Zeal Education Society's

ZEAL COLLEGE OF ENGINEERING & RESEARCH, PUNE – 41

(An Autonomous Institute Affiliated to Savitribai Phule Pune University)

*NAAC Accredited with **A+** Grade / ISO 21001:2018*

DEPARTMENT OF COMPUTER ENGINEERING

Curriculum Structure and Syllabus of

F.Y. M. Tech. – Computer Engineering

Data Sciences

(With effect from - Academic Year 2024- 25)

VISION OF THE INSTITUTE

To be a premier institute in technical education by imparting academic excellence, research, social and entrepreneurial attitude**.**

MISSION OF THE INSTITUTE

- To achieve academic excellence through innovative teaching and learning process.
- To imbibe the research culture for addressing industry and societal needs.
- To inculcate social attitude through community engagement initiatives.
- To provide conducive environment for building the entrepreneurial skills.

DEPARTMENT OF COMPUTER ENGINEERING

VISION:

To emerge as a department of repute in Computer Engineering through innovative teaching, research, social responsibility, and entrepreneurial skills, developing responsible IT professionals.

MISSION:

M1: To provide in depth technical education and hands-on experiences in Computer engineering using modern tools and technologies.
M2: To endeavor innovative research culture to fulfill the needs of Industry and Society.
M3: To instill in students a deep sense of social responsibility.
M4: To strengthen collaboration between industry and academia, fostering the development of entrepreneurial skills among the students.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

PEO1: Graduates will apply knowledge of computer engineering to solve complex engineering problems, propose algorithmic solutions, thus establishing themselves as successful IT professional.
PEO2: Graduates will exhibit leadership qualities and innovative thinking, contributing to the development of cutting-edge solutions and career advancements in the field of computer engineering through research, collaborative teamwork and entrepreneurial initiatives.
PEO3: Graduates will maintain ethics, meet societal duties, and pursue life-long learning to stay updated and contribute meaningfully to their field and the society.

PROGRAM OUTCOMES (POs):

PO1: An ability to independently carry out research /investigation and development work to solve practical problems.
PO2: An ability to write and present a substantial technical report/document.
PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PROGRAM SPECIFIC OUTCOMES (PSOs):

PSO1: Professional Skills-The ability to understand, analyze and develop computer programs in the areas related to algorithms, system software, multimedia, web design, big data analytics, and networking for efficient design of computer-based systems of varying complexities.

PSO2: Problem-Solving Skills- The ability to apply standard practices and strategies in software project development using open-ended programming environments to delivera quality product for business success.

PSO3: Successful Career and Entrepreneurship- The ability to employ modern computer languages, environments and platforms in creating innovative career paths to be an entrepreneur and to have a zest for higher studies.

DEPARTMENT OF COMPUTER ENGINEERING

LIST OF ABBREVIATIONS

Abbreviation	Description
PCC	Programme Core Course
PEC	Programme Elective Course
OEC	Multidisciplinary Minor
LC	Open Elective - Other than a particular program
SEM	Vocational and Skill Enhancement Course
MC	Management Courses
DIS	Dissertation Phase
MOOC	Massive Open Online Course -I
M. Tech.	Master of Technology
L	Lecture
P	Practical
T	Tutorial
H	Hours
CR	Credits
CIE	Continuous Internal Evaluation
ETE	End Term Evaluation
TH	Theory
TW	Term Work
OR	Oral
PR	Practical

DEPARTMENT OF COMPUTER ENGINEERING

First Year M. Tech. – Data Science: Semester - I

Course Code	Course Type	Course Name	Teaching Scheme (hrs/Week)						Evaluation Scheme (Marks)					
			L	P	H	CR			CIE	ETE	TW	PR	OR	Total
						TH	PR	Total						
CODS101	PCC	Advanced Mathematics for Data Science	4	-	4	4	-	4	50	50	-	-	-	100
CODS102	PCC	Machine Learning Fundamentals	4	-	4	4	-	4	50	50	-	-	-	100
CODS103	PCC	Database Systems for Data Science	3	-	3	3	-	3	50	50	-	-	-	100
CODS104	PEC	Professional Elective – I*	3	-	3	3	-	3	50	50	-	-		100
	OEC	Open Elective – I#	3	-	3	3	-	3	50	50	-	-	-	100
CODS106	LC	Laboratory Proficiency – I	-	4	2	-	2	2	-	-	25	50	-	75
CODS107	SEM	Seminar	-	2	2	-	1	1	-	-	25	-	50	75
CODS108	MC	Audit Course – I: Technical Paper writing	1	-	1	-	-	-	-	-	-	-	-	-
Total			**18**	**6**	**24**	**17**	**3**	**20**	**250**	**250**	**75**	**25**	**50**	**650**

*** Program Elective – I: Choose any one from the following:**

Course Code	Course Type	Program Elective-I
CODS104A	PEC	Information Systems Management
CODS104B		Artificial Intelligence for Data Science

 # Open Elective – I: Choose any one from the following:

Course Code	Course Type	Open Elective – I	Offered by Department
EEPS105	OEC	Industrial Automation	Electrical
ETIS105		Internet of Things	E&TC
MEDE105		Product Lifecycle Management (PLM)	Mechanical
MERA105		Microcontrollers Architecture and Programming	Mechanical

BoS Chairman

ZES's Zeal College of Engineering & Research PU/PN/Engg./285/2007 Narhe, Pune-41

Director
ZES's Zeal College of Engineering & Research Narhe, Pune - 411041.

DEPARTMENT OF COMPUTER ENGINEERING

First Year M. Tech. – Data Science: Semester - II

Course Code	Course Type	Course Name	Teaching Scheme (hrs/Week)						Evaluation Scheme (Marks)					
			L	P	H	CR			CIE	ETE	TW	PR	OR	Total
						TH	PR	Total						
CODS201	PCC	Statistical Methods for Data Science	4	-	4	4	-	4	50	50	-	-	-	100
CODS202	PCC	Deep Learning	4	-	4	4	-	4	50	50	-	-	-	100
CODS203	PCC	Data Visualization	3	-	3	3	-	3	50	50	-	-	-	100
CODS204	PEC	Program Elective – II*	3	-	3	3	-	3	50	50	-	-		100
	OEC	Open Elective – II#	3	-	3	3	-	3	50	50	-	-	-	100
CODS206	LC	Laboratory Proficiency – II	-	4	4	-	2	2	-	-	50	50	-	100
CODS207	DIS	Dissertation Phase – I	-	2	2	-	1	1	-	-	25	-	25	50
CODS208	MC	Audit Course – II: Constitution of India	1	-	1	-	-	-	-	-	-	-	-	-
Total			**18**	**6**	**24**	**17**	**3**	**20**	**250**	**250**	**75**	**25**	**50**	**650**

*** Program Elective – II: Choose any one from the following:**

Course Code	Course Type	Program Elective - II
CODS204A	PEC	Recommender Systems
CODS204B		Web Intelligence

 # Open Elective – II: Choose any one from the following:

Course Code	Course Type	Open Elective – II	Offered by Department
EEPS205	OEC	Electric Vehicles	Electrical
ETIS205		Embedded System	E&TC
MEDE205		Process Equipment and Plant Design	Mechanical
MERA205		Micro Electro Mechanical Systems	Mechanical

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DEPARTMENT OF COMPUTER ENGINEERING

SYLLABUS

SEMESTER - I

DEPARTMENT OF COMPUTER ENGINEERING

Program: M. Tech. (Computer – Data Science)								**Semester:** I	
Course: Advanced Mathematics for Data Science.								**Code:** CODS101	
Teaching Scheme (hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
04	-	-	04	50	50	-	-	-	100

Prerequisites:

Basic knowledge of Linear Algebra, Fundamental concepts of Calculus, Introductory Probability and Statistics, Basic Programming Skills.

Course Objectives:

1. To equip students with advanced mathematical tools and techniques essential for analysing complex data sets and constructing predictive models.
2. To Equip students with the skills to apply mathematical approaches in formulating and solving real-world problems effectively
3. To integrate theoretical concepts with practical applications to foster a comprehensive understanding of data science.

Course Outcomes: At the end of the course, the student will be able to -

CO1	Understand and apply advanced concepts of vector spaces and linear transformations.
CO2	Perform differentiation and integration of functions of multiple variables.
CO3	Understand stochastic processes and their applications in modelling and prediction.
CO4	Apply statistical methods to infer properties about populations from sample data.
CO5	Implement optimization algorithms to solve complex data science problems.
CO6	Explore advanced mathematical techniques used in contemporary data science research.

Course Contents:

Unit	**Description**
1.	**Advanced Linear Algebra:** Vector Spaces and Subspaces, Linear transformations and Matrices, Eigenvalues and Eigenvectors, Singular Value Decomposition (SVD) Principal Component Analysis (PCA) and its Applications
2.	**Multi-variable Calculus:** Partial Derivatives and Gradient Vectors, Multiple Integrals and Applications, Optimization Techniques: Gradient Descent, Constrained Optimization, Lagrange Multipliers, Introduction to Partial Differential Equations (PDEs)
3.	**Probability Theory and Stochastic Processes:** Probability Distributions and Densities, Expectation and Variance, Law of Large Numbers and Central Limit Theorem, Markov Chains and Hidden Markov Models, Brownian Motion and Random Walks
4.	**Statistical Inference:** Estimation Theory: Point and Interval Estimation, Hypothesis Testing: t-tests, Chi-Square Tests, Bayesian Inference and Methods , Analysis of Variance (ANOVA), Regression Analysis and

	Model Diagnostics.
5.	**Optimization Techniques:** Convex Optimization, Linear Programming and Integer Programming, Non-Linear Optimization Techniques, Gradient-Based Methods, Heuristic and Metaheuristic Methods: Genetic Algorithms, Simulated Annealing.
6.	**Advanced Topics in Mathematics for Data Science:** Tensor Analysis and Deep Learning, graph theory and network analysis, Advanced machine learning, Algorithms: Support Vector Machines, Ensemble Methods, Mathematical Foundations of Neural Networks, Applications of Algebraic Geometry in Data Science.

Text Books:

1. Gilbert Strang, "Linear Algebra and Its Applications", Pearson, 4th Edition, 2006.
2. Dimitri P. Bertsekas and John N. Tsitsiklis, "Introduction to Probability", Athena Scientific, 2nd Edition, 2008.
3. George Casella and Roger L. Berger, "Statistical Inference", Cengage Learning, 2nd Edition, 2002.
4. Stephen Boyd and Lieven Vandenberghe, "Convex Optimization", Cambridge University Press, 2004.

Reference Books:

1. James Stewart, "Multivariable Calculus", Cengage Learning, 8th Edition, 2015.
2. Patrick J. Flynn, "Advanced Calculus: A Differential Forms Approach", Springer, 2006.
3. Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
4. Mykel J. Kochenderfer and Tim A. Wheeler, "Algorithms for Optimization", MIT Press, 2019.

DEPARTMENT OF COMPUTER ENGINEERING

Program: M. Tech. (Computer – Data Science)									**Semester:** I
Course: Machine Learning Fundamentals									**Code:** CODS102
Teaching Scheme (hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
04	-	-	04	50	50	-	-	-	100

Prerequisites:

1. **Basic Programming Skills:** Proficiency in Python or similar programming languages.
2. **Mathematics:** Understanding of linear algebra, probability, and statistics.
3. **Fundamentals of Data Science:** Basic knowledge of data pre-processing and exploratory data analysis.

