

مناهج الدراسات العليا في قسم الهندسة الميكانيكية

تخصص / دكتوراه قدرة

الوحدات	الساعات	اسم الموضوع باللغة الانكليزية	اسم الموضوع باللغة العربية	الفصل الدراسي
3	3	Advanced Mathematic & FEM	رياضيات متقدم	الأول
3	3	Major elective course(1)	موضوع اختياري اساسي	
3	3	Major elective course(2)	موضوع اختياري اساسي	
3	3	Minor elective course	موضوع اختياري ثانوي	
1	2	English language (1)	لغة انكليزية -1	
13	14	Total		
3	3	Numerical analysis & CFD	تحليلات عددية متقدمة	الثاني
3	3	Major elective course(1)	موضوع اختياري اساسي	
3	3	Major elective course(2)	موضوع اختياري اساسي	
3	3	Minor elective course	موضوع اختياري ثانوي	
1	2	English language (2)	لغة انكليزية -2	
13	14	Total		

الدروس الاختيارية لدراسة الدكتوراه/قدرة

Minor	Major	ت
Advanced Control	Selected topics in heat transfer (1)	.1
Advanced Vibration	Selected topics in heat transfer (11)	.2
Advanced Engineering Material (1)	heat transfer in porous media	.3
Advanced Engineering Material (11)	Turbulent flow	.4
Advanced Manufacturing (1)	Renewable Energy Sources	.5
Optimization in Engineering design	Industrial Pollution	.6
	Combusting Systems	.7
	Energy conversion and management	.8
	Two Phase Flow	.9
	Aerodynamics	.10

تخصص / ماجستير قدرة

الوحدات	الساعات	اسم الموضوع باللغة الانكليزية	اسم الموضوع باللغة العربية	رقم الممهد	الفصل الدراسي
3	3	Engineering analysis	تحليلات هندسية		الأول
3	3	Advanced Heat and mass Transfer	انتقال حرارة متقدم		
3	3	Advanced Thermodynamic	ديناميك حرارة متقدم		
3	3	Advanced Fluid dynamics	ديناميك موائع متقدمة		
1	2	English / 1	لغة انكليزية / 1		

13	14	Total	المجموع	
3	3	Advanced Numerical Analysis	تحليلات عددية متقدمة	الثاني
2	2	Measurement systems	اجهزة قياس	
2	2	Elective Course (1)	درس اختياري (1)	
2	2	Elective Course (2)	2(درس اختياري)	
2	2	Elective Course (3)	درس اختياري (3)	
1	2	English / 2	لغة انكليزية / 2	
12	13	Total	المجموع	

الدروس الاختيارية لتخصص القدرة / الماجستير :

رقم الممهد	اسم الموضوع باللغة العربية	اسم الموضوع باللغة الانكليزية
	ديناميك الحرارة لمكانن الاحتراق الداخلي	Thermodynamics of internal combustion engines
	تصميم معدات انتقال الحرارة والكتلة	[Design of heat and mass transfer equipment
	جريان الموائع الانضغاطية	Compressible Fluid flow
	مكانن توربينية متقدمة	Advanced Turbomachinery
	تلوث	Polutions
	نظرية الطبقات المتاخمة	Boundary Layer Theory

تخصص / ماجستير ميكانيك تطبيقي

الوحدات	الساعات	اسم الموضوع باللغة الانكليزية	اسم الموضوع باللغة العربية	رقم الممهد	الفصل الدراسي
3	3	Advanced engineering analysis	متقدمة تحليلات هندسية	الأول	
3	3	Advanced Vibrations	اهتزازات متقدمة		
3	3	Elasticity	مرونة		
3	3	Instrumentation and Experimental Stresses Analysis	قياسات وتحليل اجهادات تجريبية		
1	2	English / 1	لغة انكليزية / 1		
13	14	Total	المجموع		
3	3	Advanced Numerical Analysis	تحليلات عددية متقدمة	الثاني	
3	3	System dynamic and control	أنظمة ديناميكية وسيطرة		
3	3	Plasticity	لدونه		
2	2	Elective Course	درس اختياري		
1	1	English / 2	لغة انكليزية / 2		
12	13	Total	المجموع		

الدروس الاختيارية لتخصص الميكانيك التطبيقي / الماجستير :

رقم الممهد	اسم الموضوع باللغة العربية	اسم الموضوع باللغة الانكليزية
	ديناميك متقدم	Advanced Dynamics

Tribology	ترايبولوجي	
Engineering materials	مواد هندسية	
Fracture Mechanics	ميكانيك كسر	
Impact	ديناميك الصدم	

مفردات مناهج دراسة الماجستير قدرة

Engineering analysis

Introduction

Complex variable (analytic function, absolute values, elementary function, integration in the complex plane, Cauchy-Riemann equation, infinite series, residues, mapping).

