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| **DEPARTMENT OF MECHANICAL ENGINEERING****Content of Ph.D. in Mechanical Engineering** |
| **COURSE CODE** | **COURSE NAME AND CONTENTS** | **T** | **A** | **C** | **ECTS** |
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| **LUEE801** | **Scientific Research Techniques and Science Ethics** | **3** | **0** | **3** | **8** |
| **Purpose and Content** | Understanding the process of scientific research and knowing how to prepare a scientific report. Basic concepts and information related to science, the structure of scientific research, scientific methods, and various perspectives on these methods. Topics include the problem, research model, universe, and sample, as well as data collection and data collection methods (quantitative and qualitative data collection techniques). Additionally, covering the recording, analysis, interpretation, and reporting of data. |
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| **MKM801** |  **Source Inspection and Control** | **3** | **0** | **3** | **8** |
| **Purpose and Content** | Acquiring information to ensure the safety and enhance the quality of welded components. Non-destructive, mechanical, and visual inspection of weld seams, material definitions, and metallurgy. Definitions of welding consumables, technical drawings, dimensions, and application tolerances. Welding instructions and methods, inspection methods, and acceptance criteria. Identifying irregularities in weld seams that may occur during and after manufacturing. |
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| **MKM802** | **Unconventional Manufacturing Methods** | **3** | **0** | **3** | **8** |
| **Purpose and Content** | Providing information to students in all engineering disciplines about traditional and unconventional manufacturing methods. Introducing commonly used manufacturing methods by examining the problems encountered in traditional manufacturing methods and the necessary precautions to overcome them. This course covers theoretical and practical information about unconventional manufacturing methods. Unconventional manufacturing methods, which are generally known as non-traditional and have developed and found application since World War II, are indispensable and play a primary role in contemporary technology. These methods have a significant impact on today's economy due to their different processing principles and the opportunities they provide to design engineering, such as miniaturization, the ability to use extraordinary materials, and flexible manufacturing. |
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| **MKM803** | **Heat Conduction** | **3** | **0** | **3** | **8** |
| **Purpose and Content** | Providing a new perspective on heat conduction problems to prepare the necessary groundwork for advanced studies. General heat conduction equation; Boundary conditions; Solution methods for time-dependent and time-independent heat conduction problems; Modeling techniques for one, two, and three-dimensional heat conduction problems. |
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| **MKM804** | **Finite Element Method** | **3** | **0** | **3** | **8** |
| **Purpose and Content** | Providing graduate students with the ability to discretize and solve common engineering problems. Creating systems of equations, Stiffness matrix, Boundary conditions, Minimum potential energy, Plane stress and strain equations, Volume and surface forces, Three-dimensional stress analysis, Heat and mass transfer applications: One, two, and three-dimensional problems. |
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| **MKM811** | **Exergy Analysis** | **3** | **0** | **3** | **8** |
| **Purpose and Content** | Teaching students the fundamental principles and terminology of thermodynamics, the theory of exergy and irreversibility, and the ability to analyze the energy and exergy of advanced power and cooling cycles. Basic definitions and laws of thermodynamics, Otto, Diesel, and Brayton cycles, entropy, and entropy changes of ideal gases, concepts of exergy and irreversibility, definitions of exergy and energy, exergy balance and exergy losses, exergy efficiency of thermal systems, basic thermodynamic applications of exergy analysis, exergy calculation, exergy calculation in open systems, physical exergy calculation, chemical exergy calculation, exergy analysis of typical thermal systems, exergy analysis of heat exchangers, exergy analysis of combustion processes, exergy analysis of steam generators and heating furnaces, exergy analysis of steam power systems, exergy analysis of vapor compression refrigeration systems and heat pumps, exergy analysis of combined processes. |
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| **MKM821** | **Composite Materials and Their Machinability** | **3** | **0** | **3** | **8** |
