FACULTY OF ENGINEERING

FACULTY LIST

OFFICERS OF THE FACULTY

Salem, Elie	President of the University
Nahas, George	Vice-President for Planning and Educational Relations
Karam, Nadim	Dean of Faculty of Health Sciences, Vice President for Health and Community Relations
Najjar, Michel	Dean for Faculty of Engineering, Vice President for Development, Administration and Public Affairs
Moubayed, Walid	Dean of Admissions and Registration
Ayoub, Olga	Librarian

STAFF OF THE FACULTY

Antoun, Sally	Laboratory Assistant
Bachawati, Makram	Research Assistant
Chedid, Katia	Laboratory Assistant
Daoud, Nassif	Instructor
Fallah, Hala	Laboratory Assistant
Ghorayeb, Fadi	Instructor
Hage Obeid, Marina	Research Assistant
Hanna, Badia	Faculty Secretary
Hilal, Nina	Instructor
Iaaly, Amal	Instructor
Jbeily, Christiane	Laboratory Assistant
Kheir, Michella	Laboratory Assistant
Khoury, Richard	Assistant Instructor
Khoury (El), Vanessa	Research Assistant
Malek, Abdallah	Laboratory Supervisor
Minkara, Rania	Instructor
Moujaes, Nabil	Laboratory Assistant
Murr, Nicolas	Laboratory Assistant Technician
Nakad, Mantoura	Executive Secretary
Semaan, Marie	Instructor
Rouphael, Fadi	Instructor
Sleiman, Mirna	Faculty Secretary
Yaacoub, Tony	Instructor

FACULTY MEMBERS

Abche, Antoine	Ph.D., Biomedical Engineering, Rutgers, The State University of New Jersey, USA.
Abi Aad, Elie	M.S. Petroleum Engineering University of Houston
Akkary, Ghassan	MS, Petroleum Processing, Institute of Petroleum and Gases, Romania.

Alamddine, Abdul-Menhem	M.S.E.S., Computer Engineering, University of Southeastern Louisiana, USA.
Ayoubi, Rafic	Ph.D., Computer Engineering, University of Southwestern Louisiana, USA.
BadaouiEl-Najjar, Maged	Ph.D., Electrical Engineering, Purdue University, USA.
Chalhoub, Elie	Doctor of Engineering, Applied Biomedical Engineering, Cleveland State University, Ohio, USA
Bou Farah, Lama	Ph.D., Advanced Medicine, Neuroscience and Electrophysiology, Australian School of Advanced Mediciene, Macquarie University, NSW, Australia
Chaouk, Hamdi	Ph.D., Aeronautical Engineering, University of Sydney, Australia.
Daaboul, Michel	Ph.D., Fluid Mechanics, University of Poitiers, France.
Daba, Jihad	Ph.D., Electrical Engineering, Purdue University, USA.
Dagher, Issam	Ph.D., Electrical Engineering, University of Central Florida, USA.
Estephane, Jane	Ph.D., Chemistry and Material Science, Claude Bernard (Lyon, France) and Torino (Turin, Italy) Universities.
Fares, Nabil	Ph.D., Civil Engineering, Massachusetts Institute of Technology, Massachusetts, USA.
Gerges, Antoine	Ph.D., Civil Engineering, University of South Florida, USA.
Gerges, Najib	Ph.D., Civil Engineering, University of South Florida, USA.
Haddad, Nicolas	Ph.D., Electrical Engineering, Ohio University, Athens, Ohio.
Haidar, Haissam	Ph.D., Mechanical Engineering, MIT, Cambridge, Massachusetts, USA.
Hamouche, Nakhle	Ph.D., Engineering Mechanics, Mississippi State University, USA.
Hassan(El), Moustapha	Ph.D., Electrical Engineering, University of Bordeaux, France.
Hassan, Nisrine	Ph.D., Chemical Process Engineering, Pierre & Marie Curie University, France.
Honein, Elie	Ph.D., Mechanical Engineering, Stanford University, Stanford, California, USA.
Hoz (El), Mervat	Ph.D., Civil Engineering, The University of Sydney, Australia.
Ibrahim, Farah	Ph.D., Chemistry Université Paris-Sud, France, and the Lebanese University
Inaty, Elie	Ph.D., Optical Communications, Université Laval, Quebec City, Canada.
Issa, Georges	Diplôme D'Ingénieur, Saint Joseph University, Lebanon.

Issa, Ghassan	Diploma, Architecture, University of Athens, Greece.
Jadayel, Oussama	Ph.D., Mechanical Engineering, University of Birmingham, UK.
Karam, Elie	Ph.D., Biomedical Engineering, Rutgers, The State University of New Jersey, USA.
Karam, Walid	Ph.D., Telecommunications Engineering, Ecole Nationale Supérieure des Télécommunications, Paris, France
Khaldi, Mohamad	Ph.D., Electrical Engineering, Pennsylvania State University, USA.
Khalil, Nariman	Ph.D., Civil Engineering, Leeds University, England.
Khazma, Mahmoud	Ph.D., Process Engineering, University of Picardy, Jules Vernes, Amiens, France
Koura, Jessica	M.S., Food Science and Technology, University of Balamand, Lebanon
Krayem, Fadi	Ph.D., Chemical Engineering and Applied Chemistry University of Pierre & Marie Curie, Paris, France
Makhoul, Nisrine	Ph.D., Civil Engineering, Ecole Nationale Supérieure des Arts et Métiers.
Manneh, Rima	Ph.D., Chemical Engineering (Environmental), Ecole Polytechnique de Montréal, Canada.
Mokbel, Chafic	Ph.D., Telecommunications, Ecole Nationale Supérieure des Télécommunications, France.
Moubayed, Walid	Ph.D., Civil Engineering, University of Houston, USA.
Najjar, Michel	Ph.D., Civil Engineering, Oklahoma State University, USA.
Najjar, Samar	Ph.D., Development of Tip Enhanced Raman Spectroscopy (TERS), Université de Bordeaux I, France
Nasr, Karim	Ph.D., Mechanical Engineering, Purdue University, West Lafayette, USA.
Nasr, Sandra	M.S., Interior Architecture, Lebanese University, Lebanon
Nassreddine, Salim	Ph.D., Catalysis and Physical Chemistry, Université Claude Bernard, Lyon, France
Nehme, Gabi	Ph.D., Mechanical Engineering, University of Texas, USA.
Nini, Robert	Ph.D., Civil Engineering, Ecole Centrale de Paris, France.
Raad, Robert	Ph.D., Electrical Engineering, Université Laval, Quebec City, Canada.
Rajeh, Roger	MS, Chemical Engineering, RWTH Aachen, Germany.
Rai, Habib	Ph.D., Mechanical Engineering, The University of Dayton, Ohio, USA.
Rishmany, Jihad	Ph.D., Mechanical Engineering, Ecole Nationale Supérieure d'Ingénieurs de Constructions, Aéronautiques, France.
Rizk, Joe	MS, Civil Engineering, Florida International University, USA.

Saba, Riad	MS, Electrical Engineering, Oklahoma State University, USA.
Saliba, Najib	Ph.D., Structural Engineering, Imperial College, London, UK
Semaan, Nabil	Ph.D., Engineering & Construction Management, Concordia University, Canada.
Salem, Salem	Public Housing Degree, Bowscentrum, Holland. BS, Architecture, University of Texas, USA.
Tawk, Issam	Ph.D., Mechanical Engineering, Université de Toulouse, France.
Youssef, Khaled	Ph.D., Technical Sciences, Moscow Power Institute, Russia.
Zakhem, Elias	MS, Chemical Engineering, Berlin University, Germany.
Zakhem, Henri	Ph.D., Chemical Engineering (Food Quality Control), University of Technology of Compiègne, France.
Zerbe, Hikmat	Ph.D., Structural Engineering, Rice University, Texas, USA

PROGRAMS OF STUDY

The Faculty of Engineering includes:

The Department of Computer Engineering
The Department of Electrical Engineering
The Department of Civil Engineering
The Department of Mechanical Engineering
The Department of Chemical Engineering

The Faculty of Engineering offers two undergraduate programs of study:

A three year program leading to the Bachelor of Science Degree
A five year program leading to the Bachelor of Engineering Degree

In both programs, the sequence of study proceeds from an education in science fundamentals toward training designed to give the student mastery of the principles and arts central to Engineering Science.

The award of the Bachelor of Science (BS) Degree in Engineering indicates that the graduate has acquired the general foundation in a certain branch of engineering. By acquiring the Bachelor of Engineering (BE) Degree, the graduate becomes better prepared and more equipped to begin the professional practice. The graduate may apply to advanced study leading to a Master of Science Degree in Engineering, provided he/she has obtained the required averages in the undergraduate programs of studies, either immediately following the BS degree or after completing the BE degree. The final decision on acceptance to the Master of Science program resides with the Admissions Committee of the Faculty.

The Faculty of Engineering offers the following undergraduate degrees:

Engineering Faculty	Years	Degree	Status
All Engineering Majors	3	BS	Offered
	5	BE	Offered

UNDERGRADUATE PROGRAM

1. ADMISSION REQUIREMENTS

Admission to the undergraduate program in the Faculty of Engineering is normally restricted to the first year. However, in exceptional cases, and with the approval of the Admissions Committee, students transferring from other accredited institutions may be considered for admission on an individual basis provided the following requirements are satisfied:

a- Enrollment quotas are not filled.
b- The applicant attended a reputable university and obtained a minimum average of 70 in at least 20 transferable credits or, has successfully completed one year of study.
c- The applicant's Baccalaureate qualifies him/her for admission to the University.
d- The applicant satisfies the University admission requirements concerning English proficiency.
e- The Faculty Admissions Committee has evaluated the applicant's qualifications for academic success in scientific and engineering subjects and approved the transfer admission.

2. ACADEMIC RULES AND REGULATIONS

A. GRADUATION REQUIREMENTS

Refer to the Graduation Requirements in the General Section.

B. PERMISSION TO TAKE GRADUATE COURSES

A Student is permitted to take Graduate courses if he/she meets the following conditions:

1- Students who are finishing their last 20 credits of Bachelor degree and have an average in major courses of 75 or above are allowed to take a maximum of two master courses, provided that the total number of credits per semester does not exceed 15.

2- Students who are finishing their last 20 credits for the Bachelor degree and have an average in major courses of 75 or below may not take any Master courses.

C. ADMISSION TO THE M.S. PROGRAM

Students who achieve an undergraduate average above 75 but below 80 are accepted in a graduate program on probation.

Students who achieve an undergraduate average of 80 or above are accepted in a graduate program with clear standing.

D. EVALUATION CRITERIA

Refer to Scholastic Standing, General Section, I

E. PASSING GRADE

a- The passing grade to 200-level and 300-level courses is 60.

b- The passing grade to 400-level and 500-level courses is 70.

F. DEAN'S HONOR LIST

To be placed on the Dean's honor list of the semester, a student must:

a- Be a regular full time student registered for at least 12 credits.

b- Have a semester major course average of 85 or above or have a semester general course average of 80 or above and rank in the top 10% of his/her class.

c- Have no failing, withdrawals, or incomplete grades.

d- Have no disciplinary action against him/her.

e- Be deemed worthy by the Dean to be placed on the Honor List.

G. CHANGE OF MAJOR

To transfer from any other Faculty of the University of Balamand to the Faculty of Engineering, the student must have a cumulative average of at least 70 to be eligible for consideration by the Admissions Committee of the Faculty. He/she must have obtained an average in major science courses (determined by the department) of at least 70 with no failures. The Faculty Admissions Committee grants the final approval.

3. LABORATORY CHARGES

A. SUPPLIES

Each student taking laboratory subjects must furnish, at his/her expense, the necessary notebooks, blank forms, lab coat, and similar supplies. For regular students taking prescribed laboratory work, no charge is made for

normal amounts of expendable material used in connection with laboratory subject. Expendable materials are those that are necessarily consumed or rendered unfit for further use in the normal conduct of a laboratory test. If an excessive amount of expendable material is required because of carelessness on the part of the student, the cost of the additional material will be charged to the student or group responsible.

B. DAMAGES

Students will be charged for damage to instruments caused by lack of care. The amount of the charge will be the actual cost of repair, and if the damage results in total loss of the apparatus, adjustment will be made in light of the condition of the instruments. Where there is danger of costly damage, an instructor will be asked to check the set up. When a group does laboratory work, charges for breakage will be divided among the members of the group concerned. The amount of the charge will be stated at the time or as soon as it can be determined.

DEPARTMENT OF COMPUTER ENGINEERING

BACHELOR OF SCIENCES (B.S.) DEGREE

FIRST YEAR
Semester 1

Course Code	Course Title	Credit
CSIS 200	Introduction to Computer Programming	3
CSIS 285	Basic Programming Lab	1
ELEN 201	Instrumentation Lab	1
ENGL 203	English Communication Skills III	3
MATH 200	Calculus I	3
MATH 211	Linear Algebra	3
MECH 211	Engineering Drawing I	1
MECH 221	Engineering Dynamics	3
Total		**18**

FIRST YEAR
Semester 2

Course Code	Course Title	Credit
CPEN 211	Introduction to Digital Logic Design	3
CSIS201	Object-Oriented Programming	3
CSIS 286	Object Oriented Programming Lab	1
ELEN 202	Electrical Simulation and Design	1
ELEN 221	Circuits Analysis I	3
MATH 202	Calculus II	3
MATH 270	Differential Equations	3
Total		**17**

SECOND YEAR
Semester 3

Course Code	Course Title	Credit
CPEN 202	Logic Lab	1
CPEN 212	Logic Circuits	3
CPEN 220	Programming for Engineering Solutions	3
ELEN 222	Signals and Systems Theory	3
ELEN 231	Electronics I	3
ENGL 2xx	English Elective	3
MATH 230	Numerical Analysis I	3
Total		**19**

SECOND YEAR
Semester 4

Course Code	Course Title	Credit
CPEN 213	Microprocessors	3
CPEN 241	Information Networking I	3
CSPR 201	The Formation of Civilization	3

ELEN 303	Circuits Analysis Lab	1
ELEN 304	Electronics Lab	1
LISP 200	Library Use and Research Methods	1
MATH 246	Probability for Engineers	3
MECH 232	Thermodynamics	3
Total		**18**

THIRD YEAR
Semester 5

Course Code	**Course Title**	**Credit**
	Track Elective (*)	3
CPEN 305	Microcontrollers Lab	1
CPEN 307	PLC Lab	1
CPEN 309	Embedded Controllers Lab	1
CPEN 313	Computer Embedded System	3
CPEN 324	Programmable Logic Controllers	3
CSPR 202	The Religious Experience: The Sacred	3
ELEN 341	Telecommunications	3
GENG 290	Introduction to the Engineering Design Process	1
Total		**19**

THIRD YEAR
Semester 6

Course Code	**Course Title**	**Credit**
	Track Elective (*)	3
CPEN 308	Electronics Design Automation (EDA) Lab	1
CPEN 341	Cybersecurity	3
CSIS 221	Operating Systems	3
CSPR 203	Introduction to Modernity	3
ELEN 306	Telecommunications Lab	1
ELEN 326	Digital Signal Processing	3
GENG 390	Senior Project Design	1
Total		**18**

Total credits **109**

Track Electives (2 courses based on selected track):

(*) Telecommunications and Networking Track (OE Students):

Course Code	**Course Title**	**Credit**
ELEN 223	Electricity and Electromagnetism	3
ELEN 340	Signal Transmission	3

(*) Computer Hardware and Software Track:

Course Code	**Course Title**	**Credit**
CPEN 314	Computer Architecture	3
CSIS 270	Database	3

(*) Cyber Systems Track:

Course Code	Course Title	Credit
CPEN 347	Teletraffic	3
CSIS 270	Database	3

(*) Mechatronic Systems Track:

Course Code	Course Title	Credit
CPEN 324	Programming Logic Controllers	3
CPEN 313	Computer Embedded Systems	3

(*) Robotics and Mechatronics Track:

Course Code	Course Title	Credit
ELEN 324	Circuits Analysis II	3
ELEN 350	Control Systems	3

DEPARTMENT OF COMPUTER ENGINEERING

BACHELOR OF ENGINEERING (B.E.) DEGREE

FIRST YEAR
Semester 1

Course Code	Course Title	Credit
CSIS 200	Introduction to Computer Programming	3
CSIS 285	Basic Programming Lab	1
ELEN 201	Instrumentation Lab	1
ENGL 203	English Communication Skills III	3
MATH 200	Calculus I	3
MATH 211	Linear Algebra	3
MECH 211	Engineering Drawing I	1
MECH 221	Engineering Dynamics	3
Total		**18**

FIRST YEAR
Semester 2

Course Code	Course Title	Credit
CPEN 211	Introduction to Digital Logic Design	3
CSIS 201	Object-Oriented Programming	3
CSIS 286	Object Oriented Programming Lab	1
ELEN 202	Electrical Simulation and Design	1
ELEN 221	Circuits Analysis I	3
MATH 202	Calculus II	3
MATH 270	Differential Equations	3
Total		**17**

SECOND YEAR
Semester 3

Course Code	Course Title	Credit
CPEN 202	Logic Lab	1
CPEN 212	Logic Circuits	3
CPEN 220	Programming for Engineering Solutions	3
ELEN 222	Signals and Systems Theory	3
ELEN 231	Electronics I	3
ENGL 2xx	English Elective	3
MATH 230	Numerical Analysis I	3
Total		**19**

SECOND YEAR
Semester 4

Course Code	Course Title	Credit
CPEN 213	Microprocessors	3
CPEN 241	Information Networking I	3
CSPR 201	The Formation of Civilization	3
ELEN 303	Circuits Analysis Lab	1
ELEN 304	Electronics Lab	1
LISP 200	Library Use and Research Methods	1
MATH 246	Probability for Engineers	3
MECH 232	Thermodynamics	3
Total		**18**

THIRD YEAR
Semester 5

Course Code	Course Title	Credit
	Track Elective (*)	3
CPEN 305	Microcontrollers Lab	1
CPEN 307	PLC Lab	1
CPEN 309	Embedded Controllers Lab	1
CPEN 313	Computer Embedded System	3
CPEN 324	Programmable Logic Controllers	3
CSPR 202	The Religious Experience: The Sacred	3
ELEN 341	Telecommunications	3
GENG 290	Introduction to the Engineering Design Process	1
		19

