Ministry of Higher Education and
Scientific Research - Iraq
University of Tikrit
College of Engineering
Department of Mechanical Engineering

مواد الامتحان التنافسي لدراسة الدكتوراه في قسم الهندسة الميكانيكية في جامعة تكريت للعام الدراسي (2026-2025)

ت	المادة	Subject
1	الرياضيات الهندسية المتقدمة	Advanced Engineering Mathematics
2	الاهتزازات الميكانيكية المتقدمة	Advanced Mechanical Vibrations
3	مرونة	Elasticity
4	انتقال الحرارة متقدم	Advanced Heat Transfer
5	ديناميك الحرارة متقدم	Advanced Thermodynamics
6	مواد هندسية متقدمة	Advanced Engineering Materials
7	عمليات سباكة متقدمة	Advanced Casting Process

1-Ddvanced Engineering Mathematics

1- Second Order Homogeneous DEs with Constant Coefficients
2- Euler – Cauchy Differential Equation
3- Second Order Nonhomogeneous DEs with Constant Coefficients

4- Gamma Function
5- Euler Beta Function
6- Orthogonal and Orthonormal Functions
7- Sturm – Liouville B.V. Problem
8- Engineering applications of separation of variables method of PDEs (wave and heat equations)
9- Bessel's Equation and Bessel Function
10- Legendre Equation and Legendre Polynomials

2-Advanced Vibrations

Generalized Coordinates
Equation of Motion (Lagrange's Equations)
Lagrange's Equations with Damping
Solution of Equation of Motion (un-damped Single Degree of Freedom)
Damped Single Degree of Freedom (Equation of Motion, damped Natural Frequency damping ratio)
Frequency Response Function (forced vibration Single Degree of Freedom)
Solution of Equation of Motion (damped Single Degree of Freedom, under damped , critical damped)
Response of Single Degree-of-Freedom Systems to impulse Force (impulse response $g(t)$)
Two Degree Of Freedom Systems (Equations Of Motion, Natural frequencies and mode shape)
Orthognality and orthonormality properties of mode shape
Derivation of stiffness matrix by flexibility and stiffness influence Coefficients

3-Elasticity

Types of Stress.
-Two-Dimensional Stress at a Point.
- Principal Stresses in Two Dimensions.
- Cauchy's Stress Principle and Direction Cosines.

- Stress Components on an Arbitrary Plane.
Stress Components on Oblique Plane (Stress Transformation).
- Principal Stress in Three Dimensions.
- Stress Invariant.
- Equilibrium of a Two-Dimensional or Plane Element Differential Element.
Mohr's Stress Circle &Mohr Circles for Two-Dimensional Stress Systems.
- Construction of Mohr's Circle for Two- Dimensional Stress System.
- Equilibrium Equations in Polar Co-ordinates (Two-Dimensional State of Stress).
- Analysis of Strain.
Deformations , Displacement and Strain.
- Concept of Strain, Strain Tensor, Rotations.
- Deformation of an Infinitesimal Line Element.
- Change in Length of a Linear Element—Linear Components.
- Strain Transformation, Spherical and Deviatorial Strain Tensors.
- Principal Strains and Strain Invariants, Octahedral Strains.
- Mohr's Circle for Strain, Equations of Compatibility for Strains.
- Measurement of Surface Strains—Strain Rosettes.
- Measurement of Strains Using Rosettes.
Stress–Strain Relations.
- Linear Elasticity—Generalized Hooke's Law.
- Elastic Strain Energy for Uniaxial Stress.
- Strain Energy in an Elastic Body, Boundary Conditions.
- ST. Venant's Principle, Principle of Superposition.
- Existence and Uniqueness of Solution (Uniqueness Theorem)

4-Advanced Heat Transfer

The derivation of the three-dimension conduction heat transfers for un steady state with heat generations for different geometries.
- Basic equation
- Fourier's law
- General heat conduction equation
- Boundary and I initial conditions
- Composite sections.
□ Thermal conductivity variation with temperature and location for one-dimension conduction heat transfer.
Basic equation
- Variable thermal conductivity
- Location Dependent thermal conductivity
- Temperature Dependent thermal conductivity
- Non uniform heat generation
- Temperature and location dependent thermal conductivity.

□ Heat transfer from extended surface (Fins)
- Regular fin
- Non regular fin
□ The analytical solution for the two-dimension conduction heat transfer for different geometries.
- The method of separation of variables in Cartesian, cylindrical and spherical coordinates.
- Method of super position Optimization of Unconstrained Functions: One-Dimensional Search
□ The Finite difference method to solve the two-dimension heat conduction equation in Cartesian and cylindrical coordinates.
□ The analytical solution for transient conduction heat transfer in two-dimension.

5- Advanced Thermodynamics:

Thermodynamic relations
Entropy
Exergy

6- Advanced Engineering Materials

Crystal Structures
Fundamental Concepts
Metallic Crystal Structures
Density Computations
Crystallographic Planes
Linear And Planar Densities
Imperfections in Solids
Point Defects
Specification Of Composition
Microscopic Examination
Diffusion
Diffusion mechanism
Steady state mechanism
Factors That Influence Diffusion
Mechanical Properties of Metals
Concepts Of Stress and Strain
Elastic Deformation
Anelasticity
Elastic Properties of Materials
Plastic Deformation
Dislocations and Strengthening Mechanisms
Dislocations And Plastic Deformation
Characteristics Of Dislocations
Deformation By Twinning

7-Advanced Casting Process

Introduction to advanced casting technology, historical evolution, and industrial significance.
Overview of melt processing for ferrous and non-ferrous alloys.
In-depth study of melt processing techniques and the operation of melting equipment.
Introduction to pattern and mold design; basics of resin-bonded mold and core making.
Fundamentals of fluid flow and heat transfer during casting solidification.
Study of governing equations and boundary conditions relevant to various casting methods.
Principles of gating and riser design with emphasis on directional solidification.
Introduction to inspection methods: visual, penetrant, magnetic, and metallurgical techniques.
Study the common defects (porosity, shrinkage, hot tears, inclusions), NDT methods (X-ray, ultrasonic), and ISO standards.
Strategies for defect remediation and process improvement in castings.
Discussion of mechanization and automation in casting; course review and project presentations.
Exploration of special casting processes such as centrifugal casting, low-pressure die casting, and investment casting.
Continuation with continuous casting, squeeze casting, and thixo-forming methods; review of automotive and aerospace case studies.
Sustainability in casting includes recycling, energy-efficient practices, and circular economy principles.