| **Purpose and Content** | The aim of this course is to: 1. Provide information about the general definition and classification of composite materials. 2. Help understand the superior aspects of composite materials compared to traditional materials. 3. Introduce the matrix and reinforcement elements used in the manufacturing of composite materials. 4. Teach the mechanisms that affect the development of strength properties in composite materials. 5. Introduce the applications of composite materials. 6. Convey the importance of the matrix-reinforcement interface and wetting concepts in composite materials. 7. Introduce the production methods of metal matrix, ceramic matrix, and plastic matrix composites. 8. Present methods and parameters related to the machinability of composites. The course aims to provide information about the definition of composite materials, their structural components, their importance compared to traditional materials, their applications, and manufacturing methods, as well as their machinability characteristics. |
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| **MKM823** | **Powder Metallurgy Production Methods** | **3** | **0** | **3** | **8** |
| **Purpose and Content** | Powder production, Mechanical production method, Production with Liquid Phase Atomization, Electrolysis Method, Special powder production methods, Compression of powders, Design limitations in powder metallurgy, Compaction of powders, Sintering of powders, Control of final product properties. |
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| **MKM827** |  **Power Transmission in Vehicles** | **3** | **0** | **3** | **8** |
| **Purpose and Content** | The aim of this course is to provide detailed information about the structure, operation, and design of power transmission elements. Classification of vehicles. Types and arrangements of vehicle drives. Concepts. Gearboxes. Determination of gear ratios (gearbox and differential). Universal joints, flexible couplings, and constant velocity joints. Differential and Axles. Hydraulic concepts and Automatic transmissions. |
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| **MKM829** | **Advanced Maintenance Techniques** | **3** | **0** | **3** | **8** |
| **Purpose and Content** | The purpose of this course is to provide information about maintenance practices in the industry and enhance students' knowledge and skills through practical work. The importance and principles of maintenance. Dynamic maintenance planning. Basic vibration information and frequency analysis. Diagnosis of faults with frequency analysis. Engineering applications related to damage determination. |
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| **MKM830** | **Optimization of Machinability Properties of Industrial Materials** | **3** | **0** | **3** | **8** |
| **Purpose and Content** | The aim of this course is to provide advanced knowledge about engineering materials and their machinability for graduate students. The concept of machinability. Metal cutting mechanics, chip formation, cutting forces, cutting temperatures. Tool wear and tool life. Surface quality and factors affecting surface quality. Evaluation of machinability. Sources of machinability data. Machinability of ferrous and non-ferrous materials. Effect of alloying elements on machinability. Influence of heat treatments, microstructure, and mechanical properties on machinability. Machinability of powder metallurgy materials. Machinability of composite materials. Cutting parameters and optimization of machining outputs. Machinability and cost analysis. The importance of machining in sustainable manufacturing. |
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| **MKM831** | **Energy Quality** | **0** | **2** | **0** | **6** |
| **Purpose and Content** | Terms and definitions related to power quality; Types, sources, effects of power quality problems, and improvement of power quality; Power quality and Standards; Measurement and monitoring of power quality; Economics of power quality; Power quality control techniques; Power quality in energy distribution systems; Modeling of systems and elements under non-sinusoidal conditions; Application. |
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| **MKM833** | **Quality Management and Organization I** | **4** | **0** | **0** | **4** |
| **Purpose and Content** | Global competition, strategy and management, collaboration, quality culture, leadership, and change are concepts covered in this course. |
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| **MKM834** | **Quality Management and Organization II** | **0** | **1** | **0** | **26** |
| **Purpose and Content** | This course covers a review of Total Quality Management and tools and techniques for problem-solving and decision-making. It includes Total Quality Management, Problem-Solving Techniques, Statistical Process Control, Benchmarking, and Just-In-Time (JIT) production. |
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| **MKM841** | **Fundamentals of Fracture Mechanics** | **3** | **0** | **3** | **8** |