THIRD YEAR
Semester 6

Course Code	Course Title	Credit
	Track Elective (*)	3
CPEN 308	Electronics Design Automation (EDA) Lab	1
CPEN 341	Cybersecurity	3
CSIS 221	Operating Systems	3
CSPR 203	Introduction to Modernity	3
ELEN 306	Telecommunications Lab	1
ELEN 326	Digital Signal Processing	3
Total		**17**

Track Electives (2 courses based on selected track):

(*) Telecommunications and Networking Track (OE Students):

Course Code	Course Title	Credit
ELEN 223	Electricity and Electromagnetism	3
ELEN340	Signal Transmission	3

(*) Computer Hardware and Software Track:

Course Code	Course Title	Credit
CPEN 314	Computer Architecture	3
CSIS 270	Database	3

(*) Cyber Systems Track:

Course Code	Course Title	Credit
CPEN 347	Teletraffic	3
CSIS 270	Database	3

(*) Robotics and Mechatronics Systems Track:

Course Code	Course Title	Credit
CPEN 324	Programming Logic Controllers	3
CPEN 313	Computer Embedded Systems	3

FOURTH YEAR
Semester 7

Course Code	Course Title	Credit
	Core Course 1	3
	Core Course 2	3
	Directed Elective	3
	Track Course	3
	Track Course	3
Total		**15**

FOURTH YEAR
Semester 8

Course Code	Course Title	Credit
GENG 400	Engineering Seminars	1
GENG 490	Graduation Project	3
	Directed Elective	3
	Track Course	3
	Track Course	3
Total		**13**

FOURTH YEAR
Semester 9 (Summer)

Course Code	Course Title	Credit
GENG 480	Field Training	3

FIFTH YEAR

Semester 10

Course Code	Course Title	Credit
GENG 490	Graduation Project (Reactivation)	0
	Elective Lab	1
	Track Course	3
	General Elective	3
Total		**7**

(**) Elective Lab (one from the following list):

Course Code	Course Title	Credit
CPEN 309	Embedded Controllers Lab	1
ELEN 305	Digital Signal Processing Lab	1
CPEN 310	Cybersecurity Lab	1

Total credits **109**

FACULTY REQUIRED COURSES (8 Credits)

Course Code	Course Title	Credit
GENG 480	Field Training	3
GENG 400	Engineering Seminars	1
GENG 490	Graduation Project	3

CORE REQUIRED COURSES (6 Credits from the following Core list)

Course Code	Course Title	Credit
ELEN 400	Linear Systems	3
ELEN 401	Optimization Theory	3
ELEN 402	Stochastic Theory and Estimation and Detection	3

TRACK COURSES (15 Credits from the following Tracks list):

(*) Hardware and Software Track

Course Code	Course Title	Credit
CPEN 417	Advanced Computer Hardware	3
CPEN 427	Advanced Hardware Applications	3
CPEN 432	Parallel Programming	3
CPEN 528	Machine Vision	3
CSIS 375	Software Engineering	3
CPEN 551	Switching Theory	3
CSIS 320	Advanced Operating Systems	3
ELEN 525	Mobile Robots	3

(*) Cyber Systems Track

Course Code	Course Title	Credit
CPEN 442	Network Programming	3
CPEN 445	Biometrics	3

CPEN 446	Network Management and Security	3
CSIS 375	Software Engineering	3
CPEN 447	Advanced Teletraffic	3
CPEN 448	Cloud Computing and Big Data	3
CPEN 546	Wireless and Mobile Networks	3
CPEN 549	Intelligent Networks	3

(*)Robotics and Mechatronics Track

Course Code	**Course Title**	**Credit**
CPEN 452	Advanced Microcontroller Applications	3
CPEN 425	Neural Networks Design	3
ELEN 411	Mechatronics Systems	3
ELEN 431	Specialty Machinery	3
ELEN 466	Industrial Intelligent Networks	3
ELEN 525	Mobile Robots	3
ELEN 527	Fuzzy Logic	3
MECH 513	Robotics	3

(*) Telecommunications and Networking Track

Course Code	**Course Title**	**Credit**
CPEN 442	Network Programming	3
CPEN 546	Wireless Networks	3
ELEN 441	Information Theory and Error Correction	3
ELEN 472	Fiber Optic Communication Systems	3
ELEN 542	Wireless Communication Systems	3
ELEN 572	Satellite and Radar Communication	3
CSIS 375	Software Engineering	3
ELEN 574	Optical WDM Networks	3

DIRECTED ELECTIVE (6 Credits from the following list):

Course Code	**Course Title**	**Credit**
CPEN 441	Information Networking II	3
CSIS 375	Software Engineering	3
ELEN 443	Digital Communication	3

GENERAL ELECTIVE (3 Credits from the following list):

Course Code	**Course Title**	**Credit**
CPEN 425	Neural Networks Design	3
CPEN 452	Advanced Microcontroller Applications	3
CPEN 545	Cryptography	3
CSIS 374	Advanced Database Applications	3
ELEN 446	Telecom Electronics	3
ELEN 459	Engineering Image Processing	3
ELEN 525	Mobile Robots	3
ENMG411	Engineering Economy and Management	3
ENMG420	Financial Engineering	3
ENMG460	Decision and Risk Management	3
ENMG555	Decision and Planning of Engineering Systems	3
ENMG585	Quality Assurance and Quality Control	3
GENG 402	Project Management	3
MECH 513	Robotics	3

COURSE DESCRIPTIONS

CPEN 202 LOGIC LAB **0.3: 1 cr. E**
This laboratory provides an introduction to analysis and design of digital circuits and systems; combinational logic; sequential logic; MSI circuits; and selected topics in more advanced areas.
Co-requisite: CPEN 212.

CPEN 211 INTRODUCTION TO DIGITAL LOGIC DESIGN **3.0: 3 cr. E**
This course covers number Systems; Boolean algebra; Karnaugh maps; logic gates; combinational and sequential circuit design; adders; multiplexers; flip-flops; counters; shift registers.
Pre-requisite: CSIS 200 (or CSIS 206) and MATH 211.

CPEN 212 LOGIC CIRCUITS **3.0: 3 cr. E**
This course covers combinational logic design using MSI and LSI integrated circuits; sequential circuit analysis and design; state-machine design; registers; counters, and memory system analysis and design; register-transfer logic design techniques based on CPLD and FPGA technologies. Pre-requisites: CPEN 211 and ELEN 221.

CPEN 213 MICROPROCESSORS **3.0: 3 cr. E**
This course covers the microprocessor architecture and assembly language: building blocks of microprocessors, memories, input/output circuits; bus structures; software development for microprocessors; instruction sets, assembler; development tools; addressing structures; interfacing peripherals and input/output processing techniques; interface devices, interfacing input/output devices, microprocessor interrupt structures, direct memory access; 16 and 32 bit microprocessors; micro-controllers. Prerequisite: CPEN 212 and ELEN 231.

CPEN 220 PROGRAMMING FOR ENGINEERING SOLUTIONS **3.0: 3 cr. E**
The purpose of this course is to provide the students with proficient skills in designing engineering simulations to solve electrical and computer problems using C and Mathworks-MATLAB.
Co-requisite: MATH 230;
Pre-requisite: CSIS 206.

CPEN 241 INFORMATION NETWORKING I **3.0: 3 cr. E**
Networks and Open Systems Intercommunication (OSI) reference model. Standards organizations. Functionality, principal entities of protocol in physical link, network, transport, and session of applications layer.

CPEN 305 MICROCONTROLLERS LAB **0.3: 1 cr. E**
This laboratory applies the theory of both switching and dynamical control. Switching control includes Microprocessor hardware analysis, timing, and design, Microcontroller, and Programmable IC. Dynamical control includes system modeling, analysis, and control (PID, phase compensation, optimal control). Prerequisites: CPEN 202, 213.

CPEN 307 PLC LAB **0.3: 1 cr. E**
This Lab covers applications on the uses of Programmable Logic Controller (PLC); Programming Logic, Memory organization, Relay Logic Ladder Diagram (RLLD), Instruction List Programming (ILP), State Based Design (SBD), Sequential Function Charts/Grafcet (SFC), Function Block Programming (FBP), Program Control Instructions, Timers, Counters, Data Manipulation, Sequencers; Project Design.
Co-requisite: CPEN 324.

CPEN 308 ELECTRONIC DESIGN AUTOMATION LAB **0.3: 1 cr. E**
Electronic Design Automation (EDA) tools are used to design large-scale logic circuits with emphasis on

hardware implementation using FPGA technology. Lab assignments are based on Verilog Hardware Description language, where students design, simulate, synthesize, and download to FPGA-based boards using the same commercial EDA tools for all these steps.

CPEN 309 EMBEDDED CONTROLLERS LAB **0.3: 1 cr. E**
This lab covers experiments on Arduino platform or equivalent embedded system tools and techniques. The students will apply different applications of embedded system design and programming.

CPEN 312 ALGORITHM ORGANIZARION AND DESIGN **3.0: 3 cr. E**
This course presents an introduction to the techniques for designing efficient computer algorithms and analyzing their running times. General topics include asymptotics, solving summations and recurrences, algorithm design techniques, analysis of data structures, and introduction to NP-completeness.

CPEN 313 COMPUTER EMBEDDED SYSTEMS **3.0: 3 cr. E**
This course focus on learning to design and program embedded systems is a critical skill that is necessary for many industry and scientific jobs. In this course you will learn the basics of designing, interfacing, configuring, and programming embedded systems. Arduino platform or equivalent embedded system will be used to help the students to master different applications of embedded system design and programming.

CPEN 314 COMPUTER ARCHITECTURES **3.0: 3 cr. E**
The goal of this course is to develop an understanding of hardware and software structure of modern computer systems. The central ideas of computer organization and design are covered with emphasis on processor architecture implementation, the relationship between hardware and software, and the basic design trade-offs employed in contemporary computer systems.
Prerequisite: CPEN 213.

CPEN 317 COMPUTER HARDWARE DESIGN **3.0: 3 cr. E**
This course covers the specification and design of RISC-based microprocessor, taking into account such factors as cost versus performance. Details of ALU, floating points units, data path (unpipelined and pipelined), control units based on state diagrams and microprogramming, and techniques for peripheral interfacing.
Prerequisite: CPEN 213.

CPEN 324 PROGRAMMABLE LOGIC CONTROLLERS **3.0: 3 cr. E**
This course covers the understanding and uses of Programmable Logic Controller (PLC); Programming devices, Memory organization, LADDER diagram, Relay type instructions, Program Control Instructions, Timers, Counters, Data Manipulation, Sequencers; Project design.
Co-requisite: CPEN 307.

CPEN 341 CYBERSECURITY **3.0: 3 cr. E**
This course introduces students to the interdisciplinary field of cybersecurity by discussing the evolution of information security into cybersecurity, cybersecurity theory, and the relationship of cybersecurity to nations, businesses, society, and people. Students will be exposed to multiple cybersecurity technologies, processes, and procedures, learn how to analyze the threats, vulnerabilities and risks present in these environments, and develop appropriate strategies to mitigate potential cybersecurity problems.

CPEN 346 BASICS OF COMPUTER SECURITY **3.0: 3 cr. E**
This introductory course builds on computer network and computer system concepts to create a feel for how information and respective information systems are best secured from threats. This general goal is addressed through creating an understanding of information security management best practices based on computer security known vulnerabilities and attack vectors in the framework of a typical organization.

CPEN 347 TELETRAFFIC **3.0: 3 cr. E**

This subject exposes students to theoretical and practical aspects of modern communication network design, including teletraffic engineering and network performance modeling. It covers an overview of relevant stochastic traffic modeling, traffic characterization, traffic measurement techniques, network dimensioning principles, queuing theory and its application to performance evaluation of networks. Students analyze practical examples of network dimensioning for capacity and network performance evaluation using simulation software packages.

Prerequisite: CSIS 222.

CPEN 417 ADVANCED COMPUTER HARDWARE **3.0: 3 cr. E**

A quantitative study of RISC architecture; advanced pipelining techniques and instruction-level parallelism (ILP): static vs. dynamic scheduling, Tomasulo's algorithm, hardware-based speculation, branch prediction, thread-level parallelism and multiprocessing; memory hierarchy design; storage systems.

CPEN 425 NEURAL NETWORKS DESIGN **3.0: 3 cr. E**

Neural dynamics: architecture and signals, activation model, unsurprised learning, surprised learning, architectures and equilibrium. The Hopfield model and recurrent networks. The self- organizing map. Adaptive resonance theory.

CPEN 427 ADVANCED HARDWARE APPLICATIONS **3.0: 3 cr. E**

Advanced logic design topics are covered: Synchronous vs. asynchronous state machines; timing issues such as metastability, hazards, skewing; techniques to improve performance: parallelism, pipelining techniques; high-speed digital units: fast adders, multipliers, etc; VHDL vs. Verilog hardware description languages. These concepts will be enforced through a system-level project.

CPEN 432 PARALLEL PROGRAMMING **3.0: 3 cr. E**

This course examines how to program parallel processing systems. Various parallel algorithms are presented to demonstrate different techniques for mapping tasks onto parallel machines. Parallel architectures to be considered are: SIMD (synchronous), MIMD (asynchronous), and mixed-mode (SIMD/MIMD hybrid). Emphasis will be on MPI parallel programming language.

CPEN 441 INFORMATION NETWORKING II **3.0: 3 cr. E**

Design of protocols for error recovery, reliable delivery, routing, and congestion control. Store-and-forward networks, satellite networks, local-area networks, and locally distributed systems. Case studies of networks, protocols, and protocol families. Emphasis on software design issues in computer communication.

CPEN 442 NETWORKING PROGRAMMING **3.0: 3 cr. E**

This course gives the students a fundamental knowledge and hands-on exercise of the UNIX networking software design and client/server applications development. Topics include the TCP/IP model, UNIX model, communication protocols, Berkeley sockets, Unix transport layer interface (TCP and UDP), client and server software design, introduction to Remote Procedure Calls, and network applications development.

CPEN 445 BIOMETRICS **3.0: 3 cr. E**

Biometrics has emerged from the specialized use in the forensics domain to a more mainstream use for computer authentication, identification document security, and surveillance for public safety. This course introduces the emerging area of biometrics and its challenges, with applications using MATLAB/OCTAVE. Topics include: Identity recognition (verification, identification), biometric modalities (Face, fingerprint, voice, iris, hand geometry, etc.), performance measurement evaluation and reliability, multimodal biometric recognition (fusion, score normalization), biometric security, biometric privacy, imposture.

CPEN 446 NETWORK MANAGEMENT AND SECURITY **3.0: 3 cr. E**

This course is an introduction to network management and security. Topics include TMN concepts such as TMN definition, different TMN architectures, interfaces and reference points, as well as management protocols used in TMN such as ACSE, CMISE, SNMPv1, SNMPv2, and SNMPv3. Topics related to computer security will be also covered like encryption, digital signatures, s-http, ssl, Kerberos, and firewall.

CPEN 447 ADVANCED TELETRAFFIC **3.0: 3 cr. E**

This course exposes students to source characterization of bursty sources (video, audio) through stochastic modeling of bursty traffic. The theory is illustrated through simulated results from the research literature. Students are also given computer projects to simulate bursty traffic sources. A major portion of the course is devoted to performance evaluation of networks using advanced queueing theory. The course will also treat traffic management and control in ATM networks, statistical multiplexing, dimensioning of cellular networks, and frame relay dimensioning. Prerequisite: ELEN 443.

CPEN 448 CLOUD COMPUTING AND BIG DATA **3.0: 3 cr. E**

This course provides a hands-on comprehensive study of Cloud concepts and capabilities across the various Cloud service models with a detailed study the evolution of infrastructure migration approaches from VMWare/ Xen/KVM virtualization, to adaptive virtualization, and Cloud Computing / on-demand resources provisioning. Mainstream Cloud infrastructure services and related vendor solutions are also covered in detail. The course also covers the Cloud security model and associated challenges and delves into the implementation and support of High Performance Computing and Big Data support capabilities on the Cloud.

CPEN 452 ADVANCED MICROCONTROLLER APPLICATIONS **3.0:3 cr. E**

The course is intended to enhance your knowledge in the area of microcontrollers through an in-depth coverage of the dsPIC30F Digital Signal Controller. The emphasis will be on: efficient software design techniques, on-chip I/O subsections and advanced peripheral devices. By the end of the course, students are expected to design, build and prototype a full-blown system. Typical applications include the following areas: control, telecommunications, data acquisition, telemetry, power electronics, instrumentation, etc.
Prerequisite: ELEN 400.

CPEN 480 FIELD TRAINING **2.0: 4 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.

CPEN 481 DATABASE PROGRAMMING **3.0: 3 cr. E**

This course introduces to engineering students the database concepts. It describes the different steps involved in the process of database development. It covers data modeling with emphasis on rational model, normalization, entity-relationship modeling, application design, SQL, and the implementation for personal and multi-user databases. Client-server systems are also discussed with the associated security issues, as part of the described architecture. A detailed study of database technologies is part of the course in order to provide the student with the maximum ability to accomplish a database project.

CPEN 500 RESEARCH METHODLOGIES IN COMPUTER ENGINEERING **3.0: 3 cr. E**

The Research Methodologies combines lectures and seminars designed to provide opportunities for professional development of graduate students, raise their awareness of various other issues that they may face in their professional careers, and provide them opportunities to survey research seminars of their interest.

CPEN 528 MACHINE VISION **3.0: 3 cr. E**

The purpose of this course is to introduce the students to fundamental techniques for low level and high level

computer vision. Topics include image formation, early processing, boundary detection, image segmentation, texture analysis, shape from shading, photometric stereo, motion analysis via optic flow, object modeling, shape description, and object recognition. Models of human vision, subjective contours, visual illusions, apparent motion, mental rotations, cyclopean vision.

CPEN 545 CRYPTOGRAPHY **3.0: 3 cr. E**

This course aims to introduce the students to cyptography in its algorithmic sides. The course starts with a definition of cryptosystems using simple examples (shift cipher, affine cipher, hill ciper, Vigenère cipher…). A small review of Shanon theory is then performed. Bulk encryption is detailed with a focus on Data Encryption Standard (DES) and its variants. Afterwards, public-key cryptosystems are studied (Diffie-Hellman, RSA, …). Attacks on both classes of cryptosystems are presented. The final part of the course is relative to hashing algorithms (MD4, MD5, …). At the end of the course, students will become aware of cryptography and of the strength and weakness of every cryptosystem.
Prerequisite: ELEN 402.

