FACULTY OF ENGINEERING

DEPARTMENT OF ELECTRICAL ENGINEERING

Master of Science (MS) Degree – 46 Credits

The Master of Science (MS) in Electrical Engineering degree 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	ELEN 401	Optimization Theory	3		
7	ELEN 417	Measurement Systems	3		
7	ELEN 437	Power Systems I	3		
7	GENG 450	Advanced Engineering Analysis and Research Methods	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
8	GENG 400	Engineering Seminars	1		
8	GENG 599	Master's Thesis	6	GENG 450	
8		Specialized Area Elective	3		
8		Specialized Area Elective	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
9	ELEN 480	Field Training	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
10	GENG 599	Master's Thesis (Reactivation)	0		
10		Specialized Area Elective	3		
10		Specialized Area Elective	3		
10		Specialized Area Elective	3		
10		Specialized Area Elective	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
11	GENG 599	Master's Thesis (Reactivation)	0		
11		General Elective	3		
11		Specialized Area Elective	3		
		TOTAL	**46**		

General Elective (3 credits from the following list):					
	ENMG 422	Project Life Cycle Cost Management	3		
	ENMG 460	Decision and Risk Management	3		
	ENMG 555	Decision and Planning of Engineering Systems	3		
	ENMG 585	Quality Assurance and Control	3		
	GENG 402	Project Management	3		
		Specialized Area Elective	3		
Specialized Area Electives (18 credits from the following lists)					
Biomedical Track:					
	BMEN 467	Musculoskeletal Biomechanics	3		
	CPEN 425	Neural Networks Design	3		
	CPEN 445	Biometrics	3		
	CPEN 528	Machine Vision	3		
	ELEN 462	Biomedical Instrumentation I	3		
	ELEN 463	Medical Imaging I	3		
	ELEN 459	Engineering Image Processing	3		
	ELEN 562	Biomedical Instrumentation II	3		
	ELEN 564	Medical Imaging II	3		
		Specialized Area Elective	3		
Telecommunications and Networking Track:					
	CPEN 441	Information Networking II	3	CPEN 241	
	CPEN 442	Networking Programming	3	CPEN 241	
	CPEN 546	Wireless Networks	3		
	ELEN 402	Stochastic Theory	3		
	ELEN 441	Information Theory and Error Correction	3		
	ELEN 443	Digital Communication	3		
	ELEN 446	Telecom Electronics	3		
	ELEN 472	Fiber Optics	3		
	ELEN 542	Wireless Communication Systems	3		
	ELEN 572	Satellite and Radar Communication	3		
	ELEN 574	Optical WDM Networks	3		
		Specialized Area Elective	3		
Control and Automation Track:					
	CPEN 425	Neural Networks Design	3		
	CPEN 452	Advanced Microcontroller Applications	3	CPEN 213	

				CPEN 220	
	CPEN 528	Machine Vision	3		
	ELEN 402	Stochastic Theory	3		
	ELEN 411	Mechatronics Systems	3		
	ELEN 466	Industrial Intelligent Networks	3		
	ELEN 523	Optimal Control Systems	3		
	ELEN 527	Fuzzy Logic Control	3		
		Specialized Area Elective	3		
Power and Energy Track:					
	CPEN 425	Neural Networks Design	3		
	ELEN 435	Advanced Electric Machines	3		
	ELEN 466	Industrial Intelligent Networks	3		
	ELEN 523	Optimal Control Systems	3		
	ELEN 536	Power Systems Control	3		
	ELEN 537	Power Systems II	3		
	ELEN 539	Power Quality	3		
		Specialized Area Elective	3		
AI and Machine Learning Track:					
	CPEN 425	Neural Networks Design	3		
	CPEN 426	Deep Learning	3	CSIS 200 Or CSIS 206	
	CPEN 445	Biometrics	3		
	CPEN 448	Cloud Computing and Big Data	3		
	CPEN 452	Advanced Microcontroller Applications	3	CPEN 213 CPEN 220	
	CPEN 528	Machine Vision	3		
	ELEN 402	Stochastic Theory	3		
	ELEN 523	Optimal Control Systems	3		
	ELEN 525	Mobile Robots	3		
	ELEN 527	Fuzzy Logic Control	3		
	MECH 513	Robotics	3		
		Specialized Area Elective	3		

COURSE DESCRIPTIONS

ELEN 400 LINEAR SYSTEMS **3.0: 3 cr. E**

This course covers the concepts and theories of linear system analysis; state-space modeling and analysis; controllability, observability, and stability of linear systems; properties of transfer function matrices; minimal realization.

