FACULTY OF ENGINEERING

Master of Science (MS) Degree – 46 Credits

Aeronautical Engineering Specialty

The Master of Science (MS) in Aeronautical Engineering Specialty is 46 credits after the BS of which 37 are the transition credits from the BS program to the BE program and an additional minimum of 9 credits.

Sem	Course Code	Course Title	Credit	Pre-Req	Co-Req
7	AERO 411	Advanced Aerodynamics	3	AERO 232 MECH 314	
7	AERO 413	Advanced Aircraft Structures	3	AERO 234	
7	MECH 412	Mechanics of Composite Materials	3	CIVE 202	
7	MECH 450	Advanced Engineering Analysis for Mechanical Engineers	3	MATH 230 MATH 202	
7		General Elective or Management	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
8	AERO 421	Gas Turbine Propulsion Systems	3	AERO 344	
8	AERO 422	Aircraft Design II	3	AERO 316	
8	MECH 517	Finite Element Methods in Mech. and Aero. Eng.	3	CIVE 202	
8	GENG 599	Master's Thesis	6	MECH 450 or GENG 450	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
9	MECH 480	Field Training	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
10	GENG 400	Engineering Seminars	1		
10	GENG 599	Master's Thesis (Reactivation)	0		
10		General Elective or Management	3		
10		General Elective or Management	3		
10		General Elective or Management	3		
10		General Elective or Management	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	
11	GENG 599	Master's Thesis (Reactivation)	0		
		TOTAL	**46**		

List of Electives (*Management Option: 15 credits are required)				
MECH 411	Advanced Mechanics of Materials	3	MECH 311 CIVE 202	
MECH 412	Mechanics of Composite Materials	3	CIVE 202	
MECH 413	Internal Combustion Engines	3	MECH 232	
MECH 415	Turbomachinery	3	MECH 324 or AERO 344	
MECH 423	Advanced Manufacturing Processes	3	MECH 323	
*ENMG 422	Project Life Cycle Cost Management	3		
*ENMG 435	Operations Management	3		
*ENMG 555	Design and Planning of Engineering Systems	3		
*ENMG 460	Decision and Risk Management	3		
*ENMG 585	Quality Assurance and Quality Control	3		
*GENG 402	Project Management	3		
MECH 511	Computational Fluid Dynamics	3	MECH 314	
*MRKT 450	Marketing Management	3		

COURSE DESCRIPTIONS

AERO 411 ADVANCED AERODYNAMICS **3.0: 3 cr. E**

This course covers the dynamics of inviscid, compressible airflows, treatment of normal and oblique shock waves, transonic drag, critical mach number, Prandtl-Meyer expansion flow around convex corners, supersonic airfoil sections, supersonic intakes, friction and heat transfer on compressible flows-shock waves and boundary layer interactions.

Pre-requisites: AERO 232, MECH 314

AERO 413 ADVANCED AIRCRAFT STRUCTURES **3.0: 3 cr. E**

This course covers the analysis of plates and shells; optimum structures, Structural dynamics; Structural fatigue, principles and practices. Introduction to aero elasticity; static and dynamic.

Pre-requisite: AERO 234

AERO 421 GAS TURBINE PROPULSION SYSTEMS **3.0:3 cr. E**

This advanced course on gas turbine engines is concerned with the identification of the suitability different engines to different flight missions. Details of engine performance during different phases of flight are discussed. In addition, the course seeks to give students insight into the workings of engines at off-design conditions.

Pre-requisite: AERO 344

AERO 422 AIRCRAFT DESIGN II **3.0: 3 cr. E**

This course highlights the significance of various engineering courses and their interactions in the design process of an aircraft satisfying certain requirements as the best compromise of several trials and modifications, weight estimation, and methods of improvement. Minor and major projects in the design of light and large airplanes are assigned to students' teams. A graduate from this course plays the role of an architect and a designing aircraft structural engineer.