Course Objectives:

1. To understand the core concepts and techniques in machine learning.
2. To apply various machine learning algorithms to real-world problems.
3. To gain hands-on experience in implementing and evaluating machine learning models.
4. To explain reinforcement learning and its algorithms.
5. To introduce and integrate models in the form of advanced ensemble.
6. To develop the ability to select and justify appropriate machine learning methods for specific tasks.

Course Outcomes: At the end of the course, the student will be able to -

CO1	Understand the basic concepts of machine learning and its applications.
CO2	Preprocess and clean data for machine learning applications.
CO3	Implement and evaluate various supervised learning algorithms.
CO4	Apply reinforcement learning and its algorithms for different applications
CO5	Integrate multiple machine learning algorithms in the form of ensemble learning
CO6	Understand the processes involved in deploying machine learning models.

Course Contents:

Unit	**Description**
1.	**Introduction to Machine Learning :** Definition and history of machine learning, Types of machine learning: Supervised, Unsupervised, Reinforcement, Overview of machine learning workflow: Data Collection, Pre-processing, Model Building, Evaluation, Tools and frameworks for machine learning (e.g., Scikit-Learn, TensorFlow, PyTorch)
2.	**Data Preprocessing and Feature Engineering :** Data cleaning and pre-processing techniques, Feature scaling and normalization, Feature extraction and selection, Dimensionality reduction: PCA, LDA
3.	**Supervised Learning Algorithms :** Linear Regression and Logistic Regression, Decision Trees and Random Forests, Support Vector Machines k-Nearest Neighbors , Model evaluation metrics (e.g., Accuracy, Precision, Recall, F1 Score, ROC Curve)

4.	**Reinforcement Learning:** Reinforcement learning: Introduction of Reinforcement Learning, Need for Reinforcement Learning, Supervised vs Unsupervised vs Reinforcement Learning, Types of Reinforcement, Elements of Reinforcement Learning, Real time applications of Reinforcement learning. Markov's Decision Process: Markov property, Markov chain/process, Markov reward process (MRP),Markov decision process (MDP), Return, Policy, Value functions, Bellman equation
5.	**Ensemble Learning:** Ensemble Learning: Introduction to Ensemble Learning, Need of Ensemble Learning, Homogeneous ,and Heterogeneous ensemble methods, Advantages and Limitations of Ensemble methods, Applications of Ensemble Learning. **Ensemble Learning Techniques:** Bagging: Bootstrapping, Aggregation. Boosting: Adaptive Boosting (AdaBoost), Gradient Boosting, XGBoost. Stacking: Variance Reduction, Blending, Random Forest Ensemble, Advantages of Random Forest.
6.	**Model Deployment and Real-World Applications:** Model deployment strategies and tools (e.g., Docker, AWS SageMaker, Google Cloud ML) ,Model monitoring and maintenance ,Case studies of machine learning applications in industry ,Ethical considerations and challenges in machine learning

Text Books:

1. Ethem Alpaydin, "Introduction to Machine Learning", The MIT Press, 2014.
2. Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", Cambridge University Press, 2012.
3. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", The MIT Press, 2012.

Reference Books:

1. Ian H. Witten, Eibe Frank, Mark A. Hall, "Data Mining: Practical Machine Learning Tools and Techniques", Elsevier, 3rd Edition.
2. Jiawei Han, Micheline Kamber, Jian Pei, "Data Mining: Concepts and Techniques", Elsevier Publishers, 3rd Edition.
3. Shai Shalev-Shwartz, Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms", Cambridge University Press, 2014.
4. Wes McKinney, "Python for Data Analysis", O'Reilly Media.
5. Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow", O'Reilly Media, 2017.
6. Andrew Ng, "Machine Learning Yearning", Self-published, 2017.

DEPARTMENT OF COMPUTER ENGINEERING

Program: M. Tech. (Computer – Data Science)								**Semester:** I	
Course: Database Systems for Data science								**Code:** CODS103	
Teaching Scheme (hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
03	-	-	03	50	50	-	-	-	100

Prerequisites:

1. Basic knowledge of computer programming.
2. Understanding of data structures and algorithms.
3. Familiarity with basic statistical concepts.

Course Objectives:

1. To provide in-depth knowledge of database concepts, data models, and database management systems.
2. To equip students with skills to design and implement databases for data-intensive applications.
3. To explore advanced database techniques and technologies relevant to data science.
4. To understand and apply data warehousing, data mining, and big data technologies.
5. To familiarize students with NoSQL databases and their applications in data science.
6. To enable students to use SQL and other query languages for data retrieval and manipulation.

Course Outcomes: At the end of the course, the student will be able to -

CO1	Understand the fundamental concepts of database systems.
CO2	Apply normalization techniques to optimize database design.
CO3	Utilize advanced SQL features for complex queries.
CO4	Understand the concepts of data warehousing and OLAP.
CO5	Apply data mining techniques for knowledge discovery.
CO6	Analyze and differentiate between NoSQL, NewSQL, and traditional RDBMS.

Course Contents:

Unit	Description
1.	**Introduction to Database Systems :** Overview of Database Systems,Database System Architecture,Data Models: Relational, Object-Oriented, Semi-Structured, and NoSQL,DBMS Components and Functionality,Data Independence,Database Languages: DDL, DML, DCL, and TCL
2.	**Relational Database Design :** Relational Model Concepts,Integrity Constraints,Entity-Relationship (ER) Model, SQL: Data Definition, Data Manipulation, and Data Control,Normalization: 1NF, 2NF, 3NF, BCNF,Database Design Process
3.	**Advanced SQL and Query Optimization :** Advanced SQL Queries: Joins, Subqueries, Views, Indexing, Stored Procedures and Triggers,Query Processing and Optimization,Cost-Based Query Optimization,Indexing and Hashing Techniques,Transactions and Concurrency Control.

4.	**Data Warehousing and OLAP :** Data Warehousing Concepts,Data Warehouse Architecture,ETL (Extract, Transform, Load) Processes,OLAP (Online Analytical Processing) Concepts,Star and Snowflake Schemas,Data Cube and OLAP Operations
5.	**Data Mining and Big Data Technologies :** Introduction to Data Mining, Data Mining Techniques: Classification, Clustering, Association Rules,Big Data Concepts and Technologies,Hadoop Ecosystem: HDFS, MapReduce, Spark,NoSQL Databases: MongoDB, Cassandra, HBase,Case Studies and Applications.
6.	**NoSQL Databases and NewSQL :** NoSQL Databases: Overview and Characteristics, Types of NoSQL Databases: Key-Value Stores, Document Stores, Column Stores, Graph Databases, CAP Theorem, NewSQL Databases: Characteristics and Use Cases,Scaling Databases: Sharding, Replication, and Consistency Models, Case Studies and Practical Applications

Text Books:

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, "Database System Concepts", McGraw-Hill Education, 6th Edition, 2010.
2. Raghu Ramakrishnan, Johannes Gehrke, "Database Management Systems", McGraw-Hill Education, 3rd Edition, 2002.

Reference Books:

1. Jiawei Han, Micheline Kamber, Jian Pei, "Data Mining: Concepts and Techniques", Elsevier, 3rd Edition, 2012.
2. Tom White, "Hadoop: The Definitive Guide", O'Reilly Media, 4th Edition, 2015.
3. Pramod J. Sadalage, Martin Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", Addison-Wesley, 1st Edition, 2012.

DEPARTMENT OF COMPUTER ENGINEERING

Program: M. Tech. (Computer – Data Science)								**Semester:** I	
Course: Program Elective – I (Information Systems Management)								**Code:** CODS104A	
Teaching Scheme (hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
03	-	-	03	50	50	-	-	-	100

Prerequisites:

1. Basic knowledge of Information Systems and Database Management.
2. Understanding of Computer Networks and IT Infrastructure.
3. Familiarity with Business Management Principles.

Course Objectives:

1. To provide an understanding of the role and importance of information systems in organizations.
2. To explore various aspects of managing information systems and IT projects.
3. To develop strategies for aligning information systems with organizational goals.
4. To analyze contemporary issues and emerging trends in information systems management.

Course Outcomes: At the end of the course, the student will be able to -

CO1	Identify different types of information systems and their applications.
CO2	Analyze the strategic role of information systems in achieving organizational goals.
CO3	Understand project management principles and methodologies specific to information systems.
CO4	Describe methodologies for developing and implementing information systems.
CO5	Understand and apply IT service management frameworks.
CO6	Evaluate the impact of new technologies on information systems management.

Course Contents:

Unit	**Description**
1.	**Fundamentals of Information Systems Management:** Introduction to Information Systems, Components of Information Systems: Hardware, Software, Data, People, and Processes, Types of Information Systems: Transaction Processing Systems (TPS), Management Information Systems (MIS), Decision Support Systems (DSS), and Executive Support Systems (ESS), Information Systems in Business Operations.
2.	**Strategic Management of Information Systems:** Strategic Role of Information Systems, IT Governance and Strategy Formulation Aligning IT with Business Strategy, Case Studies: IT Strategy Implementation and Outcomes.
3.	**Information Systems Project Management:** Project Management Life Cycle: Initiation, Planning, Execution, Monitoring, and Closing, Project Management Methodologies: Agile, Waterfall, Scrum, Kanban Project Planning and Scheduling Tools, Risk Management and Quality Assurance in IT Projects.
4.	**Information Systems Development and Implementation:** Systems Development Life Cycle (SDLC), Requirements Analysis and Specification, System Design and Prototyping, Implementation and Change Management.

5.	**IT Operations and Service Management:** IT Operations Management: Practices and Processes, IT Service Management (ITSM) and ITIL Framework, Infrastructure Management: Data Centers, Networks, and Cloud Services, Performance Monitoring and Optimization.
6.	**Emerging Trends and Issues in Information Systems:** Big Data and Analytics, Cybersecurity Threats and Protection Strategies, Artificial Intelligence and Machine Learning in Information Systems, Digital Transformation and Future Trends.

Text Books:

1. Barbara C. McNurlin, Robert B. Hayes, "Information Systems Management in Practice", Pearson, 8th Edition, 2010.
2. Keri E. Pearlson, Carol S. Saunders, "Managing and Using Information Systems: A Strategic Approach", Wiley, 6th Edition, 2019.
3. Gabriele Piccoli, "Information Systems for Managers: With Cases", Wiley, 2nd Edition, 2009.

Reference Books:

1. Kenneth C. Laudon, Jane P. Laudon, "Management Information Systems: Managing the Digital Firm", Pearson, 15th Edition, 2017.
2. John Gallaugher, "Information Systems: A Manager's Guide to Harnessing Technology", Flat World Knowledge, 2011.
3. James Cadle, Donald Yeates, Peter Wright, "Project Management for Information Systems", BCS Learning & Development Ltd, 6th Edition, 2014.
4. Alan Calder, Steve Watkins, "IT Governance: An International Guide to Data Security and ISO27001/ISO27002", Kogan Page, 5th Edition, 2014.