Linear algebra (matrices, characteristic- value problem, system of linear equations).

Partial differential equation.

Fourier integrals (transformation).

Special functions (Bessel function, Alpha and Beta function, Error functions,etc).

Advanced thermodynamics

Equilibrium of thermodynamic systems.

Thermodynamic properties of system with constant chemical composition.

Law of corresponding states general thermodynamic relations.

Relationships between specific heats.

The Clausius clapeyron equation.

Liquidification of gases.

Thermodynamic properties of ideal gases and gas mixtures of constant composition.

Thermodynamic properties of gas mixtures with variable composition.

Available and unavailable energy.

Applications of thermodynamic to special systems.

Introduction to statistical thermodynamics.

Heat and mass transfer

Conduction heat transfer: three dimensional Fourier conduction equation, unidirectional heat conduction with heat dissipation to the environment, analytical and numerical solutions of one, two, three dimensional unsteady-state heat conduction, insulation, critical thickness of insulation, low temperature insulation.

Convection heat transfer: forced convection in laminar flow, forced convection in turbulent flow, natural convection from horizontal surface, natural convection from vertical surface and tubes.

Conduction and boiling: theory of laminar film condensation, bubble growth and collapse.

Radiation heat transfer: radiant heat exchanges between black and gray bodies, radiation between hot and its enclosure, radiation from gases, flames and solar radiation.

Mass transfer: steady state diffusion of gases and liquids through solids, equi-molar diffusion, mass transfer coefficient, similarity relations, simultaneous heat and mass transfer.

Fluid dynamics

Basic concept: ideal fluid flow, stream function, velocity potential, sources and sinks, the doublet flow, circulation and vorticity equations.

Equation of motion: Euler's equation of motion, derivation Bernoulli's equation from the Euler's equation, Euler's equation and Bernoulli equation in the streamwise direction, Navier-Stokes equation of motion, exact solution of N.S. equations.

Energy equation: steady flow energy equation, derivation of Bernoulli's equation from the energy equation, status of the Bernoulli equation.

Boundary layer theory: friction drag of boundary layer, the turbulent boundary layer, friction drag in the transition region, laminar sub-layer, separation of boundary layer.

The dynamics of incompressible fluids.

The dynamics of compressible fluids.

Numerical analysis

Numerical solution of the system of equations: a) linear system, Gaussian elimination, Jacobi iteration method, Gauss-Seidel method successive relaxation over and under relaxation.

b) non-linear equation, fixed point method, Newton-Raphson method.

Numerical solution of ordinary differential equations: single step formula, Taylor's formula, Runge-Kutta methods, Euler's (modified and improved) methods, error propagation, Simultaneous ordinary differential equation.

Numerical integration: open integration formulas, closed integration formulas, truncation error, stability, and step wise control.

Approximation and the solution of partial differential equations: using finite difference methods, explicit method, implicit method, convergence, stability, consistency, Crank-Nicolson method applications.

Introduction to finite element methods

Measurements systems

Pressure measurement: piezometer and piezometer ring, static tube, manometer, mechanical gauges, standard and calibration, pressure transducers, high-pressure measurement, low-pressure (vacuum) measurement.

Flow measurement: local flow velocity, pitot-static tube, hot-wire anemometers,.

Mean velocity and flow rate measurement: orifice meter, orifice in pipe, orifice in reservoir, unsteady orifice flow venturi meter, nozzle meter, rotameter.

Open channel flow measurement: weirs.

Velocity measurement in compressible flow.

Viscosity measurement: concentric-cylinder viscometer, capillary-tube viscometer.

Temperature and heat flux measurement: standard and calibration, thermal expansion methods, liquid in glass thermometers, thermocouples, heat flux sensors, slug-type sensor, steady state sensor.

Sound measurement: basic definitions, sound level meter, microphones, spectrum analysis.

Generalized performance: characteristics of instrument, static characteristic, the meaning of static calibration, accuracy, precision and Bias, combination of component, errors in overall system accuracy calculation, addition, subtraction, multiplication, division.

Motion measurement: displacement, translation and rotational, relative velocity, translational and rotational, relative acceleration.

Force, torque and shaft power measurement.

Thermodynamics of internal combustion engines (Elective 1)

Description of internal combustion engines: compression ignition engines, spark ignition engines, stratified charge engines, torch ignition engines, rotary engines.