Pre-requisite: AERO 316

MECH 410 MATERIAL CHARACTERIZATION LAB. **0.3: 1 cr. E**

This course introduces the theoretical and practical framework for different methods used in the characterization of engineering materials. The laboratory portion of this course offers intensive instruction in the most widely practiced light microscopy methods and associated sample preparation. Particular emphasis will be placed on Microstructure characterization: grain sizing, phase identification, fiber orientation and fractography: cracks, fracture type, loading.

Pre-requisites: MECH 222, MECH 325, CIVE 202

MECH 411 ADVANCED MECHANICS OF MATERIALS **3.0: 3 cr. E**

This course provides theories of stress and strains. Linear elastic general anisotropic, orthotropic and isotropic material behaviors. Formulation of elasticity and boundary conditions. Plane stress and plane strain. Navier equations. Calculus of variations and its application to elasticity. Energy formulation. Unsymmetrical bending and shear center. Torsion of beams of noncircular cross-sections. If time permits, beams on elastic foundations will be covered as well.

Pre-requisites: MECH 311, CIVE 202

MECH 412 MECHANICS OF COMPOSITE MATERIALS **3.0: 3 cr. E**

This course offers an introduction to composite materials, macromechanics of a lamina, 3-D constitutive equations, plane stress, lamina constitutive equations, thin plate theory, classical lamination theory, thermo-elastics lamination theory, failure analysis and design of laminate.

Pre-requisite: CIVE 202

MECH 413 INTERNAL COMBUSTION ENGINES **3.0: 3 cr. E**

This course provides the fundamentals of how the design and operation of spark-ignition engines affect their performance and fuel requirements. We will study fluid flow, thermodynamics, combustion, heat transfer and friction phenomena, and fuel properties, relevant to engine power, efficiency, and emissions. We will also examine the design features and operating characteristics of different types of engines: Spark-ignition and diesel engines.

Pre-requisite: MECH 232

MECH 414 PROCESS CONTROL SYSTEMS **3.0: 3 cr. E**

The course builds upon the foundation developed in previous course in Control System Theory. It covers advanced topics in analysis of process control systems such as Feedback control; Modeling and computer simulation of control systems; Discrete time models; Process control techniques; State Space methods applied to process control systems; Logic programming and devices.

MECH 415 TURBOMACHINERY **3.0: 3 cr. E**

This course covers fundamental principles of turbomachinery. The objective is to introduce students to several types of turbomachines. Basic concepts and performance of turbines (gas, steam, wind, and hydraulic), compressors, fans, and pumps are incorporated. Axial and radial turbomachines are covered. Students are expected to have solid background in fluid mechanics and thermodynamics.

Pre-requisite: MECH 324 or AERO 344

MECH 421 REFRIGERATION AND AIR CONDITIONING **3.0: 3 cr. E**

The course covers basic refrigeration cycles, psychrometrics and psychrometric processes, ventilating, U-values, heating and cooling loads, air-conditioning systems, ducts and pipe design.

Pre-requisite: MECH 321

MECH 422 MECHANICAL DESIGN II **3.0: 3 cr. E**

This course aims to develop working ability for analysis, synthesis, and design with various mechanical elements such as permanent and nonpermanent joints, springs, bearings, breaks, clutches, flywheels, belts, shafts and axles.

Pre-requisites: MECH 311, CIVE 202

MECH 423 ADVANCED MANUFACTURING PROCESSES **3.0: 3 cr. E**

This course teaches students different areas of manufacturing processes. It introduces students to Metal cutting, ASTM Standards, Surface finishing, Casting, Extrusion, Planning, Quality Control, Production and large volume manipulation. It also covers statistical techniques and decision-making. Students will develop professional and practical skills of different manufacturing and production areas to assist them in obtaining jobs.