DEPARTMENT OF COMPUTER ENGINEERING

Program: M. Tech. (Computer – Data Science)								**Semester:** I	
Course: Program Elective – I (Artificial Intelligence for Data Science)								**Code:** CODS104B	
Teaching Scheme (hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
03	-	-	03	50	50	-	-	-	100

Prerequisites:

1. Basic knowledge of Linear Algebra, Calculus, Probability, and Statistics.
2. Programming experience in Python or R.
3. Basic understanding of Data Science principles and Machine Learning

Course Objectives:

1. To understand the fundamental principles of Artificial Intelligence (AI) and its applications in Data Science.
2. To learn about various AI techniques and their practical implementation.
3. To develop skills in applying AI algorithms to solve real-world data-driven problems.
4. To explore advanced AI topics such as deep learning, natural language processing, and reinforcement learning.
5. To evaluate and optimize AI models for better accuracy and efficiency.

Course Outcomes: At the end of the course, the student will be able to -

CO1	Understand the role of AI in modern technology and data science.
CO2	Solve AI problems using search algorithms and heuristics.
CO3	Represent and manipulate knowledge for intelligent systems.
CO4	Evaluate model performance and optimize algorithms for accuracy.
CO5	Understand deep learning architectures and their application in AI.
CO6	Apply AI techniques for language processing and visual recognition.

Course Contents:

Unit	**Description**
1.	**Introduction to Artificial Intelligence:** History and evolution of AI, AI vs. Machine Learning vs. Data Science, types of AI (Narrow, General, and Super AI), key AI techniques.
2.	**Problem Solving and Search Algorithms:** Problem formulation, Uninformed search (BFS, DFS), Informed search (A* and Greedy algorithms), Heuristics, Constraint Satisfaction Problems (CSPs).
3.	**Knowledge Representation and Reasoning:** Logic-based AI (Propositional logic, Predicate logic), knowledge representation techniques, reasoning under uncertainty (Bayesian networks, Hidden Markov Models).
4.	**Machine Learning for AI:** Supervised learning (Regression, Classification), Unsupervised learning (Clustering, Dimensionality reduction), Reinforcement learning basics, Model evaluation and optimization.

5.	**Deep Learning Fundamentals:** Neural Networks (Perceptron, Multi-layer Perceptron), Deep learning architectures (CNNs, RNNs), Backpropagation, training deep networks.
6.	**AI in Natural Language Processing and Computer Vision:** NLP (Tokenization, Embedding, Sentiment Analysis, Sequence Models), Computer Vision (Image processing, Object detection, Generative models).

Text Books:

1. Stuart Russell, Peter Norvig, "Artificial Intelligence: A Modern Approach", Prentice Hall, 3rd Edition, 2010.
2. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2016.
3. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.

Reference Books:

1. Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
2. Richard S. Sutton, Andrew G. Barto, "Reinforcement Learning: An Introduction", MIT Press, 2nd Edition, 2018.
3. Steven Bird, Ewan Klein, Edward Loper, "Natural Language Processing with Python", O'Reilly Media, 2009.

DEPARTMENT OF COMPUTER ENGINEERING

Program: M. Tech. (Electrical – Power Systems)									**Semester:** I
Course: Open Elective – I (Industrial Automation)									**Code:** EEPS105
Teaching Scheme (hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
03	-	-	03	50	50	-	-	-	100

Prerequisites:

Knowledge of Engineering fundamentals, mathematics, control systems, mechanical and manufacturing process.

Course Objectives:

1. To emphasize the role of automation techniques in manufacturing and process industries.
2. To impart the role of PLC in industry automation.
3. To familiarize with the various control techniques used in process automation.
4. To design automation systems for manufacturing and process industries.

Course Outcomes: At the end of the course, the student will be able to -

CO1	Apply automation principles and strategies in manufacturing systems.
CO2	Design and analyze Detroit-type automated flow lines, transfer mechanisms, and buffer storage for enhanced machining operations.
CO3	Evaluate and design material handling systems with product identification technologies.
CO4	Apply control technologies in automation, including industrial control systems, SCADA, and PLCs.
CO5	Design and analyze automated manufacturing systems, including flexible and cellular manufacturing.
CO6	Integrate DDC, DCS, SCADA, and PLCs for process safety and control in process industries.

Course Contents:

Unit	**Description**
1.	**Introduction to automation in Manufacturing Industries:** Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations. Production Economics: Methods of Evaluating Investment Alternatives, Costs in Manufacturing, Break Even Analysis, Unit cost of production, Cost of Manufacturing Lead time and Work-in-process.
2.	**Detroit-Type Automation:** Automated Flow lines, Methods of Work part Transport, Transfer Mechanism, Buffer Storage, Control Functions, and Automation for Machining Operations, Design and Fabrication Considerations. Analysis of Automated Flow Lines: General Terminology and Analysis, Analysis of Transfer Lines Without Storage, Partial Automation, Computer Simulation of Automated Flow Lines.

3.	**Material handling and identification technologies:** The material handling function, Types of Material Handling Equipment, Analysis for Material Handling Systems, Design of the System, Conveyor Systems, Automated Guided Vehicle Systems. Automated Storage Systems: Storage System Performance, Automated Storage/Retrieval Systems, Work-in-process Storage, Interfacing Handling and Storage with Manufacturing. Product identification system: Barcode, RFID etc.
4.	**Control technologies in automation:** Industrial Control Systems, Process Industries Verses Discrete Manufacturing Industries, Continuous Verses Discrete Control, Computer Process Control and its Forms. Computer Based Industrial Control: Introduction & Automatic Process Control, Building Blocks of Automation System: LAN, Analog & Digital I/O Modules, and SCADA System & RTU.
5.	**Automated Manufacturing Systems:** Components, Classification and overview of manufacturing systems, Cellular manufacturing, Flexible manufacturing system (FMS), FMS and its planning and implementation, Automated assembly system – design and types of automated assembly systems, Analysis of multi station and single station assembly machine.
6.	**Automation in Process Industries:** Introduction to computer based industrial automation- Direct Digital Control (DDC), Distributed Control System (DCS) and supervisory control and data acquisition (SCADA) based architectures. SCADA for process industries includes understanding of RTUs, Pumping stations, Evacuation processes, Mass Flow Meters and other flow meters, Leak-flow studies of pipelines, Transport Automation, Programmable Logic Controller (PLC)- Block diagram of PLC, Programming languages of PLC, Basic instruction sets, Design of alarm and interlocks, Networking of PLC, Overview of safety of PLC with case studies. Process Safety Automation: Levels of process safety through use of PLCs, Integrating Process safety PLC and DCS, Application of international standards in process safety control.

Text Books:

1. M. P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing", 5th Edition, Pearson Education, 2009.
2. John W. Webb and Ronald A. Reis, "Programmable Logic Controllers: Principles and Applications", 5th Edition, Prentice Hall Inc., New Jersey, 2003.
3. Krishna Kant, "Computer-Based Industrial Control", 2nd Edition, Prentice Hall, New Delhi, 2011.
4. Frank D. Petruzella, "Programmable Logic Controllers", 5th Edition, McGraw-Hill, New York.

Reference Books:

1. Curtis D. Johnson, "Process Control Instrumentation Technology", 8th Edition, Pearson New International, 2013.
2. Lukas M. P., "Distributed Control Systems", Van Nostrand Reinhold Co., New York, 1986.
3. N. Viswanandham, Y. Narahari, "Performance Modeling of Automated Manufacturing Systems", 1st Edition, 2009.

4. Carlos Smith and Corripio, "Principles and Practice of Automatic Process Control", 3rd Edition, John Wiley & Sons, 2006.

Program: M. Tech. (E&TC – IoT and Sensor Systems)								**Semester:** I	
Course: Open Elective – I (Internet of Things)								**Code:** ETIS105	
Teaching Scheme (hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
03	-	-	03	50	50	-	-	-	100
Prerequisites:									

1. Basics of sensors and hardware components. 2. Basic networking concepts. 3. Knowledge of Microcontroller and embedded systems.	
Course Objectives:	
To provide students with a comprehensive understanding of sensor and actuator technologies, IoT architecture, communication protocols, and interfacing techniques, alongside their applications in smart environments, industrial systems, and healthcare.	
Course Outcomes: At the end of the course, the student will be able to -	
CO1	Comprehend and analyze concepts of sensors, actuators, IoT and IoE.
CO2	Interpret IoT Architecture Design Aspects.
CO3	Comprehend the operation of IoT protocols.
CO4	Describe various IoT boards, interfacing, and programming for IoT.
CO5	Illustrate the technologies, Catalysts, and precursors of IIoT using suitable use cases.
CO6	Provide suitable solution for domain specific applications of IoT.
Course Contents:	
Unit	**Description**
1	**Sensors, Actuators, IoT & IoE:** Definitions, Types of sensors, Types of Actuators, Example and Working, Networking Basics, RFID Principals and components, Wireless Sensor Networks, Definition, and characteristics of an IoT, Physical Design of an IoT, Logical design of IoT, Communication Models, Communication API's, What is the IoE? Difference between IoT and IoE, Pillars of the IoE, Connecting the Unconnected, Transitioning to the IoE, Bringing It All Together.
2	**IoT Architecture Design Aspects:** IoT-An Architectural Overview, building architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service (XaaS), M2M and IoT Analytics, Knowledge Management
3	**IoT Protocols:** PHY/MAC Layer (3GPP MTC, IEEE 802.11, IEEE 802.15), Wireless HART, Z Wave, Bluetooth Low Energy, Zigbee Smart Energy, DASH7 - Network Layer-IPv4, IPv6, 6LoWPAN, 6TiSCH, ND, DHCP, ICMP, RPL, CORPL, CARP, Transport Layer (TCP, MPTCP, UDP, DCCP, SCTP)-(TLS, DTLS) – Session Layer HTTP, CoAP, XMPP, AMQP, MQTT.
4	**Interfacing Boards and Programming:** Introduction to IoT Boards, Interfacing with IoT Boards, IoT deployment for Raspberry Pi /Arduino/Equivalent platform – Reading from Sensors, Communication: Connecting microcontroller with mobile devices – communication through Bluetooth, wifi and USB - Contiki OS- Cooja Simulator.

5	**Industrial IoT:** Introduction, Key IIOT technologies, Catalysts, and precursors of IIoT, Innovation and the IIoT, Applications of IIoT Examples: Healthcare, Oil and Gas Industry, Logistics and the Industrial Internet, Retail applications, IoT innovations and design methodologies, Industrial Internet Architecture Framework (IIAF): Control domain, operational domain and application domain, Three tier topology, Design of low power device network, legacy industrial protocols, Bluetooth, Zigbee IP, Z-wave, Wi-Fi backscatter in IIoT design.
6	**Applications of IoT:** Smart Environment: Forest Fire Detection, Air Pollution, Smart Cities: Parking, Structural Health, Noise Urban maps, Smart Metering: Smart Grid, Tank level, Photovoltaic Installations, Silos Stock Calculation, Health: Fall Detection, Medical Fridges, Sportsmen Care, Patients Surveillance, Ultraviolet Radiation.

List of Experiments:

1. Study of Raspberry-Pi, Beagle board, Arduino, and different operating systems for Raspberry-Pi/Beagle board/Arduino. Understanding the process of OS installation on Raspberry- Pi/Beagle board/Arduino.
2. Open-source prototype platform- Raspberry-Pi/Beagle board/Arduino -Simple program digital read/write using LED and Switch -Analog read/write using sensor and actuators.
3. Interfacing sensors and actuators with Arduino/Raspberry-pi.\
4. IoT based Stepper Motor/DC Motor Control with Arduino/Raspberry Pi.
5. Introduction to MQTT/ CoAP and sending sensor data to cloud using Raspberry-Pi/Beagle board/Arduino.
6. Get the status of a bulb at a remote place (on the LAN) through web.
7. Interfacing Arduino to Bluetooth Module.
8. Communicate between Arduino and Raspberry PI using any wireless medium like ZigBee.