Basic thermodynamics and gas dynamics: state equation, first law of thermodynamic, second law of thermodynamics, homentropic flow, gas mixtures, internal energy and enthalpy diagrams, dissociation.

Air standard cycles: air standard cycles efficiencies, limitations.

Combustion in compression ignition engines: description of combustion process, model for compression ignition, combustion calculations, single zone models, two zone models, multi zone models, turbulent flow prediction models, combustion generated emissions.

Combustion in spark ignition engines: Definitions of different types of combustions, normal combustion, abnormal combustion, engine knock, uncontrolled combustion, chemical thermodynamic models for normal combustion, combustion generated emissions.

Heat transfer in engines: basic principles, radiation heat transfer, convection heat transfer, heat transfer in internal combustion engine, instantaneous heat transfer calculation, single zone heat transfer calculation multi zone heat transfer calculations.

Compression ignition engine cycle calculation,

Spark ignition engine cycle calculations.

Supercharging: mechanical supercharging, turbocharging, mean exhaust temperature, simple turbocharging system, ideal turbocharging system, actual turbocharging system, efficiency of exhaust systems, matching turbocharger to engine, high pressure turbocharging, some turbocharged engine performance characteristics.

Design of heat and mass transfer equipment (elective 2)

Empirical equation for heat transfer coefficient pressure drop used in heat exchanger.

Log mean temperature difference and effectiveness in heat exchanger (F.E.M.).

Computer simulation and optimization of heat exchanger (F.E.M).

Design of heat exchangers, mechanical design and thermal design.

Heat transfer in packed beds, fluidised beds and heat pipes.

Heat transfer processes between moist air and water.

Air washers, spray dehumidifiers and cooling towers.

A)Liquid-Liquid heat exchanger, B)Liquid –gas heat exchanger, C)Gas-gas heat exchanger.

Condenser, evaporator and cooling tower.

Advanced compressible fluid flow (Elective 3)

Fundamental concepts and definitions: law of thermodynamics, property and fluid, speed of sound, Mach number.

Isentropic flow: flow in duct, mass flow and Mach number, nozzle and diffuser, impulse function.

Normal shock waves: formation of compression and expansion waves, Prandtl relation, Rankine Hugoniot relation, Fanno and Rayleigh lines, normal shock in a convergent, divergent nozzle, supersonic diffuser, wind tunnel, moving shock wave, the shock tube.

Adiabatic frictional flow: the Fanno lines.

Flow with heat interaction and generalized flow: Table of properties, Rayleigh line, combustion waves, isothermal flow with friction in constant area duct.

Two-dimensional waves: charts for oblique shock waves, Detach shock, Prandtl Mayer flow, supersonic diffuser.

Turbomachines

Homologous units, specific speed: elementary cascade theory, theory of turbomachines.

Impulse turbines: reaction turbines, pumps.

Element of centrifugal compressor stage: stage velocity triangles, stage work, pressure coefficient, stage pressure rise, Enthalpy-Entropy diagram, stage efficiency, degree of reaction.

Stage velocity triangles: work, blade loading and flow coefficients, Enthalpy-Entropy diagram, Efficiencies, degree of reaction, stator blade row, stage losses and efficiencies.

|Measurements

Types of measuring devices: Zero order device, first order device, second order device.

Modulated signals

Resistance strain gauges

Differential transformer

Induction potentiometer

Piezo-electric transducer

Displacement to pressure transducer(Nozzle-flapper)

Absolute displacement transducer

Relative velocity measurements: mechanical flyball angular velocity sensor, stroboscope, translational- velocity transducer, D-C tachometer, absolute velocity pickup.

Absolute acceleration pickup: Piezoelectric accelerometer, Null-balance (servo-type) accelerometer.

Force-torque measuring device: Null-balance torquemeter.

Sound measurements: condenser Mic or capacitor Mic.

Force, voltage, motion relation: open circuit analysis, closed circuit analysis, modeling, linearization.

Filters: sharper cut-off filter, high pass filter, band rejection filter.

Theory of Elasticity:

-Beam on elastic foundation: equation of the elastic curve, beam with a concentrated load at or near center, beam with a central moment, beam with a concentrated load at one end, beam with an end moment, hinged beam with a distributed load, beams supported by equally elastic supports.

-Thin walled cylindrical tubes

-2-dimensional theory of elasticity: strain and displacement, compatibility, relations between stresses and strains, plane stress and plane strain, application to polynomials in rectangular coordinates, applications in polar coordinates, stress concentration of circular hole, the Kirsch solution, thick cylinders, concentrated load on edge of plate or wedge, the Boussieq's solution, cylinder subjected to two diametrically opposite force, Mitchel solution.