Pre-requisite: MECH 323

MECH 425 MECHATRONICS **3.0: 3 cr. E**
This course introduces students to sensors and transducers, signal conditioning, measurement systems, pneumatic and hydraulic actuation systems, mechanical and electrical actuation systems, dynamic responses of systems, system transfer, frequency response, adaptive control, microprocessors, PLC, communication systems, fault finding.

MECH 426 PLUMBING ENGINEERING **3.0: 3 cr. E**
This course covers basic principles of plumbing engineering in buildings through water supply requirement, tanks, pumps, drainage and venting, rainwater systems, septic tanks, pits and submersible pumps, firefighting, and gas systems.

Pre-requisite: MECH 314

MECH 427 FACILITY PLANNING AND CONTROL **3.0: 3 cr. E**
This course offers students, knowledge that is required for the planning, construction and commissioning of production facilities. Apart from this amount of knowledge the project engineers have to feature a certain amount of character traits, the so-called “soft skills”. Furthermore, due to strong international competition the project engineers are under an enormous cost- and time pressure. This shows the importance of good facility planning. Furthermore, a company has only long-term survival chances if the product development times are minimized and quality control measures at every stage of product life cycle can be applied. This leads to the definition of relevant product-quality features and the specification of target values and tolerances. It is close to the process design and procurement. This is about the optimal design of production conditions and the selection of suitable precursors.

MECH 428 SPECIAL TOPICS IN THERMAL SCIENCES **3.0: 3 cr. E**
This course covers some of the topics of particular interest to the thermal engineer but not covered in other courses. The main focus of the course is combustion and multiphase flows. A number of practical applications are included and these range from analytical direct application to numerical modeling and computational exercises.

Pre-requisite: MECH 232
Co-requisite: MECH 511

MECH 450 ADVANCED ENGINEERING ANALYSIS FOR MECHANICAL ENGINEERS 3.0: 3 cr. E
This course covers the formulation of one-dimensional and multi-dimensional heat equation, equation of vibrating string, vibration of membrane, and the steady state heat equation. Analytical and numerical methods of solution are also discussed as well as the method of characteristics, self-similar techniques, method of separation of variables, and Eigenvalue and Eigen function expansion. It also provides an introduction to the Calculus of Variations and Euler equation with application to mechanical engineering problems (subject to time availability). In addition, it covers the introduction to research, research papers outline, methods of research, literature review, and research evaluation and critique.

Pre-requisite: MATH 230, MATH 202

MECH 480 FIELD TRAINING **0.0: 3 cr. E**
Prior to MS graduation, students are expected to undergo a two- to four-month training program at an institution whereby they get exposed and engaged in activities related to their field of studies, thereby gaining experience and demonstrating their skills.

MECH 511 COMPUTATIONAL FLUID DYNAMICS 3.0: 3 cr. E
This course offers an introduction to computational techniques theory in fluid mechanics and heat transfer. It also provides detailed tutorials for applying these techniques using a widely adopted commercial CFD package, FLUENT. Students should identify the various numerical schemes together with their properties and limitations and be capable of applying them in solving fundamental and real-life thermo-fluids problems.

Pre-requisite: MECH 314

MECH 512 SOLAR ENERGY 3.0: 3 cr. E
The course provides a brief overview and historical background about the development solar energy and related applications. It outlines the fundamental principles of solar energy, as well as thermodynamic analyses applied in solar energy field. It reviews the optics of solar radiations and covers the radiation characteristics of materials. As an application to the theory, the course covers flat and curved solar collectors, water heating using solar energy, and solar ponds.

Pre-requisite: MECH 232

MECH 513 ROBOTICS 3.0: 3 cr. E
The course deals with the basic components of robotics systems, kinematics for manipulators, selection of coordinate frames, homogeneous transformations, solutions to kinematics equations, lagrangian equations and manipulator dynamics, motion planning, position, velocity and force control, controller design, digital simulations.

