



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

DEPARTMENT OF MECHANICAL
ENGINEERING



M.SC CURRICULUM
COURSES
2020-2021



M. Sc. Mechanical Engineering Courses

(A) Compulsory Courses

Course Code	Course Name	Theo.	App.	Credit
MEC 501	Advanced Engineering Mathematics	2	-	2
MEC 502	Experimental Design	2	-	2
MEC 503	Computer Techniques	2	2	3
MEC 504	Scientific Research Methodology	1	-	1
MEC 505	English language	2	-	2

(B) Selective Courses

Course Code	Course Name	Theo.	App.	Credit
MEC510	Advanced Thermodynamics	2	-	2
MEC511	Advance Heat Transfer (Conduction & Radiations)	3	-	3
MEC512	Advanced Convection Heat and Mass Transfer	2	-	2
MEC513	Advanced Fluid Mechanics	3	-	3
MEC514	Design of Refrigeration System	2	-	2
MEC515	Advanced Internal Combustion Engine	2	-	2
MEC516	Design of Thermal System	2	-	2
MEC517	Stress Analysis	2	-	2
MEC518	Advanced Dynamics	2	-	2
MEC519	Advanced Plasticity and Elasticity	2	-	2
MEC520	Advanced Machine Design	3	-	3
MEC521	Engineering Material	2	-	2
MEC522	Advanced Machining	3	-	3
MEC523	Metal Forming	2	-	2
MEC524	Industrial Engineering	2	-	2
MEC525	Composite Material	2	-	2
MEC526	Workshop Technology	3	-	3
MEC527	Non-Destructive Testing	2	-	2

MEC528	Advanced additive manufacturing	2	-	2
MEC529	Advanced Aerodynamics	2	-	2

- M. Sc. Thesis (ME 699) units = 10
- Total units is (26) which consists 10 units of compulsory courses (A) and 16 units from selective courses (B)
- Total units required with thesis = 36 unit

M. Sc. Courses Descriptions

MEC501 Advanced Engineering Mathematics

1. Introduction to series solution of ODE, Bessel equation, Solution of Bessel equation (Bessel Functions), Recurrence Relations of Bessel Function of first kind, Bessel function of second kind, modified Bessel equation, generalized form of Bessel equation. Legendre polynomials, Fourier-Legendre expansion, orthogonally of Legendre polynomials. Application of Bessel Function and Legendre polynomials in PDE in cylindrical and spherical frames, 2. Calculus of variations, Functional analysis, Definitions, Euler equation, Isoperimetric problems, Functional of second and higher derivatives, Rayleigh-Ritz method, Galerkin method, Least-square method. 3. Tensor Analysis, Definitions, First-order tensor, Second order tensor, Coordinates transformations, calculus of tensors, Kronecker tensor, tensor field, Eigen-value and Eigen-vector of tensors. 4. Green Function, introduction, Dirac delta definitions, application to non-homogeneous elliptic partial equation. .

MEC502 Experimental Design

The use for data collection and analysis. Basic statistical analysis. Parameters and estimators. Estimation and testing of hypothesis. Simple linear regression. Multiple linear regressions. Analysis of variance and ANOVA tables. Non-linear estimation. Model selection methods. Uncertainty analysis, Computer applications.



MEC503 Computer Techniques

1. Difference calculus and equation 2. Basic Finite Difference formulations, 3. Finite difference methods of elliptic equations: Jacobi, point Gauss-Seidel, Line Gauss-Seidel, and ADI, 4. Finite difference methods of hyperbolic equations: explicit methods FTFS, Euler FTCS, Lax and Lax-Wendroff method, implicit Crank-Nicolson, BTCS, 5. Finite difference methods of parabolic equations: explicit methods: FTCS, Dufort-Frankel and ADE methods, Implicit methods: Laasonen, Crank-Nicolson, and Beta methods, stability analysis. 6. Finite element Concept: Reviewing of Functional methods, 7. One-dimensional finite element analysis, 8. Applications 9. Two-dimensional finite element analysis, 10. Applications.

MEC504 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.

