Zeal Education Society's

ZEAL COLLEGE OF ENGINEERING & RESEARCH, PUNE – 41

(An Autonomous Institute Affiliated to Savitribai Phule Pune University)

*NBA Accredited, NAAC Accredited with **A+** Grade, ISO 21001:2018*

DEPARTMENT OF MECHANICAL ENGINEERING

Curriculum Structure and Syllabus of

S.Y. M. Tech. – Mechanical Engineering

(Robotics and Automation)

(With effect from - Academic Year 2025 - 26)

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 MECHANICAL ENGINEERING

VISION:

To be recognized as center for quality education in the field of mechanical engineering, integrating top-tier teaching, innovative research, and fostering socially conscious and entrepreneurial engineers.

MISSION:

M1: To impart value-added education by creating an ambiance of academic excellence in teaching-learning processes.
M2: To inculcate research approach through innovation and skill development centers.
M3: To inculcate a strong sense of social responsibility and empathy among the students.
M4: To imbibe the entrepreneur skill amongst the students by strengthening Industry- Institute interaction.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

PEO1. Graduates will achieve successful careers as design engineers in mechanical and related industries.
PEO2. Graduates will pursue advanced studies and engage in lifelong learning.
PEO3. Graduates will address societal issues with professionalism and ethics, paying careful attention to environmental considerations.

PROGRAM OUTCOMES (POs):

PO1: Conduct independent research, investigations, and development work to resolve practical issues in design engineering.
PO2: Develop and deliver comprehensive technical reports and documents.
PO3: Gain expertise in analytical calculations, stress analysis, mechanical vibration, and acoustics design, and apply these skills to solve complex problems.
PO4: Acquire thorough knowledge in design and hands-on experience with modern engineering tools to address real-world engineering challenges while being socially responsible.
PO5: Utilize modern engineering, management, and design tools to meet community needs.
PO6: Adhere to high ethical standards, demonstrate professional integrity, and consider the social and environmental impacts of their work.

PROGRAM SPECIFIC OUTCOMES (PSOs):

PSO1. Develop the ability to apply fundamental knowledge of machine design in the synthesis, analysis, design, and development of components and machines using advanced engineering tools.
PSO2. Conduct independent research to find effective solutions to real-world problems in machine design and related fields, and prepare detailed technical reports.

DEPARTMENT OF MECHANICAL 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
TW	Term Work
OR	Oral
PR	Project

DEPARTMENT OF MECHANICAL ENGINEERING

Second Year M. Tech. – Robotics and Automation : Semester - III

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						
MERA301	OEC	Open Elective – III[#]	4	-	4	4	-	4	50	50	-	-	-	100
MERA302	MOOC	Massive Open Online Course – I	4	-	4	4	-	4	-	-	100	-	-	100
MERA303	DIS	Dissertation Phase – II	-	20	20	-	10	10	-	-	50	-	50	100
MERA304	HSMC	Data Analytics Lab	-	4	4	-	2	2	-	-	50	-	-	50
Total			**8**	**24**	**32**	**8**	**12**	**20**	**50**	**50**	**200**	**-**	**50**	**350**

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

Course Code	Course Type	Open Elective – III	Offered by Department
MEDS301	OEC	Advanced Computer Vision & Image Processing	Computer
EEPS301		Energy Management & Auditing	Electrical
ETIS301		Renewable Energy Studies	E&TC
MEDE301		Design thinking, Innovation and Entrepreneurship	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 MECHANICAL ENGINEERING

Second Year M. Tech. – Robotics and Automation : Semester - IV

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						
MERA401	DIS	Dissertation Phase - III	-	32	32	-	16	16	-	150	-	100	250	-
MERA402	MOOC	Massive Open Online Course /Internship*	4	-	4	4	-	4	-	100	-	-	100	-
Total			**4**	**32**	**36**	**4**	**16**	**20**	**-**	**250**	**-**	**100**	**350**	**-**

BoS Chairman

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

Director
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DEPARTMENT OF MECHANICAL ENGINEERING

SYLLABUS

SEMESTER - III

DEPARTMENT OF MECHANICAL ENGINEERING

Program: M. Tech. (Computer – Data Science)								**Semester:** III	
Course: Open Elective – III (Advanced Computer Vision & Image Processing)								**Code:** CODS301	
Teaching Scheme (hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
04	-	-	04	50	50	-	-	-	100

Prerequisites:

OpenCV (Python/C++), MATLAB, and image analysis libraries, Scikit-image, NumPy, and PyWavelets.

Course Objectives:

1. To introduce the fundamental principles of image formation, camera models, and essential techniques used in computer vision and image processing.
2. To explain advanced methods for image enhancement, restoration, feature extraction, and representation required for complex vision tasks.
3. To explore segmentation techniques, object representation methods, motion analysis, and algorithmic approaches for understanding visual scenes.
4. To develop a thorough understanding of 3D vision concepts, including stereo imaging, depth estimation, and reconstruction techniques used in real-world applications.
5. To provide knowledge of deep learning architectures and modern AI frameworks for image classification, object detection, and image segmentation.
6. To introduce generative models, emerging trends, ethical considerations, and practical applications of computer vision in industry.

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

CO1	Understand advanced image formation, camera models, and preprocessing techniques for computer vision.
CO2	Apply enhancement, restoration, and feature extraction methods to analyze and improve images.
CO3	Implement advanced segmentation, representation, and motion analysis algorithms in vision tasks.
CO4	Develop 3D vision solutions using stereo vision, depth estimation, and reconstruction techniques.
CO5	Build and evaluate deep learning models for image classification, detection, and segmentation.
CO6	Apply generative models, emerging AI techniques, and ethical principles in modern computer vision applications.

Course Contents:

Unit	**Description**
1.	**Fundamentals of Computer Vision & Advanced Image Formation:** Image formation models, radiometry, reflectance, advanced camera models (pinhole, fisheye, omnidirectional), geometric transformations, color spaces, sampling, quantization, image interpolation, HDR imaging, multi-view geometry basics, and camera calibration techniques (intrinsic & extrinsic parameters).