Pre-requisite: MECH 221

MECH 514 FATIGUE AND FRACTURE MECHANICS DESIGN 3.0: 3 cr. E
This course focuses on the fundamental concepts and background required for fatigue and fracture mechanics principles applied to pressurized and un-pressurized structural components with and without cracks. Specific topics covered include: Quick review on the mechanics of deformable bodies, Material properties, Stress intensity calculation for fatigue evaluation, S-N traditional method, Stress life model, Strain life model, Linear Elastic Fracture Mechanics (LEFM) principles, Crack-tip stress intensity factor calculations and handbooks use, Crack growth models, The use of Finite Element analysis in fatigue life calculations.

Pre-requisite: CIVE 202

MECH 517 FINITE ELEMENT METHODS IN MECH. AND AERO. ENG. 3.0: 3 cr. E
This course offers finite element formulations in one, two and three dimensions in solids. Structural analysis, vibrations and heat transfer. Computer implementations and projects.

Pre-requisite: CIVE 202

MECH 521 MODERN THERMO-MECHANICAL TREATMENT PROCESSES 3.0: 3 cr. E
The ongoing trend towards lightweight components aims in the integration of elevated mechanical properties and geometries adapted to the load profile. [STE09]. Based on theoretical fundamentals of materials science, mechanics and production technology, the application of locally and temporally differential thermo-mechanical effects to initial homogeneous workpiece materials combines thermally-controlled material flow with functional grading of mechanical properties [SAB09]. This new approach is explained and deepened with examples from current research and development.

Pre-requisite: MECH 222

MECH 522 METAL FORMING TECHNOLOGIES **3.0: 3 cr. E**
Classification of forming processes, Material behavior, Related and logarithmic strain, Strain rate, Flow curves, Introduction into the calculation of forming processes.

Pre-requisite: MECH 521

MECH 523 FORMING MACHINES AND MATERIALS **3.0: 3 cr. E**
Classification of forming machines, Work-dependent forming machines, Path-dependent forming machines, Force-dependent forming machines, Industrial use of forming machines, Accuracy characteristics of forming machines, Workpiece materials, Tool materials, Materials characterization.

Pre-requisite: MECH 521

MECH 525 COMPOSITES PROCESSES AND APPLICATIONS **3.0: 3 cr. E**
This course introduces definitions and classifications for major types of composite structures, structure of the matrix, reinforcement forms, thermosets, thermoplastics, reinforcing agents, fibre forms, different processing techniques of polymer (open mould and closed mould processes), wet lay-up processes, bag moulding and curing processes, autoclave moulding process, transfer moulding, compression moulding, injection moulding, filament winding and pultrusion, machining and joining processes.

MECH 526 ADVANCED FLUID MECHANICS **3.0: 3 cr. E**
Analysis of important inviscid flows, Potential Flows, Stokes' Theorem, Circulation, Vorticity, Velocity Potentials and Stream Functions, Uniform Flows, Sources and Sinks, Vorticies and Doublets, Superposition, Lift and Drag over Cylinders, Transformations. Further Considerations of Viscous Flows, Boundary Layers in External and Bounded Flows and Subject to Pressure Gradients, Boundary Layer Separation and Separation Control. Advanced experimental Techniques in Flow Measurement.

Pre-requisite: MECH 243

MECH 527 INTRODUCTION TO CONTINUUM MECHANICS **3.0: 3 cr. E**
This course introduces tensor algebra and analysis with emphasis to second order tensors. Some fundamental theorems of vector calculus. Kinematics of motion. Balance equations of forces, mass, linear momentum, angular momentum, energy and entropy. Constitutive equations for linear and nonlinear isotropic and anisotropic materials.

Pre-requisite: CIVE 202

MECH 528 ADVANCED NUMERICAL ANALYSIS **3.0: 3 cr. E**
This course covers various numerical techniques for interpolation, integration, solution to systems of ordinary differential equations and introduction to solutions of partial differential equations, with emphasis on convergence, accuracy, and stability and formulation of high order methods.

