

Master of Science in Mechanical Engineering Program

College of Engineering

2025



Prepared By: VP For Academic Programs and Graduate Studies Office

College of Engineering

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Master of Science in Mechanical Engineering Program

Program Components

Course Type	CRD
University Requirement (UR)	00
College Requirement (CR)	00
General Studies Compulsory (GSCC)	00
Major Requirement (MR)	24
Major Elective (ME) ¹	12
General Studies Elective (GSE) ²	00
Training (Internship) Yes	00
Total Credit (CRD)	36

Detailed Study Plan

Year 1 - Semester 1

Course Code	Course Title	Course Hours			Course Type	Pre requisite	Major GPA
		LEC	PRAC	CRD			
MENG600	Advanced Numerical Methods for Mechanical Engineers	4	0	4	MR	None	Yes
MENG601	Artificial Intelligence for Advanced Mechanical Engineering	4	0	4	MR	None	Yes
MENG602	Research Methods in Engineering	4	0	4	MR	None	Yes

Year 1 - Semester 2

Course Code	Course Title	Course Hours			Course Type	Pre requisite	Major GPA
		LEC	PRAC	CRD			
MENG6XX	Major Elective I	4	0	4	ME	None	Yes
MENG6XX	Major Elective II	4	0	4	ME	None	Yes
MENG6XX	Major Elective III	4	0	4	ME	None	Yes

Year 2 - Semester 3

Course Code	Course Title	Course Hours			Course Type	Pre requisite	Major GPA
		LEC	PRAC	CRD			
MENG698	Thesis	0	36	12	MR	20 Credits	No

Major Elective Courses

Course Code	Course Title	Course Hours			Course Type	Pre requisite	Major GPA
		LEC	PRAC	CRD			
MENG611	Contemporary Cooling Technologies	4	0	4	ME	None	Yes
MENG612	Smart Materials and Structures	4	0	4	ME	None	Yes
MENG613	Technologies for Contemporary & Future Manufacturing	4	0	4	ME	None	Yes
MENG614	Computational Fluid Dynamics	4	0	4	ME	None	Yes
MENG615	Classical Continuum Mechanics	4	0	4	ME	None	Yes
MENG616	Advance Thermodynamics	4	0	4	ME	None	Yes
MENG617	Mechanics of Laminated Composites	4	0	4	ME	None	Yes
MENG618	Solar Thermal Technologies	4	0	4	ME	None	Yes
MENG619	Additive Manufacturing	4	0	4	ME	None	Yes
MENG620	Entrepreneurship: Crafting Business Journey	4	0	4	ME	None	Yes
MENG621	Renewable Energy Sources	4	0	4	ME	None	Yes
MENG622	Quality Improvement	4	0	4	ME	None	Yes
MENG623	Reliability and Maintainability	4	0	4	ME	None	Yes
MENG624	Advanced Mechanical Vibration	4	0	4	ME	None	Yes
MENG625	Aerodynamics	4	0	4	ME	None	Yes
MENG626	Applied Heat and Mass Transfer	4	0	4	ME	None	Yes
MENG627	Robotics and Automation	4	0	4	ME	None	Yes
MENG628	Advanced Finite Element Analysis and Design	4	0	4	ME	None	Yes
MENG629	Industry 4.0 for Mechanical Engineers	4	0	4	ME	None	Yes
MENG630	Fracture Mechanics	4	0	4	ME	None	Yes
MENG631	Special Topics	4	0	4	ME	None	Yes

Course Description

Course Code: MENG600 **Course Title:** Advanced Numerical Methods for Mechanical Engineers

This course provides an in-depth exploration of numerical methods critical for solving complex mechanical engineering problems. It emphasizes the practical application of finite difference, finite volume, and optimization techniques to partial differential equations. Students will gain proficiency in solving linear and non-linear algebraic systems, initial and boundary value problems of ODEs and PDEs, and optimization challenges using computational tools like MATLAB®. By integrating theoretical knowledge with practical skills, this course equips students to address real-world engineering challenges through innovative numerical approaches.