2.	**Image Enhancement, Restoration & Feature Engineering:** Spatial and frequency domain enhancement, wavelet transforms, noise modelling, advanced denoising (Non-local Means, BM3D), deblurring, blind deconvolution, super-resolution, filtering, edge detection, segmentation basics, and feature extraction methods (Harris, SIFT, SURF, ORB, HOG, LBP, GLCM).
3.	**Advanced Segmentation, Object Representation & Vision Algorithms:** Graph-based segmentation (Normalized Cuts, GrabCut), active contours (Snakes), level-set methods, watershed, morphological processing, contour detection, shape descriptors, texture analysis, region descriptors, optical flow (dense & sparse), object tracking (Kalman filter, Particle filter, Meanshift, CAMShift), and motion analysis. Applications include medical imaging, surveillance, and robotics.
4.	**3D Computer Vision, Depth, Motion & Reconstruction:** Stereo vision, disparity maps, epipolar geometry, essential/fundamental matrices, triangulation, projective geometry, Structure-from-Motion (SfM), Visual Odometry, SLAM (MonoSLAM, ORB-SLAM), depth sensing technologies (LiDAR, ToF cameras), point cloud processing, and 3D reconstruction
5.	**Deep Learning for Computer Vision & AI Models:** CNN architectures (LeNet, VGG, ResNet, DenseNet, MobileNet, EfficientNet), object detection (Faster R-CNN, YOLO, SSD), segmentation (FCN, U-Net, DeepLab), instance segmentation (Mask R-CNN), Vision Transformers (ViT, Swin Transformer), multimodal models (CLIP), data augmentation, transfer learning, model optimisation,
6.	**Generative Models, Ethics, Applications & Emerging Trends:** GANs (DCGAN, CycleGAN, StyleGAN), diffusion models, image-to-image translation, 3D generative models, deepfake detection, self-supervised learning (SimCLR, MoCo), reinforcement learning for vision, real-time edge vision, Vision–Language models, digital twins, and ethical considerations (privacy, surveillance risks, bias, fairness).

Text Books:

1. Szeliski Richard, "Computer Vision: Algorithms and Applications", Springer, 2022 (Latest Edition)
2. Gonzalez Rafael C., & Woods Richard E., "Digital Image Processing", Pearson, 2018

Reference Books:

1. Forsyth David, & Ponce Jean – "Computer Vision: A Modern Approach", Pearson, 2011.
2. Goodfellow Ian, Bengio Yoshua, & Courville Aaron – "Deep Learning", MIT Press, 2016.
3. Hartley Richard, & Zisserman Andrew – "Multiple View Geometry in Computer Vision", Cambridge University Press, 2003.
4. Bradski Gary, & Kaehler Adrian – "Learning OpenCV", O'Reilly Media, 2008.
5. Prince Simon – "Computer Vision: Models, Learning, and Inference", Cambridge University Press, 2012.
6. Krizhevsky Alex, & Sutskever Ilya – "Neural Networks for Vision", Various Academic Sources.
7. Stanford CS231N – "Convolutional Neural Networks for Visual Recognition", Stanford University (Course Notes & Research Papers).

DEPARTMENT OF MECHANICAL ENGINEERING

Program: M. Tech. (Electrical – Power Systems)									**Semester:** III
Course: Open Elective – III (Energy Management & Auditing)									**Code:** EEPS301
Teaching Scheme (hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
04	-	-	04	50	50	-	-	-	100

Prerequisites:

Energy Scenario, Engineering Measurements and Instrumentation, Computer Skills

Course Objectives:

1. To provide students with a strong foundation in energy principles, including types of energy, energy conversion and energy flow in systems.
2. To introduce the core concepts and strategies of energy management, including planning, monitoring and optimization of energy usage in various sectors.
3. To train students to analyze energy data and prepare professional energy audit reports with recommendations and cost-benefit analysis.
4. To equip students with the skills and methodologies required to conduct energy audits in industrial, commercial and residential settings.

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

CO1	Identify and describe present state of energy security and its importance.
CO2	Identify and describe the basic principles and methodologies adopted in energy audit of utility.
CO3	Describe the energy performance evaluation of some common electrical and thermal installations and identify the energy-saving opportunities.
CO4	Analyze the data collected during the performance evaluation and recommend energy saving measures.
CO5	Analyze energy consumption patterns and identify saving opportunities.
CO6	Explain the principles of energy management and energy conservation.

Course Contents:

Unit	**Description**
1.	**Basic Principles of Energy Audit:** Energy audit- definitions, concept, types of audit, energy index, cost index, pie charts, Sankey diagrams, load profiles, Energy conservation schemes, Energy audit of industries, energy saving potential, energy audit of process industry, thermal power station, building energy audit. Need for energy management, energy basics, designing and starting an energy management program, energy audit process, energy accounting, energy monitoring, targeting and reporting.
2.	**Energy Cost and Load Management:** Important concepts in an economic analysis, economic models, time value of money, utility rate structures, cost of electricity, loss evaluation. Load management: demand control techniques, utility monitoring and control system, HVAC and energy management, economic justification.

3.	**Energy Efficient Motors**: Energy efficient motors, factors affecting efficiency, loss distribution, constructional details, characteristics, variable speed, variable duty cycle systems, RMS hp, voltage variation, voltage unbalance, over motoring, motor energy audit applications to Systems and equipment such as: electric motors, transformers and reactors, capacitors and synchronous machines.
4.	**Metering for Energy Management:** Relationships between parameters, Units of measure, typical cost factors, utility meters, timing of meter disc for kilowatt measurement, demand meters, paralleling of current transformers, instrument transformer burdens, multitasking solid-state meters, metering location vs. requirements, metering techniques and practical examples.
5.	**Lighting Systems and Cogeneration:** Concept of lighting systems, the task and the working space, light sources, ballasts, luminaries, lighting controls, optimizing lighting energy, power factor and effect of harmonics on power quality, cost analysis techniques, lighting and energy standards. Cogeneration: forms of cogeneration, feasibility of cogeneration, electrical interconnection.
6.	**Economic Aspects and Analysis:** Economic Analysis, Depreciation Methods, time value of money, rate of return, present worth method, replacement analysis, life cycle costing analysis, Energy efficient motors, calculation of simple payback method, net present worth method, Power factor correction, lighting, Applications of life cycle costing analysis, return on investment.

Text Books:

1. Eastop T.D and Croft D.R, "Energy Efficiency for Engineers and Technologists", Logman Scientific & Technical, 1990.
2. Reay D.A., "Industrial Energy Conservation", first edition, Pergamon Press, 1977.
3. Energy Audit and Management, Volume-I, IECC Press.
4. W.R. Murphy, G. McKay Butter worth; Energy management, Elsevier/bsp Books Pvt. Ltd., 2003.
5. Gupta B. R.: Generation of Electrical Energy, Eurasia Publishing House Pvt. Ltd., New Delhi, 2001
6. Prasanna Chandra, "Financial management", Tata McGraw Hill, 10th Edition, 2019.

Reference Books:

1. IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities, IEEE, 1996.
2. Amit K. Tyagi, "Handbook on Energy Audits and Management", TERI, 2003.
3. Barney L. Capehart, Wayne C. Turner and William J. Kennedy, "Guide to Energy Management", Fifth Edition, The Fairmont Press, Inc., 2006.
4. Albert Thumann, P.E., C.E.M. William J. Younger, "Handbook of Energy Audits", River Publishers.
5. Paul O'Callaghan, "Energy management", McGraw-Hill Education, 1992.
6. CB Smith, "Energy Management Principles", Pergamon Press, New York.
7. W. C. Turner, "Energy Management Hand Book", John Wiley and sons.

