



**Ministry of Higher Education
and Scientific Research
University of Mosul
College of Engineering**



DEPARTMENT OF MECHANICAL ENGINEERING



Ph.D Degree Programs

MECHANICAL ENGINEERING 2024-2023



First Semester

No	Code	Subject	Hours	Units
1	ME601	Advanced Mathematics / Finite Element Method (FEM)	3	3
2	/	Major Elective Course (1)	3	3
3	/	Major Elective Course (2)	3	3
4	/	Minor Elective Course (1)	3	3
5	ME603	English Language	2	2
Total			14	14

Second Semester

No	Code	Subject	Hours	Units
1	ME602	Advanced Mathematics / Boundary Element Method (BEM)	2	2
2	/	Major Elective Course (3)	3	3
3	/	Major Elective Course (4)	3	3
4	/	Minor Elective Course (2)	3	3
5	ME604	Scientific Research Methodology	1	1
Total			12	12



• **Major Elective Courses for Ph.D / Mechanical Engineering**

No	Code	Subject	Units
1	ME605	Selected Topics in Heat Transfer /1	3
2	ME606	Selected Topics in Heat Transfer /2	3
3	ME607	Fluid Transient	3
4	ME608	Turbulence	3
5	ME609	Advanced Thermodynamics and Combustion	3
6	ME610	Cryogenics	3
7	ME611	Computational Fluid Dynamics	3
8	ME612	Fracture Mechanics	3
9	ME613	Advance Elasticity and Plasticity	3
10	ME614	Failure Analysis	3
11	ME615	Advance stress analysis	3
12	ME616	Plates and Shells	3
13	ME617	Robotics	3
14	ME618	Artificial intelligence	3
15	ME619	Advanced Casting Technology	3
16	ME620	Advanced Welding Technology	3
17	ME621	Computer Integrated Manufacturing CIM	3
18	ME622	Nanomaterials and Nanotechnology	3
19	ME623	Advanced Composite Materials	3
20	ME624	Automatic Control of Manufacturing Processes	3

• **Minor Elective Courses for Ph.D / Mechanical Engineering**

No	Code	Subject	Units
1	ME625	Optimization in Engineering Design	3
2	ME626	Analysis and Design of Control Systems	3
3	ME627	Advanced Vibrations	3
4	ME628	Advanced Heat Transfer	3
5	ME629	Advanced Engineering Materials	3



ME601 Advanced Mathematics / Finite Element Method FEM

Basic Fundamentals of FEM and its Applications in Heat Transfer and Fluid Flow, Introductory Concepts and Formulations, FEM for One-Dimensional Problems, FEM for Two-Dimensional problems, FEM for Axisymmetric Problems, FEM for Time-Dependent Problems, FEM for Three-Dimensional Problems.

ME602 Advanced Mathematics / Boundary Element Method BEM

Basic Fundamentals of BEM and its Applications in Heat Transfer, Fluid Flow, Elastostatic and Elastodynamic Problems, Introductory Concepts and Principles, BEM for Steady State Two-Dimensional Field Problems, BEM for Steady State Two-Dimensional Elasticity Problems, BEM for Steady State Three-Dimensional Elasticity Problems, BEM for Axisymmetric Problems, BEM for Time-Dependent Problems.

ME603 English Language

Parts of Speech, Punctuation, Kinds of Sentences, Pronouns, Verb Tenses, Numbers, Phonetics, Agreement of Subject and verb, Definite and Indefinite Articles, Spelling, How the Suffix "S" is pronounced, Preposition of Time, Model Verbs, Phrasal Verbs. Technical Reporting: Fundamental Principles, General Procedure, Technical Description, Reports, Theses and Dissertations, Technical Papers and Articles, Oral Reports and Speaking in Public, Writing Rules and Mechanics, Visual Representation and Mechanics, Visual Representation and Information, Final Conclusions and Recommendations.

