Jordan University of Science and Technology

JUST

Faculty of Engineering

Mechanical Engineering Department

A Masters Program Proposal

In Mechanical Engineering / Thermal Power

الخطةالدراسية لبرنامج الماجستير

في الهندسة الميكانيكية / تخصص القوى الحرارية

Jordan Universrsity of Science and Technology
Faculty of Graduate Studies

Master of Science in Mechanical Engineering
Program Manual

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SECTION 1. OBJECTIVES, CURRICULUM DESIGN, AND OUTCOMES

1.1 Objectives

The primary objectives of the program are:

1. **To provide industry with highly trained engineers having interdisciplinary skills necessary to deal with state of the art tools in design, development and advancing of modern engineering systems.**

2. **To develop graduates confident in addressing open-ended problems and who possess an attitude of self-learning.**

3. **To develop appropriate skills of modeling and simulation of modern integrated engineering products, thus enabling participants to carry out the design and development of 'smart' products.**

4. **To apply the latest techniques in precision mechanical engineering, control theory, computer science and engineering, and electronics to the design process to create more functional, adaptable, and cost effective products**

5. **To insure that all students are familiar with advanced systems elements and able to apply mechanical principles in their own disciplines and in the broad context of engineering system design.**

1.2 Design of the Curriculum

The curriculum design includes an integrated system of research, development, and training in the fields of advanced online monitoring, industrial automation, manufacturing techniques, and mechatronics systems in modern state-of-the-art vehicles, electro-hydraulic and pneumatic control systems, and precision electro-mechanical devices. Distinctive features of the program are:

- **A program curriculum that places great emphasis on recognition of engineering as an integrative process in which analysis and synthesis are supported with sensitivity to social needs and environmental fragility.**
- **Courses that train graduate students to master the critical thinking that underlies problem definition (modeling, simulation, experimentation, optimization) and derives from an in-depth understanding of the physical, life, and mathematical sciences, as well as the humanities and social sciences where addressed.**
- **Education experiences in which engineers learn the creation and elegant implementation of useful systems and products, including their design and manufacture.**
- **A program designed to graduate individuals able to understand and contribute to the economic, industrial, and international environment in which engineering is practiced.**

- **A focus on the working partnership between academe and practice. It responds to the growing needs for integration and interdisciplinary education. It is committed to the idea of offering individuals the opportunity of acquiring the necessary skills to face the challenges of modernization**

Consequently, the graduates of the mechatronics program will be leading in technology transfer and industry modernization. They are prepared to be better decision makers and team leaders of multidisciplinary engineering systems. This is in concurrence with the University mission to enable students to comprehend the dynamism and complexity of contemporary global processes and to empower them to guide these processes in constructive directions.

1.3 Expected Student Outcomes

Graduates of the MS in Mechatronics Engineering program will have the following abilities:

1. Integrated systems: **Work with, and develop, integrated systems through all stages. This includes design, operation, fault diagnosis and troubleshooting.**

2. Leadership: **Lead industry modernization and automation effort; make decisions when selecting, procure and commission advanced engineering systems; lead and manage their multidisciplinary technical teams.**

3. Innovation: **Develop competitive and innovative technical solutions to complex engineering problems while driving innovations into the resulting product.**

4. Broad based**: Adapt research and development to achieve optimal technical solutions, and take into account socioeconomic, environmental, and cutting edge technology.**

SECTION 2. PROGRAM EVALUATION AND ASSESSMENT

2.1 Evaluation Procedures and Assessment Strategies

Evaluation will be conducted for the following program elements:

- Curriculum: **How the curriculum accomplishes the program objectives?**
- Students: **How the student demonstrates course outcomes. Performance in class projects and open ended engineering problems? How student performs on a multidisciplinary team. Are they learning to be innovative and creative?**
- Faculty**: How are the faculty interacting, motivating and challenging students to be more creative? Are students involved in research activities?**
- Resources: **How are resources serving program needs? Are they being developed to enhance program elements?**

To assess these outcomes, evaluation tools other than regular course work assessment have been developed. These tools are managed, developed, and transformed into corrective measures for all the elements of the program from goals and objectives to individual course introduction, restructuring, or elimination. The assessment tools are as follows:

- **Academic oriented tools for online tuning of the program (affecting individual courses)**

  1. **Course portfolios and students feedback**
  2. **Projects, presentations**
  3. **Comprehensive exams (course option) and thesis defense (thesis option)**

- **Industry feedback regarding a graduate's performance (affecting short term program goals and objectives)**

  1. **Industry questionnaires**
  2. **Graduate's promotion**
  3. **Leadership of graduates in their workplace**
  4. **Activities of graduates in local, regional, and international professional societies**
  5. **Attracting industry projects and funds**
  6. **Alumni feedback**
  7. **Professional societies feedback**
  8. **Local workshops and seminars**

- **Program response emerging and projected trends in science and technology (affecting long term and short term program goals and objectives)**