DEPARTMENT OF MECHANICAL ENGINEERING

Program: M. Tech. (E&TC – IoT and Sensor Systems)									**Semester:** III
Course: Open Elective – III (Advance Sensor Technology & Instrumentation)									**Code:** ETIS301
Teaching Scheme (hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
04	-	-	04	50	50	-	-	-	100

Prerequisites:

Familiarity with concepts such as energy, power, voltage, current, and basic circuit theory, Awareness of environmental issues and the need for sustainable development is beneficial.

Course Objectives:

1. To provide students with a comprehensive understanding of various renewable energy technologies including solar, wind, biomass, hydro, and emerging systems like fuel cells and ocean energy.
2. To equip students with the knowledge to analyze, design, and evaluate renewable energy systems in the context of global and Indian energy needs.

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

CO1	Explain the need, potential, and classification of renewable energy sources, along with their environmental and economic impact.
CO2	Analyze photovoltaic system components and performance characteristics for both grid-connected and off-grid solar applications.
CO3	Evaluate the performance of wind energy systems based on wind speed, turbine type, and system configuration.
CO4	Classify biomass resources and explain the technologies used for conversion into usable energy forms.
CO5	Assess the working principles and feasibility of small hydro, tidal, and wave energy systems for power generation.
CO6	Compare emerging technologies such as geothermal, ocean thermal, and fuel cells based on operating principles and energy output.

Course Contents:

Unit	**Description**
1.	**Introduction to Renewable Energy Systems:** Overview of global and Indian energy scenario, Need and significance of renewable energy, Classification and comparison of renewable energy sources, Environmental impact and sustainability, Government policies and incentives for renewable energy, Introduction to hybrid systems and energy storage.
2.	**Photovoltaic (Solar) Energy Systems:** Introduction to photovoltaic systems, Major types of PV systems: Standalone and Grid-connected, Current–voltage (I–V) curves for loads, Peak sun hours and estimation of PV performance, DC and AC rated power, Capacity factor and efficiency, PV-powered water

	pumping and applications in rural India, Scope and advantages of off-grid PV systems for inclusive growth, Introduction to solar inverters, MPPT, and system sizing
3.	**Wind Energy Conversion Systems:** Wind resource assessment: wind speed, wind power density, Wind power extraction principles and Betz limit, Wind turbine types: horizontal and vertical axis, Components of wind energy systems, Tower height and wind speed relationship, Variable speed operation and maximum power tracking, Safety, maintenance, and grid integration of wind farms.
4.	**Biomass and Waste-to-Energy Technologies:** Biomass resources: agricultural, forestry, and animal waste, Energy content and types of biomass fuels, Biomass conversion technologies: combustion, gasification, pyrolysis, Biomass-fired boilers and co-firing with coal, Municipal solid waste to energy: technology and challenges, Biogas plants and their role in rural electrification, Case studies of community-level biomass systems
5.	**Small Hydro, Tidal, and Wave Energy:** Introduction to mini and micro hydel schemes, Components and layout of small hydro power plants, Economics and feasibility of small hydro plants, Tidal energy: principles, potential and technology, Wave energy: energy extraction and device types , Environmental and ecological impact of hydro and marine systems
6.	**Emerging Technologies: Geothermal, OTEC & Fuel Cells:** Geothermal energy: sources, extraction technologies, and viability, Ocean Thermal Energy Conversion (OTEC): principles and systems, Introduction to fuel cells, Types of fuel cells (PEMFC, SOFC, etc.), Operating characteristics, efficiency, and energy output, Future trends in renewable energy: Hydrogen energy, hybrid RE systems, smart grids.

Text Books:

1. D.P. Kothari, K.C. Singal & Rakesh Ranjan, "Renewable Energy Sources and Emerging Technologies", PHI Learning, 2nd or 3rd Edition.
2. G.D. Rai, "Non-Conventional Energy Sources", Khanna Publishers, Latest Edition.
3. V.V.N. Kishore, "Renewable Energy Engineering and Technology – A Knowledge Compendium", The Energy and Resources Institute (TERI Press).

Reference Books:

1. R. Ramesh, "Renewable Energy Technologies", Narosa Publishing House.
2. S. Rao & Parulkar, "Energy Technology", Khanna Publishers.
3. Mittal, "Non-Conventional Energy Systems", Wheeler Publishing.
   Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press.

DEPARTMENT OF MECHANICAL ENGINEERING

Program: M. Tech. (Mechanical – Design Engineering)								**Semester:** III	
Course: Open Elective – III (Design thinking, Innovation and Entrepreneurship)								**Code:** MERA301	
Teaching Scheme (hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
04	-	-	04	50	50	-	-	-	100

Prerequisites:

Course is expected to have a basic understanding of engineering design principles, analytical problem-solving skills, and effective communication abilities. Prior exposure to design projects or interdisciplinary teamwork is desirable. An open mindset, willingness to collaborate, and readiness to engage with user-centric and creative approaches are essential for making the most of this experiential and innovation-driven course.

Course Objectives:

1. To introduce students to the principles and process of design thinking
2. To develop an understanding of innovation frameworks and tools
3. To build foundational knowledge in entrepreneurship
4. To empower students to translate ideas into actionable business models

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

CO1	Understand the fundamentals of design thinking.
CO2	Apply empathy and define user-centric problems.
CO3	Analyze various types of innovation and their strategic role in modern businesses and start-ups.
CO4	Analyze types and roles of innovation in business.
CO5	Explain core concepts and types of entrepreneurship.
CO6	Evaluate the entrepreneurial ecosystem and support systems.

Course Contents:

Unit	**Description**
1.	**Fundamentals of Design Thinking:** Definition and Origin of Design Thinking, Design Thinking vs. Traditional Design, Importance and Relevance of Design Thinking, Types of Thinking Processes, Common Methods to Influence Human Thinking, Problem Solving and the Need for Design Thinking, Design Thinking Process Models and Tools.
2.	**Empathize and Define:** Phases of Design Thinking, How to Empathize: Role and Purpose, Empathy Mapping: Tools and Techniques, Personas Development, **Integrated Design Research:** Reviewing Literature, Identifying Literature, Summarizing Literature; Determining Research Focus, Identifying and Defining Factors and Links of Interest, Formulating Research Questions and Hypotheses, Techniques for Refining Research Questions and Hypotheses, Developing Research Plan.

3.	**Understanding Innovation in the Business:** Definition and types of innovation (Product, Process, Business Model, Service), Technological innovation vs. non-technological innovation, Innovation megatrends impacting global industries, Characteristics and needs of innovation in entrepreneurship, Innovation in start-ups vs. traditional businesses.
4.	**Innovation Tools and Methods:** Ideation techniques (SCAMPER, Brainstorming, Mind Mapping), Innovation Process Models (Design Thinking, Lean Startup), Open innovation and co-creation, Innovation funnel and stage-gate processes, Measuring innovation performance and impact.
5.	**Fundamentals of Entrepreneurship:** Definition and objectives of entrepreneurship, Types of entrepreneurs: Intrapreneurs, Social entrepreneurs, Technopreneurs, Entrepreneurial mindset and risk-taking, Role of entrepreneurship in economic development.
6.	**Entrepreneurial Environment and Development:** Entrepreneurial environment analysis (PESTEL framework), Entrepreneurship Development Programs (EDPs), Start-up ecosystems in India and globally, Government schemes and policies (e.g., MSME, Startup India), Role of institutions: EDII, CIE, incubators, and accelerators.