ELEN 401 OPTIMIZATION THEORY **3.0: 3 cr. E**

This course is an introduction to various methods of obtaining the extreme of a non-dynamic or a dynamic system and its use in system design. Linear programming, various search methods, nonlinear programming and dynamic programming are also covered. Various real-life applications are discussed and appropriate case studies are investigated.

ELEN 402 STOCHASTIC THEORY **3.0: 3 cr. E**

This course covers general concepts of stochastic processes; stationarity and ergodicity; stochastic continuity and differentiation; Gaussian process; linear systems with stochastic inputs; correlation functions and power spectra; matched filtering; mean square estimation; spectral estimation; modulation; Entropy; Markov processes; queuing theory.

ELEN411 MECHATRONICS SYSTEMS **3.0: 3 cr. E**

The course covers interdisciplinary topics that integrate electronics, computer, control, and mechanical engineering to create complete electromechanical systems. It covers sensors and transducers; electrical and mechanical actuators; systems modeling and signals conditioning; analysis and identification of discrete-time dynamic systems; commonly used digital controller design methods; closed-loop control and microprocessor-based switching control.

ELEN 417 MEASUREMENT SYSTEMS **3.0: 3 cr. E**

This course covers sensors and transducers as well as electrical and mechanical actuators. A wide variety of sensors is covered in the first part of the course: temperature, humidity, pressure, strain, motion, proximity, optical and ultrasonic sensors, current, voltage, etc. Some communication protocols (UART, I2C, SPI, 1-wire, etc.) used by sensors are briefly outlined in the second part of the course. This necessitates the use of microcontrollers to measure data and hence the course will delve into this area from a data acquisition point of view. The course also emphasizes control systems in which measurements are made, data are processed, and actuators are triggered in order to service an industrial process or a home automation control application.

ELEN 435 ADVANCED ELECTRIC MACHINES **3.0: 3 cr. E**

This course covers the generalized theory of machines based on coupled circuit approach using matrix methods; transformations from stationary to rotating reference frame; applications to dc induction, and synchronous machines and their parameters; performance in the transient and the steady state.

ELEN 437 POWER SYSTEMS I **3.0: 3 cr. E**

This course enables students to model the elements of a power system including transformers, rotating machines and transmission lines using the per unit system and sequence impedance networks derived from the use of symmetrical components. Power flow analysis will be studied utilizing the system model. Matrix methods for solving network problems utilizing modern tools will be used throughout the course.

ELEN 441 INFORMATION THEORY AND ERROR CORRECTION 3.0: 3 cr. E

This course deals with orthonormal expansions, effect of additive noise in electrical communications, vector channels, waveform channels, matched filters, bandwidth, and dimensionality. Optimum receiver structures, probability of error, bit and block signaling, introduction to coding techniques. Protocols for error control, signaling, addressing, fault management, and security control. Block, cyclic, and convolutional codes; circuits and algorithms for decoding; application to reliable communication and fault-tolerant computing.

ELEN 443 DIGITAL COMMUNICATION 3.0:3 cr. E

This course treats the principles of digital transmission of information in the presence of noise where it starts with an overview of information theory and coding; analog to digital conversion; design and analysis principles of baseband PAM transmission systems; M-ary signaling; various passband carrier systems including ASK, FSK and PSK; multiple access schemes (2G TDMA, 2G CDMA, 3G WCDMA, 3G TD-CDMA, 5G BDMA). Receiver design in the presence of AWGN noise is presented at the end of the course with special focus on match filters; maximum likelihood detectors; link budget analysis in terms of QoS metrics such bit error rate and channel capacity. It also covers an introductory treatment of channel coding.

