# STUDY PLAN

## MASTER IN MECHANICAL ENGINEERING

## (Thesis Track)

| Plan Number | | | 2005 | T |
|---|---|---|---|---|

## I. GENERAL RULES CONDITIONS:

1. This plan conforms to the valid regulations of programs of graduate studies
2. Areas of specialty for admission to the Master's program:
   - Holders of the Bachelor's degree in:
     a- Mechanical Engineering
     b- Industrial Engineering
     c- Civil Engineering.
     d- Chemical Engineering
     e- Mechatronics Engineering

## II. SPECIAL CONDITIONS: None.

## III. THE STUDY PLAN: Studying (33) Credit Hours as follows:

### 1. Obligatory Courses: (18 Credit Hours)

| Course No. | Course Title | Credit hrs. | Theory | Prac. | Pre-request |
|---|---|---|---|---|---|
| 0904702 | Numerical Analysis | 3 | 3 | - | - |
| 0904703 | Engineering Measurements | 3 | 3 | - | - |
| 0904704 | Engineering Math | 3 | 3 | - | - |
| 0904705 | Energy Management and Economy | 3 | 3 | - | - |
| 0904706 | Finite Element Method | 3 | 3 | - | - |
| 0904709 | Research Methodology | 3 | 3 | - | - |

### 2. Elective Courses: Studying (6) Credit hours from the following:

| Course No. | Course Title | Credit hrs. | Theory | Prac. | Pre-request |
|---|---|---|---|---|---|
| 0904707 | Theory of Elasticity | 3 | 3 | - | - |
| 0904710 | Mechanical Vibration | 3 | 3 | - | - |
| 0904714 | Dynamics | 3 | 3 | - | - |
| 0904716 | Control | 3 | 3 | - | - |
| 0904718 | Composite Materials | 3 | 3 | - | - |
| 0904719 | Compressible Flow | 3 | 3 | - | - |
| 0904722 | Heat Transfer | 3 | 3 | - | - |
| 0904723 | Combustion | 3 | 3 | - | - |
| 0904724 | Fluid Mechanics | 3 | 3 | - | - |
| 0904725 | Design of Thermal Systems | 3 | 3 | - | - |
| 0904730 | Special Topics in Mechanical Engineering | 3 | 3 | - | - |

### 3. Thesis: 9 Credit hours (0904799)

# ***Master's Course Description***

**0904702 Numerical Analysis (3 Cr)**

**Accuracy and stability of ODE solutions: One step-methods (Heun's Method, Predictor-Corrector) Adaptive step size control. Boundary and eigen value problem. Conversion of boundary value to initial PDE solutions: Elliptic, Parabolic and Hyperbolic equations value problem. Accuracy and stability of with applications. Finite Element Method: 1-D and multidimensional unconstrained problems. Constrained optimization. Integration equations: Simpson's integration and Newton-Cotes open and closed integration.**

**0904703 Engineering Measurements (3 Cr)**

Introduction. The design of successful experiments, general concepts and dynamics. Random signal analysis. Flow measurements using pressure tubes. Flow visualization. Heat transfer instrumentation. Introduction to thermal anemometry. Laser Doppler anemometry. Particle sizing using optical methods. Computer methods, data reconstruction and flow visualization. Strain gages. Stress measurements using photoelasticity. Vibration measuring techniques. Digitization & Sampling, A/D and D/A converters. Design of computer interface cards.

**0904704 Engineering Math (3 Cr)**

ODE's: Linear ODE's Variation of parameters, Power Series Method. PDE's: Separation of Variables, Orthogonal Functions and the general expansion Problem, Bessel Function's and Legender Polynomials, Fourier Series, Integral and Transforms, Laplace Transform. Vector Calculus: differentiation, integration, vector operators, Limits (multivariable), integral theories.