CPEN 546 WIRELESS AND MOBILE NETWORKS **3.0: 3 cr. E**

Wireless technologies are constantly changing. Third generation cellular technologies, such as UMTS and EDGE, are rapidly replacing older second generation systems such as GSM and GPRS. As an indication of the rapid evolution of wireless technologies, are the plans for a fourth generation wireless technology to replace 3G before it is even universally widespread. While this course expose pertinent current and futuristic wireless systems, its main aim is to equip students with the essential principles of wireless networks at the network layers that will keep them on the cutting edge of telecommunication advancement, regardless of how the technology changes. The course features a thorough treatment of widespread cellular (GSM, GPRS, 3G-UMTS, EDGE), WLAN (Wi-Fi), WMAN (Wi-Max), and WPAN (bluetooth, UWB) systems. The course concludes with an overview of future IPv6-based 4th generation networks that promise to be homogenous and seamless.

CPEN 549 INTELLIGENT NETWORKS **3.0: 3 cr. E**

In public telecommunication networks, telephone network and wireless network, the control and services offering is one of the most important issues for successful service providing. The concept of intelligent networks has been introduced in the last 1980s to permit an easy and efficient development and deployment of services for such networks. Intelligent networks will be presented in details in this course. The underlying communication protocols (INAP) will be described. Those presentations will cover intelligent networks for both fixed and wireless telephone networks. Students must have a good knowledge of networking principles and general telecommunication concepts in order to attend this course.
Prerequisite: ELEN 443, and CSIS 321.

CPEN 551 SWITCHING THEORY **3.0: 3 cr. E**

This course covers finite-state sequential machine theory and design, state identification, state minimization in incompletely specified tables, partition theory, decomposition of machines, asynchronous machine design and test methodologies for improving testability and combinational and sequential digital systems.
Prerequisite: CPEN 417.

CPEN 552 VLSI **3.0: 3 cr. E**

The purpose of this course is to introduce students to the topic of CMOS technology in VLSI. Implementations in CMOS will be discussed starting from CMOS inverters and basic gates all the way to multiplexers, decoders, ALUs, registers, memories, sequential circuits, etc. Other topics include propagation delay, noise margins, and power dissipation. Speed, area, and power optimization are discussed. CAD Tools for layout, extraction, and simulation are used.
Prerequisite: CPEN 551.

CPEN 554 PARALLEL PROCESSING **3.0: 3 cr. E**
The design of large-scale parallel processing systems: Synchronous (SIMD) and asynchronous (MIMD) machine organizations, single stage, and multistage interconnection networks are covered. Various parallel algorithms are presented to demonstrate different techniques for mapping tasks onto parallel machines.

ELEN Courses
Refer to the Department of Electrical Engineering.

GENG 290, 390, and 391
Refer to Faculty of Engineering – General Requirement Courses

CSIS 200, 201, 202, 206, 221, 270, 320, 374, 375
Refer to Faculty of Sciences, Department of Computer Science.

CSPR 201, 202, 203
Refer to Faculty of Arts and Social Sciences, Cultural Studies Program.

ENGL 203 and Elective
Refer to Faculty of Arts and Social Sciences, Department of English Language and Literature.

GENG 311, 402, 590, 599
Refer to Faculty of Engineering Requirements.

LISP 200
Refer to Faculty of Library and Information Studies.

MECH 513
Refer to Department of Mechanical Engineering.

MATH 200, 202, 211, 230, 246, 270
Refer to Faculty of Sciences, Department of Mathematics.

MECH 211, 221, 232, 233
Refer to Department of Mechanical Engineering.

DEPARTMENT OF ELECTRICAL ENGINEERING

BACHELOROF SCIENCE (BS) DEGREE

FIRST YEAR
Semester 1

Course Code	Course Title	Credit
CSIS 206	Programming For Engineers	3
ELEN 201	Instrumentation Lab	1
ENGL 203	English Communication. Skills III	3
MATH 200	Calculus I	3
MATH 211	Linear Algebra	3
MECH 211	Mechanical Drawing I	1
MECH 221	Engineering Dynamics	3
Total		**17**

FIRST YEAR
Semester 2

Course Code	Course Title	Credit
CPEN 211	Introduction to Digital Logic Design	3
ELEN 202	Electrical Simulation and Design	1
ELEN 221	Circuits Analysis I	3
ENGL 2xx	English Elective	3
MATH 202	Calculus II	3
MATH 270	Differential Equations	3
MECH 232	Thermodynamics	3
Total		**19**

SECOND YEAR
Semester 3

Course Code	Course Title	Credit
CPEN 202	Logic Lab	1
CPEN 212	Logic Circuits	3
CPEN 220	Programming for Engineering Solutions	3
ELEN 222	Signals and Systems Theory	3
ELEN 223	Electricity and Electromagnetism	3
ELEN 231	Electronics I	3
MATH 230	Numerical Analysis I	3
Total		**19**

SECOND YEAR
Semester 4

Course Code	Course Title	Credit
CPEN 213	Microprocessors	3
CSPR 201	The Formation of Civilization	3
ELEN 303	Circuits Analysis Lab	1
ELEN 304	Electronics Lab	1
ELEN 324	Circuits Analysis II	3

ELEN 332	Electronics II	3
LISP 200	Library Use and Research Methods	1
MATH 246	Probability for Engineers	3
Total		**18**

THIRD YEAR
Semester 5

Course Code	**Course Title**	**Credit**
	Track Elective (*)	3
CPEN 305	Microcontrollers Lab	1
CSPR 202	The Religious Experience: The Sacred	3
ELEN 307	Control Lab	1
ELEN 341	Telecommunications	3
ELEN 350	Control Systems	3
ELEN 361	Electric Machines	3
GENG 290	Introduction to the Engineering Design Process	1
Total		**18**

THIRD YEAR
Semester 6

Course Code	**Course Title**	**Credit**
	Track Elective (*)	3
CSPR 203	Introduction to Modernity	3
ELEN 306	Telecommunications Lab	1
ELEN 308	Electric Machines Lab	1
ELEN 325	Electrical Installation	3
ELEN 326	Digital Signal Processing	3
ELEN 362	Power Electronics	3
GENG 390	Senior Project Design	1
Total		**18**
Total credits		**109**

TRACK ELECTIVES (2 COURSES BASED ON SELECTED TRACK):

(*) Biomedical Track (OE Students):

Course Code	**Course Title**	**Credit**
BMEN 301	Introduction to Biomedical Engineering	3
GENG 311**	Engineering Management and Economy	3

** Can be replaced upon advisor approval

(*) Telecommunications and Networking Track (EE Students):

Course Code	**Course Title**	**Credit**
CPEN 241	Information Networking I	3
ELEN340	Signal Transmission	3

(*) Robotics and Mechatronics Track:

Course Code	Course Title		Credit
CPEN 324	Programming Logic Controllers	3	
CPEN 313	Computer Embedded Systems	3	

(*) Power and Control Track:

Course Code	Course Title	Credit
CPEN 241	Information Networking I	3
ELEN340	Signal Transmission	3

DEPARTMENT OF ELECTRICAL ENGINEERING

BACHELOR OF ENGINEERING (BE) DEGREE

FIRST YEAR

Semester 1

Course Code	Course Title	Credit
CSIS 206	Programming for Engineers	3
ELEN 201	Instrumentation Lab	1
ENGL 203	English Communication Skills III	3
MATH 200	Calculus I	3
MATH 211	Linear Algebra	3
MECH 211	Engineering Drawing I	1
MECH 221	Engineering Dynamics	3
Total		**17**

FIRST YEAR

Semester 2

Course Code	Course Title	Credit
CPEN 211	Introduction to Digital Logic Design	3
ELEN 202	Electrical Simulation and Design	1
ELEN 221	Circuits Analysis I	3
ENGL 2xx	English Elective	3
MATH 202	Calculus II	3
MATH 270	Differential Equations	3
MECH 232	Thermodynamics	3
Total		**19**

SECOND YEAR

Semester 3

Course Code	Course Title	Credit
CPEN 202	Logic Lab	1
CPEN 212	Logic Circuits	3
CPEN 220	Programming for Engineering Solutions	3
ELEN 222	Signals and Systems Theory	3
ELEN 223	Electricity and Electromagnetism	3
ELEN 231	Electronics I	3
MATH 230	Numerical Analysis I	3
Total		**19**

SECOND YEAR
Semester 4

Course Code	Course Title	Credit
CPEN 213	Microprocessors	3
CVSQ 201	The Formation of Civilization	3
ELEN 303	Circuits Analysis Lab	1
ELEN 304	Electronics Lab	1
ELEN 324	Circuits Analysis II	3
ELEN 332	Electronics II	3
LISP 200	Library Use and Research Methods	1
MATH 246	Probability for Engineers	3
Total		**18**

THIRD YEAR
Semester 5

Course Code	Course Title	Credit
	Track Elective (*)	3
CPEN 305	Microcontrollers Lab	1
CVSQ 202	The Religious Experience: The Sacred	3
ELEN 307	Control Lab	1
ELEN 341	Telecommunications	3
ELEN 350	Control Systems	3
ELEN 361	Electric Machines	3
GENG 290	Introduction to the Engineering Design Process	1
Total		**18**

THIRD YEAR
Semester 6

Course Code	Course Title	Credit
	Track Elective (*)	3
CVSQ 203	Introduction to Modernity	3
ELEN 306	Telecommunications Lab	1
ELEN 308	Electric Machines Lab	1
ELEN 325	Electrical Installation	3
ELEN 326	Digital Signal Processing	3
ELEN 362	Power Electronics	3
Total		**17**

TRACK ELECTIVES(2 COURSES BASED ON SELECTED TRACK):

(*) Biomedical Track (OE Students):

Course Code	Course Title	Credit
BMEN 301	Introduction to Biomedical Engineering	3
GENG 311**	Engineering Management and Economy	3

(**) Can be replaced upon advisor approval

(*) Telecommunications and Networking Track (EE Students):

Course Code	Course Title	Credit
CPEN 241	Information Networking	3
ELEN340	Signal Transmission	3

(*) Power and Control Track:

Course Code	Course Title	Credit
CPEN 324	Programming Logic Controllers	3
ELEN 351	Digital Control Systems	3

(*) Robotics and Mechatronics Track:

Course Code	Course Title	Credit
CPEN 324	Programming Logic Controllers	3
CPEN 313	Computer Embedded Systems	3

FOURTH YEAR

Semester 7

Course Code	Course Title	Credit
	Core Course 1	3
	Core Course 2	3
	Directed Elective	3
	Directed Elective	3
	Track Course	3
Total		**15**

FOURTH YEAR

Semester 8

Course Code	Course Title	Credit
GENG 400	Engineering Seminars	1
GENG 490	Graduation Project	3
	Track Course	3
	Track Course	3
	Track Course	3
Total		**13**

FOURTH YEAR

Semester 9 (Summer)

Course Code	Course Title	Credit
GENG 480	Field Training	3
Total		**3**

FIFTH YEAR

Semester 10

Course Code	Course Title	Credit
GENG 490	Graduation Project (Reactivation)	0
	Elective Lab**	1

	General Elective	3
	Track Course	3
Total		**7**
Total credits		**109**

(**) Elective Lab (one from the following list):

Course Code	Course Title	Credit
CPEN 307	Programming Logic Controllers Lab	1
ELEN 305	Digital Signal Processing Lab	1
ELEN 309	Power Electronic and Drives Lab	1

FACULTY REQUIRED COURSES (8 CREDITS)

Course Code	Course Title	Credit
GENG 480	Field Training	3
GENG 400	Engineering Seminars	1
GENG 490	Graduation Project	3

CORE REQUIRED COURSES (6 Credits from the following Core list)

Course Code	Course Title	Credit
ELEN 400	Linear Systems	3
ELEN 401	Optimization Theory	3
ELEN 402	Stochastic Theory and Estimation and Detection	3

TRACK COURSES (15 Credits from the following Tracks list):

(*) Biomedical Track (OE Students):

Course Code	Course Title	Credit
BMEN 401	General Human Physiology	3
BMEN 460	Biomaterials	3
BMEN 461	Physiological Control Systems	3
BMEN 466	Circulatory Dynamics	3
BMEN 467	Biomechanics	3
BMEN 565	Physiological Modeling	3
ELEN 462	Biomedical Instrumentation I	3
ELEN 463	Medical Imaging I	3
ELEN 562	Biomedical Instrumentation II	3
ELEN 564	Medical Imaging II	3

(*) Power and Control Track

Course Code	Course Title	Credit
ELEN 431	Power Systems Protection and Reliability	3
ELEN 432	Advanced Power Electronics	3
ELEN 435	Advanced Electric Machines	3
ELEN 523	Optimal Control Systems	3
ELEN 525	Mobile Robots	3
ELEN 527	Fuzzy Logic	3
ELEN 536	Power Systems Control	3
ELEN 537	Power Systems II	3
ELEN 539	Power Quality	3

(*) Telecommunications and Networking Track

Course Code	Course Title	Credit
CPEN 441	Information Networking II	3
CPEN 442	Network Programming	3
CPEN 546	Wireless and Mobile Networks	3
ELEN 441	Information Theory and Error Correction	3
ELEN 443	Digital Communication	3
ELEN 472	Fiber Optic Communication Systems	3
ELEN 542	Wireless Communication Systems	3
ELEN 572	Satellite and Radar Communication	3
ELEN 574	Optical WDM Networks	3

(*) Robotics and Mechatronics Track Track

Course Code	Course Title	Credit
CPEN 452	Advanced Microcontroller Applications	3
CPEN 425	Neural Networks Design	3
ELEN 411	Mechatronics Systems	3
ELEN 431	Specialty Machinery	3
ELEN 466	Industrial Intelligent Networks	3
ELEN 525	Mobile Robots	3
ELEN 527	Fuzzy Logic	3
MECH 513	Robotics	3

DIRECTED ELECTIVE (6 Credits from the following list):

Course Code	Course Title	Credit
ELEN 417	Measurement Systems	3
ELEN 437	Power Systems I	3
ELEN 443	Digital Communication	3

GENERAL ELECTIVE (3 Credits from the following list):

Course Code	Course Title	Credit
CPEN 425	Neural Networks Design	3
CPEN 452	Advanced Microcontroller Applications	3
ELEN 432	Advance Power Electronics	3
ELEN 446	Telecom Electronics	3
ELEN 459	Engineering Image Processing	3
ELEN 525	Mobile Robots	3
ENMG 411	Engineering Economy and Management	3
ENMG 420	Financial Engineering	3
ENMG 460	Decision and Risk Management	3
ENMG 555	Decision and Planning of Engineering Systems	3
ENMG 585	Quality Assurance and Quality Control	3
GENG 402	Project Management	3
MECH 513	Robotics	3

COURSE DESCRIPTIONS

BMEN 301 INTRODUCTION TO BIOMEDICAL ENGINEERING **3.0: 3 cr. E**
This course provide an overview of applications of engineering in medicine. Topics covered include basic biology and engineering problems associated with living systems and health care delivery; introduction to biomedical problems using fundamental concepts and tools from electrical, mechanical, and chemical engineering. Examples will be used to illustrate how basic concepts and tools of science and engineering can be brought to bear in understanding and simulation of biological processes.

BMEN 401 HUMAN PHYSIOLOGY **3.0: 3 cr. E**
This course covers the human physiological systems: nervous system; cardiovascular system; respiratory system; gastrointestinal system; renal system; skeletal system; muscular system; and some special medical topics, such as exercise physiology.

BMEN 460 BIOMATERIALS **3.0: 3 cr. E**
This course provides understanding of the following topics: Mechanical and electromechanical properties of tissue; properties of biomaterials (chemical, mechanical, immunological…); biomaterial applications (artificial organs, bone/joints replacement, drug delivery…); and other specialized issues.

BMEN 461 PHYSIOLOGICAL CONTROL SYSTEMS **3.0: 3 cr. E**
This course covers the physical, mathematical and chemical bases of control organ system function and the applications of systems and control theory to biological systems; topics include cardiovascular, renal, pulmonary, pharmaco-kinetics, membrane potentials, visual and other systems. These physiological systems are covered with emphasis on the feedback control aspects.

BMEN 466 CIRCULATORY DYNAMICS **3.0: 3 cr. E**
This course covers the mechanics and fluid mechanics of circulatory system; mathematical modeling and experimental methods in circulatory dynamics; invasive and noninvasive measuring techniques. Topics include measurement of blood pressure and flow in arteries and veins, muscle mechanics, models of the heart, microcirculation, the closed cardiovascular system, and cardiac assist devices.

BMEN 467 BIOMECHANICS **3.0: 3 cr. E**
This course presents an integrated approach to the study of human movement. Fundamental mechanical principles will be reviewed, with subsequent application to the major joints and structures of various regions of the human body, resulting in an understanding of and appreciation for total body movement and the integration of biomechanics with other exercise and sport science disciplines.

BMEN 468 PHYSIOLOGICAL TRANSPORT PHENOMENA **3.0: 3 cr. E**
The course provides an introduction to transport phenomena, including the fundamentals of mass, momentum, heat transfer, and mechanical energy balances with their analogies and applications to the analysis of physiological and metabolic systems and the design of artificial tissues and drug delivery systems.

BMEN 563 BIOSIGNAL ANALYSIS **3.0: 3 cr. E**
This course covers topics of wavelet and time-frequency analysis. Applications include pulmonary and respiratory signals, ELENG, ECG, evoked potentials, MRI, X-Rays, mammograms, and other issues.

BMEN 565 PHYSIOLOGICAL MODELING **3.0: 3 cr. E**
This course covers various approaches to the design and use of mathematical models and computer simulations in the quantitative description of physiological systems. A selection will cover some of the following topics: membrane biophysics, neural modeling, cardiovascular system dynamics, respiratory mechanics, and muscle contraction, pharmacokinetics, risk extrapolation techniques, and quantitative cancer modeling.