  1. **Faculty participation in major professional meetings**

2. **Graduates participation in major professional meetings**
3. **Publication in refereed journals and major conferences**
4. **Admission to PhD programs in high quality research institutions**
5. **Partnership with world class institutions in the field**

Course Curriculum for Master Degree in Mechanical Engineering / Thermal Power

The Master Degree in Mechanical Engineering., is awarded by the Faculty of Graduate Studies at Jordan University of Science and Technology (JUST) upon the fulfillment of the following requirements:

1) **Compliance with the J.U.S.T. Master Degree regulations approved by the Dean Council (No. 492/2006), dated 8/8/2006.**
2) **Successful completion of (34) credit hours in one of the following tracks:**

First: Thesis Track

1. Compulsory Requirements: (16) credit hours as follows:

Course Symbol and Number	Course Name	Credit
ME 700	Research Methodology	3
ME 701	Advanced Applied Mathematics	3
ME 730	Modeling Simulation and Optimization	3
ME 705	Continuum Mechanics	3
ME707	Incompressible Flows	3
ME 790	Seminar	1

2. Elective Requirements: (9) credit hours from the following* :

Course Symbol and Number	Course Name	Credit
ME 709	Computational Techniques in Mechanical Engineering	3
ME 729	Energy Conversion Technologies	3
ME 741	Intermediate Heat Transfer	3
ME 742	Intermediate Thermodynamics	3
ME 743	Compressible Flows	3
ME 744	Turbo Machinery	3
ME 745	Introduction to computational fluid dynamics (CFD)	3
ME 751	Advanced Strength of Materials	3
ME 752	Advanced Composite Materials	3
ME 753	System Dynamics Analysis	3
ME 754	Advanced Vibration	3
ME 762	Project Management	3
ME 763	Design of Experiments and Data Analysis	3
ME 764	Finite Element Techniques	3
ME769	Special Topics in Thermal Power	3

*** The student may study not more than 3 credit hours from courses of 700 or 800 level offered by other programs related to his field of study upon approval of the Dean of Graduate Studies based on the recommendation of the departmental graduate studies committee.**

3. Master Thesis (ME 799): total of 9 credit hours as follows:

Course Symbol and Number	Course Name	Credit
ME 799 A	**Master Thesis**	**9**
ME 799 B	**Master Thesis**	**6**
ME 799 C	**Master Thesis**	**3**
ME 799 D	**Master Thesis**	**0**

Second: Comprehensive Exam Track

1. Compulsory Requirements: (19) credit hours

Course Symbol and Number	Course Name	Credit
ME 700	Research Methodology	3
ME 701	Advanced Applied Mathematics	3
ME 730	Modeling Simulation and Optimization	3
ME 705	Continuum Mechanics	3
ME 707	Incompressible Flows	3
ME 709	Computational Techniques in Mechanical Engineering	3
ME 790	Seminar	1

2. Elective Requirements: (15) credit hours from the following*:

Course Symbol and Number	Course Name	Credit
ME 729	Energy Conversion Technologies	3
ME 741	Intermediate Heat Transfer	3
ME 742	Intermediate Thermodynamics	3
ME 743	Compressible Flows	3
ME 744	Turbo Machinery	3
ME 745	Introduction to Computational Fluid Dynamics (CFD)	3
ME 751	Advanced Strength of Materials	3
ME 752	Advanced Composite Materials	3
ME 753	System Dynamics Analysis	3
ME 754	Advanced Vibration	3
ME 762	Project Management	3
ME 763	Design of Experiments and Data Analysis	3
ME 764	Finite Element Techniques	3
ME 769	Special Topics in Thermal Power	3

*** The student may study 6 credit hours from courses of 700 or 800 level offered by other programs related to his field of study upon approval of**

the Dean of Graduate Studies based on the recommendation of the departmental graduate studies committee.

3. **Passing the Comprehensive Exam (ME 798): zero credit hour.**

COURSE DESCRIPTION

ME 700: Research Methodology (3 credit hours)

Methods of research in advanced fields of energy engineering. Statistical tools, Methods of solution: analytical, numerical and experimental methods. Measurement systems, instruments and data acquisitions. Report writing: abstract, introduction, analysis, description of the experiment, experimental procedure, results, discussion, conclusions, recommendations and references.

ME 701: Advanced Applied Mathematics

Integral Transforms, Fourier Transforms, Legendre Transforms, two-sided Laplace transforms, special functions (Gamma, Beta, and Bessel functions), Legendre polynomials, error function. Partial differential equations (different methods of solution). Linear algebra. Applications in Mechanical Engineering.

ME730: Modeling, Simulation and Optimization (3 credit hours)

Fundamentals of mathematical modeling and simulation of energy systems. Optimization techniques; Classical direct search-for-optimum methods, Golden Mean, Conjugate Gradients, Modified Newton Method, methods for constrained optimization such as Lagrange Multipliers, Linear and Quadratic Programming. Use of non-commercial software packages.