Text Books:

1. Ovidiu Vermesan, Peter Fresiss, "Internet of Things" From research and innovation to market Deployment", River Publishers series in Communication, USA.
2. Olivier Hersent, David Boswarthick, and Omar Elloumi, "The Internet of Things: Key Applications and Protocols", 2nd Edition, Wiley Publications.

Reference Books:

1. Dr. Ovidiu Vermesan, Dr. Peter Friess, "Internet of Things: Converging Technologies for Smar Environments and Integrated Ecosystems", River Publishers Series in Communication.
2. Giancarlo Fortino and Pawan Kumar, "Internet of Things: Case Studies", CRC Press.

DEPARTMENT OF COMPUTER ENGINEERING

DEPARTMENT OF COMPUTER ENGINEERING

Program: M. Tech. (Mechanical–Design Engineering)								**Semester:** I	
Course: Open Elective – I (Product Life-cycle Management)								**Code:** MEDE105	
Teaching Scheme (hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
03	-	-	03	50	50	-	-	-	100

Prerequisites:

Knowledge of basic Engineering Science - Physics, Chemistry, Material Science, Engineering Metallurgy, Manufacturing processes, Industrial Processes, Enterprises Resource planning (ERP)s Etc.

Course Objectives:

1. To impart the latest knowledge, principles, strategies, practices, and applications in Product Life-cycle Management (PLM) domain.
2. To provide an in-depth understanding of various applications and solutions of PLM.
3. To build conceptual foundation of PLM, along with the latest industry views on PLM applications.
4. To present frameworks which provide economic justifications for PLM projects.

Course Outcomes: At the end of the course, the student will be able to -

CO1	Understand PLM Fundamentals of Product Life Cycle Management (PLM), including its definition, components, and emergence
CO2	Develop PLM Strategy by defining the company's vision, setting strategic goals, and identifying principles for effective PLM implementation
CO3	Manage Product Development Process through analyzing the tools, information systems, and personnel involved in PLM to manage the product development process effectively.
CO4	Identify and apply the components and elements of PLM and its Principles to manage the entire Product Life-cycle
CO5	Select Product Life-cycle Environment to optimize the Product Life-cycle Environment by understanding Product Data and Workflow.
CO6	Implement Effective Product Data Management (PDM) to understand the benefits and terminology of PDM functions and architectures.

Course Contents:

Unit	**Description**
1.	**Introduction:** Overview, Need, Benefits, Concept of Product Life Cycle, Components / Elements of PLM, Emergence and Significance of PLM, PLM implementation cases in various industry verticals.
2.	**PLM Strategy and Vision**: PLM Strategy and Vision: Company's PLM vision, PLM Strategy, Principles for PLM strategy, Preparing for the PLM strategy, Developing a PLM strategy, Strategy identification and selection, PLM business goals.
3.	**Product Development:** Information, Tools, Information systems and people involved in PLM. Product data and processes like New Product Development, Change Management, The phases of product design

	process, Modern approaches to product design: Concurrent Design, Quality Function Development (QFD), Rapid Prototyping.
4.	**Product Life-cycle Management:** Concept of Product Life Cycle, Components / Elements of PLM, Emergence of PLM, Significance of PLM, Customer Involvement, Threads of PLM-Computer Aided Design (CAD), Product data management (PDM), Comparison of PLM to Enterprises Resource planning (ERP). Integration of PLM & CAD, Introduction to PLM tools.
5.	**Product Life-cycle Environment:** Product Data and Product Workflow, The Link between Product Data and Product Workflow, Key Management Issues around Product Data and Product Workflow, Developing a PLM strategy, Strategy identification and selection, PLM System Architecture (2tier/3tier/4tier etc). Concept of cloud PLM.
6.	**Product Data Management:** Benefits and Terminology, CIM Data, PDM functions, definition and architectures of PDM systems, Engineering data, engineering workflow and PDM acquisition and implementation, product data interchange, collaborative product development, Internet and developments in client server computing, portal integration.

Text Books:

1. John W. Gosnay and Christine M. Mears, "Business Intelligence with Cold Fusion", Prentice Hall India, New Delhi, 2000.
2. David S. Linthicum, "B2B Application Integration", Addison Wesley, Boston, 2001.
3. Alexis Leon, "Enterprise Resource Planning", Tata McGraw Hill, New Delhi, 2002.
4. David Ferry and Larry Whipple, "Building and Intelligent e-Business", Prima Publishing, EEE Edition, California, 2000.
5. S. Rosenthal, "Effective Product Design and Development", Irwin, 1992.

Reference Books:

1. Grieves, Michael, "Product Lifecycle Management", McGraw-Hill, 2006.
2. Antti Saaksvuori and Anselmi Immonen, "Product Life Cycle Management", Springer, 1st Edition (Nov. 5, 2003).
3. Stark, John, "Product Lifecycle Management: Paradigm for 21st Century Product Realization", Springer Verlag, 2004.
4. Kari Ulrich and Steven D. Eppinger, "Product Design & Development", McGraw Hill International Edns, 1999.
5. Stark, John, "Product Lifecycle Management: Paradigm for 21st Century Product Realization", Springer Verlag, 2004.

E-Resources:

1. NPTEL Course on Product Design and Development, by Prof. Indradeep Singh, IIT Roorkee https://nptel.ac.in/courses/112107217

DEPARTMENT OF COMPUTER ENGINEERING

Program: M. Tech. (Robotics and Automation Engineering)							**Semester:** I		
Course: Open Elective – I (Microcontrollers Architecture and Programming)							**Code:** MERA105		
Teaching Scheme (hrs./week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
03	-	-	03	50	50	-	-	-	100

Prerequisites:

Basics of Microcontroller and programming.

Course Objectives:

To provide solid foundation on the fundamentals of microprocessors and applications, interfacing the external devices to the processor according to the user requirements thus, enabling to create novel products and solutions for real time problems.

Course Outcomes: At the end of the course, the student will be able to -

CO1	Describe architecture and operation of Microcontroller 8051.
CO2	Foster ability to understand the design concept of Microcontroller.
CO3	Design various applications using its peripherals.
CO4	Analyze the data transfer information through serial and parallel ports.
CO5	An in-depth knowledge of applying Microcontrollers the concepts on real time applications.

Course Contents:

Unit	**Description**
1.	**Basics of Microcontroller and Intel 8051 architecture:** Introduction to microcontrollers, difference in controller and processor. Architecture of 8051, Internal block diagram, Internal RAM organization, SFRS, pin functions of 8051, I/O port structure and Operation, External Memory Interface.
2.	**Programming model of 8051:** Instruction classification, Instruction set, Addressing Modes: Immediate, register, direct, indirect and relative, assembler directives (ORG, END), features with examples, I/O Bit and Byte programming using assembly language for LED and seven segment display (SSD) interfacing. Introduction to 8051 programming in C.
3.	**Timer /Counter, Interrupts:** Timer / counter: TMOD, TCON, SCON, SBUF, PCON Registers, Timer modes, programming for time delay using mode 1 and mode 2. **Interrupts:** Introduction to interrupt, Interrupt types and their vector addresses, Interrupt enable register and interrupt priority register (IE, IP)
4	**Interfacing, Serial Communication and RTOS:** Programming of serial port without interrupt, Serial Communication: Synchronous and asynchronous serial communication, Use of timer to select baud rate for serial communication, interfacing: ADC, DAC, LCD, stepper motor. **RTOS**: Need of RTOS, Architecture of kernel, task scheduler.

References:

1. Kenneth J. Ayala, "The 8051 Microcontroller Architecture, Programming & Applications", Penram International.
2. Raj Kamal, "Embedded Systems: Architecture, Programming and Design", Tata McGraw-Hill Education, 2008.
3. K. Uma Rao and Andhe Pallavi, "The 8051 Microcontroller – Architecture, Programming and Applications", Pearson Publications.
4. Mazidi and McKinlay, "8051 Microcontroller and Embedded Systems Using Assembly and C", Pearson Publications.

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Program: M. Tech. (Computer – Data Science)								**Semester:** I	
Course: Laboratory Proficiency – I								**Code:** CODS106	
Teaching Scheme (hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
-	04	-	02	-	-	25	-	50	75

Prerequisites:

Fundamental knowledge of mathematics, programming, databases, data science concepts, and cloud infrastructure.

Course Objectives:

1. To provide hands-on experience with mathematical and statistical techniques in data science.
2. To implement machine learning algorithms, model training, and evaluation using real-world data.
3. To develop proficiency in database management and data handling techniques for large-scale data.

Course Outcomes: At the end of the course, the student will be able to -

CO1	Implement Singular Value Decomposition (SVD) and Principal Component Analysis (PCA) on datasets to analyze the effects of dimensionality reduction.
CO2	Design and evaluate supervised learning models such as logistic regression or decision trees for data analysis.
CO3	Implement data warehousing processes, including Extract, Transform, Load (ETL), on sample datasets for effective data management.
CO4	Develop comprehensive project plans with risk assessment and scheduling, ensuring efficient management of information systems projects.
CO5	Build an NLP model for sentiment analysis using tokenization and word embeddings.
CO6	Synthesize knowledge from multiple domains to develop a mini-project demonstrating the practical application of dimensionality reduction, optimization, machine learning, data warehousing, and AI techniques.

Note:
All assignments are compulsory. Each student should implement the assignment individually. Laboratory teachers should make sure that the dataset/code/writeup is not the same.

CODS101 - Advanced Mathematics for Data Science	
1	Implement SVD and PCA on a dataset and analyzing dimensionality reduction effects.
2	Optimize using gradient descent and Lagrange multipliers for a given multi-variable function.
CODS102 - Machine Learning Fundamentals	
1	Develop and evaluating a supervised learning model (e.g., logistic regression or decision tree).
2	Implement an ensemble learning technique (e.g., random forest or boosting) on a real-world dataset.
CODS103 - Database Systems for Data Science	
1	Implement data warehousing concepts with ETL processes on sample data.

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CODS104 - Program Elective – I	
CODS104A - Information Systems Management	
1	Develop a project plan with risk assessment and scheduling for an information systems project.
CODS104B - Artificial Intelligence for Data Science	
1	Develop an NLP model for sentiment analysis using tokenization and word embeddings.
2	Mini-project: Develop an application with prediction using learning techniques in AI

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Program: M. Tech. (Computer – Data Science)								**Semester:** I	
Course: Seminar								**Code:** CODS107	
Teaching Scheme (hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
-	02	-	01	-	-	25	50	-	75

Prerequisites:

Knowledge of basic and advance engineering topics, Industry related advancement and current practices used.

Course Objectives:

To explore emerging technologies, enhance research and communication skills, practice presentations and report writing, evaluate engineering problems, discuss societal impacts, and provide constructive feedback.

Course Outcomes: At the end of the course, the student will be able to -

CO1	Analyze current topics in Data Science/emerging technologies by performing literature surveys.
CO2	Conduct literature reviews, evaluate models, draw conclusions, and gain skills in literature surveys and presentations.
CO3	Write comprehensive reports and aim to publish at least one review paper.