Text Books:

1. Nigel Cross, "Design Thinking: Understanding How Designers Think and Work", Bloomsbury Academic, 2011
2. Tim Brown, "Change by Design: How Design Thinking Creates New Alternatives for Business and Society", Harper Business, 2019
3. Patrick Van Der Pijl, Justin Lokitz & Lisa Kay Solomon, "Design a Better Business: New Tools, Skills, and Mindset for Strategy and Innovation", Wiley, 2016
4. Peter F. Drucker, "Innovation and Entrepreneurship", Harper Business, 1985

Reference Books:

1. Vijay Kumar, "101 Design Methods: A Structured Approach for Driving Innovation in Your Organization", Wiley, 2019 (2nd Edition).
2. Eric Ries, "The Startup Way: How Modern Companies Use Entrepreneurial Management to Transform Culture and Drive Long-Term Growth", Currency, 2017.
3. Saul Kaplan, "The Business Model Innovation Factory: How to Stay Relevant When the World Is Changing", Wiley, 2018.
4. Jeanne Liedtka & Tim Ogilvie, "The Designing for Growth Field Book: A Step-by-Step Project Guide", Columbia Business School Publishing, 2019.
5. Henry Chesbrough, "Open Innovation Results: Going Beyond the Hype and Getting Down to Business", Oxford University Press, 2020.
6. Alexander Osterwalder & Yves Pigneur, "Value Proposition Design: How to Create Products and Services Customers Want", Wiley, 2019 (2nd Edition).

E-Resources:

1. **Design Thinking – A Primer**, Prof. Srinivasan V (IIT Madras), Introduces core concepts and application of design thinking, **Duration:** 4 Weeks, **URL:** https://nptel.ac.in/courses/110106124.

2. **Entrepreneurship**, Prof. S. S. Murthy (IIT Delhi), Covers entrepreneurial mindset, innovation, and funding, **Duration:** 8 Weeks, **URL:** https://nptel.ac.in/courses/127105007.
3. **Innovation, Business Models and Entrepreneurship**, Prof. Ashwin Mahalingam (IIT Madras), Explores the link between innovation and business strategy, **Duration:** 8 Weeks, **URL:** https://nptel.ac.in/courses/110106146.

DEPARTMENT OF MECHANICAL ENGINEERING

Program: M. Tech. (Mechanical – Robotics and Automation)							**Semester:** III		
Course: Massive Open Online Course (MOOCs)							**Code:** MERA302		
Teaching Scheme (hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
04	-	-	04	-	-	100	-	-	100

Prerequisites:

Basic math, programming, or subject-specific foundational knowledge.

Course Objectives:

1. To develop a strong understanding of the core concepts, principles, and theories within the subject matter.
2. To learn to analyze information critically, evaluate arguments, and form well-reasoned conclusions.

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

CO1	Explain the fundamental concepts, principles, and theories covered in the course.
CO2	Apply their knowledge to real-world scenarios and solve problems related to the subject matter.
CO3	Actively participate in online discussions, share their knowledge and perspectives, and learn from their peers.
CO4	Evaluate their own learning process, identify areas for improvement, and demonstrate a commitment to continuous learning.

Course Contents:

Description

A Massive Open Online Course (MOOC) is an online course aimed at unlimited participation and open access via the web. In addition to traditional course materials, such as filmed lectures, readings, and problem sets, many MOOCs provide interactive courses with user forums to support community interactions among students, professors, and teaching assistants, as well as immediate feedback to quick quizzes and assignments.

APPLICATIONS OF MOOCS • Professional development • Skill development • Fostering soft skills, inculcating research etc. • Development of knowledge.

Student need to select any one topic for MOOC courses.

NPTEL (SWAYAM Courses)

National Programme on Technology Enhanced Learning (NPTEL) is a project of MHRD created to provide quality education to students and knowledge seekers anywhere in the world from faculty in top ranking institutions like IITs and IISc for free. It provides web and video courses across 23 disciplines as certification courses.

Some notable MOOCs providers :

1. SWAYAM Courseware : **https://swayam.gov.in/**
2. MIT Opencourseware : **https://ocw.mit.edu/index.htm**

3. Stanford ONLINE : **http://online.stanford.edu/**
4. Coursera : **https://www.coursera.org/**
5. IIT BombayX : **https://www.iitbombayx.in/**
6. Khanacademy : **https://www.khanacademy.org/**
7. Udacity : **https://in.udacity.com/**
8. edx : **https://www.edx.org/**
9. Swayam : **https://swayam.gov.in/**
10. mooKIT : **https://www.mookit.in/**
11. Spoken-tutorial : **https://spoken-tutorial.org/**
12. Open Classroom : **https://openclassrooms.com**

Institute Guideline for online MOOC Course-

1. **MOOC Course registration / approval**
   Student will register for MOOC Course in consultation with Mentor / Guide / Supervisor allotted from the Institute. The topic and concerned course should be approved by Programme Coordinator / Head of Department.
2. **Course Progress Monitoring/Review**
   Student will submit the periodic progess to Mentor / Guide / Supervisor and Programme Coordinator / Head of Department. Mentor / Guide / Supervisor and Programme Coordinator will conduct the review as per need of the course requirement (if required)
3. **Evaluation and Grading**
   Mentor / Guide / Supervisor and Programme Coordinator will verify the certificate of completion of the course and allocate equivalent score and grade based on grade / score mentioned in the certificate. If certificate does not reflect any grade / score, under such situation Mentor / Guide / Supervisor and Programme Coordinator will evaluate the student by conducting appropriate examination (Theory / Practical / Seminar).
4. **Reporting of Grade / Score to Examination Department**
   Mentor / Guide / Supervisor and Programme Coordinator will submit the evaluation report alongwith supporting document to examination Department.

Text Books:
As per Listed topics
Reference Books:
As per Listed topics

DEPARTMENT OF MECHANICAL ENGINEERING

Program: M. Tech. (Mechanical– Robotics and Automation)								**Semester:** III	
Course: Dissertation Phase – II								**Code:** MERA303	
Teaching Scheme (hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
-	20	-	10	-	-	50	50	-	100

Prerequisites:

Continuation of Dissertation Phase – I, Basic knowledge of Machine Design, Mechanical system design, Basics of Analysis software.

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

CO1	Identify a topic in advanced areas of design engineering
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

Guidelines for PG Dissertation Work:

All postgraduate M.Tech. Students are required to undertake a comprehensive and research-driven dissertation project as part of their academic curriculum. The objective is to ensure students engage with challenging and contemporary topics in their respective domains, while also contributing to the academic and professional community through research publications.

