VEERMATA JIAJABAI TECHNOLOGICAL INSTITUTE, MUMBAI

Circular / Open Elective / Semester II/ AY 2025-26 /01 Date 29th January 2026

Course Name, Detail Curriculum and Eligibility criteria of Open Elective Courses to be offered for M.Tech. semester II of the Academic Year 2025-26 are given below. Students are requested to submit google form for open elective of semester II (from 29th January 2026 to 01st February 2026).

Link of Google form: https://forms.gle/bn1JJZEAoF42k8xt7

Rules:

1. Once selected, the course will not be changed under any circumstances. Therefore students should be careful while selecting the course
2. In case number of students opting for a particular course is less than 25, the course will be not being offered.
3. Opting open elective from other department is mandatory.
4. Students should not study same course as core/programme elective and open elective.
   E.g, Students of M.Tech (CAD/CAM) having Robotics and Automation as core course should not opt for Robotics open elective.
5. Project management department students cannot select project management as open elective.

Dr. A. V. Deshpande
Associate Dean Academics

Open Elective at Institute Level
(M. Tech II Semester AY 2025-26)

Sr. No	**Course Title**	**Department Offering Elective Course**
1	Mechanics of composite material	Structural
2	Climate change and carbon Neutrality	Civil
3	Machine Learning	Computer
4	Robotics	Mechanical
5	Mathematical Foundation course for data analytics	Electrical
6	Polymers for protective applications	Textile
7	Project Management	Production

Open Elective 2 Course :								
SN	**Course Code**	**Course Title**	**L-T-P (Hours / Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
1	**CECM6061S-A**	**Climate change and carbon neutrality**	3-0-0=3	3	20	30	50	3

Course Outcome:

1. An ability to identify and analyze earth's atmosphere and air pollution related environmental issues.
2. Be able to identify the key principles, causes and consequences of climate change
3. Developing competency in use of various air modeling software and carbon footprints.
4. Ability to use the signs, future projections, impacts of carbon in research and development.

Syllabus

1. Composition of dry ambient air, properties of air, Definition of air pollution, Classification of air pollutants, Units for classification of air pollutants, History of air pollution- global and national, Scope of problem-general, urban, rural, and specific. Sources of air pollution: Natural and man-made, Major pollutants from different sources in Greater Mumbai area and other Indian cities, Emission factors.
2. Meteorological aspects of air pollution-large scale wind circulation: geotropic wind, gradient wind, cyclone, anticyclone, planetary boundary layer, lapse rate, stability conditions, wind velocity profile, maximum mixing depth
3. Introduction – Climate, The earth's natural greenhouse effect, radiative balance, importance of water. Effect of Climate change on human health, plants, animals, properties
4. Green house gases, role of Carbon dioxide and other GHG gases, their emissions. Different concerns of developed and developing part of the world, The earth's Carbon reservoir, biogeochemistry, Carbon cycling; Global Ocean circulations – introduction and overview; Introduction to Climate change- advances in computer modeling
5. Climate Change Agreements: Understanding the evolution of the climate agreements, UNFCCC, Kyoto protocol, the defining agreements of Paris and COP; The pledges of COP26,Future scenarios of climate action.
6. Carbon neutrality, Carbon net zero emissions, Scope I, II & III emissions, Carbon Footprints.

Reference Books:

1. "Air pollution" by Henry C Perkins - McGraw Hill Publications
2. "Air Pollution" by Wark and Warner
3. Climate and Eco-systems, David Schimel, Princeton University Press, 2013
4. Climate Crisis: An Introductory Guide to Climate Change; David Archer & Stefan Rahmstorf ; Cambridge University Press; 2001
5. Global Warming and Climate Change; Grover Velma.I; Science Publishers; 2008
6. UNFCCC (2008). Compendium on Methods and Tools to Evaluate Impacts of, and Vulnerability and Adaptation to, Climate Change. Available at https://unfccc.int/files/adaptation/nairobi_workprogramme/compendium_on_methods_tools/application/pdf/20080307_compendium_m_t_complete.pdf
7. UNFCCC (2006). UNFCCC Handbook. Available at https://unfccc.int/resource/docs/publications/handbook.pdf
8. UNFCCC & UNEP (2002). Climate Change Information Kit. Available at https://unfccc.int/resource/iuckit/cckit2001en.pdf
9. Atmospheric Chemistry and Physics: from Air Pollution to Climate Change, John Wiley, New York, 1998