**0904705 Energy Management and Economy (3 Cr)**

**Conducting an energy audit. Conserving energy in boilers, steam distribution systems, kilns, furnaces and dryers. Conserving energy through re-cycling, recuperation and co-generation. Energy storage.**

**0904706 Finite Element Method (3 Cr)**

Introduction: General concepts, and definitions, Physical systems, (Natural phenomena) methods for solution. Formulation of differential equations governing the physical system, and the corresponding boundary conditions. Division (discretization) of analysis region into finite elements: Techniques for discretization. Efficient mesh, mesh refinement. FE-Equations (FE Properties) Trial solution, Trial functions: polynomials, Shape functions. Methods for developing FE-equations. Assembly of FE equations, Global equations system, Imposing the BCs, Programming and solutions Verification of the solution, Accuracy and convergence . Implementation of computer programs : High order FE, Isoparametric FE Applications.

**0904707 Theory of Elasticity (3 Cr)**

Introduction: Basic definitions; A brief history of the theory of Elasticity; Basic concepts in math. (Matrices); Stress-Strain equations. Formulation of the elasticity equations in various coordinate systems; Plane elasticity; Elastic Bending and Torsion. Saint-Venant principle. Thermo Elasticity, anisotropy. Applications.

**0904709 Research Methodology (3 Cr)**

In this course, the student learns how to conduct a scientific research, starting from developing the research idea up to writing and presenting a technical report. The course starts by attending a number of lectures given by faculty and invited speakers where models of researches and case studies in advanced fields of mechanical engineering are presented. Meanwhile, students undertake limited researches of their own under the supervision of faculty staff members to learn how to define the problem; how to make literature review, searching through various resources such as the Engineering Index and Internet. Methods of Solution: Analytical, Numerical and Experimental methods. Report writing: Introduction; Analysis; Description of the experiment; Experimental procedure; Results; Discussion Conclusions; Recommendations; References; Abstract. At least one report/ paper will be prepared and presented by the student in front of colleagues and staff.

**0904710 Mechanical Vibrations (3 Cr)**

Response of SDOF oscillator to deterministic signals. Complex and real Fourier series. Convolution integrals. Equations of motions of MDOF vibration systems. Lagrange's equations, influence coefficients. Solutions of equations of motion of MDOF systems: eigenvalues and eigenvectors. Vibration of one dimensional continuous system: strings, bars and beams. Wave equation. Separation of variables methods. Introduction to nonlinear vibration. Discretization methods: Rayleyh-Ritz and finite element methods. Introduction to nonlinear vibrations of SOF oscillators. Jump phenomenon, sub and superharmonic responses. Mathieu's equation and stability analysis. Introduction to geometric methods. Phase plane plots and limit cycles.

**0904714 Dynamics (3 Cr)**

Newton laws for a single particle in a rotating coordinate system. Constraint relations and degrees of freedom. Generalized coordinates. Virtual work and Dalembert principle. Equilibrium and stability. Hamilton's principle and Lagrang's equations. Ignorable coordinates. Integrals of motion. Three dimensional rigid bodies dynamics. Euler angles and parameters. Hamilton's equations. Variational principles. Liouville's system. Introduction to canonical transformations.

**0904716 Control (3 Cr)**

Linear systems: state space representation, stability analysis, pole placement, LQR, LQG. Adaptive Control: introduction to Robust Control: introduction to H-infinity techniques in control design.

**0904718 Composite Materials (3 Cr)**

Basic definitions and advantages of composites, stress-strain relations, micromechanicsc, Effective, mechanical and thermal properties of composites, laminate behavior, strength and failure, applications to engineering structures.

**0904719 Compressible Fluid Flow (3 Cr)**

Basic phenomena in compressible fluids. Equations of flow. Isentropic flow. Normal shock waves. Adiabatic frictional flow in a constant - area duct. Flow with heat interaction and

generalized flow. Two - dimensional waves. Linearized flow. Method of characteristics. Method of experimental measurements.

**0904722 Heat Transfer (3 Cr)**

Steady, multidimensional conduction. Fin problem solutions using Beset and other functions. Unsteady multidimensional conduction. Forced convection including internal flow and heat transfer between parallel plates; entrance length. External flows over wedges and bodies of revolution. Free and mixed convection. Radiant heat transfer; heat transfer between surfaces in absorbing media. Mass transfer; Diffusion in stationary and laminar flow systems, mass transfer in turbulent flow.