Project Selection and Scope

1. **Continuation from Dissertation Phase-I:**
   Students **must continue the topic selected during Dissertation Phase-I**. Any modifications or refinements to the scope must be done in consultation with the assigned Supervisor/Guide.
2. **Thorough Study and Execution**:
   The dissertation work should include:
   - Detailed design calculations
   - Analytical modeling and development
   - Prototyping or implementation of models
   - Validation through simulations, experiments, or case studies as applicable
3. **Research Publication Requirement**:
   As part of **Dissertation Phase-II**, students **must prepare at least one review research paper** and **submit it** in a reputed **SCI / Scopus / UGC CARE-listed journal** under the supervision of their Guide.

Dissertation Supervision and Presentation

4. **Project Supervision**:
   Each student will be assigned a Supervisor/Guide who will mentor and evaluate the progress throughout the project duration. Regular interaction with the Guide is mandatory to ensure focused progress and direction.
5. **Research Gap Identification**:
   Students are required to:
   - Analyze and review relevant research papers
   - Identify gaps in existing studies
   - Formulate a well-defined problem statement in consultation with their Guide
6. **Progress Review Presentations**:
   Students must deliver **four internal progress presentations** during the dissertation period. These presentations should cover:
   - Literature survey and problem formulation
   - Design methodology and analytical work
   - Implementation and results
   - Validation and conclusions

   All stages will be **evaluated by an internal panel** in the **presence of the Guide**, and formal feedback will be recorded.
7. **Final Dissertation Report Submission**:
   Students must submit a comprehensive **Dissertation Phase-II report** that includes:
   - Introduction to the problem
   - Detailed literature survey
   - Identified research gaps
   - Objectives, Methodology, design calculations
   - Development, Testing and Validation
   - The report must follow the formatting and structural guidelines provided as below.

INSTRUCTIONS FOR DISSERTATION PHASE - II REPORT WRITING

It is important that the procedures listed below be carefully followed by all the students of M.Tech. (Mechanical Engineering).

1. Prepare **Three Hard Bound Copies** of your manuscript.
2. Limit your Dissertation report to 50 – 60 pages (preferably)
3. The footer must include the following:
   - Institute Name, M.Tech. (Mechanical) (Robotics and Automation) Times New Roman 10 pt. and centrally aligned.
4. Page number as second line of footer, Times New Roman 10 Pt, centrally aligned.
5. Print the manuscript using
   a. Letter quality computer printing.
   b. The main part of manuscript should be Times New Roman 12 pt. with alignment - justified**.**
   c. Use 1.5 line spacing.

d. Entire report shall be of 5- 7 chapters.

6. Use the paper size **8.5'' × 11''** or **A4 (210 × 197 mm).** Please follow the margins given below.

Margin Location	**Paper 8.5'' × 11''**	**Paper A4 (210 × 197 mm)**
Top	1''	25.4 mm
Left	1.5''	37 mm
Bottom	1.25''	32 mm
Right	1''	25.4 mm

7. All paragraphs will be 1.5 line spaced with a one blank line between each paragraph. Each paragraph will begin without any indentation.
8. Section titles should be bold with 14 pt typed in all capital letters and should be left aligned.
9. Sub-Section headings should be aligning at the left with 12 pt, bold and Title Case (the first letter of each word is to be capitalized).
10. Illustrations (charts, drawings, photographs, figures) are to be in the text. Use only illustrations really pertinent to the text. Illustrations must be sharp, clear, **black and white. Illustrations downloaded from internet are not acceptable.**
    a. Illustrations should not be more than **two** per page. One could be ideal
    b. Figure No. and Title at bottom with **12 pt**
    c. Legends below the title in **10 pt**
    d. Leave proper margin in all sides
    e. Illustrations as far as possible should not be Xeroxed.
11. **Photographs** if any should be of glossy prints
12. Please use **SI** system of units. If students would like to add the equivalent in inch-pound (British) units, they must be stated in parenthesis after the **SI** units. In case the final result comes out in any other units (say due to empirical formula etc.) covert the unit to **SI** unit.
13. Please **number the pages** on the front side, centrally below the footer
14. **References** should be either in order as they appear in the thesis or in alphabetical order by last name of first author
15. **Symbols** and **notations** if any should be included in nomenclature section only
16. Following will be the order of report
    i. **Cover page** and **Front page** as per the specimen on separate sheet
    ii. **Certificate** from the Institute as per the specimen on separate sheet
    iii. **Acknowledgement**
    iv. **List of Figures**
    v. **List of Tables**
    vi. **Nomenclature**
    vii. **Contents**
    viii. **Abstract** (A brief abstract of the report not more than **150 words**. The heading of abstract i.e. word "Abstract" should be **bold, Times New Roman, 12 pt** and should be typed at the **centre.** The contents of abstract should be typed on new line without space between heading

and contents. Try to include one or two sentences each on **motive, method, key-results** and **conclusions** in the Abstract)

1. **Introduction** (2-3 pages) (TNR – 14 Bold)
   1.1 Problem statement (TNR – 12)
   1.2 Objectives
   1.3 Scope
   1.4 Methodology
   1.5 Organization of Dissertation
2. **Literature Review** (20-30 pages)
   Discuss the work done so far by researchers in the domain area and their significant conclusions. No derivations, figures, tables, graphs are expected.
3. This chapter shall be based on your own simulation work (Analytical/ Numerical/FEM/CFD) (15- 20 pages)
4. Experimental Validation - This chapter shall be based on your own experimental work (15-20 pages)
5. **Concluding Remarks and Scope for the Future Work** (2-3 pages)
   References
   ANNEXURE (if any)
   (Put all mathematical derivations, Simulation program as Annexure)

17. All section headings and subheadings should be numbered. For sections use numbers **1, 2, 3, ….** and for subheadings **1.1**, **1.2**, **….** etc and section subheadings **2.1.1**, **2.1.2, ….** etc.
18. **References** should be given in the body of the text and well spread. No verbatim copy or excessive text from only one or two references. If **figures** and **tables** are taken from any reference then indicate source of it. Please follow the following procedure for references

Reference Books:

Collier, G. J. and Thome, J. R., Convective boiling and condensation, 3rd ed., Oxford University Press, UK, 1996, pp. 110 – 112.

Papers from Journal or Transactions:

1. Jung, D. S. and Radermacher, R., Transport properties and surface tension of pure and mixed refrigerants, *ASHRAE Trans*, 1991, 97 (1), pp. 90 – 98.

Papers from Conference Proceedings

1. Colbourne, D. and Ritter, T. J., *Quantitative assessment of flammable refrigerants in room air conditioners*, Proc. of the Sixteenth International Compressor Engineering Conference and Ninth International Refrigeration and Air Conditioning Conference, Purdue University, West Lafayette, Indiana, USA, 2002, pp. 34 – 40.

Reports, Handbooks etc.

1. United Nations Environmental Programme, Report of the Refrigeration, Air Conditioning and Heat Pumps, Technical Option Committee, 2002, Assessment - 2002.