Course Contents:

Sr. No.	**Description**
1	Under the supervision of a designated guide, each student must study current subjects in the field and related to Data Science also connected to the Industry.
2	A thorough literature review, mathematical modeling using a specific technique and an insightful conclusion are anticipated from the seminar research.
3	The seminar report must be turned in order to comply with the subject's term work requirements.
4	As a research consequence of the seminar, at least one review paper publication is anticipated.

Activities to be conducted in Semester:

1. Weekly meeting report submission.
2. Review-1 conduction at mid of semester, at internal level - Literature review and methodology of the selected topic, Mathematical model/advancement in technology and findings and its analysis
3. Review-2 conduction at the end of semester, at external level – Comprehensive presentation on the selected topic in external examiner, guide and departmental representatives panel
4. Review-3 comprehensive spiral report checking and submission of at least one review paper. Seminar report writing and submission to department.

E-Resources:

1. https://onlinecourses.swayam2.ac.in/ntr20_ed30/preview
2. https://onlinecourses.nptel.ac.in/noc22_hs05

DEPARTMENT OF COMPUTER ENGINEERING

Program: M. Tech. (Computer – Data Science)									**Semester:** I
Course: Audit Course – I: Technical Paper writing									**Code:** CODS108
Teaching Scheme (hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
-	-	02	-	-	-	-	-	-	-

Prerequisites:

Basic Proficiency in English, Fundamental Research Skills, Introductory Understanding of Academic Writing, Interest in Research and Writing, Analytical and Critical Thinking Skills.

Course Objectives:

1. To Equip Students with Technical Writing Skills.
2. To Instill Ethical Research Practices.
3. To Enhance Grammar and Writing Proficiency.
4. To Foster Research Skills and Knowledge.
5. To Educate on Plagiarism and Authorship.
6. To Develop Citation and Referencing Competence.

Course Outcomes: At the end of the course, the student will be able to -

CO1	Know the Technical Writing Fundamentals.
CO2	Understand the Research Ethics and Objectivity.
CO3	Proficient in Research Writing.
CO4	Develop Research Skills.
CO5	Avoid Plagiarism.
CO6	Expertise in Citation and Referencing.

Course Contents:

Sr. No.	**Description**
1.	Introduction to Ethics in Research, Five Principles of Ethics, Four Codes of Ethics, Discussion of Case Studies.
2.	Difference between Technical and Literary Style, Grammar, Common Errors, Sentence Formation, Technical Vocabulary.
3.	The different types of Research, Purpose and nature of research, selection and formulation of a research problem, introduction to research writing.
4.	Conference abstracts, proposals, projects, research reports, presentations, different styles and different types of manuscripts, different ways of approaching thesis/dissertation writing, Formal Letters and Emails.
5.	Plagiarism, Strategies to Avoid Plagiarism, Authorship and copyright in the Digital Age.
6.	Citation styles and use, References, Footnotes, Indexing, and Bibliography.

Reference Books:

1. Clyde Parker Davis and Detmar Straub, "Writing the Doctoral Dissertation: A Systematic Approach", Gordon Barrons Educational Series, 2008.
2. Gerard Genette and Jane Lewis, "Narrative Discourse: An Essay in Method", Cornell UP, 1983.

3. J. Anderson, B.H. Durston, and M. Poole, "Thesis and Assignment Writing", Wiley Eastern Limited, New Delhi, 1970.
4. Sidney Greenbaum, "The Oxford English Grammar", OUP, Oxford, 1996.
5. Wayne C. Booth and Gregory Colomb, "The Craft of Research", University of Chicago Press, 2008.

E-Resources:

1. Online course on English for Research Paper Writing, by Dr. Shoba. K. N., National Institute Of Technical Teachers Training And Research, Chennai https://onlinecourses.swayam2.ac.in/ntr24_ed15/preview
2. Coursera course on Introduction to Technical Writing https://www.coursera.org/learn/technical-writing-introduction

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SYLLABUS

SEMESTER - II

DEPARTMENT OF COMPUTER ENGINEERING

Program: M. Tech. (Computer – Data Science)									**Semester:** II
Course: Statistical Methods for Data Science									**Code:** CODS201
Teaching Scheme (hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
04	-	-	04	50	50	-	-	-	100

Prerequisites:

Basic knowledge of Probability, Fundamentals of Statistics, Introductory Data AnalysisBasic Programming Skills (e.g., Python, R)

Course Objectives:

1. To Understand Statistical Foundations: Provide a solid grounding in statistical principles and methods crucial for data analysis and interpretation.
2. To Apply Statistical Techniques: Equip students with the skills to apply statistical techniques to real-world data science problems.
3. To Integrate Theory and Practice: Enable students to effectively combine statistical theory with practical data science applications, including predictive modeling and hypothesis testing.

Course Outcomes: At the end of the course, the student will be able to -

CO1	Summarize and visualize data using various descriptive statistics and graphical techniques.
CO2	Understand and apply key probability distributions in data analysis.
CO3	Conduct hypothesis tests and make decisions based on statistical evidence.
CO4	Develop and evaluate regression models for prediction and data analysis.
CO5	Analyze time-series data to identify trends, seasonality, and cyclic patterns.
CO6	Explore advanced statistical methods and their integration with machine learning techniques.

Course Contents:

Unit	**Description**
1.	**Descriptive Statistics and Exploratory Data Analysis:** Measures of Central Tendency and Dispersion, Data Visualization Techniques: Histograms, Box Plots, Scatter Plots, Bivariate and Multivariate Analysis, Correlation and Causation, Data Cleaning and Preparation.
2.	**Probability Distributions and Sampling:**Discrete Probability Distributions: Binomial, Poisson, Geometric, Continuous Probability Distributions: Normal, Exponential, Gamma, Sampling Distributions and the Central Limit Theorem, Estimation Techniques: Point and Interval Estimation, Hypothesis Testing Fundamentals.
3.	**Statistical Inference and Hypothesis Testing:**Hypothesis Testing Procedures: Null and Alternative Hypotheses, Parametric Tests: t-tests, ANOVA, Non-Parametric Tests: Chi-Square Tests, Mann-Whitney U Test, Power and Sample Size Calculations, Model Validation and Selection Criteria.
4.	**Regression Analysis and Predictive Modeling:** Simple Linear Regression, Multiple Linear Regression, Model Diagnostics and Assumptions, Regularization Techniques: Ridge and Lasso Regression, Introduction to Generalized Linear Models (GLMs)

5.	**Time Series Analysis and Forecasting:** Time Series Decomposition: Trend, Seasonality, Residuals, Autoregressive Models (AR), Moving Average Models (MA), ARIMA (AutoRegressive Integrated Moving Average) Models, Exponential Smoothing Methods, Model Evaluation Metrics: AIC, BIC, Cross-Validation.
6.	**Advanced Statistical Methods and Machine Learning:** Bayesian Statistics and Inference, Advanced Regression Techniques: Quantile Regression, Robust Regression, Dimension Reduction Techniques: PCA, Factor Analysis, Ensemble Methods: Random Forests, Gradient Boosting, Statistical Learning Theory and Model Evaluation.

Text Books:

1. Richard A. Johnson and Dean W. Wichern, "Applied Multivariate Statistical Analysis", Pearson.
2. David S. Moore, George P. McCabe, and Bruce A. Craig, "Introduction to the Practice of Statistics", W.H. Freeman.
3. Jay L. Devore, "Probability and Statistics for Engineering and the Sciences", Cengage Learning.
4. Robert H. Shumway and David S. Stoffer, "Time Series Analysis and Its Applications: With R Examples", Springer.

Reference Books:

1. Trevor Hastie, Robert Tibshirani, and Martin Wainwright, "Statistical Learning with Sparsity: The Lasso and Generalizations", CRC Press.
2. Andrew Gelman, John B. Carlin, and others, "Bayesian Data Analysis", CRC Press.
3. W.N. Venables and B.D. Ripley, "Modern Applied Statistics with S-Plus", Springer.
4. Trevor Hastie, Robert Tibshirani, and Jerome Friedman, "The Elements of Statistical Learning: Data Mining, Inference, and Prediction", Springer.

DEPARTMENT OF COMPUTER ENGINEERING

Program: M. Tech. (Computer – Data Science)									**Semester:** II
Course: Deep Learning									**Code:** CODS202
Teaching Scheme (hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
04	-	-	04	50	50	-	-	-	100

Prerequisites:

Basic understanding of Machine Learning and Statistical Learning, Proficiency in Python programming, Familiarity with Linear Algebra, Calculus, and Probability.

Course Objectives:

1. To understand the fundamental concepts and architectures of deep learning models.
2. To implement and evaluate various deep learning techniques for solving real-world problems.
3. To explore advanced topics and current trends in deep learning research.

Course Outcomes: At the end of the course, the student will be able to -

CO1	Understand the fundamental concepts and terminology of deep learning.
CO2	Apply CNNs to image classification and object detection tasks.
CO3	Implement RNNs, LSTMs, and GRUs for sequence prediction and generation tasks.
CO4	Explore advanced deep learning techniques such as attention mechanisms and generative models.
CO5	Implement regularization strategies to prevent over fitting and enhance model generalization.
CO6	Implement and deploy models using cloud services and edge devices.

Course Contents:

Unit	**Description**
1.	**Introduction to Deep Learning:** History and Evolution of Deep Learning, Neural Network Basics: Perceptron, Activation Functions, Feed forward Neural Networks: Architecture and Training. Introduction to Deep Learning Frameworks: Tensor Flow and PyTorch.
2.	**Convolutional Neural Networks (CNNs):** Convolutional Layers: Filters, Strides, and Padding, Pooling Layers: Max Pooling and Average Pooling, Architectures: LeNet, AlexNet, VGG, ResNet, Transfer Learning and Fine-Tuning Pre-trained CNNs.
3.	**Recurrent Neural Networks (RNNs) and Sequence Modeling:** RNN Basics: Architecture and Training Issues, Long Short-Term Memory (LSTM) Networks, Gated Recurrent Units (GRUs) Applications: Time-Series Forecasting, Language Modelling, and Text Generation.
4.	**Advanced Deep Learning Techniques:** Attention Mechanisms and Transformer Models, Generative Adversarial Networks (GANs): Architecture and Applications, Vibrational Auto encoders (VAEs): Theory and Practice, Neural Style Transfer and Image Synthesis.
5.	**Deep Learning Optimization and Regularization:** Optimization Algorithms: Gradient Descent, Adam, RMSprop, Regularization Techniques:

	Dropout, L1/L2 Regularization, Hyper parameter Tuning: Grid Search, Random Search, Bayesian Optimization, Model Evaluation Metrics: Accuracy, Precision, Recall, F1-Score.
6.	**Deployment and Real-World Applications:** Model Deployment: Techniques and Tools (e.g., TensorFlow Serving, ONNX), Edge Computing: Deploying Models on Mobile and IoT Devices, Case Studies: Healthcare, Autonomous Vehicles Finance, Ethical Considerations and Responsible AI.

Text Books:

1. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, "Deep Learning", MIT Press.
2. Charu Aggarwal, "Neural Networks and Deep Learning: A Textbook", Springer.
3. Rajalingappaa Shanmugamani, "Deep Learning for Computer Vision", Packt Publishing.
4. Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow", O'Reilly Media.