Programme Name	M. Tech. (Civil Engineering with Specialization in Structural Engineering), SEMESTER II
Course Code	CESE5062T
Course Title	(Open Elective -II) Mechanics of Composite Materials

COURSE OUTCOMES:

After completion of this course students shall be able to

CO1: explain constituents of composites and their structural applications.

CO2: apply constitutive relationship for composite materials.

CO3: explain classical formulation of composite beams and plates subjected to static and dynamic loadings.

Introduction

Definition of fiber reinforced composites, applications and various reinforcement and matrix materials. Introduction to functionally graded materials. Metal composite, alloys. Different methods of manufacturing composites. Introduction to design of structures using composite materials

Mechanics of a Lamina

Linear elastic stress-strain relations, elastic constants based on micromechanics, plane stress constitutive relations, transformation of stresses and strains transformation of material coefficients, thermal stresses and strains.

Laminated Composites

Types of laminated composites, displacement field approximations for classical laminate theory, laminate strains, stress resultants, stiffness matrices, stresses and strains due to applied loads, introduction to first order shear deformation theory.

Failure Theories of a Lamina

Maximum stress failure theory, maximum strain failure theory, Tsai-Hill failure theory, Tsai-Wu failure theory.

Mechanical Properties Determination

Tensile properties, compressive properties, flexure properties, in-plane shear properties, inter- laminar shear strength.

Recommended Reading

1. Jones R. M., Mechanics of Composite Materials, McGraw-Hill, Kogakusha Ltd., Tokyo, 1975.
2. Agarwal B. D. and Broutman L. J., Analysis and Performance of Fiber Composites, John- Wiley and Sons, 1980.
3. Kaw A. K., Mechanics of Composite Materials, CRC Press, Florida, 1997.
4. Hyer M. W., Stress Analysis of Fiber-Reinforced Composite Materials, McGraw Hill, 1999.
5. Mukhopadhyay M., Mechanics of Composite Materials and Structures, University Press, India, 2004.
6. Daniel and Ishai, Engineering Mechanics of Composite Materials, Oxford University Press, 2005.
7. Christensen R. M., Mechanics of Composite Materials, Dover Publications, New York, 2005.
8. Mota Soares C. A., Mota Soares C. M., and Freitas Manuel J.M., Mechanics of Composite Materials and Structures (Proceedings), Springer Science & Business Media, 1999.

Programme Name	M. Tech. Computer Engineering
Course Code	COCE5066S
Course Title	Machine Learning
Course Type	Open Elective-II
Course Coordinator	Dr. V. B. Nikam
Prerequisites: Basic understanding of probability and statistics, linear algebra and calculus.	
Course Outcomes: At the end of the course student will be able to: **CO1.** . Gain knowledge about basic concepts of Machine Learning **CO2.** Identify machine learning tools and techniques solving real time problems **CO3.** Solve the problems using various machine learning techniques **CO4.** Optimise and test the model for best performance. **CO5.** Exploring the advances in machine learning future to solve real time case studies	

	Course Contents	Hrs.	CO
1.	**Introduction:** Introduction and Basic Concepts of ML, Taxonomy of ML, Types of machine learning: Supervised Learning, Regression Vs Classification, Unsupervised Learning, Clustering, Classification, Rules mining, Prediction, Issues in machine learning.	6	CO1
2.	**Machine learning Tools:** R, Python, Scikit Learn, BigML , WEKA, or. any one platform to make machine learning in practice with case studies.Data and Data understanding, Data pre-processing. Learning Association Rules: Mining Frequent Patterns, Apriori algorithm, and other varients of Association rules mining algorithms.	8	CO2, CO3