ELEN 201 INSTRUMENTATION LAB **0.3: 1 cr. E**

This laboratory provides an introduction on the use of multi-meters, oscilloscopes, function generators, power supplies and other instrumentation. Applications include solenoids, resistors, capacitors, periodic signals analysis, RC, RL, and RLC circuits; balanced bridge circuit.

ELEN 202 ELECTRICAL SIMULATION AND DESIGN **0.3: 1 cr. E**

The purpose of this workshop is to provide the students with working knowledge of the use and applications of NI circuit simulation, LabView, and PCB design.
Co-requisite: ELEN 221.

ELEN 221 CIRCUITS ANALYSIS I **3.0: 3 cr. E**

The purpose of this course is to provide the students with basic understanding of electrical circuit theory. Topics covered include fundamental definitions and laws; resistive circuit analysis; mesh and nodal analysis; RL, RC, and RLC circuit analysis; DC/AC analysis; Thevenin and Norton theorems; phasor analysis.
Co-requisite: ELEN 202;
Prerequisites: ELEN 201, MATH 200, and MATH 211.

ELEN 222 SIGNALS AND SYSTEMS THEORY **3.0: 3 cr. E**

This course covers continuous-time and discrete-time signal transformations and system classifications; Linear Time Invariant system analysis (convolution and ordinary differential/difference equation); Fourier series; Fourier transform; Laplace transform; and z-transform.
Pre-requisite: ELEN 202, ELEN 221 (or MECH 231), and MECH 221.

ELEN 223 ELECTRICITY and ELECTROMAGNETISM **3.0: 3 cr. E**

This course covers the governing principles and laws of charge and matter; electric fields; Gauss's law; electric potential; capacitors; dielectrics; magnetic field; Biot-Savart law; Faraday's law; Ampere's law; inductors; paramagnetism; Maxwell's equation and electromagnetic waves.
Prerequisites: ELEN 221 and MATH 270.

ELEN 231 ELECTRONICS I **3.0: 3 cr. E**

This course covers the physics and operation of semiconductor diodes, bipolar junction transistors and field-effect transistors; analysis and design of simple analog wave shaping circuits; small-signal device models; introduction to difference and operational amplifiers; circuit analysis at intermediate and high frequencies.
Prerequisites: CPEN 211 and ELEN 221.

ELEN 303 CIRCUITS ANALYSIS LAB **0.3: 1 cr. E**

This laboratory provides an introduction to electrical circuit measurements; bridge circuits; steady-state and transient waveforms; frequency response; Bode plots; impedance measurement; high-pass, low-pass, band-pass and band-reject filters.
Prerequisites: ELEN 202 and 221.

ELEN 304 ELECTRONICS LAB **0.3: 1 cr. E**

This laboratory provides an introduction to electrical measurements, analysis and design of electronic circuits; diodes and transistor characteristics, diodes and transistor circuits, amplifier gain and impedance characteristics, frequency response, distortion, switching, operational amplifiers and their applications, mirror currents, voltage-regulator integrated circuits.
Prerequisite: ELEN 231.

ELEN 306 TELECOMMUNICATIONS LAB **0.3: 1 cr. E**

This laboratory work includes oscillators, AM, FM modulation and demodulation, detectors, phase locked loops, AM receivers, ASK, PSK modulators and receivers; effects of white noise on binary signals; signal degradation and filtering; fiber optics.
Prerequisite: ELEN 341.

ELEN 307 CONTROL LAB **0.3: 1 cr. E**

The lab verifies experimentally the time constant of a 1st order, the dampness of a 2nd order, and the stability of a 3rd order systems; The students design and build analog computers to emulate real physical systems; The lab also covers the design and implementation of classical control design (such as PID and phase compensation) and modern control design (such state feedback control and linear quadratic regulator); The students use Matlab/ Simulink (in specific the Control System Toolbox) and Quanser's Rotary Servo and Ball-and-Beam modules to model, simulate, and control systems.

ELEN 308 ELECTRIC MACHINES LAB **0.3: 1 cr. E**

This laboratory covers magnetic circuits; transformers; induction motors; reluctance motors; synchronous and DC machines.
Prerequisite: ELEN 361.

ELEN 324 CIRCUITS ANALYSIS II **3.0: 3 cr. E**

This course covers general two-port networks; transfer function; Fourier techniques in network analysis; power calculations; three-phase circuits; mutual inductance and magnetically coupled circuits; series and parallel resonance; Op-Amp circuits.
Prerequisites: ELEN 202 and ELEN 221.

ELEN 325 ELECTRICAL INSTALLATIONS **0.3: 2 cr. E**

This course exposes students to electric wires and cables; wiring systems and techniques; residential and industrial wiring in conformance with the current National Electrical Code and local codes; circuit protection devices; circuits for electric lamps; metering of current, voltage, power and energy; transformer construction and winding; windings for electric machines is covered as time permit. Prerequisite: ELEN 303.

ELEN 326 SIGNAL PROCESSING **3.0: 3 cr. E**

This course covers the principles of digital signal processing; sampling, and quantization; reconstruction of signals; mathematical tools used in the modeling, analysis and synthesis of discrete-time communication and control systems; applications to sampled-data control and quantified-data communications systems; Multirate signal processing; optimal and adaptive techniques; introduction to digital filtering, Kalman filters.
Pre-requisite: ELEN 222.

ELEN 332 ELECTRONICS II **3.0: 3 cr. E**

This course covers the behavior and operating limitations of large-signal and small-signal amplifiers, differential and multistage amplifiers, feedback amplifiers, transistor and audio power amplifiers, high-frequency amplifications, stability and compensation; operational amplifiers; comparators; low frequency oscillators; active filters; tuned amplifiers and oscillators; linear power supplies; wave shaping; other integrated-circuits.
Pre-requisite: ELEN 231.

ELEN 340 SIGNAL TRANSMISSION **3.0: 3 cr. E**

This course covers the principles of field theory. Topics include solution of boundary value problems in electromagnetic using both analytic and numerical techniques; transmission line concepts; Smith charts and design tools for distributed circuits; conducting and dielectric guiding structures for waves; radiation from antennas; low frequency applications.
Pre-requisite: ELEN 223.

ELEN 341 TELECOMMUNICATIONS **3.0: 3 cr. E**

This course covers the principles of analog communication; linear modulation, AM, DSB, SSB, VSB; linear demodulation, envelope detection, coherent demodulation mixer and super-heterodyne receiver; angular (nonlinear) modulation, phase modulation, frequency modulation, stereo FM; angular demodulation, different types of discriminators pre-emphasis and de-emphasis; pulse modulation, PAM, PWM, PPM, and PFM; time division and frequency division multiplexing.
Pre-requisites: ELEN 304 and MATH 246.

ELEN 350 CONTROL SYSTEMS **3.0: 3 cr. E**

This course covers continuous-time and design; block diagram algebra and the signal flow graph; stability analysis techniques (Routh-Hurwitz and Jury stability criterions), root locus, Nyquist, Bode, and Nicholas; Impulse transfer function; state space analysis; State Feedback Control, PID, and phase compensation design.
Pre-requisite: ELEN 202 and ELEN 222.

ELEN 351 DIGITAL CONTROL SYSTEMS **3.0: 3 cr. E**

This course covers discrete-time Linear Shift-Invariant (LSI) real physical dynamical system analysis and discrete control systems design; discrete-time signal conversion and processing; sampling theorem; stability analysis techniques (Jury stability criterion); root locus; z-transform; discrete equivalents; classical (PID, phase compensation) and modern (state feedback) discrete-time control systems design.
Prerequisite: ELEN 350.

ELEN 361 ELECTRIC MACHINES **3.0: 3 cr. E**

This course covers Faraday's law applied to magnetic circuits and transformers; per unit system; energy balance and electromechanical conversion processes; analysis of reluctance machines; three-phase and single-phase induction motors; synchronous motors and generators; DC motors and generators; fractional horsepower motors.
Pre-requisites: ELEN 223/324/332.

ELEN 362 POWER ELECTRONICS **3.0: 3 cr. E**

This course covers the applications of power semiconductor devices; circuit analysis, signal analysis, and energy concepts are integrated to develop steady state and dynamic models of generic power converters; specific topics include AC/DC, DC/DC, DC/AC, and AC/AC conversions. These generic converters are applied as controlled rectifiers, switching power supplies, motor drives, HVDC transmission, induction heating, and others; ancillary circuits needed for the proper operation and control of power semiconductor devices are also discussed; computer simulation and application to power supplies and motor drives.
Pre-requisite: ELEN 202/361.

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 and ESTIMATION AND DETECTION **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.

ELEN 415 ADVANCED ELECTRONICS **3.0: 3 cr. E**

This course covers advanced applications of integrated circuits: IC regulators, Op-Amp applications, active filters, oscillators, waveform generators, frequency multiplier and divider circuits, optoelectronic circuits, and other integrated circuits and applications.

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

This course covers the principles of measurement systems from the sensor/transducer unit to the display unit; static and dynamic characteristics; accuracy; loading effects; signals and noise; reliability, choice and economics; sensing elements: resistive, capacitive, inductive, electromagnetic, thermoelectric, elastic, piezoelectric, and electromechanical; signal conditioning; signal processing, and software; data presentation. Applications selection from force and pressure measurement systems; flow measurement systems; intrinsically safe measurement systems; heat transfer effects in measurement systems; optical measurement systems; ultrasonic measurement systems; gas/chemical measurement systems.

ELEN 431 SPECIALTY MACHINERY **3.0: 3 cr. E**

Special purpose motors; stepper motors; servo motors; PM motors. Other motors that are used in manufacturing, robotics, and electrical systems are also covered.
Pre-requisite: ELEN 400.

ELEN 432 ADVANCED POWER ELECTRONICS **3.0: 3 cr. E**

Advanced static VAR compensation; system stability enhancement; harmonic minimization; mathematical modeling of switching power converters; advanced power converter topologies; design constraints and control methods; design-oriented analysis techniques for applications in electro-mechanical systems, power systems, transportation systems, etc.

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 three-phase to two-phase dq variables; applications to dc induction, and synchronous machines and there parameters; performance in the transient and the steady state.

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

This course covers the three-phase power systems; matrix methods; symmetrical components; sequence; impedance diagrams; power system transformers; per unit system; transmission line parameter; steady state operation of transmission lines and power flow; computer projects included.

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. The course starts with an overview of information theory and coding, analog to digital conversion, and focuses on the design and analysis principles of baseband PAM transmission systems, M-ary signaling, and various carrier systems including ASK, FSK and PSK. An introductory treatment of channel coding is also presented.

ELEN 444 COMMUNICATION SYSTEMS II **3.0:3 cr. E**

This course covers source coding and compression techniques. Students are exposed to entropy coding (DCT and arithmetic coding), predictive coding (DPCM), transform coding (DCT, Walsh-Hadamard, Karhunen-Loeve), vector quantization, statistical coding (BTC), and an overview of MPEG compression. Design issues in communication systems are also covered with special emphasis to system trade-offs, Shannon-Hartley capacity theorem, and Shannon's limit. Students are exposed to M-ary signaling, the design of binary waveforms (orthogonal, biorthogonal, and transorthogonal-simplex) for channel coding. Modulation of vector codes is also analyzed with concentration on non-coherent MFSK, QAM, MSK, DPSK, and OQPSK schemes.

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; R.F. amplifiers; micro-strip circuits; I.F. circuits; oscillators; Phase-locked loops (PLLs).

ELEN 454 DIGITAL FILTERS **3.0: 3 cr. E**

This course covers advanced methods and techniques in digital filter design; linear optimum filtering: Wiener filters, linear prediction; linear adaptive filtering, steepest descent, LMS algorithm, frequency-domain adaptive filters, square-root and order-recursive adaptive filters; introduction to nonlinear adaptive filtering.

ELEN 455 SELECETD ENGINEENRING APPLICATIONS **0.3: 1 cr. E**

This advanced design laboratory includes selected applications in the topics of DSP, control, communications, measurement, and digital hardware (FPGA and CPLD chips).

ELEN 459 ENGINEERING IMAGE PROCESSING **3.0: 3 cr. E**

In this course, an observer is helped 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 covers the physical principles, design and functions of ultrasonic- and X-ray- based diagnostic imaging systems (including radiographic, fluoroscopic and computer topography); and other related issues.

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

This course covers a selection of topics including applications of intelligent systems in various industries, including collaborative systems, quality control, optimization, decision support, planning, high-level and low-level control concepts, supply chains, value chains, virtual organizations, and virtual societies, emergency preparedness, crisis management, business channels, electronic marketplaces, enterprise resources planning; design and analysis of real-time embedded industrial systems, including real-time computing, real-time operating systems, real-time communications, networked embedded systems technology; novel control techniques, with respect to process control, equipment control, supervisory control, adaptive control, motion control; automated manufacturing systems, regarding formal modeling and analysis of manufacturing systems, scheduling of manufacturing systems, queuing systems and petri nets in manufacturing systems.
Pre-requisite: CPEN452 and ELEN 417.

ELEN 470 ELECTROMAGNETICS **3.0: 3 cr. E**

This course covers the theory and applications of plane waves and transmission lines.

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 **2.0: 4 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.

ELEN 500 RESEARCH METHODLOGIES IN ELECTRICAL ENGINEERING **3.0: 3 cr. E**
The Research Methodologies combines lectures and seminars designed to provide opportunities for professional development of graduate students, raise their awareness of various other issues that they may face in their professional careers, and provide them opportunities to survey research seminars of their interest.

ELEN 520 NONLINEAR SYSTEM DYNAMICS **3.0: 3 cr. E**
This course covers topics related to nonlinear systems; definition of linear and nonlinear systems; introduction to approximate analysis of nonlinear systems-describing functions, Krylov and Bogliubov asymptotical method, and Tyskin locus; Forced oscillations-jump resonance; stability analysis-Liapunov criterion; Lure problem and Popov method.
Prerequisite: ELEN 400.

ELEN 522 STOCHASTIC CONTROL SYSTEMS **3.0: 3 cr. E**
This course covers control systems using random process; properties of Markov process; systems of covariance equivalence and of deterministic and stochastic control equivalence; dynamic programming for Markov process-principle of optimality; linear systems with quadratic cost; Kalman filtering; smoothing; predicting.
Prerequisite: ELEN 402.

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) controllability tests; Cayley-Hamilton theorem; Ackerman's formula; state feedback control design; identity and Luenberger observer design; optimal control design (LQR); analytical control system design; system identification; robust control.
Prerequisite: ELEN 400.

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 **3.0: 3 cr. E**
A course covering the analysis and design of adaptive Fuzzy Systems; Training of Fuzzy Logic Systems Using Back-Propagation, 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.
Prerequisite: ELEN 400.

ELEN 531 POWER SYSTEMS PROTECTION AND RELIABILITY **3.0: 3 cr. E**
This course covers the concepts of high voltage engineering, circuits breaks and switch gear, H.V. power equipment; protection schemes; digital protection and fault diagnosis; reliability analysis.
Prerequisite: ELEN 437.

ELEN 533 RENEWABLE ENERGY **3.0: 3 cr. E**
An introduction to alternative clean energy: Wind, Solar, Hydro, Biomass, and others. However emphasis will be on Solar and Wind energies that include: Power generation, conversion, distribution and utilization.
Prerequisite: ELEN 437.

ELEN 534 INDUSTRIAL AND COMMERCIAL POWER SYSTEMS **3.0: 3 cr. E**

An introduction to power system design for commercial buildings and industrial plants; legal and economic considerations; equipment specifications and ratings; design practice; fault calculations, protection, and coordination; grounding; and illumination design.
Prerequisite: ELEN 437.

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.
Prerequisites: ELEN 400 and 435.

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.
Prerequisite: ELEN 437.

ELEN 538 POWER SYSTEMS GENERATION AND DISTRIBUTION **3.0: 3 cr. E**

This course presents the concepts of power generation and synchronization; functional and equivalent circuits for transmission lines and transformers; per unit system; balanced three-phase systems and power transfer limits; unbalanced system harmonics; symmetrical components and sequence network characteristics of transmission lines and transformers; symmetrical component fault analysis; Clarke components; switching surges; lighting surges; traveling waves; impact of surges on terminal equipment; insulation coordination; system protection; synchronization laboratory.

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

In this course 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.
Prerequisite: ELEN 402 and ELEN 443.

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 details. State of the art Speech recognition systems are also presented covering Hidden Markov Models (HMM). N-grams language models are explained.
Prerequisite: ELEN 402.

ELEN 546 ESTIMATION AND DETECTION **3.0: 3 cr. E**

As a major subject in statistical communication, this course is intended to provide solid foundation for advanced studies

and research in telecommunication systems. Topics include: Bayes' decision, maximum likelihood estimator and detector, MAP estimator, linear mean-square estimation, the Karhunen-Loeve expansion, Wiener filter, Kalman filter, sampling of random signals, detection of signals in Gaussian noise, and fading in Rayleigh and Rician channels. Prerequisite: ELEN 402.

ELEN 548 REAL-TIME TELECOM APPLICATIONS **3.0: 3 cr. E**

The course is intended to expose you in depth to the dsPIC30F DSP and show you all the features that make it a powerful processor for digital filtering applications, FFT computation, adaptive filtering, etc. A meticulous study of the processor will be covered along with many real-time telecom applications. Prerequisite: ELEN 443.

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

This course covers selected topics on the design and maintenance of major medical equipment: electrocardiography, pressure and other cardiovascular measurement and life support instruments, respiratory measurement instruments, brain-parameters measurement instruments, medical lab instruments, ultrasound equipment, electro-optics, fiber optics and lasers, computers and biomedical equipment, electromagnetic interference to medical electronic equipment, battery-operated medical equipment. In-hospital visits and observation are included in the course.

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

This course covers the physical principles, design and functions of magnetic resonance imaging (MRI) and nuclear medicine diagnostic imaging systems; and other related issues.

ELEN 571 CELLULAR COMMUNICATION **3.0: 3 cr. E**

This course focuses on cellular communication in general. Cellular communication principles will be explained to the students. The constraints and solutions for different particular cases are given. Different cellular systems will be presented: the GSM, Wireless LAN, and Bluetooth. Students must have a good knowledge of networking principles and general telecommunication concepts in order to attend this course. Prerequisite: ELEN 443.

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).