**0904723 Combustion (3 Cr)**

Fundamental concepts of combustion including: Stoichiometry, Chemical kinetics, Conservation laws for reacting flow. Theories of flames and detonation waves. Also the course covers solid fuel combustion, simulation of IC engines. Environmental pollution.

**0904724 Fluid Mechanics (3 Cr)**

Introductory concepts. Hydrostatics. Kinematics of fluid motion. Conservation of mass. Introduction to inviscid flow. Momentum theorems. Introduction to viscous flow. The Navies - Stokes equation. Similitude, scaling, dimensional Analysis and modeling . Inertial free flows at low Reynolds number. Boundary layers. Turbulence. vorticity, circulation. Potential flows.

**0904725 Design of Thermal Systems (3 Cr)**

This course is offered for postgraduate level students in order to utilize their knowledge of basic sciences in designing systems and components of thermal application. Use of computer algorithms and systems simulation and designing computer algorithms for the systems and components such as: Piping systems, Heat exchangers and Prime movers

**0904730 Selected Topics in Mechanical Engineering (3 Cr)**

This course is delivered according to the availability of staff members in light of the advent of new specializations in the fields of thermal sciences and applied mechanics. The student is not allowed to take this course more than once, even if the subjects are different.

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## (None Thesis Track)

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2. Areas of specialty for admission to the Master's program:
   - Holders of the Bachelor's degree in:
     a- Mechanical Engineering
     b- Industrial Engineering
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     d- Chemical Engineering
     e- Mechatronics Engineering

**V. SPECIAL CONDITIONS:** None.

**VI. THE STUDY PLAN: Studying (33) Credit Hours as follows:**

**1. Obligatory Courses: (24) Credit Hours:**

| Course No. | Course Title | Credit hrs. | Theory | Prac. | Pre-request |
|---|---|---|---|---|---|
| 0904702 | Numerical Analysis | 3 | 3 | - | - |
| 0904703 | Engineering Measurements | 3 | 3 | - | - |
| 0904704 | Engineering Math | 3 | 3 | - | - |
| 0904705 | Energy Management and Economy | 3 | 3 | - | - |
| 0904706 | Finite Element Method | 3 | 3 | - | - |
| 0904709 | Research Methodology | 3 | 3 | - | - |
| 0904710 | Mechanical Vibrations | 3 | 3 | - | - |
| 0904722 | Heat Transfer | 3 | 3 | - | - |

**2. Elective Courses: (9) Credit hours from the following:**

| Course No. | Course Title | Credit hrs. | Theory | Prac. | Pre-request |
|---|---|---|---|---|---|
| 0904707 | Theory of Elasticity | 3 | 3 | - | - |
| 0904714 | Dynamics | 3 | 3 | - | - |
| 0904716 | Control | 3 | 3 | - | - |
| 0904718 | Composite Materials | 3 | 3 | - | - |
| 0904719 | Compressible Flow | 3 | 3 | - | - |
| 0904723 | Combustion | 3 | 3 | - | - |
| 0904724 | Fluid Mechanics | 3 | 3 | - | - |
| 0904725 | Design of Thermal Systems | 3 | 3 | - | - |
| 0904730 | Special Topics in Mechanical Engineering | 3 | 3 | - | - |

**3. A comprehensive exam (0904797)**

## ***Master's Course Description***

**0904702 Numerical Analysis (3 Cr)**

**Accuracy and stability of ODE solutions: One step-methods (Heun's Method, Predictor-Corrector) Adaptive step size control. Boundary and eigen value problem. Conversion of boundary value to initial PDE solutions: Elliptic, Parabolic and Hyperbolic equations value problem. Accuracy and stability of with applications. Finite Element Method: 1-D and multidimensional unconstrained problems. Constrained optimization. Integration equations: Simpson's integration and Newton-Cotes open and closed integration.**

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