Prerequisite Courses: None



ME604 Scientific Research Methodology

Theoretical foundations of scientific and research work, general methodology of scientific work, the logic of scientific research process, the model of research, planning the research, the conceptual framework, The research problem and objectives, the literature review, techniques of thesis preparation and defense

ME605 Selected Topics in Heat Transfer /1

Individual or Group Studies of A Selected Topics in Conduction and Radiation Heat Transfer Under the Supervision of the Instructor, Conduction Heat Transfer: Steady and Unsteady Conduction in Two-, and Multi - Dimensional Problems, Numerical Methods in Conduction, Variable Thermal Conductivity: Temperature and Location Dependent Thermal Conductivity, Non Uniform Heat Generation: Temperature and Location Dependent Heat Generation, Analytical and Numerical Solution for Longitudinal and Radial Convicting Fins: Rectangular, Trapezoidal, Triangular, Concave and Convex Fins. Convicting Spine: Cylindrical, Conical, Concave Parabolic and Convex Parabolic Spine, Radiation Heat Transfer: Spectral Radiation From Black Body, Radiation from Real Surfaces, Exchange of Radiation Between Black Isothermal Surface And Geometric Configuration Factor, Applications of Radiation.

ME606 Selected Topics in Heat Transfer /2

Individual or Group Studies of A Selected Topics in Convection Heat and Mass Transfer under the Supervision of the Instructor, Free convection boundary-layer flow over a vertical flat plate, Mixed convection boundary-



layer flow along a vertical flat plate, Free and mixed convection boundary-layer flow past inclined and horizontal plates, Double-diffusive convection, Convective flow in buoyant plumes and jets, Conjugate heat transfer over vertical and horizontal flat plates, Free and mixed convection from cylinders, Free and mixed convection boundary-layer flow over moving surfaces, Unsteady free and mixed convection, Free and mixed convection boundary-layer flow of non-Newtonian fluids.

ME607 Fluid Transient

Transient Flow Concepts, Arithmetic Derivation of Transient Flow Equations, Effect of Air Entrainment, Cause of Transient, Column Separation, Method of Analysis, Basic Differential Equations for Transient Flow, Waves Speed in Special Conduits, Characteristic Equations, Finite Difference Equations, Basic Boundary Conditions, Single Pipeline Applications, Equations for Water Hammer, Single Pipe with Reservoir, Pipes in Series, Lumped Elements, Air Chamber, Transient Caused by Turbo Pumps, Methods for Controlling Transient.

ME608 Turbulence

Nature of Turbulence-Method of Analysis - Origin of Turbulence-Diffusivity-Length Scale-Turbulent Transport of Momentum And Heat. Reynolds Equation-Estimate of The Reynolds Stress-Kinetic Energy of The Mean And Turbulence Flow - Vortices Dynamics-Wall Bounded Shear Flows (Pipes And Channels) - Problem of Multiple Scales-One And Three-Dimensional Spectra-Energy Cascade.



ME609 Advanced Thermodynamics and Combustion

Exhaustive discussions on entropy and exergy analysis in thermodynamic systems; Combustion involving premixed and non-premixed flames for laminar and turbulent combustion; Combustion phenomena in practical occurring applications such IC and GT engines.

ME610 Cryogenics

Introduction to Cryogenic Systems, Low-Temperature Properties of Engineering Materials, Gas-Liquefaction Systems, Separation and Purification Systems, Cryogenic Refrigeration Systems, Measurement Systems for Low Temperatures, Cryogenic-Fluid Storage and Transfer, Vacuum Technology.

ME611 Computational Fluid Dynamics

Classifications of Partial Differential Equations, Finite Difference Formulation, Parabolic Partial Differential Equations, Elliptic Partial Differential Equations, Hyperbolic Partial Differential Equations, Fluid Flow Equations (Viscous Flow), Grid Generation, Transformation of Equations, Euler Equations, Full Navier Stokes Equations.

ME612 Fracture Mechanics

Complex stresses Theories of yielding under complex stresses, Introduction to fracture mechanics, strength of structures in the presence of cracks, elastic crack-tip stress field, the stress intensity factor K , fracture modes, stress intensity factor for different crack shapes, Crack-tip plastic deformation, plane stress and plane strain, the accurate shape of plastic zone, The energy release rate G , energy criterion for crack growth, the crack resistance, Standard test method for K_{Ic} , Effect of loading rate and temperature



on fracture toughness, Elastic-plastic fracture mechanics, the crack-tip opening displacement, the J-integral, Applications and case studies.