ELEN 578 ANTENNA DESIGN **3.0: 3 cr. E**

This course presents electrically small antennas; wire antennas, antenna arrays; aperture antennas (slots, horns, and parabolic reflectors); broadband antennas; high frequency methods; antenna synthesis; ground wave and ionospheric propagation; receiving antennas and antenna measurements. Students design and construct antennas in associated laboratory.
Prerequisite: ELEN 443.

CPEN Courses
Refer to the Department of Computer Engineering.

GENG 290, 390, and 391
Refer to Faculty of Engineering – General Requirement Courses

CSIS 200, 201, 202, 206, 221, 270, 320, 374, 375
Refer to Faculty of Sciences, Department of Computer Science.

CSPR 201, 202, 203
Refer to Faculty of Arts and Social Sciences, Cultural Studies Program.

ENGL 203 and Elective
Refer to Faculty of Arts and Social Sciences, Department of English Language and Literature.

GENG 311, 402, 590, 599
Refer to Faculty of Engineering Requirements.

LISP 200
Refer to Faculty of Library and Information Studies.

MECH 513
Refer to Department of Mechanical Engineering.

MATH 200, 202, 211, 230, 246, 270
Refer to Faculty of Sciences, Department of Mathematics.

MECH 211, 221, 232, 233
Refer to Department of Mechanical Engineering.

DEPARTMENT OF CIVIL ENGINEERING
BACHELOR OF SCIENCE (B.S.) DEGREE

FIRST YEAR
Semester 1

Course Code	Course Title	Credit
CIVE 201	Statics	3
CSIS 206	Principles of Programming	3
ENGL 203	English Comm. Skills III	3
MATH 200	Calculus I	3
MATH 211	Linear Algebra	3
	Elective 1	3
Total		**18**

FIRST YEAR
Semester 2

Course Code	Course Title	Credit
CIVE 202	Mechanics of Materials	3
CIVE 203	Engineering Drawing 1	1
ENGL 2xx	English Elective	3
GENG 290	Introduction to the Engineering Design Process	1
MATH 202	Calculus II	3
MECH 222	Science of Materials	3
	Elective Lab 1	1
	Elective 2	3
Total		**18**

SECOND YEAR
Semester 3

Course Code	Course Title	Credit
CIVE 204	Construction Materials and Methods	3
CIVE 205	Theory of Structures I	3
CIVE 206	Engineering Drawing II	1
CSPR 201	The Formation of Civilization	3
MATH 246	Probability For Engineers	3
MATH 270	Differential Equations	3
	Elective 3	3
Total		**19**

SECOND YEAR
Semester 4

Course Code	Course Title	Credit
CIVE 208	Surveying	2
CIVE 209	Reinforced Concrete I	3
CIVE 210	Strength of Materials Laboratory	1
CIVE 214	Surveying Laboratory	1

CIVE 243	Fluid Mechanics Laboratory	1
CSPR 202	The Religious Experience: The Sacred	3
MATH 230	Numerical Analysis	3
MECH 243	Fluid Mechanics	3
LISP 200	Library Use and Research Methods	1
Total		**18**

THIRD YEAR
Semester 5

Course Code	**Course Title**	**Credit**
CIVE 301	Soil Mechanics and Foundation	3
CIVE 303	Computer Aided Design	1
CIVE 304	Reinforced Concrete II	3
CIVE 305	HVAC	3
CIVE 306	Soil Lab	1
CIVE 310	Building Laws	2
CIVE 312	Construction Management Fundamentals	2
CIVE 316	Construction Management Modeling	1
CSPR 203	Introduction to Modernity	3
Total		**19**

THIRD YEAR
SEMESTER 6

Course Code	**Course Title**	**Credit**
CIVE 307	Foundation Design	3
CIVE 308	Transportation Engineering	3
CIVE 309	Engineering Economy	3
CIVE 311	Sanitary Engineering	3
	Elective Lab 2	1
GENG 390	Senior Project Design	1
	Elective 4	3
Total		**17**

Total credits **109**

Electives 1 and 2: Two Courses from the Following List:

Course Code	**Course Title**	**Credit**
CHEM 202	Basic Chemistry	3
MECH 221	Engineering Dynamics	3
MECH 232	Thermodynamics	3

Elective 3: One Course from the Following List (or any 3-credit course approved by the Department):

Course Code	**Course Title**	**Credit**
CIVE 212	Introduction to Environmental Engineering	3
CIVE 317	Engineering Geology	3

Elective 4: One Course from the Following List (or any 3-credit course approved by the Department):

Course Code	Course Title	Credit
CIVE 213	Introduction to GIS for Environmental Engineering	3
CIVE 241	Technical Platform Computing for Civil Engineering	3
CIVE 314	Advanced Computer-Aided Design	3
GENG 310	Introduction to GIS	3

Elective Lab 1 and 2: Two Labs from the Following List (or any 1-credit Lab approved by the Department):

Course Code	Course Title	Credit
CIVE 313	Transportation Engineering Modeling	1
CIVE 315	Geotechnical Engineering Modeling	1
CIVE 318	Environmental Engineering Modeling	1
MECH 233	Workshop Technology	1

DEPARTMENT OF CIVIL ENGINEERING

BACHELOR OF ENGINEERING (BE) DEGREE

FIRST YEAR
Semester 1

Course Code	Course Title	Credit
CIVE 201	Statics	3
CSIS 206	Principles of Programming	3
ENGL 203	English Comm. Skills III	3
MATH 200	Calculus I	3
MATH 211	Linear Algebra	3
	Elective 1	3
Total		**18**

FIRST YEAR
Semester 2

Course Code	Course Title	Credit
CIVE 202	Mechanics of Materials	3
CIVE 203	Engineering Drawing 1	1
ENGL 2xx	English Elective	3
GENG 290	Introduction to the Engineering Design Process	1
MATH 202	Calculus II	3
MECH 222	Science of Materials	3
	Elective Lab 1	1
	Elective 1	3
Total		**18**

SECOND YEAR
Semester 3

Course Code	Course Title	Credit
CIVE 204	Construction Materials and Methods	3
CIVE 205	Theory of Structures I	3

CIVE 206	Engineering Drawing II	1
CSPR 201	The Formation of Civilization	3
MATH 246	Probability For Engineers	3
MATH 270	Differential Equations	3
	Elective 2	3
Total		**19**

SECOND YEAR

Semester 4

Course Code	Course Title	Credit
CIVE 208	Surveying	2
CIVE 209	Reinforced Concrete I	3
CIVE 210	Strength of Materials Laboratory	1
CIVE 214	Surveying Laboratory	1
CIVE 243	Fluid Mechanics Laboratory	1
CSPR 202	The Religious Exp.: The Sacred	3
MATH 230	Numerical Analysis	3
MECH 243	Fluid Mechanics	3
LISP 200	Library Use and Research Methods	1
Total		**18**

THIRD YEAR

Semester 5

Course Code	Course Title	Credit
CIVE 301	Soil Mechanics and Foundation	3
CIVE 303	Computer Aided Design	1
CIVE 304	Reinforced Concrete II	3
CIVE 305	HVAC	3
CIVE 306	Soil Lab	1
CIVE 310	Building Laws	2
CIVE 312	Construction Management Fundamentals	2
CIVE 316	Construction Management Modeling	1
CSPR 203	Introduction to Modernity	3
Total		**19**

THIRD YEAR

Semester 6

Course Code	Course Title	Credit
CIVE 307	Foundation Design	3
CIVE 308	Transportation Engineering	3
CIVE 309	Engineering Economy	3
CIVE 311	Sanitary Engineering	3
	Elective Lab 2	1
	Elective 4	3
Total		**16**

SEMESTER 7

Course Code	Course Title	Credit
CIVE 401	Theory of Structures II	3
CIVE 403	Deep Foundations	3
CIVE 404	Hydraulics	3
	Elective 5	3
Total		**12**

FOURTH YEAR
Semester 8

Course Code	Course Title	Credit
CIVE 405	Prestressed Concrete	3
GENG 400	Engineering Seminars	1
GENG 402	Project Management	3
GENG 490	Graduation Project	3
	Elective 6	3
Total		**13**

FOURTH YEAR
Semester 9 (Summer)

Course Code	Course Title	Credit
GENG 480	Field Training	3
Total		**3**

FIFTH YEAR
Semester 10

Course Code	Course Title	Credit
CIVE 501	Theory of Steel Structures	3
CIVE 503	Highway Design	3
CIVE 520	Principles of Environmental Engineering	3
CIVE XXX	Elective Lab	1
GENG 490	Graduation Project (Re-activation)	0
Total		**10**

Total credits **146**

ElectiveS 1 and 2: Two Courses from the Following List:

Course Code	Course Title	Credit
CHEM 202	Basic Chemistry	3
MECH 221	Engineering Dynamics	3
MECH 232	Thermodynamics	3

Elective 3: One Course from the Following List(or any 3-credit course approved by the Department):

Course Code	Course Title	Credit
CIVE 212	Introduction to Environmental Engineering	3
CIVE 317	Engineering Geology	3

Elective 4: One Course from the Following List (or any 3-credit course approved by the Department):

Course Code	Course Title	Credit
CIVE 213	Introduction to GIS for Environmental Engineering	3
CIVE 241	Technical Platform Computing for Civil Engineering	3
CIVE 314	Advanced Computer-Aided Design	3
GENG 310	Introduction to GIS	3

Elective 5: One Course from the Following List:

Course Code	Course Title	Credit
CIVE 428	Construction Safety Management	3
CIVE 555	Special Topics in Civil Engineering	3

Elective 6: One Course from the Following List:

Course Code	Course Title	Credit
CIVE 411	Introduction to Earthquake Engineering and Seismology	3
CIVE 443	Seismic Design of Reinforce Concrete Buildings	3

Electives Lab 1, 2 and 3: Three Labs from the Following List (or any 1-credit Lab approved by the Department):

Course Code	Course Title	Credit
CIVE 313	Transportation Engineering Modeling	1
CIVE 315	Geotechnical Engineering Modeling	1
CIVE 318	Environmental Engineering Modeling	1
MECH 233	Workshop Technology	1

COURSE DESCRIPTIONS

CIVE 201 STATICS **3.0: 3 cr. E**

Fundamental concepts of the statics of rigid bodies using a vector analysis approach: force systems, analysis of simple structures, centroids and centers of gravity, free body diagrams, equilibrium, friction, moments of inertia, and shear and bending moment diagrams.

CIVE 202 MECHANICS OF MATERIALS **3.0: 3 cr. E**

Fundamental stress and strain relationships, axial stress, safety factors, statically indeterminate axially loaded members, torsion, bending and shear stresses in beams, transformation of stress and strain, combined stresses, deflections in beams, and analysis of columns.
Pre-requisite: CIVE 201

CIVE 203 DRAWING I **0.3: 1 cr. E**

Concepts and practices in lettering, geometric construction, multi-view and auxiliary projections, sections and connections, dimensioning, and isometric and oblique pictorials. Emphasis on freehand sketching skills.

CIVE 204 CONSTRUCTION MATERIALS and METHODS **3.0: 3 cr. E**

Materials and methods used in the construction industry. Physical and mechanical properties of construction materials; Portland cement concrete, asphalt, wood, ferrous metals, non-ferrous metals; proportioning of concrete mixtures including admixtures.

CIVE 205 THEORY OF STRUCTURES I **3.0: 3 cr. E**

Stability and determinacy of structures. Analysis of statically determinate structures: Stress resultants (reactions, axial forces, shear forces, and bending moments) for beams and framed structures. Deflection of beams and frames by geometric methods (moment-area theorems, conjugate-beam analogy), by energy methods (virtual-

work method, Castigliano's theorems). Influence lines functions and their applications. Criteria for moving loads. Analysis of statically indeterminate structures by force methods: (consistent deformations method), by displacement methods (slope-deflection method and moment-distribution method).
Pre-requisite: CIVE 202

CIVE 206 DRAWING II (AutoCad) 0.3: 1 cr. E
Concepts and practices in lettering, geometric construction, multi-view and auxiliary projections, sections and connections, dimensioning, and isometric and oblique pictorials. Emphasis on freehand sketching skills.
Pre-requisite: CIVE 203

CIVE 208 SURVEYING 2.2: 2 cr. E
Principles of surveying, instruments, basic measuring procedures, error analysis, traverse, leveling and mapping. Principles and practice in measuring distances, elevation differences and angles; construction surveys, traverses, topographic surveys and subdivision of land, mass diagram, cut and fill calculations. Boundary surveys, area computations and profile surveys. Introduction to horizontal and vertical curves design.

CIVE 209 REINFORCED CONCRETE I 3.0: 3 cr. E
Strength and deformation of reinforced concrete according to the provisions of ACI building code, beams in flexure and shear, one way ribbed and solid slabs, deflection and cracking control, allowable stress design of rectangular sections, bond stress and reinforcement anchorage, and short reinforced concrete columns.
Pre-requisite: CIVE 205

CIVE 210 STRENGTH OF MATERIALS LABORATORY 0.3: 1 cr. E
Concrete constituents and mix design; time of setting of cement; mixing and testing fresh concrete; determination of density of hardened concrete; compressive strength of concrete cubes and cylinders; flexural tensile strength of concrete; splitting tensile Strength of cylindrical concrete specimens; determination of static modulus of elasticity in compression; tensile strength of steel bars; Marshall stability and flow of bituminous mixtures.
Pre-requisite: CIVE 204
Co-requisite: CIVE 209

CIVE 212 INTRODUCTION TO ENVIRONMENTAL ENGINEERING 3.0: 3 cr. E
Knowledge of environmental elements; mass and energy transfer and balances; environmental chemistry; mathematics of growth and decay; risk assessment and management; surface water pollutants, biological and chemical oxygen demands, eutrophication; water supply systems and drinking water standards; wastewater treatment systems and effluent standards; groundwater flow, contaminant transport, and remediation technologies; hazardous waste and pollution prevention; air pollution sources, control and atmospheric stability; ambient air quality standards, indoor air quality; global temperature, greenhouse effect and warming potential; global energy balance, carbon emission, and stratospheric ozone depletion; solid waste management, landfill disposal; medical waste; green building; and environmental law, ethics, and justice. Field trips are integrated into the classes.

CIVE 213 INTRODUCTION TO GEOGRAPHIC INFORMATION SYSTEMS (GIS) FOR ENVIRONMENTAL ENGINEERING 3.0: 3cr. E
Basic theoretical and practical understanding of GIS concepts and technical issues and its application to the design and analysis of environmental engineering systems. The focus is a fundamental understanding of spatial data acquisition, geo-processing, geo-statistical methods; visualization, and querying of spatial data; network modeling, terrain mapping, and spatial analysis. Students are trained through extensive computer lab sessions, including applications in urban stormwater management, nonpoint source pollution control, ecological assessment, water distribution and sewer network analysis. The course will be based on the recently released ESRI ArcGIS 11.

CIVE 214 SURVEYING LABORATORY **0.3:1 cr. E**

Field application of concepts learned in class (CIVE 208) including basic measuring procedures for distances, elevations, angles, bearings, azimuth; theory of measurements and errors, mapping, construction and topographic surveys, traverses, adjustment and closure, area and volume computations.
Pre-requisite: CIVE206
Co-requisite: CIVE 208

CIVE 241 TECHNICAL PLATFORM COMPUTING FOR CIVIL ENGINEERING **3.0: 3cr. E**

This course develops computing skills using the technical computing platform Mathematica. Topics include: introduction to Mathematica, symbolics, numerics, graphics, animations, programming, document organization and typesetting. Applications to statics, dynamics, engineering mechanics, fluid mechanics and other engineering related courses. Emphasis on ability to plan solutions to technical problems then execute and prepare organized technical reports including tables, figures and illustrations.
Pre-requisites: MATH 200, 211, CIVE 201, CSIS 206

CIVE 243 FLUID MECHANICS LABORATORY **0.3: 1 cr. E**

Laboratory applications in fluid mechanics including fluid measurements and properties; flow in pipes; Reynolds number; forces on gates; orifices; weirs; open channel flow; and pumps.
Co-requisite: MECH 243

CIVE 301 SOIL MECHANICS and FOUNDATIONS **3.0: 3 cr. E**

Origin of soil and grain size, weight volume relationships and soil plasticity, engineering classification of soil, permeability and seepage, effective pressure concept, shear strength of soil, stress in a soil mass, soil consolidation settlement, lateral earth pressure (Retaining wall).
Pre-requisite: CIVE 202
Co-requisite: CIVE 209.

CIVE 303 COMPUTER-AIDED DESIGN **0.3: 1 cr. E**

Application of computers to analyzing common structures. Use of standard industry software packages (ETABS and SAFE) for analyzing two dimensional and three dimensional structures including trusses, moment resisting frames, and shear walls against gravity loads as well as lateral loads (seismic and wind). Introduction of Local and Global Coordinates Systems, the importance of the proper connectivity among elements as well as the definition of the Cardinal points and the insertion points. Modeling of one-way and two-way slabs using different slabs types. Export of Structure Reactions from ETABS to SAFE and modeling of foundations.
Pre-requisite: CIVE 209

CIVE 304 REINFORCED CONCRETE II **3.0: 3 cr. E**

Analysis and design of advanced reinforced concrete structures and components: short columns subjected to flexure in one or in two directions, slender columns, beams subjected to shear and torsion, and floor systems including two-way slabs (flat slabs and slabs with beams).

Prerequisites: CIVE 209, 210.

CIVE 305 HEATING, VENTILATING and AIR CONDITIONING (HVAC) **3.0: 3 cr. E**

Environmental comfort parameters. Heat transfer in building sections. Estimating heating, cooling and ventilation loads and the choice of appropriate systems. Selection of equipment, design and layout of distribution ducts, pipes, and outlets.