Course Code: MENG601 **Course Title:** Artificial Intelligence for Advanced Mechanical Engineering

AI in Mechanical Engineering course focusses on various applications of Artificial Intelligence (AI) in the field. Topics include an introduction to AI concepts, machine learning fundamentals, computational tools like Python and MATLAB, and their use in mechanical design. Advanced modules cover AI applications in manufacturing, automation, thermodynamics, predictive maintenance, and sustainability. The curriculum also incorporates ethics, case studies, and real-world applications, culminating in project presentations to explore future trends and summarize learning outcomes.

Course Code: MENG602 **Course Title:** Research Methods in Engineering

Understanding data sets and coding, along with the current methodological landscape and ethical research principles. Students will learn about research planning and proposal development, as well as sample collection methods such as surveys. Additionally, the course addresses measuring variables, experimental design, and methods specific to mechanical engineering. It includes data preparation for analysis and various quantitative analysis techniques, including regression, multilevel modeling, and meta-analysis. Students will also explore qualitative research methods and focus on reporting results clearly. The course emphasizes enhancing transparency, reproducibility, and replicability, alongside strategies to maximize research impact. Finally, case studies in mechanical engineering research will provide valuable real-world context.

Elective Courses Descriptions

Course Code: MENG 611 **Course Title:** Contemporary Cooling Technologies

Conventional and non-conventional methods of producing cold, thermodynamic modeling and parametric analysis of simple and multi-pressure vapor compression refrigeration (Energy and exergy analysis), cascade systems, cryogenics: Gas liquification system, Linde – Hampson System, Precooled L – H Cycle, Claude System, Thermodynamic modeling and analysis of absorption refrigeration systems: water-LiBr absorption refrigeration (single and multi-effect effect), water-NH₃ absorption refrigeration (single and double effect), Adsorption refrigeration, desiccant cooling, solar based cooling, Energy and exergy analysis of cooling system components: compressors, expansion devices, condensers and evaporators, cooling towers and evaporative coolers, vortex tube refrigeration, thermoelectric refrigeration.

Course Code: MENG 612 **Course Title:** Smart Materials and Structures

The aim is to familiarize students with the fundamental and advanced concepts of smart materials and structures essential for their design and application in engineering contexts. The course provides an overview of the properties, characterization, and applications of various smart materials and structures. It explores the use of these materials in sensors, actuators, and energy devices, covering topics such as piezoelectric materials, electroactive polymers, magnetostrictive materials, magnetorheological fluids, and shape memory polymers. The course will also cover case studies for student to provide them the application of smart material and structure in real work application.

Course Code: MENG 613 **Course Title:** Technologies for Contemporary & Future Manufacturing

This course is designed to meet the current and future challenges of manufacturing sector. This entails advanced and emerging manufacturing technologies and trends. Contemporary subtractive, additive, forming and welding processes are introduced. The latest concepts and practices in manufacturing like sustainability, hybridization and digital manufacturing are introduced to prepare professionals for the current and future market. Theory is integrated with real-life applications/independent study thereby further deepening the understanding of students. Specific topics include: Advanced Machining Processes; Advanced Welding Processes; Advanced Metal Forming Processes; Rapid

Manufacturing & Rapid Prototyping; Hybrid Manufacturing; Sustainable Manufacturing; Emerging Trends in Manufacturing.

Course Code: MENG 614 **Course Title:** Computational Fluid Dynamics

The course covers topics including a review of fundamental CFD concepts, advanced numerical techniques for CFD, turbulence modeling and simulation, high-performance computing in CFD, CFD for complex flows, finite element and hybrid methods, error analysis, verification, and validation, applications in industry and research, and research projects and case studies.

Course Code: MENG 615 **Course Title:** Classical Continuum Mechanics

This course explores the fundamental principles of classical continuum mechanics, focusing on the mathematical and physical descriptions of continuous media. Topics include tensor algebra and calculus, kinematics of deformation, conservation laws, stress measures, constitutive theories, and principles of objectivity. Through a combination of theoretical learning and practical applications, students develop a robust understanding of the mechanics underlying solid and fluid systems, preparing them for advanced research and engineering practice.

Course Code: MENG 616 **Course Title:** Advance Thermodynamics

Comprehensive exploration of the foundational concepts and principles of thermodynamics, focusing on both macroscopic and microscopic systems. Covers the definition and role of entropy, temperature, pressure, heat, and work. Detailed examination of thermodynamic relations, including Gibbs, Euler, Gibbs-Duhem, and Maxwell relations, along with characteristic functions and the state principle. Emphasis on the Second Law of Thermodynamics and its applications to energy conversion, chemical reactions, and chemical equilibrium.