ME613 Advance Elasticity and Plasticity

Stress-strain relations for linearly elastic solids, Generalized Hooke's law. Notation of Force and Stress. Components of stress and Components of strain. Tensor character of stress. Strain-displacement relations, Torsion as an Elasticity Problem. Plane stress and plane strain, Airy Stress Functions in Cartesian and Polar Coordinates, Beams Under Elastic Foundations Theoretical concepts of plasticity, Yield criteria - Tresca and Von Mises criterion of yielding, Plastic stress strain relationship

ME614 Failure Analysis

Introduction to failure types and failure analysis, Fracture mechanisms and microfractographic features, Fracture modes and macrofractographic features, Metallurgical aspects of fracture and fractography, Failure analysis procedure, Failure case studies and failure analysis report, Failure analysis of creep and extrapolation from short time data, Analysis of fatigue failure, Failure analysis of composite materials, Failure analysis of polymers, Failure analysis and prevention

ME615 Advance stress analysis

Characterization of Internal Forces, stress tensor; equations of equilibrium Characterization of the Geometry of Deformation displacements; strain tensor; compatibility,



Material Response: isotropic linear elastic behavior, Theory of Elasticity field equations of elasticity in three dimensions plane stress and plane strain, Bernoulli-Euler Beam Bending Theory, Principle of Minimum Potential Energy, Rayleigh-Ritz Techniques, approximate methods of structural analysis, Analysis of Structures, analysis of complex structures made of rods, beams, plates, Elastic stability: buckling of columns.

ME616 Plates and Shells

Plates: Theory of Thin plates with Small Deflection, Kirchoff's Hypothesis, Differential Equation of Bending, Rectangular Plates with Various Edge Conditions and Loadings, Navier and Levy's Solutions, Plates with Different Shapes (Triangular, Elliptical), Plates under Elastic Foundation, Stability of Plates, Large Deflection of Plates, Thick Plates. Shells: Three-Dimensional Differential Geometry, Membrane Theory of Shells, Sheets of Revolution with Symmetric and Un-Symmetric Loading, Spherical and Cylindrical Shells, Shallow Shells, Bending Theory of Shells, Cylindrical Shells, Shallow Shells.

ME617 Robotics

Definition, Structure, Classification and Specifications of Robots, Industrial Robots, Coordinate Frames, Mapping and Transformation, Frame attachments, Link parameters, Solvability, Multiple solutions, Methods of solution, Velocity propagation, Jacobian, Static force in manipulators., Acceleration of a rigid body, mass distribution, Newtons equation, iterative Newton Euler dynamic formulation, Lagrangian formulation of manipulator dynamics, Cubic polynomials, LSPB, Task requirements, Kinematics configuration , Actuation schemes, stiffness and deflections, control law partitioning, trajectory following control, multi



input multi output control systems, Cartesian based control scheme, Robot Programming for Manufacturing and Other Applications, Robot Integration with CAD and CAM..

ME618 Artificial intelligence

Introduction to Artificial intelligence (AI) in mechanical engineering applications, Introduction to Artificial Neural Networks, Neuron Model, Feed forward Neural Networks, Derivation of Error Back propagation (EBP) Training Algorithm, Improving the Convergence Properties of EBP, Second Order Training Schemes, Radial Basis Function Neural Networks, Unsupervised Learning, Fuzzy Logic, Membership Functions, Standard Fuzzy Systems (SFS), Adaptive Neuro-Fuzzy Inference Systems (ANFIS), Introduction to Evolutionary Computing, Encoding, and Decoding, Operators: Mutation, Crossover, Offspring generation, AI applications in optimum design of mechanical systems; intelligent control, system identification, and damage detection; solid mechanics, geomechanics, material modeling, and smart materials; and structural dynamics, vibration, and inverse vibration problems, Project work.

ME619 Advanced Casting Technology

Introduction and Types of Foundries, Mould and Mould Making, Melting and Pouring, Gating Systems, Finishing Processes, Advance Casting Processes, Inspection and Testing of Casting, Modernization and Mechanization of Foundry, Economics of Casting



ME620 Advanced Welding Technology

Laser Properties and Fundamentals, Laser Optics and Optical Materials, Laser Material Interaction, Laser Welding Including Hybrid Processes, Laser Cutting and Drilling, Laser Surface Treatment, Laser Material Processing Systems, Advanced Digital Arc Welding, Flux Cored Arc Welding, Advanced Modeling and Monitoring of Resistance Welding, Friction Stir Welding, Additive Manufacture, Residual Stress, Distortion and Their Management.