MEC505 English Language

Grammar, The parts of speech , Features of scientific English, Features of scientific translation, Translating passages of the field, Scientific writing

MEC510 Advance Thermodynamics

An introduction to thermodynamics, Laws of Thermodynamics, Energies types, thermodynamic processes, Constant volume, Constant pressure, Isothermal, Adiabatic process and Polytropic process. Control volume analysis using energy, conservation of mass for a control volume, conservation of energy for a control volume, spontaneous and non spontaneous processes , statistical thermodynamics , Boltzmann relation for entropy. Entropy , thermodynamic potential , Helmholtz energy, Gibb's free energy , chemical potential , Maxwell relations. Exergy , exergy analysis , exergy balance , maximum work , second law efficiency , entropy generation , Exergy destruction. Exergy Analysis of Components and Cycles. Exergy analysis for combined gas turbine power plants , Optimization of thermal systems.



MEC511 Advance Heat Transfer (Conduction & Radiations)

• One – Dimensional Conduction Heat Transfer : General Problem , Composite Structures , Bessel’s Equation , Extended Surfaces with Constant Cross-Section, Extended Surfaces with Variable Cross-Section, Efficiency and Effectiveness Optimum Extended Surfaces Dimensions Steady. • Two- and Three–Dimensional Conduction Heat Transfer : Separation of Variables Orthogonality Fourier Series , Homogeneous Problems , Non- Homogeneous Problems Partial Solutions Variation of Parameters , Cylindrical Geometry , Spherical Geometry. • Steady Three – Dimensional Geometry : Method of Superposition , Heterogeneous Solids (Variable Thermal Conductivity) • Unsteady Heat Conduction: Lumped Heat Capacity System , Distributed Systems Finite Internal Resistance Finite External Resistance Heat Generation and Heat Fluxes , Cylinder Geometry , Spherical Geometry , Semi – Infinite Solid Constant Surface Temperature Constant Heat Flux Convection Boundary Conditions , Heisler Charts. • Multi – Dimensional Systems : Duhamel’s Superposition Integral Theorem. • Radiation Heat Transfer : Introduction , Blackbody Radiation , Radiation Properties , Atmospheric and Solar Radiation , The Shape Factor , Blackbody Radiation Heat Transfer , Gray body Radiation Heat Transfer , Applications of Radiation Heat Transfer

MEC512 Advanced Convection Heat and Mass Transfer

1. Concepts, Basic differential form of basic Laws (momentum, energy equations) 2. Exact one- dimensional solutions, 3. Boundary Layer concept, exact solution of boundary layer, 4.External Flow , 5.Flow in channels, 6.Natural convection concept , flat plates, cylinders and enclosures7. Mass transfer concepts, Fick’s law of diffusion, 8. Species conservation equation, 9.Steady and transient Diffusion 10.Diffusion in semi-infinite media, 11.Convective mass transfer.

MEC513 Advanced Fluid Mechanics

Fluid kinematics, Fundamental of control volume concept, Conservation equations of mass, momentum, and energy, Reynolds Transport Theorem, Fluid Dynamics : Eulers, Bernoulli and Navier Stokes equations, Internal and, external laminar viscous boundary layer, Internal and external turbulent, viscous boundary layer, Boundary layer equations, Advanced Compressible fluid flow (selected topics).



MEC514 Design of Refrigeration systems

Overview of refrigeration systems, Thermodynamics of vapour compression cycle, Refrigerants, Improvements in vapour compression cycles, compound vapour compression cycles, Multiple evaporator and compressor systems, cascade systems, Air refrigeration systems, Vapour absorption systems, Ejector refrigeration systems.

MEC515 Internal Combustion Engine

Mixture of ideal gases, Definition of combustion and types, Equivalence ratio, 1st law and 2nd laws of thermodynamics applied to combustion process. Introduction to I.C.Engines, types, operation . Performance of I.C.engines , Combustion Phenomena in Spark ignition and compression ignition engines. Cyclic variation ,Intake process and Exhaust process. Effect of EGR on Engine Performance, Exhaust Emission from engines and Aftertreatment Methods to reduce emission.

MEC516 Design of thermal systems

Introduction, Data analyses, Economics, Component simulation, System simulation, System optimization, Different optimization methods

MEC517 Stress Analysis

Introduction to stress analysis. Two and three dimension complex stress analysis. Stress and strain in thin and thick composite cylinders. Experimental stress analysis. Theory of photo elasticity techniques. Stress and strain measurements. Analysis and techniques of electrical resistance strain gauges, Semiconductor Gauges, Circuit analysis of various types of measurements. Motion measurements using force transducers.