- Membrane stress in shells: symmetrically loaded shells of revolution, a spherical dome under its own weight, non-symmetrical loading cylindrical shells, cantilevered pipe with a concentrated load at the free end.
- Torsion of non-circular shafts
- Elastics membrane (soap film) analogy
- Thin walled tube with a slit
- Round sections composed of narrow rectangular
- Torsion of an I- beam having one section restrained from warping
- 3-dimension state of stress at a point
- stress components on Tetrahedron

Instrumentations and Experimental stress analysis

Instrumentations:-

Types of measuring devices: Zero order device, first order device, second order device.

Modulated signals

Resistance strain gauges

Differential transformer

Induction potentiometer

Piezo-electric transducer

Displacement to pressure transducer(Nozzle-flapper)

Absolute displacement transducer

Relative velocity measurements: mechanical flyball angular velocity sensor, stroboscope, translational- velocity transducer, D-C tachometer, absolute velocity pickup.

Absolute acceleration pickup: Piezoelectric accelerometer, Null-balance (servo-type) accelerometer.

Force-torque measuring device: Null-balance torquemeter.

Sound measurements: condenser Mic or capacitor Mic.

Force, voltage, motion relation: open circuit analysis, closed circuit analysis, modeling, linearization.

Filters: sharper cut-off filter, high pass filter, band rejection filter.

- Experimental stress analysis:-
-
- Light, polarized light, Monochromatic light
- Polariscope types
- Birefringent materials
- Isoclinics and isochromatics
- Quarter wave plate
- 2-dimensional photoelasticity(plane strain system)
- 3-dimensional photoelasticity
- Stress freezing technique
- Sandwich technique

The brittle lacquer method of stress analysis: modes of lacquer failure , types of strain indicated film.

Moir"e fringes method: interpretation of fringe pattern.

Strain gauges: types of strain gauges, electrical strain gauges.

Factors affecting gauge selection: Rosette analysis , two element rectangular rosette, Delta rosette, 4-element rectangular rosette.

Advanced Engineering analysis

Introduction

Complex variables (analytic function, absolute values, elementary function, integration in the complex plane, Cauchy-Riemann, infinite series, residues, mapping).

Linear algebra (Matrices, Characteristic-value problem, System of linear equations).

Partial differential equation.

Fourier integrals(Transformation).

Special functions(Bessel function, Alpha and Beta function, Error functions, etc).

Advanced Vibrations

Multi-degree of freedom lumped element system: equation of motion (Newton's second law and Lagrange equations), matrix formulation, linear transformation-coupling, undamped free vibration, Orthogonal properties of eigen vector, Modal matrix P, forced vibration and coordinate-decoupling, forced normal modes of damping system, method of influence coefficients, Rayleigh principle, Dunkerly formula, method of matrix iteration, transfer matrix (Holzer-type problem), torsional system, geared system, beams.

Continuous systems: the vibrating string, longitudinal vibration of rod, torsional vibration of rods, the Euler equation of beam, effect of rotary inertia and shear deformation, vibration of membrane, transient solution by Laplace transform.

Random vibration: the frequency response function, spectral density, probability distribution, correlation, Fourier transform, response of continuous system to random excitation.

Advanced Dynamics:

- Review Plane kinematics of rigid body
- Review Plane kinetics of rigid body
- 3D space motion of particles
 - 3D cylindrical coordinates
 - spherical coordinates
- 3D Kinematics of Rigid Body
 - General Translation
 - Rotation about fixed point
 - General 3D Motion including translation and rotation
- 3D Kinetics of Rigid Body
 - 3D mass and product of inertia
 - Principal mass moment of inertia
 - Momentum Equation in 3D
 - General Euler Equation
 - General Gyroscopic motion

Impact

Stress wave propagation : types of waves, stress intensity, wave speed.

Alternative approach for stress intensity using momentum consideration: a flat ended cylinder striking a sheet of water.

Division of the total energy acquired by the bar: reflection and superposition of waves, normal collinear impact of identical bar, normal impact of two bars of the same material but unequal lengths, moving bar strikes stationary one.

Space time diagram for the collinear impact of bars: impact of two identical bars, moving bar strikes two similar stationary bars in contact.

The propagation of a torsional pulse along a circular section bars: alternative approach using momentum consideration.

Wave transmission along a bar with lateral constraint.

Wave transmission along a bar constrained to deform under condition of plane strain.

Impact of bars of different materials and cross sectional area.

Stress wave transmission in bars with discontinuity in material and cross section.

A rigid striker impinging on one end of a free rod.