CIVE 306 SOIL MECHANICS LABORATORY **0.3: 1 cr. E**

Soil properties and behavior, soil classifications, sieve analysis of soil, specific gravity of soil, relative density of soil, Atterberg limits, Proctor test, CBR test, in situ density of base material, hydrometer of fine grained soil, permeameter test (Constant head and falling head method), consolidation and settlement, strength characteristics.
Co-requisite: CIVE 301

CIVE 307 FOUNDATION DESIGN **3.0: 3 cr. E**

Design and analysis for shallow reinforced concrete footings: centrally loaded isolated footing, eccentrically loaded isolated footings, combined rectangular footing, combined trapezoidal footing, strap footing, mat foundation, retaining wall design.
Pre-requisite: CIVE 301
Co-requisite: CIVE 304

CIVE 308 TRANSPORTATION ENGINEERING **3.0: 3 cr. E**

The role of transportation in society and the engineer's role in planning, design and operation of transportation systems; consideration of system constraints, costs and basic design criteria. Theory and practice in highway design according to AASHTO criteria; design of vertical and horizontal curves and cross-sections. Introduction to traffic elements including intersection design and analysis of roads and intersections service levels.
Pre-requisite: CIVE 208

CIVE 309 ENGINEERING ECONOMY **3.0: 3 cr. E**

The course introduces the student to the fundamental concepts of engineering economy covering: time value of money; economic analysis and evaluation of private construction projects, namely: net present value, future and annual worth, and internal rate of return; evaluation of public projects, mainly benefit to cost ratio; replacement analysis; depreciation methods; break even analysis; economic risk analysis; and after tax cash flow.
Pre-requisite: MATH 200

CIVE 310 BUILDING LAWS **2.2: 2 cr. E**

The purpose of this course is to instruct the students to organize the building industry, and to enhance their knowledge of the Lebanese Building Laws in order to safeguard the environment and private and public rights.
Pre-requisite: CIVE 203

CIVE 311 SANITARY ENGINEERING **3.0: 3 cr. E**

Sources and quantities of water supply and methods of collection, treatment and distribution. Quantities, treatment and disposal of wastewater. Quality parameters, criteria and international standards for drinking water and wastewater pollution control.
Pre-requisite: MECH 243

CIVE 312 CONSTRUCTION MANAGEMENT FUNDAMENTALS **2.2: 2 cr. E**

Civil engineers working on sites as construction managers need to know the fundamentals of construction management. This course introduces the basic principles and procedures of construction management, mainly contracts management, planning, scheduling and cost estimation. It also expands on project deterministic scheduling, mainly, bar charts, network schedules AON and AOA, and CPM. The course expands on the basic cost terminology, quantity take-off, bar bending schedule estimation and bill of quantities.
Pre-requisite: CIVE 209

CIVE 313 TRANSPORTATION ENGINEERING MODELING **0.3: 1 cr. E**

Highway design using professional commercial softwares integrating planning, geometric design including horizontal and vertical curves design, cross-sections with cut and fill calculations, and traffic modeling including traffic lights design and level of service. Results visualizations and assessment.
Co-requisite: CIVE 308

CIVE 314 ADVANCED COMPUTER AIDED DESIGN **3.0: 3 cr. E**

The introduction of advanced modeling techniques using ETABS Software package. It consists of modeling in multiple-grid systems using Cartesian and/or Polar coordinates, as well as non-concentric modeling with a variation in the Cardinal Points and Insertion Points; the use of Section Designer members and Non-Prismatic elements; all loading types and shapes in the global and local coordinates; the ETABS concept for the Pattern Live Load Factor; modeling of inclined slabs for stairs and ramps, and modeling of shells for all types of domes. Introduction to the ETABS overwrites for the design of Reinforced Concrete members (Seismic or

Non-Seismic Design) using ACI318 Provisions.
Pre-requisite: CIVE 303
Co-requisite: CIVE 304

CIVE 315 GEOTECHNICAL ENGINEERING MODELING 0.3: 1 cr. E
Geotechnical analysis and design using commercial software PLAXIS including design of foundations and lateral earth retaining systems. Results visualizations and assessment.
Pre-requisite: CIVE 301
Co-requisite: CIVE 307

CIVE 316 CONSTRUCTION MANAGEMENT MODELING 0.3:1 cr. E
Use of commercial software for the operations, planning, budgeting, scheduling, resource allocation, resource leveling, and controlling construction projects.
Co-requisite: CIVE 312

CIVE 317 ENGINEERING GEOLOGY 3.0: 3 cr. E
This course explores the fundamentals of geology applied to civil engineering problems. Topics include rock and mineral types, soil properties, rock mechanics, geologic structures, groundwater, active tectonics and earthquake hazards, causes and classification of landslides, stability assessment for soil and rock slopes, mitigation of landslide hazard, effect of earthquakes on constructed facilities and infrastructure, geotechnical and structural considerations in mitigation of earthquake hazard.

CIVE 318 ENVIRONMENTAL ENGINEERING MODELING 0.3:1 cr. E
Fundamental quantities, titration, standards, physical, chemical, and biological water and wastewater characteristics, and parameter determination using standard methods, data reduction, analysis, and interpretation.
Co-requisite: CIVE 212.

CIVE 401 THEORY OF STRUCTURES II 3.0: 3 cr. E
Approximate analysis of continuous beams and frames. Parametric studies of some basic structures including towers, buildings and bridges. Analysis of beam, truss and frame structures using the direct stiffness method. Two topics selected from nonlinear truss analysis, energy methods, Timoshenko beam-columns, structural optimization, influence lines, arches, cable structures and others (content varies by year).

CIVE 403 DEEP FOUNDATIONS 3.0: 3 cr. E
Fundamentals of geotechnics applied to design and analysis of deep soil structure systems, single pile, sheet pile, group of piles, laterally loaded piles, efficiency of group pile, settlement of pile, braced cut, reinforced earth structure.

CIVE 404 HYDRAULICS 3.0: 3 cr. E
Design and analysis of hydraulic projects using modern computational procedures; student team projects involving steady and unsteady flow in pipelines, pipe networks, bridge and culvert hydraulics, flood-plain delineation, water supply canals, structures and channel modification, design of drainage elements such as storm water networks, sewerage networks, water supply networks, grates and inlets, and introduction to scour analysis.

CIVE 405 PRESTRESSED CONCRETE 3.0: 3 cr. E
Introduction to Materials and Systems of Prestressing; Basic Concepts of Prestressing: Basic-Concept Method, Load-Balancing Method, Pressure-Line Method; Prestress Losses; Composite Construction; Ultimate Flexural Strength Analysis and Design; Shear Design; Continuous Prestressed Concrete Beams.

CIVE 411 INTRODUCTION TO EARTHQUAKE ENGINEERING and SEISMOLOGY 3.0: 3 cr. E
Earthquake engineering, deals with the effects of earthquakes on people and their environment and with methods reducing those effects. This course was designed to help understand the fundamental principles and

practical methods of earthquake engineering. It introduces the basic concepts of seismology, earthquakes, and strong ground motion and introduces procedures of deterministic and probabilistic seismic hazard analysis.

CIVE 428 CONSTRUCTION SAFETY MANAGEMENT **3.0: 3 cr. E**
Identification of hazards and risks on construction sites; hazards evaluation; hazard control; fault tree analysis; crane, equipment, universal, access, construction, operation and maintenance hazards; and safety measures application.

CIVE 443 SEISMIC DESIGN OF REINFORCED CONCRETE BUILDINGS **3.0: 3 cr. E**
Basic seismology, earthquake characteristics and effect of earthquakes on structures. Seismic base shear calculation using the Uniform Building Code (UBC-97). Earthquake resisting structural systems and plan and vertical irregularities. Design and detailing of seismic resistant reinforced concrete shearwalls (tension/compression design, and uniform reinforcement design) including boundary elements and coupling beams. Design and detailing of Moment Resisting Frames (OMRF, IMRF, SMRF). All designs are based on the ACI-318 (Chapter 21) Seismic Provisions as well as the ACI-352 Beam-to-Column Connections Recommendations.

CIVE 501 THEORY OF STEEL STRUCTURES **3.0: 3 cr. E**
AISC Load and resistance factor design (LRFD) of tension members, columns, beams, beam-columns, built-up and composite members, connections (welded and bolted). Materials specifications (ASTM) for conventional and high performance steel grades.
Prerequisite: CIVE 401

CIVE 503 HIGHWAY DESIGN **3.0: 3 cr. E**
Theory and practice in highway design according to AASHTO criteria; highway classification and design criteria, location studies, complete design of vertical and horizontal alignment, cross section, pavement, intersections and highway drainage elements, and design of noise barriers. Introduction to airport design.

CIVE 520 PRINCIPLES OF ENVIRONMENTAL ENGINEERING **3.0: 3 cr. E**
Man and environment. Sources of environmental pollution. Water pollution and its control. Principles of water and wastewater treatment. Air pollution and its control. Solid wastes and noise problems. Environmental Impact Assessment studies. Case studies.

CIVE 555 SPECIAL TOPICS IN ENGINEERING **3.0: 3 cr. E**
Analysis and design of advanced concrete structures: stairways, reinforced concrete water tanks (rectangular and circular), concrete domes, corbels and deep beams, wind load provisions, walls, fiber polymer reinforcement, chimneys and minaret.

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 480 FIELD TRAINING **1.0: 3 cr. E**

CHEM 202
Refer to the Department of Chemistry.

CSIS 206
Refer to the Department of Computer Science.

CSPR 201, 202, 203
Refer to the Civilization Sequence Program.

ENGL 203, Elective
Refer to the Division of English Language and Literature.

GENG 290-PBL 310, 390, 400, 490
Refer to the Faculty of Engineering requirements.

LISP 200
Refer to the Faculty of Library and Information Studies.

MATH 200, 202, 211, 230, 246, 270
Refer to the Department of Mathematics.

MECH 221, 222, 232, 233, 243
Refer to the Department of Mechanical Engineering.

DEPARTMENT OF MECHANICAL ENGINEERING
BACHELOR OF SCIENCE (BS) DEGREE

FIRST YEAR
Semester 1

Course Code	Course Title	Credit
CIVE 201	Statics	3
CSIS 206	Programming for Engineers	3
ENGL 203	English Communication Skills III	3
MATH 200	Calculus I	3
MATH 211	Linear Algebra	3
MECH 212	Instrumentation & Experimentation I	1
MECH 211	Mechanical Drawing I	1
GENG 290	Introduction to the Engineering Design Process	1
Total		**18**

FIRST YEAR
Semester 2

Course Code	Course Title	Credit
CHEM 204	General Applied Chemistry	3
CIVE 202	Mechanics of Materials	3
	English Elective	3
MATH 202	Calculus II	3
MECH 221	Engineering Dynamics	3
MECH 222	Science of Materials	3
Total		**18**

SECOND YEAR
Semester 3

Course Code	Course Title	Credit
CSPR 201	The Formation of Civilization	3
ELEN 201	Electrical Instrumentation Lab	1
MATH 230	Numerical Analysis	3
MATH 246	Probability for Engineers	3
MECH 231	Circuit Fundamentals	3
MECH 232	Thermodynamics	3
MECH 233	Workshop Technology	1
MECH 234	Mechanical Drawing II	1
Total		**18**

SECOND YEAR
Semester 4

Course Code	Course Title	Credit
CSPR 202	The Religious Experience	3
ELEN 222	Signals & Systems Theory	3
MATH 270	Differential Equations	3
MECH 241	Comp. Tech. in Mech. Eng.	3

MECH 242	Engineering Vibrations	3
MECH 243	Fluids Mechanics	3
MECH 244	Instrumentation & Experimentation II	1
Total		**19**

THIRD YEAR
Semester 5

Course Code	Course Title	Credit
CSPR 203	Introduction to Modernity	3
ELEN 361	Electric Machines	3
GENG 311	Engineering Management and Economics	3
MECH 311	Mechanical Design I	3
MECH 313	Electromechanical Systems	3
MECH 314	Gas Dynamics	3
MECH 315	Mechanics of Machines	3
MECH 325	Instrumentation and Experimentation III	1
Total		**19**

THIRD YEAR
Semester 6

Course Code	Course Title	Credit
ELEN 350	Control System	3
GENG 390	Undergraduate Project	1
LISP 200	Library Use and Research Methods	1
MECH 321	Heat Transfer	3
MECH 323	CAD/CAM	3
MECH 324	Steam & Gas Turbines	3
	Elective	3
Total		**17**

Total credits **109**

DEPARTMENT OF MECHANICAL ENGINEERING

BACHELOR OF ENGINEERING (BE) DEGREE

FIRST YEAR
SEMESTER 1

Course Code	Course Title	Credit
CIVE 201	Statics	3
CSIS 206	Programming for Engineers	3
ENGL 203	English Communication Skills III	3
GENG 290	Introduction to the Engineering Design Process	1
MATH 200	Calculus I	3
MATH 211	Linear Algebra	3

MECH 212	Instrumentation and Experimentation I	1
MECH 211	Mechanical Drawing I	1
Total		**18**

FIRST YEAR
SEMESTER 1

Course Code	Course Title	Credit
	English Elective	3
CHEM 204	General Applied Chemistry	3
CIVE 202	Mechanics of Materials	3
MATH 202	Calculus II	3
MECH 221	Engineering Dynamics	3
MECH 222	Science of Materials	3
Total		**18**

SECOND YEAR
Semester 3

Course Code	Course Title	Credit
CSPR 201	The Formation of Civilization	3
MATH 246	Probability for Engineers	3
ELEN 201	Electrical Instrumentation Lab	1
MECH 231	Circuit Fundamentals	3
MATH 230	Numerical Analysis	3
MECH 232	Thermodynamics	3
MECH 233	Workshop Technology	1
MECH 234	Mechanical Drawing II	1
Total		**18**

SECOND YEAR
Semester 4

Course Code	Course Title	Credit
CSPR 202	The Religious Experience	3
ELEN 222	Signals and Systems Theory	3
MATH 270	Differential Equations	3
MECH 241	Comp. Tech. in Mech. Eng.	3
MECH 242	Engineering Vibrations	3
MECH 243	Fluids Mechanics	3
MECH 244	Instrumentation and Experimentation II	1
Total		**19**

THIRD YEAR
Semester 5

Course Code	Course Title	Credit
CSPR 203	Introduction to Modernity	3
ELEN 361	Electric Machines	3
GENG 311	Engineering Management and Economics	3 3

MECH 313	Electromechanical Systems	3
MECH 314	Gas Dynamics	3
MECH 315	Mechanics of Machines	3
MECH 325	Instrumentation and Experimentation III	1
Total		**19**

THIRD YEAR
Semester 6

Course Code	Course Title	Credit
ELEN 350	Control Systems	3
LISP 200	Library Use and Research Methods	1
MECH 321	Heat Transfer	3
MECH 323	CAD/CAM	3
MECH 324	Steam and Gas Turbines	3
	Elective	3
Total		**16**

FOURTH YEAR
Semester 7

Course Code	Course Title	Credit
MECH 411	Advanced Mechanics of Materials	3
MECH 412	Mechanics of Composite Materials	3
MECH 413	Internal Combustion Engines	3
	Elective	3
Total		**12**

FOURTH YEAR
Semester 8

Course Code	Course Title	Credit
GENG 400	Engineering Seminars	1
GENG 490	Graduation Project	3
MECH 421	Refrigeration and Air Conditioning	3
MECH 422	Mechanical Design II	3
MECH 423	Advanced Manufacturing Process	3
Total		**13**

FOURTH YEAR
Semester 9 (Summer)

Course Code	Course Title	Credit
GENG 480	Field Training	3
Total		**3**

FIFTH YEAR
Semester 10

Course Code	Course Title	Credit
GENG 490	Graduation Project (Reactivation)	0

MECH 517	Finite Element Methods in Mech. and Aero Eng.	3
MECH 415	Turbomachinery	3
	Elective	3
	Elective Lab	1
Total		**10**
Total credits		**146**

DEPARTMENT OF MECHANICAL ENGINEERING

BACHELOR OF SCIENCE (BS) DEGREE (AERONAUTICAL SPECIALTY)

FIRST YEAR
Semester 1

Course Code	Course Title	Credit
AERO 211	Aircraft Basic Science	3
CIVE 201	Statics	3
ENGL 203	English Communication Skills III	3
MATH 200	Calculus I	3
MATH 211	Linear Algebra	3
MECH 211	Mechanical Drawing I	1
MECH 212	Instrumentation and Experimentation I	1
GENG 290	Introduction to the Engineering Design Process	1
Total		**18**

FIRST YEAR
Semester 2

Course Code	Course Title	Credit
AERO 221	Airframe Workshop	1
CIVE 202	Mechanics of Materials	3
CSIS 206	Programming for Engineers	3
	English Elective	3
MATH 202	Calculus II	3
MECH 221	Engineering Dynamics	3
MECH 222	Science of Materials	3
Total		**19**

SECOND YEAR
Semester 3

Course Code	Course Title	Credit
AERO 234	Fundamentals of Aircraft Structures	3
CSPR 201	The Formation of Civilization	3
MATH 270	Differential Equations	3
MECH 231	Circuit Fundamentals	3
MECH 232	Thermodynamics	3

MECH 234	Mechanical Drawing II	1
MECH 243	Fluid Mechanics	3
Total		**19**

SECOND YEAR
Semester 4

Course Code	Course Title	Credit
AERO 231	Aircraft Dynamics and Control	3
AERO 232	Aerodynamics of Flight	3
AERO 244	Aero-Engines Workshop	1
CSPR 202	The Religious Experience	3
LISP 200	Library Use and Research Methods	1
MATH 230	Numerical Analysis	3
MECH 242	Engineering Vibrations	3
MECH 244	Instrumentation & Experimentation II	1
Total		**18**

THIRD YEAR
Semester 5

Course Code	Course Title	Credit
AERO 245	Aircraft Instruments and Systems	3
MATH 246	Probability for Engineers	3
MECH 241	Computational Techniques in Mech. Eng.	3
MECH 314	Gas Dynamics	3
MECH 315	Mechanics of Machines	3
MECH 325	Instrumentation and Experimentation III	1
MECH321	Heat Transfer	3
Total		**19**

THIRD YEAR
Semester 6

Course Code	Course Title	Credit
AERO 316	Fundamentals of Aircraft Design	3
AERO 343	Helicopter Fundamentals	3
AERO 344	Aircraft Propulsion Systems	3
AERO 346	Safety Management Systems	3
CSPR 203	Introduction to Modernity	3
GENG 390	Design Project	1
Total		**16**

Total credits **109**

DEPARTMENT OF MECHANICAL ENGINEERING

BACHELOR OF SCIENCE (BE) DEGREE (AERONAUTICAL SPECIALTY)