Course Code: MENG 617 **Course Title:** Mechanics of Laminated Composites

This course explores unidirectional composites, focusing on their characteristics, behavior, and failure mechanisms. It begins with an introduction to carbon/epoxy composites and polymer properties. Students investigate stress in unidirectional plies through tensile and shear tests. The course covers the fracture behavior of laminated composites, analyzing tension and compression scenarios, and examines criteria like maximum stress and strain. Additionally, it addresses membrane analysis, bending behavior, damage tolerance, interlaminar shear stresses, and buckling of plates. Practical applications include calculating holed and bolted plates, along with exercises for experimental determination of unidirectional material characteristics.

Course Code: MENG 618 **Course Title:** Solar Thermal Technologies

Introduction to Solar Energy and Solar Radiation, Absorbed Radiation, Radiation Transmission Through Glazing, Components of Solar Thermal Systems, Thermal Analysis of Flat Plate liquid and air solar collectors, Concentrating Solar Collectors, Solar Water Heating and Air-conditioning Systems, Other potential solar thermal application e.g., solar drying, solar thermal power plants, solar cooking, solar ponds etc.

Course Code: MENG 619 **Course Title:** Additive Manufacturing

Additive Manufacturing allows fabrication of complicated parts, through layers addition, which once had been hard to produce. The goal of this course is to introduce this innovative approach to students for preparing them to cope with future challenges. Principles of several additive manufacturing processes are introduced, opportunities of their hybridization with traditional processes are discussed, applications to produce high-end products are elaborated, and future of the AM technology is reviewed in this course. Particular contents include:

VAT Polymerization, Powder Bed Fusion, Direct Energy Deposition, Extrusion Based Printing, LOM Processes, Printing Processes, Hybridization of Additive & Subtractive Manufacturing, Applications of Additive Manufacturing.

Course Code: MENG 620 **Course Title:** Entrepreneurship: Crafting your Business Journey

In this course students bring their business ideas to life. Students learn how to generate ideas, identify opportunities, conduct feasibility studies, and refine their business model. Throughout the course, students are guided through the process of developing a comprehensive business plan. Moreover, by examining real-world case studies and engaging in hands-on activities, students gain practical insights into the entrepreneurial mindset. By the end of the course, students will have developed a comprehensive understanding of the entrepreneurial process and gained practical skills to pursue their own ventures or contribute effectively to entrepreneurial initiatives within existing organizations.

Course Code: MENG 621 **Course Title:** Renewable Energy Sources

This course provides an in-depth exploration of renewable energy systems, their environmental impacts, and their applications in addressing global energy challenges. Students will study the fundamentals of renewable energy sources, such as solar, wind, biomass, hydropower, geothermal, and ocean energy, and explore various technologies, designs, and optimization methods in renewable energy systems. The course will also cover energy storage solutions, grid integration, economics, policies, and the future of renewable energy, providing students with a comprehensive understanding of the renewable energy landscape.

Course Code: MENG 622 **Course Title:** Quality Improvement

Contemporary approaches, systems, and statistical techniques to assess, control, and improve product and/or service quality in manufacturing and service sectors. Topics include Six Sigma, International Standards Organization (ISO), Total Quality Management (TQM), Quality Assurance, Statistical Process Control (SPC), Poke Yoke, Taguchi methods, and Balanced Scorecard..

Course Code: MENG 623 **Course Title:** Reliability and Maintainability

This course prepares engineering professionals to design and maintain reliable products by addressing variability in materials, processes, and systems. Students will explore reliability definitions, parameters, and costs, along with methods for evaluating reliability, including failure rate estimation, modeling, and system availability. The course also covers strategies for reliability assurance and improvement, such as demonstration testing, growth testing, and risk assessment. By understanding and managing variability, students will gain the skills to enhance product performance, optimize systems, and address challenges in reliability and maintainability effectively.

Course Code: MENG 624 **Course Title:** Advanced Mechanical Vibration

This course focuses on the analysis and control of vibration in mechanical systems. Topics include vibration analysis of continuous systems such as strings, bars, and beams, and advanced methods for vibration control, measurement, and numerical modeling. The course integrates theoretical concepts with practical applications, leveraging computer-based tools for dynamic system analysis. Students will also explore nonlinear and random vibration phenomena, ensuring a comprehensive understanding of advanced vibration mechanics in engineering contexts.