The longitudinal impact of a rigid mass on a rod perfectly fixed at one end.

Momentum trap.

Energy absorber and mechanical load limiting device.

Explosive welding : parallel plate, preset angle setup.

Theory of Plasticity

Plastic bending of beams: partial plastic bending of unsymmetrical sections, plastic deflection of beam, collapse load, residual stresses after yielding.

Plastic torsion of shafts: partially plastic case, plastic torsion of hollow shafts, residual stresses after yielding in torsion.

Thick spheres under internal pressure.

Stresses: displacements, compatibility, elastic plastic analysis for spherical shapes, fully plastic sphere.

Thick cylinder: partially plastic.

Types of strains: engineering strain, natural or logarithmic strain, volume constancy law, condition for maximum tensile load, stress-strain relation for yielding.

Plastic-elastic material: Poisson's ratio for plastic strain, resilience a) volumetric b) shear.

Theories of failure: Tresca, Von-mises, Rankine, St-Venant, Beltrami, Mohr failure theory.

Mechanics of metal forming: stress consideration, plain strain forging of lubricated thin strip, forging of a flat lubricated disc.

Simple upsetting of a cylinder.

Swaging of a cylindrical rod: cylindrical drawing through a conical die.

Tube sinking: close pass mandrel drawing with a conical die, plug drawing with a circular profile die.

Sheet metal rolling: rolling with no external tensions, rolling with front and back tensions.

Advanced Numerical analysis

Numerical solution of the system of equations

- a) linear system: Gaussian elimination, Jacobi iteration method, Gauss-Siedal method, Successive relaxation over and under relaxation.
- b) Non-linear equation : Fixed point method, Newton –Raphson method.

Numerical solution of ordinary differential equations: single step formula, Taylor's formula, Runge-Kutta methods, Euler's (modified and improved) methods, Error propagation, simultaneous ordinary differential equation.

Numerical integration: open integration formulas, closed integration formulas, truncation error, stability, step wise control.

Approximation and the solution of partial differential equations: using finite difference methods, explicit method, implicit method, convergence, stability, consistency, Crank-Nicolson method applications.

Introduction to finite element methods.

Tribology

Wear: types of wear, Hertzian contact, adhesion wear, Archard model of adhesion wear, abrasive wear, fatigue wear, erosive wear, corrosive wear, fretting wear.

Friction: friction theories, roughness theory, adhesion theory, ploughing, and composite theories, effect of contaminant, friction laws (first, second and third laws), modified adhesion theory.

Lubrication: types of lubrication, hydrodynamic lubrication (fluid film lubrication), Newton's law in viscous flow, dynamic viscosity and kinematic viscosity, method of fluid film formation, viscous flow between infinitely wide parallel plate.

Reynolds equation: assumptions, derivation, Couette and Poiseuille flow.

Bearings: full analysis to calculate load carrying capacity, friction, centre of pressure for the following types, plane, inclined surface bearing, pad bearing, taper land bearing, convergent-divergent wedge.

Infinitely long and infinitely short bearings

Gas bearings (advantages and disadvantages): gas bearing theory, gas step bearing.

Lubrication of spheres.

Elastohydrodynamic lubrication-theory: lubrication of spheres (point contact), step bearing.

Journal bearing (theory)

Porous bearing.

Hydrostatic lubrications: flow through narrow slot-Hydrostatic, Hydrostatic step bearing.

System dynamics and Control

Analog computer: D-C amplifier, adder or summer, integrator, potentiometer, functional description of electronic analog computer, magnitude scaling.

Non-linear system: describing function method, types of non-linearities, stability analysis, describing function with a phase shift, frequency sensitive describing function, phase-plane method, isocline, colomb friction, Pell's method, Delta method, phase plane trajectories for a singular point, Liapunov direct method, positive definite function, Liapunov function, stability criteria, variable gradient method, formate method.

State-variable analysis of linear dynamic systems: matrix representation of state equation, solution of homogeneous state equation (the state transition matrix), solution of non-linear homogeneous state equations (or state transition equation), relation between the state equation and high order differential equation.

General gain formula for signal flow graph: signal flow graph method for computing the transition matrix, transformation of $n \times n$ A matrix to phase variable canonical form, diagonalization of $n \times n$ matrix, relation between state equation and transfer function, characteristic equation, eigenvalues and eigenvectors, decomposition of transfer function, direct decomposition, cascade and parallel decomposition .

Controllability and observability of linear systems: definition of controllability and observability, state space design of linear feedback control system, Pole placement design through state feedback, observer design, single input single output system, closed loop dynamics and observer roots, Ackermann formula, Faddev algorithm.