ELEN 446 TELECOM ELECTRONICS 3.0: 3 cr. E

This course covers applications of operational amplifiers and other integrated circuits in current technology; wide bandwidth amplifiers; low-noise amplifiers; current mode circuits; analog multipliers; radio frequency input circuits and impedance matching; RF amplifiers; micro-strip circuits; IF circuits; oscillators; Phase locked loops (PLLs).

ELEN 459 ENGINEERING IMAGE PROCESSING 3.0: 3 cr. E

This course helps to interpret the content of an image by improving the pictorial image information interpretation and processing of seen data for autonomous machine perception. Topics covered include: Image acquisition and storage, image transformation, image enhancement in frequency and special domains, representation and description of a seen, recognition and interpretation.

ELEN 462 BIOMEDICAL INSTRUMENTATION I 3.0: 3 cr. E

This course covers the concepts and applications of biomedical instrumentation; basic transducers and principles; amplifiers and biomedical signal processing; origin of bio-potentials; electrodes and amplifiers; blood pressure and sound; measurement of blood flow and volume; measurements of the respiratory system parameters; clinical laboratory instrumentation; electrical safety.

ELEN 463 MEDICAL IMAGING I 3.0: 3 cr. E

This course provides an introduction to the physical principles and functions of Ultrasound (Interactions, Propagation, Attenuation, sensitivity, transducer construction, Focusing, 2D/3D, Arrays, Image reconstruction, etc.) and X-ray Diagnostic Radiology such as X-ray Computed tomography (including Image reconstruction), Mammography, etc. Other related issues will also be discussed.

ELEN 466 INDUSTRIAL INTELLIGENT NETWORKS 3.0: 3 cr. E.

This course covers industrial networks and their applications such as advanced set of PLC problems covering a wide range of systems; MODBUS RTU protocol and its use in industrial automation; PLC communications; ethernet-based industrial networks such as MODBUS/TCP; home automation (KNX/DALI).

ELEN 472 FIBER OPTICS **3.0: 3 cr. E**

This course covers the principles of fiber optics communication systems; optics review; Light fundamentals; integrated optic wave guides; light sources, detectors, and couplers; distribution networks and fiber components; modulation; noise; system design; measurement.

ELEN 480 FIELD TRAINING **0.0: 3 cr. E**

This course requires students 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.

ELEN 523 OPTIMAL CONTROL SYSTEMS **3.0: 3 cr. E**

This course covers the analysis and design of modern feedback control systems; advanced state space analysis; Popov-Belevitch-Hautus (PBH) tests; Cayley-Hamilton theorem; Ackerman's formula; state feedback control design and the Kalman gain; state estimation and the identity and Luenberger observer design; optimal control design (LQR); Hamiltonian and Riccati equations; analytical control system design.

ELEN 525 MOBILE ROBOTS **3.0: 3 cr. E**

This course covers inspiration to implementation of mobile robots: Computational hardware, designing and prototyping, sensors, mechanics, motors, power, and robot programming.

ELEN 527 FUZZY LOGIC CONTROL **3.0: 3 cr. E**

This course covers analysis and design of adaptive fuzzy systems: Training of fuzzy logic systems using backpropagation, orthogonal least squares, table lookup scheme, Nearest neighborhood clustering; Comparison of adaptive fuzzy systems with artificial neural networks; Design using input-output linearization concept; fuzzy adaptive filters.

ELEN 536 POWER SYSTEMS CONTROL **3.0: 3 cr. E**

This course presents the transient, dynamic, and static stability and control of power systems represented by a Single Machine Infinite Bus (SMIB); synchronous generator models; nonlinear swing differential equation; definitions of transient stability and the equal-area criterion; the Phillips-Heffron linearized model of a synchronous machine; Power System Stabilizer (PSS); the Load Frequency Control (LFC); the Automatic Voltage Regulator (AVR); steady-state voltage stability and control.