Patent :- Patent no, Country (in parenthesis)

DEPARTMENT OF MECHANICAL ENGINEERING

Program: M. Tech. (Mechanical – Robotics and Automation)								**Semester:** III	
Course: Data Analytics Lab								**Code:** MERA304	
Teaching Scheme (hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
-	04	-	02	-	-	50	-	-	50

Prerequisites:

Basic knowledge of Python programming, including variables, loops, and functions, is essential. Familiarity with data handling using libraries like Pandas, NumPy, and basic statistics will be beneficial.

Course Objectives:

1. To introduce the fundamentals of Python programming and data analytics.
2. To develop the ability to read, manipulate, and visualize data.
3. To enable students to create and manage DataFrames.
4. To provide hands-on experience in solving mathematical models and systems of equations using MATLAB.
5. To apply statistical techniques such as correlation, hypothesis testing (Z-test, T-test), ANOVA, and data visualization tools.

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

CO1	Understand and apply the basic of data analytics concepts of statistics and probability.
CO2	Apply the data processing techniques on Data Frame using Python Libraries.
CO3	Implement and evaluate the data analytics techniques using MATLAB, R and Python tools.
CO4	Define and explain to python for data cleaning and visualization as a data analytics tool.

Course Contents:

List of Program

1. Introduction to Python and Analytics:-Write a Python Program to Get Total Price of all Fuel Type from Toyota.csv file and show it using a line plot with the following Style properties. Generated line plot must include following Style properties:
   - Line Style dotted and Line-color should be red
   - Show legend at the lower right location.
   - X label name = Fuel Type
   - Y label name = Price
   - Add a circle marker.
   - Line marker color as red
   - Line width should be 3
2. Write a Python Program to Read 'Petrol' and 'CNG' FuelType sales data from Toyota.csv file and show it using the bar chart.
3. Write a Python program to create and display a Data Frame from a specified dictionary data which has the index labels. exam_data = {'name': ['Dinesh', 'Suresh', 'Rahul', 'Ravi', 'Manoj', 'Hari', 'Yatharth', 'Saurabh', 'Kapil', 'Salini'], 'score': [12.5, 9, 16.5, np.nan, 9, 20, 14.5, np.nan, 8, 19], 'attempts': [1, 3, 2, 3, 2, 3, 1, 1, 2, 1], 'qualify': ['yes', 'no', 'yes', 'no', 'no', 'yes', 'yes', 'no', 'no', 'yes']} labels = ['a', 'b', 'c', 'd', 'e', 'f', 'g', 'h', 'i', 'j']

4. Write a Python program to display a summary of the basic information like index, columns, non-null values of each column, memory usage etc. about a specified DataFrame which is Toyota.csv.
5. WAP in Python to insert a column named "AGE_IN_MONTH" and then fill the values into inserted Column on the basis of "AGE" column using user defined function where function return a value. AGE_IN_MONTH=AGE*12
6. Explain and Understand the steps to solve the following system of linear equations using MATLAB: 2x-3y+4z=5 , y+4z+x=10 , -2z+3x+4y=0
7. The dataset Toyota.csv may be found on the web page. This dataset contains Car information: Price, Age, KM, FuelType, KM, CC and Doors. Save this file and use read. table to import it into R. What are the means and standard deviations of the data variables (excluding Age)? Apply Data Analytic tool.
8. Normal curves, Correlation and scatter plots, Correlation coefficient.
9. Z-test, T-test and ANOVA.

Text Books:

1. Wes McKinney, "Python Programming & Data Analytics", O'Reilly Media
2. Al Sweigart, "Automate the Boring Stuff with Python", No Starch Press
3. Holly Moore, "MATLAB for Engineers", Pearson
4. Sheetal Taneja & Naveen Kumar, "Python Programming – A Modular Approach", Pearson

Reference Books:

1. Reema Thareja, "Python Programming", Oxford University Press
2. V. K. Jain, "Data Science and Analytics using Python", Khanna Book Publishing
3. S. C. Gupta & V. K. Kapoor, "Fundamentals of Mathematical Statistics", Sultan Chand & Sons
4. Rudra Pratap, "Getting Started with MATLAB: A Quick Introduction for Scientists and Engineers", Oxford University Press

E-Resources:

1. Introduction to Python and Analytics:- Python.org Official Docs, NPTEL Python for Data Science, W3Schools Python Tutorial.
2. Line plot using Toyota.csv with specific styles:- Matplotlib Plot Styles, YouTube: Matplotlib Line Plot.
3. Bar chart for 'Petrol' and 'CNG' data from Toyota.csv:- Pandas & Matplotlib for Bar Charts - Tutorial: Read CSV in Pandas.
4. Solve system of equations in MATLAB:- YouTube: Solve Linear Equations in MATLAB, MathWorks Official Docs.
5. Normal curves, correlation & scatter plots:- Python: Normal Distribution & Correlation, Scatter Plots in Python.
6. Z-test, T-test, and ANOVA:- SciPy Stats Tests Guide, YouTube: Z-Test, T-Test, and ANOVA in Python, Medium Article: Statistical Tests in Python.

DEPARTMENT OF MECHANICAL ENGINEERING

SYLLABUS

SEMESTER - IV

DEPARTMENT OF MECHANICAL ENGINEERING

Program: M. Tech. (Mechanical – Robotics and Automation)									**Semester:** IV
Course: Dissertation Phase – III									**Code:** MERA401
Teaching Scheme (hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
-	32	-	16	-	-	150	100	-	250

Prerequisites:

Continuation of Dissertation Phase – II, Basic knowledge of Machine Design, Mechanical system design, Basics of Analysis software.

Course Objectives:

1. To develop the ability to independently conduct original research that addresses significant societal, national, and global engineering challenges.
2. To enable students to undertake an independent and original study on a topic of their choice, fostering specialization in their area of interest with faculty guidance.
3. To encourage academic research and critical thinking.
4. To develop their research, technical writing, and presentation skills.

Course Outcomes:

CO1	Problem Identification and Research Design
CO2	Technical Implementation and Analytical Competence
CO3	Research Communication and Publication

Guidelines for PG Dissertation Work:

All postgraduate M.Tech. Students are required to undertake a comprehensive and research-driven dissertation project as part of their academic curriculum. The objective is to ensure students engage with challenging and contemporary topics in their respective domains, while also contributing to the academic and professional community through research publications.

1. **Continuation from Dissertation Phase-I and II:**
   Students **must continue the topic selected during Dissertation Phase-I**. Any modifications or refinements to the scope must be done in consultation with the assigned Supervisor/Guide.
2. **Thorough Study and Execution**:
   The dissertation work should include:
   - Detailed design calculations
   - Analytical modeling and development
   - Prototyping or implementation of models
   - Validation through simulations, experiments, or case studies as applicable
3. **Research Publication Requirement**:
   As part of **Dissertation Phase-III**, students **must publish at least one research paper** in a reputed **SCI / Scopus / UGC CARE-listed journal** under the supervision of their Guide.
4. **Dissertation Supervision and Presentation**:
   - Each student will be assigned a Supervisor/Guide who will mentor and evaluate their progress throughout the project, with regular interaction being mandatory to ensure focused development and proper guidance.