Reference Books:

1. Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer.
2. François Chollet, "Deep Learning with Python", Manning Publications.
3. Andrew Ng, "Machine Learning Yearning", available as a free eBook.
4. David Barber, "Bayesian Reasoning and Machine Learning", Cambridge University Press.

DEPARTMENT OF COMPUTER ENGINEERING

Program: M. Tech. (Computer – Data Science)								**Semester:** II	
Course: Data Visualization								**Code:** CODS203	
Teaching Scheme (hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
03	-	-	03	50	50	-	-	-	100

Prerequisites:

Basic knowledge of statistics and data analysis, Familiarity with programming languages such as Python or R, Understanding of fundamental data science concepts.

Course Objectives:

1. To provide a comprehensive understanding of data visualization principles and techniques.
2. To equip students with the skills to create effective and informative visualizations.
3. To enable students to use various tools and libraries for data visualization.
4. To enhance the ability to interpret and communicate data insights through visual means.

Course Outcomes: At the end of the course, the student will be able to -

CO1	Understand the significance and evolution of data visualization.
CO2	Prepare and transform data for accurate and meaningful visual representation.
CO3	Create and interpret basic visualizations using common chart types.
CO4	Create comprehensive dashboards and narratives with data visualizations.
CO5	Visualize and interpret machine learning models and their outcomes.
CO6	Implement best practices for designing ethical and accurate visualizations.

Course Contents:

Unit	**Description**
1.	**Introduction to Data Visualization:** Importance of data visualization, History and evolution of data visualization, Principles of good visualization design, Types of data visualizations (charts, graphs, and plots), Tools and software for data visualization.
2.	**Data Preparation and Cleaning for Visualization:** Data types and structures ,Data cleaning and preprocessing techniques ,Handling missing data and outliers ,Data transformation and normalization ,Preparing data for visualization.
3.	**Basic Visualization Techniques:** Bar charts, line charts, and pie charts, Histograms and density plots**,** Scatter plots and bubble charts**,** Box plots and violin plots**,** Creating basic visualizations using Python (Matplotlib, Seaborn) and R (ggplot2).
4.	**Advanced Visualization Techniques:** Interactive visualizations (Plotly, Bokeh), Geospatial visualizations (maps, choropleths), Network visualizations (graphs, nodes, edges), Time-series visualizations, Dashboards and storytelling with data.

5.	**Visualization for Machine Learning and Big Data:** Visualizing machine learning models and results ,Feature importance and model interpretation ,Visualizing big data with tools like D3.js and Tableau ,High-dimensional data visualization techniques (t-SNE, PCA) ,Case studies and real-world applications .
6.	**Best Practices and Ethical Considerations in Data Visualization:** Best practices for designing clear and effective visualizations, Avoiding misleading visualizationsEthical considerations in data visualization, Data privacy and security in visualizationFuture trends in data visualization.

Text Books:

1. Edward R. Tufte, "The Visual Display of Quantitative Information", Graphics Press.
2. Kieran Healy, "Data Visualization: A Practical Introduction", Princeton University Press.
3. Scott Murray, "Interactive Data Visualization for the Web", O'Reilly Media.
4. Jake VanderPlas, "Python Data Science Handbook", O'Reilly Media.
5. Hadley Wickham and Garrett Grolemund, "R for Data Science", O'Reilly Media.

Reference Books:

1. Cole Nussbaumer Knaflic, "Storytelling with Data: A Data Visualization Guide for Business Professionals", Wiley.
2. Claus O. Wilke, "Fundamentals of Data Visualization", O'Reilly Media.
3. Stephen Few, "Information Dashboard Design", O'Reilly Media.
4. Peter Bruce and Andrew Bruce, "Practical Statistics for Data Scientists", O'Reilly Media.
5. Julie Steele and Noah Iliinsky, "Beautiful Visualization: Looking at Data through the Eyes of Experts", O'Reilly Media.

DEPARTMENT OF COMPUTER ENGINEERING

Program: M. Tech. (Computer – Data Science)								**Semester:** II	
Course: Program Elective – II (Recommender Systems)								**Code:** CODS204A	
Teaching Scheme (hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
03	-	-	03	50	50	-	-	-	100

Prerequisites:

Basic knowledge of Machine Learning, Understanding of Data Mining concepts, Programming skills (Python, R, etc.), Basic knowledge of Statistics and Probability

Course Objectives:

1. To understand the fundamental concepts and techniques in recommender systems.
2. To explore different types of recommendation algorithms.
3. To evaluate and improve the performance of recommendation systems.
4. To study various applications and challenges in recommender systems.
5. To implement recommendation systems using appropriate tools and techniques.

Course Outcomes: At the end of the course, the student will be able to -

CO1	Identify the different types of recommender systems and their applications.
CO2	Develop content-based recommendation algorithms.
CO3	Evaluate the performance and scalability of collaborative filtering methods.
CO4	Assess the effectiveness of hybrid recommender systems using appropriate metrics.
CO5	Address privacy and security challenges in recommender systems.
CO6	Apply recommender system techniques to real-world scenarios.

Course Contents:

Unit	**Description**
1.	**Introduction to Recommender Systems:** Overview of Recommender Systems, Types of Recommender Systems: Content-Based, Collaborative Filtering, Hybrid Systems, Applications of Recommender Systems.
2.	**Content-Based Recommender Systems:** Item Profiling and User Profiling, Similarity Measures, Advantages and Limitations, Case Studies.
3.	**Collaborative Filtering:** User-Based and Item-Based Collaborative Filtering, Neighborhood Models, Matrix Factorization Techniques (SVD, NMF), Scalability and Efficiency.
4.	**Hybrid Recommender Systems:** Combining Content-Based and Collaborative Filtering, Model-Based and Memory-Based Hybrid Methods, Evaluation Metrics, Case Studies.
5.	**Advanced Topics in Recommender Systems:** Context-Aware Recommender Systems, Social Recommender Systems, Deep Learning for Recommender Systems, Privacy and Security Issues.

6.	**Case Studies and Applications:** Real-World Applications of Recommender Systems, Case Studies from Various Domains (e.g., E-commerce, Entertainment, Social Networks), Implementation Using Tools and Libraries (e.g., Apache Mahout, TensorFlow),Future Trends and Research Directions

Text Books:

1. Dietmar Jannach, Markus Zanker, Alexander Felfernig, and Gerhard Friedrich, "Recommender Systems: An Introduction", Cambridge University Press, 2010.
2. Francesco Ricci, Lior Rokach, and Bracha Shapira, "Recommender Systems Handbook", Springer, 2015.

Reference Books:

1. Jure Leskovec, Anand Rajaraman, and Jeffrey Ullman, "Mining of Massive Datasets", Cambridge University Press, 2014.
2. Kim Falk, "Practical Recommender Systems", Manning Publications, 2019.
3. Shengxiang Yang, Wei Fan, and Dilip S. Madan, "Deep Learning for Recommender Systems", World Scientific Publishing, 2020.

DEPARTMENT OF COMPUTER ENGINEERING

Program: M. Tech. (Computer – Data Science)								**Semester:** II	
Course: Program Elective – II (Web Intelligence)								**Code:** CODS204B	
Teaching Scheme (hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
03	-	-	03	50	50	-	-	-	100

Prerequisites:

1. Basic knowledge of data science and statistics.
2. Familiarity with web technologies (HTML, CSS, JavaScript).
3. Proficiency in programming languages such as Python or R.

Course Objectives:

1. To explore Web Intelligence concepts, data types, techniques, and applications.
2. To equip students with skills to extract web data, handle dynamic content, and address legal and ethical concerns.
3. To understand web data extraction, learn scraping tools like Beautiful Soup and Scrapy, handle dynamic content, and explore legal and ethical issues.
4. To explore social media data, perform sentiment analysis, apply network analysis, and study case applications in data science.
5. To learn data visualization principles and study web data visualization for business intelligence.
6. To apply web intelligence through case studies, hands-on projects in data extraction, mining, visualization, and project development from data to insights.

Course Outcomes: At the end of the course, the student will be able to -

CO1	Understand the fundamental concepts and scope of web intelligence.
CO2	Develop skills to extract and crawl web data effectively.
CO3	Apply web mining techniques to analyze and extract patterns from web data.
CO4	Analyze social media data to extract meaningful insights.
CO5	Create effective visualizations of web data for insights and decision-making.
CO6	Develop and present projects showcasing web intelligence solutions

Course Contents:

Unit	**Description**
1.	**Introduction to Web Intelligence:** Overview of Web Intelligence, Web Data: Structured, Semi-Structured, and Unstructured, Key Technologies: Web Crawling, Web Mining, and Web Analytics, Applications and Challenges in Web Intelligence.
2.	**Web Data Extraction and Crawling:** Web Crawling Fundamentals, Web Scraping Techniques and Tools (e.g., BeautifulSoup, Scrapy), Handling Dynamic Web Content and JavaScript, Legal and Ethical Issues in Web Data Extraction.
3.	**Web Mining Techniques:** Introduction to Web Mining: Concepts and Techniques**,**Text Mining: Techniques for Processing Web Text Data**,** Web Usage Mining: Analyzing User Behavior and Web Logs**,** Web Content

	Mining: Extracting and Analyzing Web Content.
4.	**Social Media Analytics:** Social Media Data: Sources and Types, Sentiment Analysis and Opinion Mining, Social Network Analysis and Visualization, Case Studies: Applications of Social Media Analytics in Data Science.
5.	**Web Data Visualization:** Principles of Data Visualization, Visualization Tools and Libraries (e.g., D3.js, Tableau), Interactive and Real-Time Visualization Techniques, Case Studies: Visualization of Web Data for Business Intelligence.
6.	**Practical Applications and Case Studies:** Case Studies in Web Intelligence, Hands-on Projects: Web Data Extraction, Mining, and Visualization, Project Development: From Data Collection to Insight Generation, Presentation and Evaluation of Web Intelligence Projects.
Text Books:	
1. Mitchell Ryan, "Web Scraping with Python: Collecting Data from the Modern Web", O'Reilly Media. 2. Chakrabarti Soumen, "Web Mining: Applications and Techniques", Kluwer Academic Publishers. 3. Murray Scott, "Interactive Data Visualization for the Web", O'Reilly Media.	
Reference Books:	
1. Chakrabarti Soumen, "Mining the Web: Discovering Knowledge from Hypertext Data", Morgan Kaufmann. 2. Provost Foster and Tom Fawcett, "Data Science for Business," O'Reilly Media.	

DEPARTMENT OF COMPUTER ENGINEERING

Program: M. Tech. (Electrical – Power Systems)									**Semester:** II
Course: Open Elective – II (Electrical Vehicles)									**Code:** EEPS205
Teaching Scheme				**Evaluation Scheme**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
03	-	-	03	50	50	-	-	-	100

Prerequisites:

Power Electronics, Control Systems.

Course Objectives:

1. To distinguish between different configuration of electric vehicles with merits and demerits.
2. To recommend drive for EV applications with suitable energy storage technology.

Course Outcomes: At the end of course, student will be able to -

CO1	Explore the history, development, and configurations of EVs and hybrid EVs, focusing on efficiency and energy storage.
CO2	Analyze EV battery specifications, charging cycles, drives, and converter topologies.
CO3	Examine energy sources, battery features, charging methods (conductive and inductive), and charging infrastructures, including domestic, public, and fast-charging stations.
CO4	Select appropriate motor and converter for EV applications.
CO5	Study EV power devices, power electronics converters along with its switching methods for EV operation.
CO6	Investigate particular drive for EV including speed control methods and advanced control strategies like FOC and adaptive control.