ELEN 537 POWER SYSTEMS II **3.0: 3 cr. E**

This course presents symmetrical and unsymmetrical fault studies; bus impedance and admittance methods; power system controls; transient operation of transmission lines; transient stability; computer projects included.

ELEN 539 POWER QUALITY **3.0: 3 cr. E**

This course covers electric power quality; measures and standard of power quality measurements; modeling of networks and components under non-sinusoidal conditions; loads which may cause power quality problems; analysis methods, harmonics in power systems; and power quality improvement are covered.

ELEN 542 WIRELESS COMMUNICATION SYSTEMS **3.0: 3 cr. E**

This course aims to present wireless communication systems in general. It is a graduate course that covers several aspects of wireless communication starting from the general concepts and going towards specific wireless networking protocols. Different propagation models, modulation techniques, multiple

access approaches will be deepened. Speech coding and data transmission approaches will be introduced. Examples on the GSM, DECT and satellite communication will be given. As a result, the students will have a good knowledge of the most common wireless communication systems which permits them to easily start any study in this area.

ELEN 544 SPEECH TECHNOLOGIES **3.0: 3 cr. E**

Speech is the most natural way of communication. Classical telecommunication systems have been built to carry this signal. Nowadays, speech is a major media in human-machine communication. Besides, the classical and basic studies on speech coding, new speech technologies have been developed, i.e. speech synthesis, speech recognition and speaker verification. This course presents the state-of-the-art techniques. It starts with a brief presentation of the signal and of the most widely used coding techniques. Concatenative speech synthesis is then described in detail. State of the art Speech recognition systems are also presented covering Hidden Markov Models (HMM).

ELEN 562 BIOMEDICAL INSTRUMENTATION II **3.0: 3 cr. E**

This course covers selected topics on the major medical equipment: Blood pressure and sounds, Blood flow, respiratory measurement instruments, Biochemical parameters measurement instruments. In-hospital visits and observation are included in the course.

ELEN 564 MEDICAL IMAGING II **3.0: 3 cr. E**

This course provides an understanding on the principles of Magnetic Resonance Imaging (Spins, MDM, Tissue contrast, image formation, Artifacts), and Nuclear Medicine (SPECT, PET, Planar, etc.). Also issues such as reconstruction algorithms, Image quality will be addressed.

ELEN 572 SATELLITE AND RADAR COMMUNICATION **3.0: 3 cr. E**

This course is designed to provide students with an understanding of the working principles of satellite communications and the technologies involved. Topics covered include: introduction to satellite and radar communication, orbital aspects of satellite communication, satellite link design, multiple access methods (FDMA, TDMA, CDMA, FCMA), and systems examples (satellite TV, VSAT applications, mobile to satellite communication).

ELEN 574 OPTICAL WDM NETWORKS **3.0: 3 cr. E**

This course is designed to provide students with an understanding of the working principles and challenges of optical networks. Topics covered include: Enabling technologies and building blocks, single-hope networks, multihop networks, optical access networks (like PON, EPON and WDM PON), optical metro networks (including interconnected WDM ring networks and packet communication using tunable WADM), wavelength- routed networks (including routing and wavelength assignment strategies, light path establishment: static (SLE) and dynamic (DLE), fixed and adaptive routing and wavelength assignment strategies using heuristics).

Refer to General Listing of Course Descriptions for:

CPEN XXX
Refer to the Department of Computer Engineering

CSIS XXX
Refer to the Faculty of Arts and Sciences

CSPR XXX
Refer to the Faculty of Arts and Sciences

ENGL XXX
Refer to the Faculty of Arts and Sciences

ENMG XXX
Refer to the Faculty of Engineering

GENG XXX
Refer to the Faculty of Engineering

LISP XXX
Refer to the Faculty of Arts and Sciences

MATH XXX
Refer to the Faculty of Arts and Sciences

MECH XXX
Refer to the Department of Mechanical Engineering

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.