- Each student is required to meet their respective guide **at least once a week** and work regularly as per the guide's instructions and feedback.
- Students must deliver **four progress presentations** during the dissertation phase.
- These presentations shall be conducted in front of an **internal panel**, which will be circulated by the **PG Coordinator**.
- **Only after receiving satisfactory remarks in all four progress presentations**, the student will be **eligible to appear for the final dissertation presentation**, which will be conducted by an **external examiner**.
- Timely submission of work, regular interaction with the guide, and adherence to feedback are mandatory for successful completion.

Dissertation Outline

1. **Research Gap Identification**

   Students are required to:
   - Analyze and review relevant national and international research papers.
   - Identify gaps or limitations in existing studies.
   - Formulate a clear and researchable problem statement in consultation with their Guide/Supervisor.
2. **Progress Review Presentations**

   Students must deliver **four internal progress presentations** during the dissertation period, covering the following stages:
   1. Literature Survey & Problem Formulation
   2. Design Methodology & Analytical Work
   3. Implementation & Results
   4. Validation & Conclusions

Each stage will be evaluated by an internal review panel in the presence of the Guide, and formal feedback will be documented.

3. **Final Dissertation Report Submission**

   Students are required to submit a comprehensive Phase-II Dissertation Report that includes:
   1. Introduction to the research problem
   2. Detailed literature survey
   3. Identification of research gaps
   4. Clearly defined objectives, methodology, and design calculations
   5. System development, testing, and validation of results
   6. Proper formatting and structure as per the prescribed dissertation guidelines

INSTRUCTIONS FOR DISSERTATION PHASE - III REPORT WRITING

It is important that the procedures listed below be carefully followed by all the students of M.Tech. (Mechanical Engineering).

1. Prepare **Three Hard Bound Copies** of your manuscript.
2. Limit your Dissertation report to 50 – 60 pages (preferably)
3. The footer must include the following:

- Institute Name, M.Tech. (Mechanical) (Robotics and Automation) Times New Roman 10 pt. and centrally aligned.

4. Page number as second line of footer, Times New Roman 10 Pt, centrally aligned.
5. Print the manuscript using
   a. Letter quality computer printing.
   b. The main part of manuscript should be Times New Roman 12 pt. with alignment - justified**.**
   c. Use 1.5 line spacing.
   d. Entire report shall be of 5- 7 chapters.
6. Use the paper size **8.5'' × 11''** or **A4 (210 × 197 mm).** Please follow the margins given below.

Margin Location	**Paper 8.5'' × 11''**	**Paper A4 (210 × 197 mm)**
Top	1''	25.4 mm
Left	1.5''	37 mm
Bottom	1.25''	32 mm
Right	1''	25.4 mm

7. All paragraphs will be 1.5 line spaced with a one blank line between each paragraph. Each paragraph will begin without any indentation.
8. Section titles should be bold with 14 pt typed in all capital letters and should be left aligned.
9. Sub-Section headings should be aligning at the left with 12 pt, bold and Title Case (the first letter of each word is to be capitalized).
10. Illustrations (charts, drawings, photographs, figures) are to be in the text. Use only illustrations really pertinent to the text. Illustrations must be sharp, clear, **black and white. Illustrations downloaded from internet are not acceptable.**
    a. Illustrations should not be more than **two** per page. One could be ideal
    b. Figure No. and Title at bottom with **12 pt**
    c. Legends below the title in **10 pt**
    d. Leave proper margin in all sides
    e. Illustrations as far as possible should not be Xeroxed.
11. **Photographs** if any should be of glossy prints
12. Please use **SI** system of units. If students would like to add the equivalent in inch-pound (British) units, they must be stated in parenthesis after the **SI** units. In case the final result comes out in any other units (say due to empirical formula etc.) covert the unit to **SI** unit.
13. Please **number the pages** on the front side, centrally below the footer
14. **References** should be either in order as they appear in the thesis or in alphabetical order by last name of first author
15. **Symbols** and **notations** if any should be included in nomenclature section only
16. Following will be the order of report
    i. **Cover page** and **Front page** as per the specimen on separate sheet
    ii. **Certificate** from the Institute as per the specimen on separate sheet
    iii. **Acknowledgement**

iv. **List of Figures**
v. **List of Tables**
vi. **Nomenclature**
vii. **Contents**
viii. **Abstract** (A brief abstract of the report not more than **150 words**. The heading of abstract i.e. word "Abstract" should be **bold, Times New Roman, 12 pt** and should be typed at the **centre.** The contents of abstract should be typed on new line without space between heading and contents. Try to include one or two sentences each on **motive, method, key-results** and **conclusions** in the Abstract)

1. **Introduction** (2-3 pages) (TNR – 14 Bold)
   1.1 Problem statement (TNR – 12)
   1.2 Objectives
   1.3 Scope
   1.4 Methodology
   1.5 Organization of Dissertation
2. **Literature Review** (20-30 pages)
   Discuss the work done so far by researchers in the domain area and their significant conclusions. No derivations, figures, tables, graphs are expected.
3. This chapter shall be based on your own simulation work (Analytical/ Numerical/FEM/CFD) (15- 20 pages)
4. Experimental Validation - This chapter shall be based on your own experimental work (15-20 pages)
5. **Concluding Remarks and Scope for the Future Work** (2-3 pages)
   References
   ANNEXURE (if any)
   (Put all mathematical derivations, Simulation program as Annexure)

17. All section headings and subheadings should be numbered. For sections use numbers **1, 2, 3, ….** and for subheadings **1.1**, **1.2**, **….** etc and section subheadings **2.1.1**, **2.1.2, ….** etc.
18. **References** should be given in the body of the text and well spread. No verbatim copy or excessive text from only one or two references. If **figures** and **tables** are taken from any reference then indicate source of it. Please follow the following procedure for references

Reference Books:

Collier, G. J. and Thome, J. R., Convective boiling and condensation, 3rd ed., Oxford University Press, UK, 1996, pp. 110 – 112.

Papers from Journal or Transactions:

1. Jung, D. S. and Radermacher, R., Transport properties and surface tension of pure and mixed refrigerants, *ASHRAE Trans*, 1991, 97 (1), pp. 90 – 98.

Papers from Conference Proceedings

1. Colbourne, D. and Ritter, T. J., *Quantitative assessment of flammable refrigerants in room air conditioners*, Proc. of the Sixteenth International Compressor Engineering Conference and Ninth International Refrigeration and Air Conditioning Conference, Purdue University, West Lafayette, Indiana, USA, 2002, pp. 34 – 40.

Reports, Handbooks etc.

1. United Nations Environmental Programme, Report of the Refrigeration, Air Conditioning and Heat Pumps, Technical Option Committee, 2002, Assessment - 2002.