3.	**Supervised Learning:** Decision Trees: ID3, Classification and Regression Trees, Regression. Neural Networks, Support vector machines, Generalized Linear Models (GLM), Probabilistic Learning: Bayesian Learning, Bayes Optimal Classifier, Naıve Bayes Classifier, Markov Decision Process (MDP). Ensemble Learning: Model Combination Schemes, Bagging: Random Forest Trees, Boosting: Adaboost, Stacking	08	CO1, CO3
4.	**Unsupervised learning:** Clustering, Instance-based learning, K-nearest Neighbour, Dimensionality Reduction, K-Mode Clustering, Expectation Maximization, Gaussian Mixture Models.	6	CO3
5.	**Balanced Machine Learning Model and Model Evaluation:** What Are Evaluation Metrics? Types of Predictive Models, Confusion Matrix, F-Score, Accuracy, Precision, Recall, Gain and Lift Charts , Kolmogorov-Smirnov Chart , Area Under the ROC Curve, Log Loss, Gini Coefficient, Concordant – Discordant Ratio, Root Mean Squared Error (RMSE), Root Mean Squared Logarithmic Error, R-Squared/Adjusted R-Squared, Cross Validation, Bias-Variance and Error Analysis, Bias/variance trade-off, Error Analysis, Normal Equations, Variance, Gradient Descent, Model Balancing: Overfitting, underfitting, Variance, Bias and Model Complexity in Machine Learning.	8	CO4
6.	**Introduction to Advanced topics in Machine Learning:** Deep Neural Networks, Vectorization, Backpropagation, Forward propagation, multi-label classification, Conditional Random Fields (CRFs), Reinforcement Learning, Spectral clustering- Semi-supervised learning. Deep Learning Models: Introduction to NN, important terms in NN, DNN, CNN, RNN, Model Training and testing, Pretrain models, parameter tuning and customized models, Deep learning in images processing, video processing, text processing.	6	CO5

Text Books	
1.	Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, Prentice Hall of India, Third Edition, 2014.
2.	Miroslav Kubat, "An Introduction to Machine Learning", Springer, 2015.
Reference Books	
1.	Tom Mitchell, "Machine Learning", McGraw-Hill, 2017
2.	Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems", Third Edition, OReilly Publication, 2022
3.	John D. Kelleher, Deep Learning, The MIT Press Essential Knowledge series, 2019
4.	Jerome Friedman, Robert Tibshirani, Trevor Hastie, "The Elements of Statistical Learning" Springer, 2017.

Programme Name	M. Tech. (IoT), SEMESTER – II (Open Elective)
Course Code	EEIT5062S
Course Title	Mathematical Foundation Course for Data Analytics

Course Objective

- The course will introduce the fundamental concepts of linear algebra, probability and statistics required for a program in data science.
- To enable learners to develop knowledge and skills in current and emerging areas of data analytics.
- To critically assess and evaluate business and technical strategies for data analytics.
- To demonstrate expert knowledge of data analysis, statistics, tools, techniques and technologies of data analytics.

Course Outcomes

- Ability to use the mathematical concepts in the field of data science.
- Employ the techniques and methods related to the area of data science in variety of applications.
- Apply logical thinking to understand and solve the problem in context.

Module 1: Introduction of Data Science	
	Basics of Data Science: Introduction; Typology of problems; Importance of linear algebra, statistics and optimization from a data science perspective; Structured thinking for solving data science problems.
Module 2: Linear Algebra	
	Linear Algebra: Matrices and their properties (determinants, traces, rank, nullity, etc.); Eigenvalues and eigenvectors; Matrix factorizations; Inner products; Distance measures; Projections; Notion of hyperplanes; half-planes.
Module 3: Probability, Statistics and Random Processes:	
	Probability, Statistics and Random Processes: Probability theory and axioms; Random variables; Probability distributions and density functions (univariate and multivariate); Expectations and moments; Covariance and correlation; Statistics and sampling distributions; Hypothesis testing of means, proportions, variances and correlations; Confidence (statistical) intervals; Correlation functions; White-noise process
Module 4 : Optimization	
	Optimization: Unconstrained optimization; Necessary and sufficiency conditions for optima; Gradient descent methods; Constrained optimization, KKT conditions; Introduction to non-gradient techniques; Introduction to least squares optimization; Optimization view of machine learning. Introduction to Data Science Methods: Linear regression as an exemplar function approximation problem; Linear classification problems.