Course Contents:

Unit	Description
1	**Introduction to EV:** History and development of on-road Electric Vehicles (EV). Different configurations of hybrid EVs with block diagram representation, merits & demerits of different configurations in view of vehicle efficiency and energy storage system.
2	**Basics of EV batteries:** Specifications of batteries, power density, Energy density, Charging & Discharging cycle and recommended methodologies for charging. Recommended drives for EV and converter topology used in EVs

3	**Energy Sources & Charging:** Different Batteries and Ultra-capacitors, Battery characteristics (Discharging &Charging) Battery Chargers: Conductive (Basic charger circuits, microprocessor based charger circuit. Arrangement of an off-board conductive charger, Standard power levels of conductive chargers, Inductive (Principle of inductive charging, Soft-switching power converter for inductive charging), Battery indication Methods Charging Infrastructure: Domestic Charging Infrastructure, Public Charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move and-charge zone.
4	**EV Propulsion- Electric Motor:** Choice of electric propulsion system, block diagram of EV propulsion system, concept of EV Motors, single motor and multi-motor configurations, fixed & variable geared transmission, In wheel motor configuration, classification of EV motors, Electric motors used in current vehicle applications, Recent EV Motors, Comparison of Electric Motors for EV applications.
5	**Power Electronics & Control requirement for EV:** Comparison of EV power devices, introduction to power electronics converter, four quadrant DC chopper, three-phase full bridge voltage-fed inverter, soft-switching EV converters, comparison of hard-switching and soft-switching converter, three-phase voltage-fed resonance DC-link inverter, Basics of Microcontroller & Control Strategies.
6	**EV Motor Drives:** DC Motor: Type of wound-field DC Motor, Torque speed characteristics DC-DC Converter, Two quadrant DC Chopper, two quadrant zero voltage transition converter-fed dc motor drive, speed control of DC Motor Induction Motor Drive: Three Phase Inverter Based Induction Motor Drive, Equal Area PWM, Three Phase Auxiliary resonant snubber (ARS) Inverter Type (ZVC & ZCS), Single Phase ARS Inverter Topology, Speed Control of Induction Motor, FOC, Adaptive Control, Model Reference Adaptive Control (MARS), Sliding mode Control.

Text Books:

1. Dr. S. Sujatha, Senthil Kumar, 'A textbook on Electric vehicle technology'Scientific International Publishing House.
2. Stefano Longo Mehrdad Ehsani, Yimin Gao, 'Modern electric, Hybrid electric & fuel cell vehicles, Taylor & Fransis Exclusive

Reference Books:

1. Amelie Ewert, Stephan Schmid, et al., 'Small Electric vehicles : An international view on light three and four wheeler, Springer publications
2. Ron Hodkinson & John Fenton, Light Weight Electric/Hybrid Vehicle design, Butterworth Publications, Heinemann.
3. Marcedle K keirn, H. A. Kiehne, 'Battery Technology Handbook', Sandeep Dhameja, Electric vehicle battery systems, Butterworth–Heinemann

E-Resources:

1. NPTEL :: Electrical Engineering - NOC: Electric vehicles and Renewable energy

DEPARTMENT OF COMPUTER ENGINEERING

Program: M. Tech. (E&TC – IoT and Sensor Systems)								**Semester:** II	
Course: Open Elective – II (Embedded System)								**Code:** ETIS205	
Teaching Scheme (hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
03	-	-	03	50	50	-	-	-	100

Prerequisites:	
Microcontrollers	
Course Objectives:	
Introduce students to the principles and programming of real-time operating systems, emphasizing task management, scheduling, and data protection in embedded applications.	
Course Outcomes: At the end of the course, the student will be able to -	
CO1	Describe the fundamental concepts, characteristics, and components of embedded systems, including the design issues, flow, and metrics.
CO2	Demonstrate proficiency in the embedded software development process and tools, including linking, locating, and integrating software into target systems.
CO3	Analyze the ARM architecture, including its design philosophy, register banking, pipelining, and interrupt handling mechanisms.
CO4	Utilize Embedded C programming to interface with peripherals on the LPC 2148 microcontroller, including LEDs, LCDs, keyboards, and ADCs.
CO5	Develop practical applications and projects using Embedded C and the LPC 2148 microcontroller, demonstrating hands-on proficiency.
CO6	Apply the concepts of real-time operating systems, including task scheduling, shared data management, and the use of semaphores to protect shared data, in embedded applications.
Course Contents:	
Unit	**Description**
1.	**Introduction to Embedded Systems:** Embedded System Definition and Characteristics: Definition, characteristics, and components of an embedded system. Design Issues and Flow: Embedded system design issues, design flow, and metrics. Hardware-Software Design: Issues in hardware-software design and co-design. Introduction to IDE.

2.	**Embedded Software Development:** Development Process and Tools: Introduction to the embedded software development process and tools. Linking and Locating Software: Techniques for linking and locating software, getting embedded software into the target system.
3.	**ARM Architecture and Embedded Processor:** ARM Architecture Details: RISC architecture design philosophy, register banking, CPSR, and SPSR. Pipelining and Interrupts: Pipelining, exceptions, interrupts, and the vector table in ARM architecture.
4.	**LPC 2148 Microcontroller:** Microcontroller Architecture: ARM7TDMI-S microcontroller LPC-2148 architecture details, SFRs, and port structure. Peripheral Modules: Timer, counter, PWM module, and Embedded C programming for interfacing LEDs and LCDs.
5.	**Embedded C Programming:** Advanced Interfacing: Embedded C programming for interfacing with keyboards and ADC. Practical Applications: Hands-on projects and real-world applications using LPC 2148.
6.	**Real Time Operating System (RTOS):** RTOS Concepts and Architectures: Introduction to RTOS concepts and embedded software architectures: round robin, round robin with interrupts, function queue scheduling, and real-time operating systems. RTOS Programming and Task Management: Tasks and task states, task scheduling, shared data and reentrancy, semaphores, and protecting shared data using semaphores.

Text Books:

1. James K. Peckol. "Embedded Systems: A Contemporary Design Tool", John Wiley & Sons.
2. Raj Kamal. "Embedded Systems: Architecture, Programming and Design", McGraw-Hill Education.

Reference Books:

1. Joseph Yiu. "The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors", Newnes.
2. Michael Barr and Anthony Massa. "Programming Embedded Systems: With C and GNU Development Tools", O'Reilly Media.
3. Real-Time Systems: Design Principles for Distributed Embedded Applications, Springer.

DEPARTMENT OF COMPUTER ENGINEERING

Program: M. Tech. (Mechanical–Design Engineering)								**Semester:** II	
Course: Open Elective – II (Process Equipment and Plant Design)								**Code:** MEDE205	
Teaching Scheme (hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
03	-	-	03	50	50	-	-	-	100

Prerequisites:

Engineering Mathematics, Machine Design, Mechanical System Design. Knowledge of Fluid Mechanics and process instrumentation.

Course Objectives:

1. To understand the importance of Elements of Material Handling System.
2. Understand the benefit of Selection of various types of material handling equipment.
3. To design of material handling systems.
4. To apply material handling/warehouse automation and safety considerations.
5. To design plant hydraulics and process vessels.
6. To know plant auxiliaries.

Course Outcomes: At the end of the course, the student will be able to -

CO1	Identify the use and importance of material handling
CO2	Select various types of material handling equipment for a particular operation.
CO3	Apply the design procedures of various material handling equipment & components and design the material handling system.
CO4	Understand Material Handling / Warehouse Automation and Safety considerations
CO5	Apply Design for plant hydraulics and process vessels
CO6	Design various plant auxiliaries

Course Contents:

Unit	**Description**
1.	**Elements of Material Handling System:** Importance, Terminology, Objectives, and benefits of better Material Handling; Principles and features of Material Handling System; Interrelationships between material handling and plant layout, physical facilities, and other organizational functions; Classification of Material Handling Equipment's.

2.	**Selection of Material Handling Equipment:** Factors affecting selection; Material Handling Equation; Choices of Material Handling Equipment; General analysis Procedures; Basic Analytical techniques; The unit load concept; Selection of suitable types of systems for applications; Activity cost data and economic analysis for design of components of Material Handling Systems; functions and parameters affecting service; packing and storage of materials.
3.	**Design of Mechanical Handling Equipment:** Drives for hoisting, components, and hoisting mechanisms; rail traveling components and Mechanisms; hoisting gear operation during transient motion; selecting the motor rating and determining breaking torque for hoisting mechanisms. Hand-propelled and electrically driven E.O.T. overheat Traveling cranes; Traveling mechanisms of cantilever and monorail cranes; design considerations for structures of rotary cranes with fixed radius ; fixed post and overhead traveling cranes; Stability of stationary rotary and traveling rotary cranes.
4.	**Material Handling / Warehouse Automation and Safety Considerations:** Storage and warehouse planning and design; computerized warehouse planning; Need, Factors, and Indicators for consideration in warehouse automation; which function, When, and How to automate; Levels and Means of Mechanizations. Safety and design; Safety regulations and discipline.
5.	**Plant Hydraulics and Process Vessels:** Plant hydraulics, Pumps, Compressors, Piping and Pipe fittings, Piping schemes for processes, and Process vessels.
6.	**Plant Auxiliaries:** Process Utilities, Plant Instrumentation and Process Control, Engineered safety.

Text Books:

1. N. Rudenko, "Material Handling Equipments", Peace Publishers, Moscow.
2. James M. Apple, "Material Handling System Design", John Wiley and Sons Publication, New York.
3. John R. Immer, "Material Handling", McGraw-Hill Co. Ltd., New York.
4. Colin Hardi, "Material Handling in Machine Shops", Machinery Publication Co. Ltd., London.

Reference Books:

1. M. P. Nexandrn, "Material Handling Equipment", MIR Publication, Moscow.
2. C. R. Cock and J. Mason, "Bulk Solid Handling", Leonard Hill Publication Co. Ltd., U.S.A.
3. Spivakovsky, A. O. and Dyachkov, V. K., "Conveying Machines", Volumes I and II, MIR Publishers, 1985.
4. Kulwiac, R. A., "Material Handling Handbook", 2nd edition, John Wiley Publication, New York.

E-Resources:

1. NPTEL course on Process Equipment Design by Prof. Shabina Khanam, IIT Roorkee - https://onlinecourses.nptel.ac.in/noc21_ch18/preview
2. NPTEL course on Equipment Design: Mechanical Aspects by Prof. Shabina Khanam, IIT Roorkee https://onlinecourses.nptel.ac.in/noc24_ch38/preview

DEPARTMENT OF COMPUTER ENGINEERING

DEPARTMENT OF COMPUTER ENGINEERING

Program: M. Tech. (Robotics and Automation Engineering)								**Semester:** II	
Course: Open Elective – II (Micro Electro Mechanical Systems)								**Code:** MERA205	
Teaching Scheme (hrs./week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
03	-	-	03	50	50	-	-	-	100

Prerequisites:

Fundamental of electrical and electronics engineering; Mechatronics; Manufacturing machine tools.

