
CO4:	Relate techniques and results from existing literature with the implemented research work and propose possible future research directions.
CO5	Understand and appreciate practical implications, constraints, and limitations associated with the specialized research domain.

Course Guidelines

Dissertation Stage–II represents the final phase of the M.Tech dissertation work. In this stage, the student is expected to complete the remaining part of the research work initiated during Dissertation Stage–I. The work carried out in this phase typically includes selection of appropriate technologies, installation and configuration of required tools or environments, implementation of system modules or algorithms, and development of the proposed solution.

The student must perform detailed system implementation which may involve UML-based system realization, algorithm implementation, model development, or experimental setup depending on the nature of the research problem. After implementation, rigorous testing and validation of the developed system should be conducted.

The student must evaluate the performance of the proposed system using suitable metrics and parameters. Experimental results should be carefully documented and analyzed using data tables, graphs, and comparative studies with existing or baseline algorithms or systems. The work should include performance measurements,

discussions of improvements over existing approaches, comparative analysis, and validation of results.

Based on the experimental observations and analysis, the student should derive meaningful conclusions and highlight the contributions of the research work. Any limitations encountered during the research process should also be discussed, along with potential directions for future work.

At the completion of Dissertation Stage–II, the student shall prepare and submit the final dissertation report in the prescribed standard format. The report must be duly approved and certified by the research guide and the Head of the Department/Institute.

Students are encouraged to validate their research contributions by publishing their work in recognized conferences and/or peer-reviewed journals.

Students must demonstrate continuous progress through periodic meetings with the research guide, progress presentations, and proper documentation of research activities as advised by the PG coordinator.

All documentation should follow the formats and guidelines specified in the Dissertation Workbook approved by the Board of Studies