Reference books

1. "Introduction to Linear Algebra", G. Strang . Wellesley-Cambridge Press, Fifth edition,2016.
2."Random Data: Analysis and Measurement Procedures", Bendat, J. S. and A. G. Piersol. fourth Edition. John Wiley & Sons, Inc., NY, USA, 2010
3. "Applied Statistics and Probability for Engineers", Montgomery, D. C. and G. C. Runger. Fifth Edition. John Wiley & Sons, Inc., NY, USA, 2011.
4. "Optimization by Vector Space Methods", David G. Luenberger, John Wiley & Sons (NY), 1969.
5 ."Doing Data Science", Cathy O'Neil and Rachel Schutt ,O'Reilly Media, 2013.

Programme Name		**Master of Technology in Mechanical Engineering with specialization in CAD/CAM & Automation**
Course Title		**ROBOTICS**
Course Code		**MECC5063S**

COURSE OUTCOMES:

After completion of course, students would be able:

1. Analyze various types Robots and their applications
2. To understand terminologies related to Kinematics of Robotics.
3. To analyze basics of motion programming as per kinematics
4. To apply logic for selection of robotic sub systems and systems.

COURSE CONTENTS:

Introduction to robotics : Brief History, Basic Concepts of Robotics such as Definition , Three laws, Elements of Robotic Systems i.e. Robot anatomy, DOF, Misunderstood devices etc., Classification of Robotic systems on the basis of various parameters such as work volume, type of drive, etc., Associated parameters i.e. resolution, accuracy, repeatability, dexterity, compliance, RCC device etc., Introduction to Principles & Strategies of Automation, Types & Levels of Automations, Need of automation, Industrial applications of robot. Robotics application: current and future.

Grippers and Sensors for Robotics: Grippers for Robotics - Types of Grippers, Guidelines for design for robotic gripper, Force analysis for various basicgripper systems. Sensors for Robots - Types of Sensors used in Robotics, Classification and applicationsof sensors, Characteristics of sensing devices, Selections of sensors. Need for sensorsand vision system in the working and control of a robot.

Drives and Control for Robotics: Drive - Types of Drives, Types of transmission systems, Actuators and its selection while designing a robot system. Control Systems: Types of Controllers, Introduction to closed loop control

Robot Kinematics: Spatial Descriptions: positions, orientations, and frame, mappings: changing description from frame to frame, Operators: translations, rotations and transformations, transformation arithmetic, compound Transformations, inverting a transform, transform equations, Euler Angles, Fixed Angles, Euler Parameters. Manipulator Kinematics, Link Description, Link to reference frame connections, Denavit-Hartenberg Approach, D-H Parameters, Position Representations, Homogeneous Transformation Matrix, Forward Kinematics. Inverse Kinematics, Geometric and analytical approach.

Trajectory Planning: Introduction, path vs trajectory, joint space vs Cartesian space description, basics of tractor planning, joint space trajectory planning: Third order polynomial, Fifth order polynomial, linear segment with parabolic blends, linear segment with parabolic blends and via points, higher order trajectories, etc.

Computer vision for robotic system: Imaging Components, Image Representation, Hardware Considerations, Picture Coding, Object Recognition and Categorization, Software Considerations, Need for Vision Training and Adaptations, Review of Existing Systems, etc.

Computer Considerations for Robotic Systems: Objectives, Motivation, Architectural Considerations, Hardware Considerations, Computational Elements in Robotic Applications, Real-Time Considerations, Robot Programming, Path Planning, etc.

Related Topics in Robotics: Socio-Economic aspect of robotisation. Economical aspects for robot design, Safety for robot and standards, Introduction to Artificial Intelligence, AI techniques, Need and application of AI, New trends & recent updates in robotics.