Course Objectives:

To explore micro engineering devices, electrostatic sensor principles, piezoelectric materials and transducers, micromachining terms, and polymers in MEMS.

Course Outcomes: At the end of the course, the student will be able to -

CO1	Understand the operation of micro devices, micro systems and their applications.
CO2	Apply scaling laws that are used extensively in the conceptual design of micro devices and systems.
CO3	Choose a micromachining technique, such as bulk micromachining and surface micromachining for a specific MEMS fabrication process.
CO4	Simplify the design of micro devices, micro systems using the MEMS fabrication process.
CO5	Select suitable polymer for given application.

Course Contents:

Unit	**Description**
1.	**Introduction:** Intrinsic Characteristics of MEMS, Energy Domains and Transducers, Sensors and Actuators, Introduction to Microfabrication, Silicon-Based MEMS Processes, New Materials, Review of Electrical and Mechanical Concepts in MEMS, Semiconductor Devices, Stress and Strain Analysis, Flexural Beam Bending, Torsional Deflection.
2.	**Electrostatic Sensing and Actuation:** Introduction to Electrostatic Sensors and Actuators, Parallel-Plate Capacitors, Applications of Parallel Plate Capacitors, Interdigitated Finger Capacitors, Applications of Comb Drive Devices. Thermal Sensing and Actuation: Introduction, Sensors and Actuators Based on Thermal Expansion, Thermal Couples, Thermal Resistors, Applications. Magnetic Actuation: Essential Concepts and Principles, Fabrication of Micro Magnetic Components, Case Studies of MEMS Magnetic Actuators. Piezo Resistive Sensors: Piezo resistive Sensor Materials, Stress Analysis of Mechanical Elements, Applications of Piezo Resistive Sensors. Piezoelectric Sensing and Actuation: Introduction, Properties of Piezoelectric Materials, Applications.
3.	**Sensors and Actuators:** Piezo-Resistive Sensors, Piezo-Resistive Sensor Materials, Stress Analysis of Mechanical Elements, Applications to Inertia, Pressure, Tactile, and Flow Sensors, Piezoelectric Sensors and Actuators, Piezoelectric Effects, Piezoelectric Materials, Applications to Inertia, Acoustic, Tactile, and Flow Sensors.

4.	**Micromachining:** Silicon Anisotropic Etching, Anisotropic Wet Etching, Dry Etching of Silicon, Plasma Etching, Deep Reactive Ion Etching (DRIE), Isotropic Wet Etching, Gas Phase Etchants, Case Studies, Basic Surface Micro-Machining Processes, Structural and Sacrificial Materials, Acceleration of Sacrificial Etch, Stiction and Anti-Stiction Methods, LIGA Process, Assembly of 3D MEMS.
5.	**Polymer and Optical MEMS:** Polyimide, SU-8, Liquid Crystal Polymer (LCP), PDMS, PMMA, Parylene, Fluorocarbon, Application to Acceleration, Pressure, Flow, and Tactile Sensors, Optical MEMS, Lenses and Mirrors, Actuators for Active Optical MEMS

Text Books:

1. Chang Liu, "Foundations of MEMS", Pearson Education Inc., 2012.
2. Stephen D. Senturia, "Microsystem Design", Springer Publication, 2000.
3. Dr. T. Kamatchi, "Fundamentals of Micro-electromechanical Systems (MEMS)", Technical Publication.
4. Nadim Maluf, Kirt Williams, "An Introduction to Micro-electromechanical Systems Engineering", Artech House, Boston.

Reference Books:

1. Tai Ran Hsu, "MEMS & Microsystems Design and Manufacture", TMH, New Delhi, 2002.
2. Marc Madou, "Fundamentals of Microfabrication".

E-Resources:

1. https://nptel.ac.in/courses/108106165
2. https://www.me.iitb.ac.in/~gandhi/me645/05L1_coursecontents_mtvn.pdf
3. https://www.edx.org/learn/engineering/ecole-polytechnique-federale-de-lausanne-micro-and-nanofabrication-mems
4. https://engineering.purdue.edu/online/courses/fundamentals-mems

DEPARTMENT OF COMPUTER ENGINEERING

Program: M. Tech. (Computer – Data Science)									**Semester:** II
Course: Laboratory Proficiency – II									**Code:** CODS206
Teaching Scheme (hrs./week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
-	04	-	02	-	-	50	50	-	100

Prerequisites:

Knowledge about Deep learning, data Virtualization, distributed database ,Recommender Systems, GPU Computing, web Intelligence

Course Objectives:

1. To design the algorithms and current trends in deep learning research.
2. To implement distributed database for real world problems.
2. To implement recommendation systems using appropriate tools and techniques.
3. To acquire hands-on experience with CUDA programming for efficient computation on NVIDIA GPUs.
4. To gain practical experience with tools and frameworks used in web intelligence for data-driven decision-making.

Course Outcomes: At the end of the course, the student will be able to -

CO1	Design and implement CNN models to classify multi-category image datasets, record accuracy across epochs, and analyze performance on CPU and GPU in Colab.
CO2	Implement an RNN model for sentiment analysis on movie reviews and evaluate its performance.
CO3	Perform exploratory data analysis (EDA) on datasets such as email data and apply time series analysis with various visualization techniques
CO4	Build and implement a recommender system using cosine similarity scores and content-based recommendation techniques.
CO5	Perform web scraping for a selected application (e.g., movie review analysis, house price prediction, hotel pricing analytics, or flight ticket price) and analyze the collected data.
CO6	Create a data visualization for a selected topic (e.g., Patient Risk Healthcare, Marketing Campaign, Crime Analysis, or Covid-19 Outbreak) using a visualization tool.

Course Contents:

Deep Learning

Sr. No.	**Assignments**
1	Design and implement a CNN model (with 2 layers of convolutions) to classify multi category image datasets. Record the accuracy corresponding to the number of epochs. Use the MNIST, CIFAR-10 datasets.
2	Design and implement a CNN model (with 4+ layers of convolutions) to classify multi category image datasets. Use the MNIST, Fashion MNIST, CIFAR-10 datasets. Set the No. of Epoch as 5, 10 and 20. Make the necessary changes whenever required. Record the accuracy corresponding to the number of epochs. Record the time required to run the program, using CPU as well as using GPU in Colab.

3	Implement RNN for sentiment analysis on movie reviews.
Data Visualization	
1	To perform exploratory data analysis (EDA) on with datasets like email data set.
2	To perform time series analysis and apply the various visualization techniques.
Program Elective - II (Recommender Systems)	
1	Build a recommender system by using cosine similarities score.
2	Implement Content-based recommendation systems.
Program Elective – II (Web Intelligence)	
1	Carry out a web Scraping for any one, Movie Review Analysis/ House Price Prediction / Hotel Pricing Analytics/ Flight Ticket Price.
2	Create a data visualization using any tool for any one of the topics, Patient Risk Healthcare/ Marketing Campaign/ Crime Analysis/ Covid-19 outbreak.

DEPARTMENT OF COMPUTER ENGINEERING

Program: M. Tech. (Computer – Data Science)									**Semester:** II
Course: Dissertation Phase – I									**Code:** CODS207
Teaching Scheme (hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
	02	-	01	-	-	25	25	-	50

Prerequisites:

Basic knowledge of Data Science

Course Objectives:

1. To conduct review of literature to arrive at selected advanced topic for the research work.
2. To enable students to apply their knowledge about research design and methods to develop their project.
3. To inculcate research culture in students for their technical growth.

Course outcome: At the end of the course, the student will be able to -

CO1	Identify a topic in advanced areas of data science.
CO2	Review literature to identify gaps and define the objectives and scope of the work.
CO3	Employ the ideas from the literature and develop a research methodology.
CO4	Prepare good-quality technical reports based on the project.
CO5	Prepare a good-quality research paper.

Course Contents:

Sr. no.	**Description**
1.	Selection of Topic
2.	Literature Survey
3.	Defining the Objectives and Solution Methodology
4.	Performance of the Task
5.	➢ Under the guidance of a faculty called as Supervisor, PG students from first year is required to do innovative and research-oriented work related to various theory and laboratory courses he/she studied during previous semesters. Dissertation work should not be limited to analytical formulation, experimentation or survey based project. ➢ Student need to carry out an exhaustive literature survey with consultation of his/her Supervisor for not less than 25 reputed national international journals and conference papers. Students should make the Presentation with literature survey report to justify about the innovativeness, applicability relevance and significance of the work. ➢ At the time of presentation, student shall also prepare Synopsis of the work and submit to department for approval. ➢ Student shall submit dissertation as per the prescribed format to department.

DEPARTMENT OF COMPUTER ENGINEERING

Program: M. Tech. (Computer – Data Science)								**Semester:** II	
Course: Audit Course – II: Constitution of India								**Code:** CODS208	
Teaching Scheme (hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
01	-	-	-	-	-	-	-	-	-

Prerequisites:

1. Understanding of Indian History and Political Science.
2. Familiarity with Constitutional Law and Governance.
3. Awareness of Socio-economic and Cultural Diversity in India.
4. Knowledge of Democratic Processes and Institutions.

Course Objectives:

1. Examine the Historical Development of the Indian Constitution.
2. Critically Analyze the Philosophical Foundations of the Indian Constitution.
3. Explore the Scope and Implications of Constitutional Rights and Duties.
4. Understand the Structure and Functions of Key Organs of Governance.
5. Analyze the Mechanisms and Practices of Local Administration.
6. Evaluate the Role and Functioning of Electoral Institutions.

Course Outcomes: At the end of the course, the student will be able to -

CO1	Demonstrate an understanding of the Historical Context and Evolution of the Indian Constitution
CO2	Evaluate the Philosophical Foundations of the Indian Constitution
CO3	Explain the Scope and Significance of Constitutional Rights and Duties
CO4	Describe the Structure and Functions of Key Organs of Governance
CO5	Evaluate the Functioning of Local Administration and Grassroot Democracy
CO6	Analyze the Role and Functioning of Electoral Institutions

Course Contents:

Unit	**Description**
1.	**History of Making of the Indian Constitution:** History, Drafting Committee (Composition & Working).
2.	**Philosophy of the Indian Constitution:** Preamble, Salient Features.
3.	**Contours of Constitutional Rights & Duties:** Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.
4.	**Organs of Governance:** Parliament, Composition, Qualifications and Disqualifications, Powers and Functions,

	Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.
5.	**Local Administration:** District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative CEO of Municipal Corporation, Pachayati raj: Introduction, PRI: ZilaPachayat. Elected officials and their roles, CEO ZilaPachayat: Position and role, Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy
6.	**Election Commission:** Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners, State Election Commission: Role and Functioning, Institute and Bodies for the welfare of SC/ST/OBC and women
Reference Books:	
1. "The Constitution of India, 1950 (Bare Act)", Government Publication. 2. Dr. S. N. Busi, "Dr. B. R. Ambedkar Framing of Indian Constitution", 1st Edition, 2015. 3. M. P. Jain, "Indian Constitution Law", 7th Edn., Lexis Nexis, 2014. 4. D. D. Basu, "Introduction to the Constitution of India", Lexis Nexis.	
E-Resources:	
1. Constitution of India - National Portal of India https://www.constitutionofindia.net/read/ https://legislative.gov.in/constitution-of-india/ 2. PRS Legislative Research - Articles on Indian Constitution https://prsindia.org/ 3. Election Commission of India - Official Website	