ME 705: Continuum Mechanics

Analysis of stress and deformation at a point. Derivation of the fundamental equations by applying the basic laws of conservation of mass, momentum, and energy; and the laws of thermodynamics. Relations between stress, strain, and strain rate. Constitutive laws affecting strain relationships. Applications in solid mechanics.

ME 707: Incompressible Flows

Kinematics of fluid motion. Constitutive equations of viscous compressible fluids (tensor notation). Compressible Navier-Stokes system. Special exact and similarity solutions. Admissibility of idealizations and their applications: inviscid, adiabatic, irrotational, incompressible, boundary-layer, linearized, and creeping flows. Introduction to potential flows. Introduction to turbulent flows.

ME 709: Computational Techniques in Mechanical Engineering

Review of basic tools of numerical analysis. Ordinary differential equations. Numerical methods for initial and boundary value problems. Consistency, stability, and convergence. Partial differential equations: numerical methods for elliptic, parabolic, and hyperbolic PDE's.

ME 729: Energy Conversion Technologies (3credit hours)

Forms of energy. Development of energy, sources and energy needs. Petroleum. Coal, oil shale and tar sand. Natural gas and hydrogen power. Principles of nuclear power. Conversion of chemical energy into thermal energy, including gas, liquid and solid fuel combustion systems. Conversion of thermal energy into mechanical energy, including power, and heat engine cycles, internal and external combustion systems and turbines. Conversion of thermal energy into electrical energy including thermoelectric converters, thermoelectric systems, electric generators and alternators, solar and fuel cells.

ME 741: Intermediate Heat Transfer

Governing equations. Exact and approximate solutions of: steady and unsteady conduction; forced, natural, and mixed convection. Introduction to radiation.

ME 742: Intermediate Thermodynamics

Mathematical formulation of thermodynamics (thermodynamics relations), equations of state for real gases, properties departure charts. Availability and irreversibility analysis. Phase equilibrium in one component and multi-component systems. Chemical equilibrium in reacting systems. Entropy generation.

ME 743: Compressible Flow

Review of combustion thermodynamics and chemical equilibrium including pollution formation. Review of chemical kinetics. Conservation equations. Detonation and deflagration. Introduction to laminar premixed flames. Flame stabilization. Introduction to diffusion flames. Ignition.

ME 744: Turbo machinery

Theoretical analysis of energy transfer between fluid and rotor. Principles of axial-, mixed-, and radial-flow pumps and turbines and Compressors.

ME 745: Introduction to Computational Fluid Dynamics (CFD)

Application of numerical methods (finite difference and finite volume) to basic equations in fluid mechanics and heat transfer including methods for: inviscid flow equations, boundary layer equations, and Reynolds-averaged equations in incompressible flows. Introduction to grid generation.

ME 751: Advanced Strength of Materials

Equations of equilibrium. Strain-displacement, compatibility; and constitutive equations in terms of Airy and complex potential stress functions. Application to plane engineering boundary value problems including: beams, disks, and thick-walled tubes, beams on elastic foundation, curved beams, thermal stresses, and contact stresses. This course includes experimental design/simulation executed by the student.

ME 752: Advanced Composite Materials

Particle reinforced composites, fiber reinforced composites, and structural composites. Processing of composites: micro-and macro mechanics. Behavior of composites under different types of loading. Selection and applications of composites.

ME 753: System Dynamics Analysis

Advanced analytical methods to determine dynamic performance of complex mechanical systems: damped complex exponential methods, Ibrahim time domain approach, eigen system realization, algorithm approach. The course includes an experimental project.

ME 754: Advanced Vibration

General theory of free, forced, and transient vibrations. Vibration transmission and isolation. Generalized coordinates and Lagrange's method, method of influence coefficient, matrix formulation and Solution, Rayleigh, Holzer, and Myklestad Methods. D'Alembersts principle, principle of virtual work, dynamics instability, self excitation, longitudinal and torsional vibration, wave propagation in membranes, plates, and shells. This Course includes experimental design/simulation executed by the student.

ME 762: Project Management

Management concepts. Leadership and conflict resolution. Project phases: network models (CPM and PERT), resources allocation, loading and leveling, time/cost trade-off, and constrained resources. Use of software in project management.

ME 763: Design of Experiments and Data Analysis

Introduction to design of experiments, similarity analysis and parametric study. Signal conditioning and data acquisition. Signal processing including sampling rate, Fast Fourier Transform (FFT), and power spectrum analysis. Statistical Analysis.

ME 764: Finite Element Techniques

Stiffness matrices. Assembly. One- and two-dimensional elements. Vibration Problems. Writing computer programs.

ME 769: Special Topics in Thermal Power

Offered as a Structural Courses in Thermal Power.

ME 790: Seminar

Special topics in Mechanical Engineering presented by post-graduate students, invited speakers from industry and academia.

ME 799A: M. Sc. Thesis

ME 799B: M. Sc. Thesis

ME 799C: M. Sc. Thesis