FIRST YEAR
Semester 1

Course Code	Course Title	Credit
AERO 211	Aircraft Basic Science	3
CIVE 201	Statics	3
ENGL 203	English Communication Skills III	3
MATH 200	Calculus I	3
MATH 211	Linear Algebra	3
MECH 211	Instrumentation and Experimentation I	1
MECH 212	Mechanical Drawing I	1
GENG 290	Introduction to the Engineering Design Process	1
Total		**18**

FIRST YEAR
Semester 2

Course Code	Course Title	Credit
	English Elective	3
AERO 221	Airframe Workshop	1
CIVE 202	Mechanics of Materials	3
CSIS 206	Programming for Engineers	3
MATH 202	Calculus II	3
MECH 221	Engineering Dynamics	3
MECH 222	Science of Materials	3
Total		**19**

SECOND YEAR
Semester 3

Course Code	Course Title	Credit
AERO 234	Fundamentals of Aircraft Structures	3
CSPR 201	The Formation of Civilization	3
MATH 270	Differential Equations	3
MECH 231	Circuit Fundamentals	3
MECH 232	Thermodynamics	3
MECH 234	Mechanical Drawing II	1
MECH 243	Fluid Mechanics	3
Total		**19**

SECOND YEAR
Semester 4

Course Code	Course Title	Credit
AERO 231	Aircraft Dynamics and Control	3
AERO 232	Aerodynamics of Flight	3

AERO 244	Aero-Engines Workshop	1
CSPR 202	The Religious Experience	3
LISP 200	Library Use and Research Methods	1
MATH 230	Numerical Analysis	3
MECH 242	Engineering Vibrations	3
MECH 244	Instrumentation and Experimentation II	1
Total		**18**

THIRD YEAR
Semester 5

Course Code	Course Title	Credit
AERO 245	Aircraft Instruments and Systems	3
MATH 246	Probability for Engineers	3
MECH 241	Computational Techniques in Mech. Eng.	3
MECH 314	Gas Dynamics	3
MECH 315	Mechanics of Machines	3
MECH 325	Instrumentation and Experimentation III	1
MECH321	Heat Transfer	3
Total		**19**

THIRD YEAR
Semester 6

Course Code	Course Title	Credit
AERO 316	Fundamentals of Aircraft Design	3
AERO 343	Helicopter Fundamentals	3
AERO 344	Aircraft Propulsion Systems	3
AERO 346	Safety Management Systems	3
CSPR 203	Introduction to Modernity	3
Total		**15**

FOURTH YEAR
Semester 7

Course Code	Course Title	Credit
AERO 411	Advanced Aerodynamics	3
AERO 413	Advanced Aircraft Structures	3
MECH 412	Mechanics of Composite Materials	3
MECH 415	Turbomachinery	3
Total		**12**

FOURTH YEAR
Semester 8

Course Code	Course Title	Credit
AERO 421	Gas Turbine Propulsion Systems	3
AERO 422	Aircraft Design II	3
MECH 517	Finite Element Methods in Mech. and Aero Eng.	3
GENG 400	Engineering Seminars	1
GENG 490	Graduation Project	3
Total		**13**

FOURTH YEAR
Semester 9 (Summer)

Course Code	Course Title	Credit
GENG 480	Field Training	3
Total		**13**

FIFTH YEAR
Semester 10

Course Code	Course Title	Credit
GENG 490	Graduation Project (Reactivation)	0
	Elective	3
	Elective	3
	Elective	3
	Elective Lab	1
Total		**10**

Total credits **146**

List of Electives:

Course Code	Course Title	Credit
AERO 423	Gas Turbine Combustors	3
AERO 414	Heat Transfer in Aeronautics	3
AERO 424	Aircraft Maintenance Techniques	3
AERO 514	Aero-Elasticity	3
MGMT 310	Management of Organizations	3
MGMT 323	Managing Organizational Behavior	3
MRKT 310	Marketing Management	3
ISYS 320	Information Resources Management	3
GENG 402	Project Management	3
MECH 411	Advanced Mechanics of Materials	3
MECH 412	Mechanics of Composite Materials	3
MECH 413	Internal Combustion Engines	3
MECH 414	Process Control Systems	3
MECH 419	Computers in Design and Manufacturing	3
MECH 423	Advanced Manufacturing Processes	3
MECH 511	Computational Fluid Dynamics	3
MECH 515	Turbulence and Transport Phenomena	3
MECH 518	Advanced Gas Dynamics	3

COURSE DESCRIPTIONS

AERO 211 AIRCRAFT BASIC SCIENCE **3.0: 3 cr. E**

This course provides students with an introductory treatment of the aerodynamic theory of aircraft, including flight dynamics, basic design issues, instrumentation in addition to important maintenance requirements and regulations.

AERO 221 AIRFRAME WORKSHOP **1.2: 1 cr. E**

This is a practical course which introduces students to the basic workshop practices involved in handling

airframes. Working with hand tools, machine tools and special tools appropriate to aircraft is emphasized in addition to introducing them some elementary manufacturing techniques.

AERO 231 AIRCRAFT DYNAMICS AND CONTROL **3.0: 3 cr. E**
Concepts of classical mechanics with the aerodynamic conclusions and derivations applied flying objects, range and endurance derivations for different types of aircraft, rates of climb, landing, best speeds for climb and speeds for best angle of climb, special performance problems, mechanics of some maneuvering operations, introduction to concepts of stability and control.

AERO 232 AERODYNAMICS OF FLIGHT **3.0: 3 cr. E**
This course deals with the dynamics of inviscid incompressible air flows, mathematical development of wing theory, analytical and experimental techniques in predicting performance of finite wings and thin airfoil sections, importance of boundary layer theory is emphasized.

AERO 233 HUMAN FACTORS AND AVIATION REGULATION **3.0: 3 cr. E**
This course instills in students an appreciation of the importance of human related issues in the aeronautical industry. Aspects of physiology, psychology, fatigue and sleep patterns are all discussed in addition to interpersonal professional relationships, work environments, attitudes and habits. These are analyzed in relation to flight decks, maintenance stations, dispatch units, administrations. The course also seeks to introduce students to the concepts of aviation laws and regulations, their sources, applicability and administrative control.

AERO 234 FUNDAMENTALS OF AIRCRAFT STRUCTURES **3.0: 3 cr. E**
Analysis of statically indeterminate structures. Thermal stresses and plasticity, applications in plane stress systems. Analysis of complex frameworks; structural airworthiness. Analysis of thin walled tube with all loading conditions. Multi cell tubes.

AERO 244 AERO-ENGINES WORKSHOP **1.2:1 cr. E**
Engine constructions, identification of engine parts, assembley and disassembly of piston and gas-turbine power plants, engine installation, preservation and storage.

AERO 245 AIRCRAFT INSTRUMENTS AND SYSTEMS **3.0: 3 cr. E**
Aircraft electrical, mechanical and hydraulic systems; propulsion control systems; radar radio aids, cockpit displays; guidance and communication systems; electronic surveillance and counter measures. Flight testing, video displays, crash recorders.

AERO 311 PRODUCTION PLANNING AND CONTROL **3.0: 3 cr. E**
General outline of Production Planning and control, standard terminology, Maintenance philosophies and concepts, Planning method and standards, Production forecasting, Materials Routing, Production method and standards, Manpower planning, Production scheduling and control, Production performance analysis, Computer applications in aircraft maintenance engineering.

AERO 312 BASIC AVIONICS AND NAVIGATION SYSTEMS **3.0: 3 cr. E**
General theories of dead reckoning and radio navigation. Gyroscopic flight and navigation systems, Radio navigation systems, VORs, DMEs, NDBs and ADFs, Global Positioning and Satellite Navigation Systems.

AERO 313 INTRODUCTORY AVIATION MANAGEMENT **3.0: 3 cr. E**
Introduction of the historical development of modern airports; business and operational factors, airport regulations and government agencies, labor and personnel relations, security, safety, facility maintenance. Study of airline operations; fleet composition, scheduling, demand forecasting, pricing structure, facilities planning, marketing, financing, analyzing labor requirements, operational costs, and profit/loss reporting.

AERO 316 FUNDAMENTALS OF AIRCRAFT DESIGN **3.0: 3 cr. E**
Design of minor and major components of aircraft structures, demonstration sessions on A/C models, importance of aerodynamics and solid mechanics in the design of various A/C components, a number of projects are assigned in the course.

AERO 341 QUALITY ASSURANCE IN AVIATION **3.0: 3 cr. E**

This course provides students with an appreciation of quality assurance programs, quality management and quality control philosophies, in order to prevent unnecessary loss or damage to aircraft or property, or injury to human life in parallel with improving the efficiency of an aviation business. The course includes topics relating to tasks and features of QAP, evaluation concept and quality verification inspections, personnel evaluation, special functions of QAP, QA documentation, management and implementation of QAP, statistical methods in QC, ISO9001, and the 5S concept.

AERO 342 COMPUTATIONAL TECHNIQUES IN AVIATION **3.0: 3 cr. E**

The purpose of this course is to enhance students computational capacities by exposing them to problems in aeronautical engineering problems that are best solved or analyzed numerically. Applications from flight mechanics, aerodynamics, thermo-fluids, heat transfer, and design are all considered. Special emphasis is put on pre- and post processing and the importance of appropriate presentation and animation.

AERO 343 HELICOPTER FUNDAMENTALS **3.0: 3 cr. E**

The objectives of this course are to provide an introductory treatment of the aerodynamic theory of rotary wing aircraft, including basic performance, control, and basic rotor dynamics, history of helicopter flight, fundamentals of rotor aerodynamics, blade element analysis, rotating blade motion, basic helicopter performance, conceptual design of helicopter.

AERO 344 AIRCRAFT PROPULSION SYSTEMS **3.0: 3 cr. E**

This course deals with the basic principles of aircraft propulsion. It starts with the basic theory of thrust generation, and distinguishes between propeller and jet driven aircraft. It introduces students to piston engines and propeller power-plants as used on light aircraft and then progresses towards gas turbine engines of the various types. Of particular importance is the thermodynamics performance analyses as well as thrust calculations for the different engines.

AERO 345 MODERN DEVELOPMENTS IN AVIATION **3.0: 3 cr. E**

The course deals with the most modern developments in aeronautical engineering. It covers the fundamentals of human factors concepts, an introduction to aircraft maintenance engineering human factors, automation, composite materials for the modern aircraft and the fly-by-wire technology.

AERO 401 AERODYNAMICS I **3.0: 3 cr. E**

This course is given to Mechanical Engineers specializing following the graduate aerospace option. This course deals with the dynamics of inviscid incompressible air flows, mathematical development of wing theory, analytical and experimental techniques in predicting performance of finite wings and thin airfoil sections, importance of boundary layer theory is emphasized.

AERO 402 AIRCRAFT STRUCTURES I **3.0: 3 cr. E**

This course is given to Mechanical Engineers specializing following the graduate aerospace option. Analysis of statically indeterminate structures. Thermal stresses and plasticity, applications in plane stress systems. Analysis of complex frameworks; structural airworthiness. Analysis of thin walled tube with all loading conditions. Multi cell tubes.

AERO 403 MECHANICS OF FLIGHT **3.0: 3 cr. E**

This course is given to Mechanical Engineers specializing following the graduate aerospace option. Concepts of classical mechanics with the aerodynamic conclusions and derivations applied flying objects, range and endurance derivations for different types of aircraft, rates of climb, landing, best speeds for climb and speeds for best angle of climb, special performance problems, mechanics of some maneuvering operations, introduction to concepts of stability and control.

AERO 405 AIRCRAFT DESIGN I **3.0: 3 cr. E**

This course is given to Mechanical Engineers specializing following the graduate aerospace option. Conceptual, preliminary and detail design of aircraft. Design of minor and major components of aircraft structures, demonstration sessions on A/C models, importance of aerodynamics and solid mechanics in the design of various A/C components, a number of projects are assigned in the course.

AERO 406 AIRCRAFT SYSTEMS ENGINEERING **3.0: 3 cr. E**

This course is given to Mechanical Engineers specializing following the graduate aerospace option. Aircraft electrical, mechanical and hydraulic systems; propulsion control systems; radar radio aids, cockpit displays; guidance and communication systems; electronic surveillance and counter measures. Flight testing, video displays, crash recorders.

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

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.

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

Analysis of plates and shells; optimum structures, Structural dynamics; Structural fatigue, principles and practices. Introduction to aero elasticity; static and dynamic.

AERO 414 HEAT TRANSFER IN AERONAUTICS **3.0: 3 cr. E**

The course introduces the principles of thermal conduction, convection and radiation as they are applied in the field of aeronautics. It is also concerned with the design and analysis of Heat Exchangers and outlines the basic principles of computational modeling in Heat Transfer.

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.

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

Significance of various engineering courses and their interactions in the design process are cleared out, design of an aircraft satisfying certain requirements as the best compromise of several trials and modifications, weight estimation, 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. Prerequisite: AERO 421.

AERO 423 GAS TURBINE COMBUSTORS **3.0:3 cr. E**

Stoichiometry and stoichiometric analysis, complete versus incomplete combustion, enthalpies of formation, flame speeds and flame temperatures, gas turbine combustor design and sizing.

AERO 424 AIRCRAFT MAINTENANCE TECHNOLOGY **1.2: 3 cr. E**

A practical course dealing with the general Maintenance Concept, production planning and control of aircraft checks, ground handling, fuselage and airframes, main landing gear, tires and wheels, nose landing gear, braking system, flying controls, aircraft fuel system, engine construction and maintenance, engine fuel system, propeller maintenance utility system, aircraft instruments maintenance and repairs electrical system maintenance and repairs metallic aircraft structural repairs, painting.

AERO 514 AERO-ELASTICITY **3.0: 3 cr. E**

Fluid-structure interaction, steady and unsteady aerodynamic loadings, static and dynamic aero-elasticity, flutter and forced vibration analysis, applications to aircraft, rotorcraft and turbomachines.

MECH 211 MECHANICAL DRAWING I **0.3: 1 cr. E**

Concepts and practices in lettering, geometric construction, multi-view and auxiliary projections, sections and connections, dimensioning, and isometric and oblique pictorials. Emphasis on freehand sketching skills.

MECH 212 INSTRUMENTATION AND EXPERIMENTATION I **0.3: 1 cr. E**

General considerations for safe operation within a mechanical engineering laboratory environment. Presentation of general measurement theory, and concepts of accuracy and precision. Criteria behind "confidence" in measurements, significant notation, data processing professional data presentation methodologies and various

available tools. Various measurement reporting methods. Applying learnt methodologies and techniques to various experimental cases, and the exposure of students to different experimental equipment.

MECH 221 ENGINEERING DYNAMICS **3.0: 3 cr. E**
Kinematics and kinetics of particles: Force, acceleration, work, energy and momentum. Two dimensional kinematics and kinetics of rigid bodies, translational and rotational motions. Vibrations.

MECH 222 SCIENCE OF MATERIALS **3.0: 3 cr. E**
Material classification. Atomic structures. Crystal structure solidification. Crystalline imperfections. Phase diagrams. Engineering alloys. Electrical and Mechanical properties of metals. Polymeric ceramic and magnetic materials. Corrosion. Composite materials.
Pre-requisite: English Proficiency Level: ENGL 101.

MECH 231 CIRCUITS FUNDAMENTALS **3.0: 3 cr. E**
The purpose of this course is to provide the students with basic understanding of electrical and electronics circuit theory. Topics covered include: fundamental definitions and laws; essential circuit analysis techniques applied to resistive circuits, RL, RC and RLC circuits; diodes circuits; transistor circuits; introduction to difference and operational amplifiers.
Pre-requisites: MATH 200/211.

MECH 232 THERMODYNAMICS **3.0: 3 cr. E**
Basic concepts and definitions. Properties of pure substance. Heat. Work. First Law of Thermodynamics. Second Law of Thermodynamics. Entropy. Reversibility and Irreversibility. Power and refrigeration cycles.

MECH 233 WORKSHOP TECHNOLOGY **0.3: 1 cr. E**
Drilling, milling, grinding, lath work, welding, molding, heat treatments, forging, electric workshop technologies.

MECH 234 MECHANICAL DRAWING II **0.3: 1 cr. E**
Architectural drawings of residential/commercial/ industrial buildings meeting local specifications. electrical and mechanical views, sectioning, hatching and assembling of mechanical machines and equipment.
Pre-requisite: MECH 211.

MECH 241 COMPUTATIONAL TECHNIQUES IN MECH. ENG. **3.0: 3 cr. E**
The purpose of this course is to enhance students computational capacities by exposing them to problems in mechanical engineering problems that are best solved or analyzed numerically. Applications from mechanics, thermo-fluids, heat transfer, and design are all considered. Special emphasis is put on pre- and post processing and the importance of appropriate presentation and animation.
Pre-requisite: CIVE 202, MATH 202,230, CSIS 206.

MECH 242 ENGINEERING VIBRATIONS **3.0: 3 cr. E**
Linear single degree of freedom systems, transient and steady vibrations, linear undamped multi-forced degree of freedom systems. Lagrange Equation.
Pre-requisite: MECH 221.

MECH 243 FLUID MECHANICS **3.0: 3 cr. E**
Fluid properties, fluid statics and manometry, kinematics, basic conservation equations of continuity, momentum and energy. Incompressible flows. Viscous effects in pipes and restrictions, Laminar and Turbulent Flows. Dimensional Analysis and Similitude.

MECH 244 INSTRUMENTATION AND EXPERIMENTATION II **0.3: 1 cr. E**
This lab course, the second in a series, is designed to consolidate theories gained in other courses taken up to the second year and build lab competencies through practical experiments. Typical experiments are in the areas of thermodynamics, Fluid Mechanics, Mechanics, Dynamics, Vibrations, etc. Special emphasis is exercised on

modern data acquisition techniques as well as data presentation and reporting.

MECH 311 MECHANICAL DESIGN I **3.0: 3 cr. E**

The course clarifies the role of design, and design activities and tools in the production of goods. It reviews such concepts as factor of safety, stress and strain, and deflection. The course explains static and fatigue failure theories and their applications. It also covers the design for strength of pressure vessels, columns, shafts, and other structural and machine elements. Design of weldments and bolted joints is also included.
Pre-requisite: CIVE 202.