| **Purpose and Content** | To provide students with basic knowledge in the following areas: - Principles of fracture mechanics - Fracture and crack propagation mechanisms in engineering materials - Experimental methods for determining material fracture properties - Applications of fracture mechanics to engineering materials and structures. This course covers introductory and intermediate-level concepts in the application of fracture mechanics to engineering materials. Topics covered include theoretical strength calculations, stress at the crack tip, Griffith's criterion, Irwin's modification to Griffith's theory, fracture mechanisms, crack growth, elastic crack tip stress field, plastic zone at the crack tip, energy principles, energy release rate criterion for crack growth, linear elastic fracture mechanics, Modes I, II, and III fractures, superposition of stress intensity factors, mixed-mode crack initiation theories, numerical, analytical, and experimental methods for determining stress intensity factors, elastic-plastic fracture mechanics, experimental methods, fatigue crack propagation, and applications to engineering materials and structures. |
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| **MKM844** | **Alternative Fuel Applications and Performance Analysis in Internal Combustion Engines** | **3** | **0** | **3** | **8** |
| **Purpose and Content** | The aim is to inform students about alternative fuels used in internal combustion engines and to provide insights into the performance analysis of these fuels. Topics include the main fuels used in internal combustion engines, alternative fuels used in internal combustion engines, and performance analyses of alternative fuels in internal combustion engines. |
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| **MKM896** | **Doctoral Qualification** | **0** | **1** | **0** | **26** |
| **Purpose and Content** | The goal is to educate students at the doctoral level in the fields of science, basic engineering, and mechanical engineering. |
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| **MKM897** | **Doctoral Seminar** | **0** | **2** | **0** | **6** |
| **Purpose and Content** | To impart the ability to deliver presentations to different audiences, whether they are experts or non-experts, and enhance the skill of engaging in discussions. The course aims to help students define the purpose and objectives of their doctoral thesis, learn presentation techniques, and prepare a work plan aligned with the goals of the thesis. |
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| **MKM898D** | **Course Specialised Field** | **4** | **0** | **0** | **4** |
| **Purpose and Content** | Course Specialised Field is a theoretical course proposed by a faculty member to share their knowledge, experience, and expertise in their scientific field with graduate students under their supervision. This course aims to educate students on scientific ethics and instil a strong work discipline. |
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| **MKM898T** | **Thesis Specialised Field** | **4** | **0** | **0** | **4** |
| **Purpose and Content** | Thesis Specialised Field is a theoretical course that the faculty member proposes to the graduate students he/she supervises in order to share the methods of conducting research in the current literature, following and evaluating the literature, and to establish and carry out the scientific foundations of the student's thesis / exhibition / project work. |
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| **MKM899** |  **Doctoral Thesis Work** | **0** | **2** | **0** | **6** |
| **Purpose and Content** | To impart the ability to access new information, evaluate, and interpret knowledge using scientific research techniques. |
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| **MKM815** | **Heat Transfer** | **3** | **0** | **3** | **8** |
| **Purpose and Content** | Steady-State One-Dimensional Heat Conduction: Plane Wall, Insulation and R Values, Radial Systems - Cylinder, Overall Heat Transfer Coefficient, Critical Insulation Thickness, Systems with Heat Generation, Cylinders with Heat Generation, Conduction-Convection Systems, Fins, Thermal Contact Resistance. Steady-State Multidimensional Heat Conduction: Mathematical Solution of Two-Dimensional Heat Conduction, Graphical Analysis, Shape Factor in Conduction, Numerical Methods for Solution, Electrical Analogy in Two-Dimensional Heat Conduction. Unsteady Heat Conduction: Generalized Total Mass Approach, Convection Boundary Conditions, Multidimensional Systems, Formulation of Thermal Resistance and Capacitance. Fundamentals of Convection: Viscous Flow, Inviscid Flow, Energy Equation for Boundary Layer, Thermal Boundary Layer, Relationship Between Fluid Friction and Heat Transfer, Heat Transfer in Laminar Flow Inside Tubes, Heat Transfer in Turbulent Flow Inside Tubes. Forced Convection in External and Internal Flows: Flow Over Flat Plates, Flow Over Cylinders and Spheres, Flow Around Banks of Tubes, Free Convection Systems, Heat Exchangers: Overall Heat Transfer Coefficient, Fouling Factor, Types of Heat Exchangers, Logarithmic Mean Temperature Difference, Effectiveness-NTU Method. |