Patent :- Patent no, Country (in parenthesis)

DEPARTMENT OF MECHANICAL ENGINEERING

Program: M. Tech. (Mechanical – Robotics and Automation)							**Semester:** IV		
Course: Massive Open Online Course (MOOCs)							**Code:** MERA402		
Teaching Scheme (hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
04	-	-	04	-	-	100	-	-	100

Prerequisites:

Basic math, programming, or subject-specific foundational knowledge.

Course Objectives:

1. To develop a strong understanding of the core concepts, principles, and theories within the subject matter.
2. To learn to analyze information critically, evaluate arguments, and form well-reasoned conclusions.

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

CO1	Explain the fundamental concepts, principles, and theories covered in the course.
CO2	Apply their knowledge to real-world scenarios and solve problems related to the subject matter.
CO3	Actively participate in online discussions, share their knowledge and perspectives, and learn from their peers.
CO4	Evaluate their own learning process, identify areas for improvement, and demonstrate a commitment to continuous learning.

Course Contents:

Description

A Massive Open Online Course (MOOC) is an online course aimed at unlimited participation and open access via the web. In addition to traditional course materials, such as filmed lectures, readings, and problem sets, many MOOCs provide interactive courses with user forums to support community interactions among students, professors, and teaching assistants, as well as immediate feedback to quick quizzes and assignments.

APPLICATIONS OF MOOCS • Professional development • Skill development • Fostering soft skills, inculcating research etc. • Development of knowledge.

Student need to select any one topic for MOOC courses other than the topic selected in previous semester.

NPTEL (SWAYAM Courses)

National Programme on Technology Enhanced Learning (NPTEL) is a project of MHRD created to provide quality education to students and knowledge seekers anywhere in the world from faculty in top ranking institutions like IITs and IISc for free. It provides web and video courses across 23 disciplines as certification courses.

Some notable MOOCs providers :

1. SWAYAM Courseware : **https://swayam.gov.in/**

2. MIT Opencourseware : **https://ocw.mit.edu/index.htm**
3. Stanford ONLINE : **http://online.stanford.edu/**
4. Coursera : **https://www.coursera.org/**
5. IIT BombayX : **https://www.iitbombayx.in/**
6. Khanacademy : **https://www.khanacademy.org/**
7. Udacity : **https://in.udacity.com/**
8. edx : **https://www.edx.org/**
9. Swayam : **https://swayam.gov.in/**
10. mooKIT : **https://www.mookit.in/**
11. Spoken-tutorial : **https://spoken-tutorial.org/**
12. Open Classroom : **https://openclassrooms.com**

Institute Guideline for online MOOC Course-

1. **MOOC Course registration / approval**
   Student will register for MOOC Course in consultation with Mentor / Guide / Supervisor allotted from the Institute. The topic and concerned course should be approved by Programme Coordinator / Head of Department.
2. **Course Progress Monitoring/Review**
   Student will submit the periodic progess to Mentor / Guide / Supervisor and Programme Coordinator / Head of Department. Mentor / Guide / Supervisor and Programme Coordinator will conduct the review as per need of the course requirement (if required)
3. **Evaluation and Grading**
   Mentor / Guide / Supervisor and Programme Coordinator will verify the certificate of completion of the course and allocate equivalent score and grade based on grade / score mentioned in the certificate. If certificate does not reflect any grade / score, under such situation Mentor / Guide / Supervisor and Programme Coordinator will evaluate the student by conducting appropriate examination (Theory / Practical / Seminar).
4. **Reporting of Grade / Score to Examination Department**
   Mentor / Guide / Supervisor and Programme Coordinator will submit the evaluation report along with supporting document to examination Department.

DEPARTMENT OF MECHANICAL ENGINEERING

Program: M. Tech. (Mechanical – Design Engineering))							**Semester:** IV		
Course: Internship*							**Code:** MEDE402		
Teaching Scheme (hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
-	04	-	04	-	-	100	-	-	100

Preamble:

Internships serve as vital educational and career development experiences, offering practical exposure in a specific field. Employers seek individuals who possess the necessary skills and an understanding of industry environments, practices, and cultures. This internship is designed as a structured, short-term, supervised training program, often cantered on specific tasks or projects with clear timelines. The primary goal is to immerse technical students in an industrial setting, providing experiences that cannot be replicated in the classroom. This exposure aims to develop competent professionals who understand the social, economic, and administrative factors influencing the operations of industrial organizations.

Course Objectives:

1. To expose students to real-world industrial environments
2. To develop the ability to apply technical knowledge
3. To foster professional skills and industry readiness

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

CO1	Gain exposure to industry practices and understand how academic concepts are applied in professional settings.
CO2	Develop and demonstrate effective communication and teamwork skills within a work environment.
CO3	Improve your problem-solving and time management skills by working in real-world industry settings.

Course Contents:

Description

Internship Requirements

1. **Internship Duration:**
   The students should undergo an internship in Semester-III/IV during academic period for the duration of 8 to 12 weeks. Internships completed during this period will be considered for the assessment of Term Work (TW).
2. **Internship Opportunities:**
   Students can explore various opportunities for internships at:
   a. Industries
   b. Research labs or organizations
   c. Collegiate clubs
   d. In-house research projects
3. **Support and Assistance:**
   Students can seek assistance for securing internships from:
   a. The Training and Placement cell

b. Department or institute faculty members
c. Personal contacts
d. Directly connecting with industries or organizations

4. **Request Letter:**
Once an industry, research organization, or collegiate club is identified, students must obtain a request letter from the concerned department or placement office. This letter, in the standard format must be duly signed by the authority, should be addressed to the HR manager or relevant authority.

5. **Confirmation Letter:**
Students must submit the confirmation letter from the industry, research organization, or collegiate club to the PG Coordinator and the Head of Department (HOD)

6. **Joining Report:**
Upon commencing the internship, students must submit the joining report, joining letter, or a copy of the confirmation email to the PG Coordinator and the HOD office.

7. **Faculty Mentor/ Guide:**
A faculty member will be assigned as a mentor to an individual student. The mentor will be responsible for monitoring, evaluating, and assessing student internship activities. The faculty mentor is also required to visit the internship location and submit formal feedback to the PG Coordinator.

8. **Progress Report Presentation:**
Students must submit four progress report presentations as per the departmental schedule to their faculty Guide and internal panel members. The final internship report must be submitted to the PG Coordinator, duly signed by the Guide and Head of Department (HOD), and submitted to the department office.

9. **Evaluation Report:**
After the completion of the internship, the mentor, along with the assessment panel members, should submit the evaluation report of the students to the department office and PG Coordinator.

10. **Internship Certificate:**
Students must receive the Internship Certificate from the industry and submit it to the PG Coordinator and department office.

11. **Presentation and Assessment:**
Students are required to give a presentation upon successful completion of their internship, along with four progress presentations on their internship work as part of the curriculum. The internship diary and final report will also be verified and assessed.