ME621 Computer Integrated Manufacturing CIM

Introduction to CIM, The One Model Concept, Data Base Management Systems, Networking Concept, OSI Fundamentals, MAP/TOP Fundamentals, Developing a Successful CIM Strategy, Computer Aided Process Planning Systems, Dynamic Production Planning and Control.

ME622 Nanomaterials and Nanotechnology

Definitions and course organization Historical development of Nanomaterials and Nanotechnology, Units Scaling Atoms, Molecules, Clusters and Supramolecules) Structure and Bonding in Nanomaterials: Chemical Bonds (types and strength) Intermolecular Forces Molecular and Crystalline Structures Hierarchical Structures Bulk to Surface transition, surface reconstruction Self-assembly and thermodynamics, Properties and Size dependence of properties, Nanomaterial Synthesis, Nanomaterial characterization techniques, Applications: Nano-electronics , Nano optics, Nanoscale chemical- and bio-sensing, Biological/bio-medical applications, Photovoltaic, fuel cells, batteries and energy-related



applications, High strength nanocomposites
Nanoenergetic materials.

ME623 Advanced Composite Materials

Introduction to Composite Materials, Uses of Micromechanics, Advanced Topics in Composite Materials Mechanics (Including Analysis, Design, and Optimization of Composite Structures), Failure Theories for Composites (Including Composites with Holes, Analysis and Design of Joints, Fatigues of Composites). Micromechanical Analysis of a Lamina, Hooke's Law for a Two-Dimensional Unidirectional Lamina, Strength Failure Theories of an Angle Lamina, Micromechanical Analysis of Laminates, Failure, Analysis, and Design of Laminates, Bending of Laminated Beams, Laminated Beam Buckling, Vibration of Laminated Beam

ME624 Automatic Control of Manufacturing Processes

Computer Control System Structure, Process Modeling and Dynamics, Feedback Control, Enhanced Controllers, Digital Controllers, Model Predictive Control, Advanced Control Topics, Case Studies for Process Control Systems, Hands on Control System Design Using Simulink and MATLAB

ME625 Optimization in Engineering Design

Introduction to Multidisciplinary System Design Optimization, Modeling and Simulation, Design of Experiments, Numerical Optimization, Sensitivity Analysis, Simulated Annealing, Genetic Algorithm, Goal Programming Iso performance, Multi-Objective Optimization, Post Optimality Analysis, Design of Value, Design for Flexibility.

ME626 Analysis and Design of Control Systems



Review of Continuous Control, Introduction to Digital Control, Discrete System Analysis, Sampled Data Systems, Discrete Equivalences, Design Using Transform Techniques, Implementation of Direct Digital Control Algorithms, Introduction to Real - Time Systems.

ME627 Advanced Vibrations

Modeling System, Transformation of Coordinates System, Equation of Motion-Influence Coefficients Lagrange's Equations-Energy Quadratics, Orthogonality of the System, Equator Repeated Eigenvalues, Solutions of the Eigenvalues Problem (Iteration Method, Deflation Method, Characteristics Determinate Extra and Approximations Method,(Uncoupled Systems, Response of the System to Forcing, Continuous Systems - Extra Solution, Plate and Membranes, Transfer Matrix Method, Solution of Non-Linear Differential Equation, Finite Elements Method.

ME628 Advanced Heat Transfer

Introductory Concepts, Steady One-Dimensional Conduction, Steady Two&-Three-Dimensional Conduction, Unsteady Conduction (Lumped and Distributed systems, One-; Two-; and Three-Dimensional Problems), Introductory Concepts, Laminar Forced Convection in Closed Conduits, Laminar Forced Convection in External Flow, Turbulent Forced Convection (Internal and External Flows), Natural Convection Heat Transfer, Phase Change Heat Transfer (Condensation and Boiling), Mass Transfer (Diffusive and Convective).



ME629 Advanced Engineering Materials

Atomic Structure and Interatomic Bonding, Structures of Metals and Ceramics, Polymer Structures, Types and Applications of Materials, TYPES OF CERAMICS, TYPES OF POLYMERS, Composites, Diffusion, Mechanical Properties , Deformation and Strengthening , Failure , Corrosion and Degradation of Materials, Thermal Properties of Materials, Magnetic Properties, Optical Properties, Biomaterials & Advanced Materials.