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| **MKM819** | **Engineering Optimization** | **3** | **0** | **3** | **8** |
| **Purpose and Content** | In this course, students learn how to define optimization (minimization or maximization) problems from real-life applications; convert problem descriptions into mathematical models; understand the applicability and limitations of different optimization models; grasp key mathematical concepts in optimization theory; explore algorithms and solution approaches for dealing with various optimization problems; and learn intuitive methods used in optimization problems. Introduction to Optimization: How to construct an optimization model. Fundamentals of Optimization. Linear Programming: Model assumptions, graphical solution and geometric intuition, algebraic simplex method, sensitivity analysis, duality theorem and applications. Unconstrained Optimization. Constrained Optimization. Network Optimization: Basic network terminology, network optimization models (transportation, assignment, shortest path, and maximum flow problems), duality in network models, network simplex method. Integer Programming (IP): IP modeling techniques ("if-then" and "either-or" constraints, fixed-charge model, and piecewise linear functions). Nonlinear Programming: Easy and hard problems, local and global optima, Lagrangian relaxation, optimality conditions. Heuristic Methods: Tabu Search, Simulated Annealing, Genetic Algorithm, Optimization Applications. |
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| **MKM820** | **Advanced Dynamics** | **3** | **0** | **3** | **8** |
| **Purpose and Content** | This course aims to teach advanced theories in dynamics and the analysis techniques of the dynamics of complex systems. Topics covered include particle motion, three-dimensional dynamics of rigid bodies, Euler's equations, Poinsot construction, spin stability, rotation matrix, generalized coordinates, generalized velocities, generalized forces, Lagrange's equations, Hamilton's principle, and D'Alembert's principle. |
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| **MKM824** | **Precision Machining** | **3** | **0** | **3** | **8** |
| **Purpose and Content** | This course covers the fundamentals and manufacturing aspects of precision engineering, focusing on the theory and design of precision machines, measurements, tools, machine structures, error sources, precision manufacturing processes, and precision process planning. Topics include Precision Engineering; Principles of measurement; Mechanical errors; Thermal errors; Error decomposition and error budget; Errors due to fit and vibration; Sensors for precision manufacturing; Introduction to precision manufacturing; Tool materials for precision engineering; Precision manufacturing processes: Mechanics of material cutting, advancements in precision grinding; Ultra-precision machine elements: rolling elements, hydrodynamic and hydrostatic bearings, gas-lubricated bearings; Microelectromechanical systems (MEMS); Process planning for precision manufacturing; Applications and challenges of precision manufacturing; The future of precision engineering. |
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| **MKM828** | **Fuels in Internal Combustion Engines** | **3** | **0** | **3** | **8** |
| **Purpose and Content** | The aim of this course is to provide in-depth knowledge to students on the types and characteristics of fuels used in internal combustion engines for their doctoral studies. Classification of fuels used in internal combustion engines. Acquisition of fuels. Characteristics of spark-ignition engine fuels. Characteristics of diesel engine fuels. Evaluation of fuel properties in terms of performance and emissions. Alternative fuels for spark-ignition engines. Production and use of alcohols in engines. Production and use of hydrogen in engines. Production and use of LPG in engines. Production and use of natural gas in engines. Alternative fuels for diesel engines. Production and use of biodiesel in engines. Performance, exhaust emissions, and cost analysis in engines using alternative fuels. |
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| **MKM838** | **Forming Mechanics and Applications** | **3** | **0** | **3** | **8** |
| **Purpose and Content** | This course aims to provide advanced knowledge and skills in material, technology, process, mold design, and process analysis related to plastic forming methods to enhance product quality and efficiency. Introduction to metal plastic forming. Process design and analysis in bulk forming methods - Slice method: Forging, extrusion, rolling, and drawing; Process design and analysis of Sheet Processing Methods: Cutting, bending, deep drawing, spinning, hydroforming, and stretch forming. Design and manufacturing of forming molds, Forming equipment and design, Process control technologies, and quality control in forming processes. |
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