Course Code: MENG 625 **Course Title:** Aerodynamics

The course covers the following topics: review of fundamental aerodynamics, high-speed aerodynamics, computational aerodynamics, unsteady aerodynamics, fundamentals of aerodynamic optimization techniques, experimental aerodynamics, boundary layer control and flow separation, aerodynamics of wind energy systems, and research and applications.

Course Code: MENG 626 **Course Title:** Applied Heat and Mass Transfer

Introduction to Heat and Mass Transfer, Advanced Conduction Heat Transfer, 1D and 2d Analytical and Graphical Methods, Numerical/Finite Difference Methods for Conduction, Convective Heat Transfer Differential Equations (mass, momentum, and energy), Free and Forced convection (internal and external flows), Phase Change (Boiling and Condensation) Heat Transfer, Radiation Heat Transfer, Mass Transfer Fundamentals, Simultaneous Heat and Mass Transfer and Heat Exchangers.

Course Code: MENG 627 **Course Title:** Robotics and Automation

Robotics and Automation provides a comprehensive understanding of robotics, focusing on key concepts such as forward and inverse kinematics, velocity kinematics, Jacobians, and the dynamics of robotic systems. It delves into feedback control basics, including PID control, and advanced control techniques for robotic joints. Topics also include mobile robot kinematics, path planning, navigation, localization, mapping, and sensor integration. The course emphasizes practical aspects through robot programming, simulation tools, trajectory generation, and the integration of artificial intelligence. Collaborative robotics (Cobots) are explored, emphasizing their interaction with humans in shared environments.

Course Code: MENG 628 **Course Title:** Advanced Finite Element Analysis and Design

This advanced course delves into the theoretical foundations and practical applications of finite element analysis (FEA) for solving complex engineering problems. Topics include linear and nonlinear analysis, dynamic systems, contact mechanics, and structural optimization. Students will gain expertise in advanced techniques such as isoparametric elements, mixed methods, and FEM applications in elasto-plasticity and viscoelasticity. Emphasis is placed on the use of FEA software, including ABAQUS and ANSYS, for simulating and solving real-world design challenges. The course prepares students for advanced research and engineering design applications in various industries.

Course Code: MENG 629 **Course Title:** Industry 4.0 for Mechanical Engineers

This course introduces the transformative principles of Industry 4.0 and their applications in mechanical engineering. It focuses on advanced technologies such as IoT, AI, Big Data, Cloud Computing, Cyber-Physical Systems, and Smart Manufacturing. Students will explore the challenges and opportunities of Industry 4.0 solutions, emphasizing sustainability, energy efficiency, and economic impact. Through case studies and industry-oriented assignments students will develop the skills to design and manage innovative, sustainable systems, preparing them to lead advancements in modern manufacturing and engineering practices.

Course Code: MENG 630 **Course Title:** Fracture Mechanics

This course provides an advanced understanding of the principles and applications of fracture mechanics in engineering. Students will explore the theoretical frameworks of linear elastic fracture mechanics (LEFM), crack-tip plasticity, fracture toughness and elasto-plastic fracture mechanics. The course emphasizes fatigue crack growth (FCG), time-dependent fracture mechanisms, and fracture modeling using finite element methods (FEM). By integrating theoretical knowledge with computational tools such as ABAQUS®, students will learn to analyze and predict material failures in complex engineering systems.

Course Code: MENG 631 **Course Title:** Special Topics

Any important, relevant and possibly hot topic in the field that is not covered in the approved elective list. Topics may vary based on students' interest and availability of staff.

Course Code: MENG 698 **Course Title:** Thesis

This 6-month research course serves as the capstone component of MSc in Mechanical Engineering Program. Students conduct independent research supervised by a faculty advisor, developing advanced research capabilities, analytical thinking, and specialized knowledge. The program culminates in a thesis that contributes new insights to the field. Students develop research proposal, review literature, collect and analyze data, write a comprehensive thesis, and defend their findings in front of faculty committee members.

University Requirements Courses Descriptions

College Requirement Courses Descriptions