Recommended Reading

1. Robert J Schilling, Fundamentals of Robotics Analysis & ControlPearson Education, Inc., 2007.
2. S. B. Niku, Introduction to Robotics – Analysis, Control, Applications, 3rd edition, JohnWiley & Sons Ltd., 2020
3. R. K. Mittal, I. J. Nagrath, Robotics and Control, TATA McGraw Hill Publishing Co Ltd,New Delhi, 2003.
4. R. D. Klafter, Thomas A. Chmielewski, and Mechael Negin, Robotic Engineering –An Integrated Approach, EEE, Prentice Hall India, Pearson Education Inc., 2009.
5. J. Angeles, Fundamentals of Robotic Mechanical Systems Theory Methods andAlgorithms, Springer,1997.
6. S. K. Saha, Introduction to Robotics 2nd edition, TATA McGraw Hills Education, 2014.
7. Ashitava Ghosal, Robotics Fundamental Concepts and Analysis, Oxford University Press, 2006.
8. T. C. Manjunath, Fundamentals of Robotics, Nandu Printers and Publishers, 2010.
9. Dilip Kumar Pratihar, Fundamentals of Robotics, Narosa Publishing House, (2019)

Program	M. Tech	Semester - II
Course Code	PEPM5062S	
Course Title	Project Management	

	Course outcomes: On the completion of this course, the learner will able to 1. To understand the basic concepts of project management. 2. Appraise the project using appropriate appraisal techniques. 3. Design and implement the project by considering risk and its evaluation. 4. Learn the process of project planning and execution.
	Course Content
1.	**Introduction** Definition, need, appropriateness and Characteristics of projects, Complexities of a Project, Different Types of Projects, Determinants of project success, Characteristics of project management, Projects in contemporary organizations, Project life cycle, sustainable project development
2.	**Project Selection and Appraisal** Brainstorming and concept evolution, Project Feasibility Analysis, Approaches to project screening and selection, nonquantitative and scoring models, Types of appraisals, SWOT analysis, and financial feasibility
3.	**Project Integration Management:** Project manager- Team building and conflict management, project organizational structure, Selection of project organization, Integration of project organization Developing project charter, Project scope, Project management plan, Direct and managing project execution, monitoring, and control, Close project
4.	**Project Scope management:** Scope definition and planning, work breakdown structure (WBS), Responsibility matrix, scope control
5.	**Project Schedule Management** Network techniques: PERT and CPM, AON and AOA representation, Three-time estimates-probability distributions for time computation, Probability of project completion, Time scale version of the network, Early start, and late start schedules.

6.	**Project Resource Management**: Resource allocation, Resource loading, and leveling, constrained resource scheduling, Multi-project scheduling, resource allocation, crashing a project, cost budgeting, and control
7.	**Project Risk Management:** Risk Management Strategies, Risk management Approaches, Risk Identification, Qualitative and quantitative risk analysis, Risk response, Risk monitoring, and control
8.	**Computerized Project Management** Computerized PMIS, Choosing software for project management, using software for project management. Case studies in project management in specific industries such as the Electrical industry, Electronics industry, IT/ITeS industry, Manufacturing industries, fashion industries, infrastructure sector, etc.
9.	**Case Studies on Project Management**: Modern cases in project management
	Text Books:
1.	John Nicholas, Project Management for Business and Technology: Principles and Practice. Pearson Prentice Hall, New Delhi.
2.	Shrub, Bard, and Globerson: Project Management: Engineering, Technology, and Implementation, PHI.
	References:
1.	A Guide to the Project Management Body of Knowledge (PMBOK Guide) Latest Edition. PMI.
2.	Harold Kerzner: Project Management-A Systemic Approach to Planning, Scheduling, and Controlling, CBS Publishers.
3.	L.S. Srinath: PERT and CPM: Principles and Applications, Affiliated East West Press Ltd.
4.	K. Joy: Total Project Management: The Indian Context, Macmillan India Ltd.
5.	Jeffrey K. Pinto: Project Management, Pearson publication.
6.	Choudhury: Project Scheduling and Monitoring in Practice. McGraw Hill Education(I) Pvt.Ltd,