MEC518 Advanced Dynamics

Formulation of equations of motion for constrained systems with: Newton/Euler equations; angular momentum principle; D'Alembert principle (Dynamics road maps); power, work, and energy; Kane's method; and Lagrange's equations. Numerical solutions of nonlinear algebraic and differential equations governing the behavior of multiple degree of freedom systems. Symbolic and numerical computational methods. Computer simulation of multi-body dynamic systems.

MEC519 Advanced Plasticity and Elasticity



Stress-strain relations for linearly elastic solids, Generalized Hooke's law. Analysis of three dimensional stresses and strains. Tensor character of stress. Strain-displacement relations, equilibrium equations Theoretical concepts of plasticity, Yield criteria - Tresca and Von Mises criterion of yielding, Plastic stress strain relationship, Elastic plastic problems in bending and torsion.

MEC520 Advanced Machine Design

Fracture mechanics and failures resulting from static loads, crack modes and fracture toughness, failure resulting from variable loads, Computer aided design (CAD) of shaft for strength and rigidity, Optimization in design of a gear mesh (Helical and Bevel) for wear resistance and strength, Case study of power transmission and Finite elements technique for a selected machine element using ANSYS software.

MEC521 Engineering Materials (2- 0)

Metallic materials: Theory of alloying and alloy systems Ternary alloy systems, their equilibrium diagrams and industrial applications. Alloy steels. Hardenability of steels. Heat- treatments of steels based on the T.T.T. curves. Precipitation hardening.

Non-metallic materials: Natural and synthetic rubbers, other elastomers. Plastics. Thermoplastics. Thermo setters. Ceramics. Carbon and graphite. Nano-Technology.

MEC522 Advanced Machining

Chip formation, Boring, Drilling, Planning, Shaping, Broaching and Grinding , Turning, Threading cutting, production turning machines.

Milling: vertical milling machines, Hole forming , Boring and shaping, Horizontal milling machines, Machine setup and practice, Gear production , Helics and cams milling.

CNC-MACHINES.

Vertical band machines, Shaping , slotting , planning machines and broaching

NON CONVENTIONAL MACHINES.

Abrasive machines, Electric Discharge machines (EDM), Electrochemical machines. (EDM), Ultrasonic machines, Laser Beam machines, Plasm machines.



MEC523 Metal Forming

Materials Processing, Die – Design ,Different Types of Forging Processes ,High Speed Metal Forming ,Die – Wear ,Lubrication in Metal Forming ,Economic Decisions in Metal Forming.

MEC524 Industrial Engineering

Production Analysis, Planning and Control, Layout of Facilities, Quality and Reliability, Work and Motion Study, Ergonomics, Financial Analysis, Human Aspects ,Robot Structures ,Control of Industrial Robots, Case studies.

MEC525 Composite materials

Introduction (Definitions, Characteristics and Properties, Classifications, and Fabrications Methods). Composite response to mechanical and thermal stresses. Wettability and interfacial bonding. Stiffness and strength of unidirectional composites. Failure criteria of composite materials. Estimation of properties. Strengthening mechanisms. Functionally Graded Composites (FGCs). Modeling of FGCs. Composite materials selections and design.

MEC526 Workshop Technology

Numerical Control Machine and Robots Technology , Computer Technology for Manufacturing Systems ,Machine Tools and Processes ,Computer Aided Design Simulation and Design Methodology, Case Studies .

MEC528 Advanced additive manufacturing

Introduction to AM technologies, Polymer physics and viscoelasticity , SLA/DLP/DLW (photopolymerization) , Laser-based additive manufacturing , Laser-based additive manufacturing, AM technology of Metals, Melt extrusion AM processes, Process control for AM techniques, Post-processing and Inspecting,

MEC529 Advanced Aerodynamics

Thin and Thick Aerofoils in Incompressible Flow. Limitations of Lifting Line Theory, Concepts of Extended Lifting Line Theory, Lifting Surface Theory, Interaction Problems, Small Perturbation Equations in Compressible Flows:Pradtl-Glauert and Goethert Rules, Ackeret'sSupersonic Airfoil Theory, Wings of Finite Span in Incompressible and Compressible Flows, Aerodynamics of the Fuselage and Wing-Fuselage Combination.