Pre-requisite: MATH 230

MECH 529 THEORY OF PLATES AND SHELLS **3.0: 3 cr. E**
This course aims to offer theory of plates: Thin plate theory; shear deformation; small and large displacement theories; Von Karman theory; Reduced theory; buckling of thin plate; Thin shell theory: theory of surface; thin shell equations; bending; membrane.

Pre-requisite: CIVE 202

MECH 530 MULTI-RIGID BODY DYNAMICS I **3.0: 3 cr. E**

This course provides concepts of vector differentiation. Kinematics: angular velocity, angular acceleration, differentiation in various reference frames, generalized speeds, partial angular velocities, and partial velocities. Mass distribution. Generalized forces and generalized inertia forces.

Pre-requisite: MECH 221

MECH 531 MULTI-RIGID BODY DYNAMICS II **3.0: 3 cr. E**

This course introduces several energy functions: potential energy and contributing potential energy, dissipative functions, kinetic energy. Formulation of equations of motions: Dynamical equations and their linearization, systems at rest in a Newtonian reference frame and steady motion. Extraction of information from equations of motion: Energy integral and momentum integrals. Numerical integration of differential equations of motion.

Pre-requisite: MECH 530

MECH 532 THEORY OF ELASTICITY **3.0: 3 cr. E**

This course covers Three-dimensional stress and strain at a point; equations of elasticity in Cartesian and curvilinear coordinates; methods of formulation of equations for solution; plane stress and plane strain; energy formulation. Solutions to problems of interest in Cartesian and curvilinear coordinates.
Pre-requisite: CIVE 202

Refer to General Listing of Course Descriptions for:

CHEM XXX
Refer to the Faculty of Arts and Sciences

CIVE XXX
Refer to the Department of Civil Engineering

CSIS XXX
Refer to the Faculty of Arts and Sciences

CSPR XXX
Refer to the Faculty of Arts and Sciences

ELEN XXX
Refer to the Department of Electrical Engineering

ENGL XXX
Refer to the Faculty of Arts and Sciences

ENMG XXX
Refer to the Department of Engineering Management

GENG XXX
Refer to the Faculty of Engineering Requirements

LISP XXX
Refer to the Faculty of Arts and Sciences

MATH XXX
Refer to the Faculty of Arts and Sciences

MGMT XXX
Refer to the Faculty of Business and Management

MRKT XXX
Refer to the Faculty of Business and Management

FACULTY OF ENGINEERING GENERAL COURSES

GENG 400 ENGINEERING SEMINARS **2.0: 1 cr. E**
This module consists of lectures and seminars covering recent research and advances in various fields and applications of engineering disciplines.

GENG 402 PROJECT MANAGEMENT **3.0: 3 cr. E**
To make available the fundamentals of project management with the most workable types of organizations and the necessary capabilities that must be included to reasonably ensure success and minimize the possibility of failure. The course consists of construction contracting for contractors, owners, and engineers: bidding, industry structure, types of contracts, and delivery systems of construction, planning, estimating, quantity take-off and pricing, labor and equipment estimate, proposal preparation, contract documents to prepare detailed estimates, permits, risk management, and taxes. Basic critical path planning and scheduling with activity on nodes and activity on arrows, monitoring, updating, controlling, crashing, resource leveling, resource allocation, and least cost scheduling including time-cost trade-off analysis. Computer applications using the Primavera software.

GENG 450 ADVANCED ENGINEERING ANALYSIS AND RESEARCH METHODS 3.0: 3cr. E
The aim of this course is to train MS students in the methodologies used for research. Starting from existing literature, students will learn the formulation and development of original research problems in engineering management and civil engineering. The focus of the course is how to plan, prepare and present research manuscripts, such theses, and papers. Overview of the most popular modeling techniques, and statistical sampling methods used for engineering research.

GENG 599 MASTER'S THESIS **6.X: 6 cr. E**
An approved final thesis project.