MECH 313 ELECTROMECHANICAL SYSTEMS **3.0: 3 cr. E**

This course deals with induced force, induced voltage in a conductor, DC machinery fundamentals. Equivalent circuit, DC generators, DC motors, single phase and three phase transformers, autotransformers, induced motors, speed control of induced motors, synchronous generators and motors.
Pre-requisite: MECH 231.

MECH 314 GAS DYNAMICS **3.0: 3 cr. E**

This course is divided in two parts: the Boundary Layer Theory and Compressible Flows. Boundary Layer Theory introduces the Navier Stokes Equations, Prandtl's approximations and practical methods of solution of viscous flows. Part 2 is directed at one dimensional compressible flow in nozzles and pipes including shock wave analysis and real effects such heat transfer and friction.
Pre-requisite: MECH 232, 243.

MECH 315 MECHANICS OF MACHINES **3.0: 3 cr. E**

Degrees of Freedom. Linkages and their kinematic analysis. Cam synthesis, kinematic requirements, and graphical and analytical design. gears and gear trains. Introduction to synthesis. Force analysis of machinery and balancing.
Pre-requisite: MECH 221.

MECH 321 HEAT TRANSFER **3.0: 3 cr. E**

The course introduces the principles of thermal conduction, convection and radiation. It is also concerned with the design and analysis of Heat Exchangers and outlines the basic principles of computational modeling in Heat Transfer.
Pre-requisites: MECH 232, 243.
Co-Requisite MECH 314.

MECH 322 AUTOMATIC CONTROLS **3.0:3 cr. E**

This course deals with introduction to design and analysis of feedback control systems, properties and advantages of feedback systems, time-domain and frequency-domain performance measures, stability and degree of stability. It also covers root locus method, nyquist criterion, frequency-domain design, and state space methods.

MECH 323 CAD/CAM **1.2: 3 cr. E**

The course explains terminology used in CAD/CAM. It also explains the concepts, the mathematics and the building blocks that are the basis of CAD and CAM packages. Mathematical details relating to curve and surface generation, display and manipulation are also covered. Basic CAD and CAM data file structures, and exchange formats are included in the course. The interface between CAD and CAM is demonstrated through the design and manufacture of sample parts on laboratory CNC tool.
Pre-requisite: MECH 234.

MECH 324 STEAM AND GAS TURBINES **3.0: 3 cr. E**

This is an advanced thermodynamics course in which students are introduced to the thermal design and analysis of Gas and Steam Turbine cycles and their variations as implemented by the power generation and aviation industries.
Pre-requisite: MECH 314.

MECH 325 INSTRUMENTATION AND EXPERIMENTATION III 0.3: 1 cr. E
This lab course, the third in a series, is designed to consolidate theories gained in other courses taken up to the third year and build lab competencies through practical experiments. Typical experiments are in the areas of Gas Dynamics, Heat Transfer, Power and Refrigeration Systems, Automatic Controls, Manufacturing Systems, etc. Special emphasis is exercised on modern data acquisition techniques as well as data presentation and reporting.

MECH 326 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 practised 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.
Prerequisites: MECH 212, 222, 244; CIVE 202.

MECH 400 ADV. ENGINEERING ANALYSIS AND RESEARCH METHODOLOGY 3.0: 3 cr. E
Formulation of some partial differential equations (PDE). Method of Characteristics and solution to 1st order PDEs. Solution of parabolic, hyperbolic, and elliptic PDEs using separation of variables. Introduction to Calculus of Variations and Euler equation with some applications in mechanics, mathematics, and economics.

MECH 411 ADVANCED MECHANICS OF MATERIALS 3.0: 3 cr. E
Theories of stresses and strains. Material behavior for general anisotropic, orthotropic and isotropic materials. 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. Beams on elastic foundations. Curved beams.

MECH 412 MECHANICS OF COMPOSITE MATERIALS 3.0: 3 cr. E
Anisotropic elasticity and laminate theory, analysis of various members of composite materials, energy methods, Failure Analysis. Applications using software packages.

MECH 413 INTERNAL COMBUSTION ENGINES 3.0: 3 cr. E
This course covers the fundamentals of how the design and operation of internal combustion engines affect their performance, fuel requirements, and environmental impact. Fluid flow, thermodynamics, combustion, heat transfer, friction, and fuel properties, relevant to engine power, efficiency, and emissions are also studied. Examination of design features and operating characteristics of different types of internal combustion engines: spark-ignition and diesel running two or four-stroke cycles.

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
The course provides a brief overview and historical background about the development turbomachinery and related applications. It details the fundamental principles of thermodynamics and fluid mechanics applied to turbomachines, introduces the concept of turbomachiney characteristic curves and terminology, covers dimensional analysis related to turbomachinery, as well as theoretical analysis of hydraulic pumps, hydraulic turbines, air compressors, and gas and steam turbines.

MECH 421 REFRIGERATION and AIR CONDITIONING 3.0: 3 cr. E
The course guides the student towards the understanding of the basic thermodynamic cycles, psychrometrics,

ventilating, heating load, cooling load, duct design, and hydraulic pipe design.

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

The course teaches the design, analysis, and selection of mechanical machine elements such as gears, bearings, brakes, springs, and power transmission sub-systems. It also covers the selection (spec-ing) of hydraulic and pneumatic parts, and electric motors. It teaches the analysis and synthesis of hydraulic and pneumatic circuits.

MECH 423 ADVANCED MANUFACTURING PROCESSES **2.2: 3 cr. E**

The course covers manufacturing engineering subjects such as concurrent engineering, design for manufacturing and assembly (DFM, DFA), BOM, MRP, ERP, Just-In-Time manufacturing systems, Automation, Flexible manufacturing, Group Technology, total quality control (TQC), statistical process control (SPC), Gantt charts, BOM, and CAM. The course also offers an introduction to manufacturing processes including CNC. The course also seeks – through the participation of students- to identify potential research themes in manufacturing.

MECH 425 MECHATRONICS **3.0: 3 cr. E**

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**

The Course guides the student towards the understanding of the different domestic water and drainage systems in buildings. It covers water treatments, domestic cold and hot water systems, pumps, drainage and venting systems, storm water, septic tanks, sump pits, and an overview on fire fighting.

MECH 427 FACILITY PLANNING AND CONTROL **3.0: 3 cr. E**

Strategy, Process and schedule design, activity relationship and space requirements, personnel requirements, statistical process control, Deming's and Crosby's approach, Probability models for quality control, sampling and interface, normal distribution, control charts for variables and attributes.

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 such as mass transfer, boiling and condensation, as well as two phase flows and heat transfer. Applications include numerical modeling, computer exercises and lab experiments.

MECH 480 INDUSTRIAL TRAINING **0.0: 3 cr. E**

MECH 511 COMPUTATIONAL FLUID DYNAMICS **2.2: 3 cr. E**

Basic theory of CFD, flow modeling, mesh generation and convergence criteria. Finite-volume discretization of 2-dimensional flow equations. Pre-processing, boundary conditions and solutions. Post processing criteria. Hands-on experience using CFD computer packages. Compressible flow applications and comparisons with theories.

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.

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.

MECH 514 FRACTURE MECHANICS **3.0: 3 cr. E**

Energy in elastic solids. Fracture mechanics versus mechanics of materials. Atomic model of fracture. Linear elastic fracture. Modes of fracture. Stress concentration. Griffith approach and energy release rate. Instability and the R curve. Stress analysis and stress intensity factor and its relation to the energy release rate. Crack tip plasticity. Plane stress/plane strain. Mixed mode fracture. Introduction to elastic/plastic fracture. Introduction to fatigue. Fracture in design.

MECH 517 FINITE ELEMENT METHODS IN MECH and AERO ENG. **3.0: 3 cr. E**

Introduction to Finite Element theories and techniques. FE formulations in 1 and 2 dimensions in solid mechanics, fluid mechanics, gas dynamics and heat transfer. Computer implementation, programming and projects. Prerequisite: MECH 411.

MECH 518 ADVANCED GAS DYNAMICS **3.0: 3 cr. E**

Turbulence concepts, numerical approaches and applications, iterative and direct matrix methods, numerical implementation of turbulence model.

MECH 525 COMPOSITES PROCESSES AND APPLICATIONS **3.0: 3 cr. E**

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 527 INTRODUCTION TO CONTINUUM MECHANICS **3.0: 3 cr. E**

Introduction to 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.

MECH 528 ADVANCED NUMERICAL ANALYSIS **3.0: 3 cr. E**

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.
Co-requisite: MECH 400.

MECH 529 THEORY OF PLATES AND SHELLS **3.0: 3 cr. E**

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.
Prerequisite: MECH 411, MECH 529.
Co-requisite: MECH 400.

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

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.

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

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 400/532.

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

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.
Co-requisite MECH 400.

DEPARTMENT OF CHEMICAL ENGINEERING

BACHELOR OF SCIENCE (BS) DEGREE

FIRST YEAR
SEMESTER 1

Course Code	Course Title	Credit
CHEM 202	Basic Chemistry	3
CHEM 203	Basic Chemistry Lab	1
CHEN 206	Instrumentation Lab	1
CHEN 215	Materials Science and Engineering	3
CHEN 222	Process Simulation and Modeling	1
ENGL 203	English Comm. Skills III	3
MATH 200	Calculus I	3
MATH 211	Linear Algebra	3
Total		**18**

FIRST YEAR
SEMESTER 2

Course Code	Course Title	Credit
CHEM 242	Organic Chemistry I	3
CHEN 212	Chemical Engineering I	3
CSIS 206	Principles of Programming	3
ENGL 2XX	English Elective	3
GENG 290	Introduction to the Engineering Design Process	1
MATH 202	Calculus II	3
MECH 232	Thermodynamics	3
Total		**19**

SECOND YEAR
SEMESTER 3

Course Code	Course Title	Credit
CHEM 244	Organic Chemistry II	3
CHEM 245	Organic Chemistry Lab I	1
CHEN 312	Mass Transfer	3
CHEN 369	Continuous-time Process Control Systems	3
CHEN 377	Chemical Engineering Thermodynamics II	3
CSPR 201	Early Formation of Civilization	3
MATH 270	Differential Equations	3
Total		**19**

SECOND YEAR
SEMESTER 4

Course Code	Course Title	Credit
CHEN 325	Chemical Reactions and Reactor Design	3
CHEM 262	Physical and Chemical Kinetics	3
CSPR 202	The Religious Experience	3

MATH 246	Probability for Engineers	3
MECH 221	Engineering Dynamics	3
MECH 243	Fluids Mechanics	3
Total		**18**

THIRD YEAR
SEMESTER 5

Course Code	Course Title	Credit
CHEN XXX	Option Elective	3
CHEN 303	Unit Operations	3
CHEN 324	Petroleum Engineering Lab	1
CHEN 357	Gas Engineering	3
LISP 200	Library Use and Research Methods	1
CSPR 203	Introduction to Modernity	3
MATH 230	Numerical Analysis	3
Total		**17**

THIRD YEAR
SEMESTER 6

Course Code	Course Title	Credit
CHEN XXX	Option Elective	3
CHEN XXX	Option Elective	3
CHEN 370	Process-Modeling and Control Lab	1
CHEN 323	Plant and Environmental Safety	3
CHEN 326	Chemical Engineering Lab	1
CHEN 336	Separation Processes	3
GENG 390	Senior Project Design	1
MECH 321	Heat Transfer	3
Total		**18**

Total Credits **109**

OPTION ELECTIVES (3 COURSES FROM THE FOLLOWING LIST):

Course Code	Course Title	Credit
CHEN 211	Fundamentals of Geology	3
CHEN 246	Chemical Engineering Instrumentation	3
CHEN 311	Petroleum Fluids	3
CHEN 321	Fundamentals of Petroleum Engineering	3
CHEN 322	Petroleum Refinery Engineering	3
CHEN 329	Plant Economics	3
CHEN 333	Food Chemistry and Technology Principles	3
CHEN 340	Food Engineering Fundamentals	3
CHEN 350	Methods of Food Preservation	3
CHEN 378	Living Cells Engineering	3
CHEN 388	Biofuel Engineering	3
CIVE 201	Statics	3
CIVE 309	Engineering Economy	3

GENG 311	Engineering Management and Economics	3
MATH 210	Algebra	3
MECH 231	Circuit Fundamentals	3

DEPARTMENT OF CHEMICAL ENGINEERING

BACHELOR OF ENGINEERING (BE) DEGREE

FIRST YEAR
SEMESTER 1

Course Code	Course Title	Credit
CHEM 202	Basic Chemistry	3
CHEM 203	Basic Chemistry Lab	1
CHEN 206	Instrumentation Lab	1
CHEN 215	Materials Science and Engineering	3
CHEN 222	Process Simulation and Modeling	1
ENGL 203	English Comm. Skills III	3
MATH 200	Calculus I	3
MATH 211	Linear Algebra	3
Total		**18**

FIRST YEAR
SEMESTER 2

Course Code	Course Title	Credit
CHEM 242	Organic Chemistry I	3
CHEN 212	Chemical Engineering I	3
CSIS 206	Principles of Programming	3
ENGL 2XX	English Elective	3
GENG 290	Introduction to the Engineering Design Process	1
MATH 202	Calculus II	3
MECH 232	Thermodynamics	3
Total		**19**

SECOND YEAR
SEMESTER 3

Course Code	Course Title	Credit
CHEM 244	Organic Chemistry II	3
CHEM 245	Organic Chemistry Lab I	1
CHEN 312	Mass Transfer	3
CHEN 369	Continuous-time Process Control Systems	3
CHEN 377	Chemical Engineering Thermodynamics II	3
CSPR 201	Early Formation of Civilization	3
MATH 270	Differential Equations	3
Total		**19**

SECOND YEAR
SEMESTER 4

Course Code	Course Title	Credit
CHEN 325	Chemical Reactions and Reactor Design	3
CHEM 262	Physical and Chemical Kinetics	3
CSPR 202	The Religious Experience	3
MATH 246	Probability for Engineers	3
MECH 221	Engineering Dynamics	3
MECH 243	Fluids Mechanics	3
Total		**18**

SECOND YEAR
SEMESTER 5

Course Code	Course Title	Credit
CHEN XXX	Option Elective	3
CHEN 303	Unit Operations	3
CHEN 324	Petroleum Engineering Lab	1
CHEN 357	Gas Engineering	3
LISP 200	Library Use and Research Methods	1
CSPR 203	Introduction to Modernity	3
MATH 230	Numerical Analysis	3
Total		**17**

THIRD YEAR
SEMESTER 6

Course Code	Course Title	Credit
CHEN XXX	Option Elective	3
CHEN XXX	Option Elective	3
CHEN 370	Process-Modeling and Control Lab	1
CHEN 323	Plant and Environmental Safety	3
CHEN 326	Chemical Engineering Lab	1
CHEN 336	Separation Processes	3
MECH 321	Heat Transfer	3
Total		**17**

OPTION ELECTIVES (3 COURSES FROM THE FOLLOWING LIST) :

Course Code	Course Title	Credit
CHEN 211	Fundamentals of Geology	3
CHEN 246	Chemical Engineering Instrumentation	3
CHEN 311	Petroleum Fluids	3
CHEN 321	Fundamentals of Petroleum Engineering	3
CHEN 322	Petroleum Refinery Engineering	3
CHEN 329	Plant Economics	3
CHEN 333	Food Chemistry and Technology Principles	3
CHEN 340	Food Engineering Fundamentals	3
CHEN 350	Methods of Food Preservation	3
CHEN 378	Living Cells Engineering	3

CHEN 388	Biofuel Engineering	3
CIVE 201	Statics	3
CIVE 309	Engineering Economy	3
GENG 311	Engineering Management and Economics	3
MECH 231	Circuit Fundamentals	3

FOURTH YEAR
SEMESTER 7

Course Code	Course Title	Credit
CHEN 400	Chemical Process Synthesis and Design	3
CHEN 404	Advanced Chemical Reactor Design	3
CHEN 412	Industrial Catalytic Processes	3
CHEN 422	Surface and Colloid Chemistry	3
Total		**12**

FOURTH YEAR
SEMESTER 8

Course Code	Course Title	Credit
CHEN 413	Advanced Transport Phenomena	3
CHEN XXX	Elective	3
CHEN XXX	Elective	3
GENG 400	Engineering Seminars	1
GENG 490	Graduation Project	3
Total		**13**

FOURTH YEAR
SEMESTER 9 (Summer)

Course Code	Course Title	Credit
GENG 480	Field Training	3
Total		**3**

FIFTH YEAR
SEMESTER 10

Course Code	Course Title	Credit
CHEN XXX	Elective	3
CHEN XXX	Elective	3
CHEN XXX	Elective	3
CHEN XXX	Elective Lab	1
GENG 490	Graduation Project (Reactivation)	0
Total		**10**

Total **146**

ELECTIVE LAB: ONE LAB FROM THE FOLLOWING LIST:

Course Code	Course Title	Credit
CHEN433	Advanced Chemical Engineering Lab	1
CHEN433	Catalysis Lab	1

CHEMICAL MANUFACTURING OPTION (15 CREDITS FROM THE FOLLOWING LIST):

Course Code	Course Title	Credit
CHEN 417	Chemical Instrumentation and Measurement	3
CHEN 418	Polymers and Polymer Engineering	3
CHEN 424	Cement Manufacturing	3
CHEN 427	Thermal Process in the Heavy Industry	3
CHEN 430	Environmental Design and Life Cycle Assessment	3
CHEN 450	Ecotoxicology for engineers	3
CHEN 478	Corrosion in Chemical Processes	3
CHEN 514	Air-Pollution Problems and Control	3
CHEN 515	Dynamics of Particulate Systems	3
CHEN 517	Chemical-Process Dynamics and Control	3
CHEN 525	Powder Technology and Operating Design	3
CHEN 527	Grinding Technology	3
CHEN 530	Environmental Modeling of Toxic Emissions	3
CHEN 544	Nanofabrication	3
CHEN 566	Bioseparation Engineering	3
CHEN 578	Nuclear Energy and Nuclear Reactors	3
CHEN 589	Waste Treatment Engineering	3
ELEN 401	Optimization Theory	3
ELEN 523	Optimal Control Systems	3
MECH 511	Computational Fluid Dynamics	3
	Approved course(s) in Eng. Management	
	Course(s) from the 2 lists below	

PETROLEUM ENGINEERING OPTION (15 CREDITS FROM THE FOLLOWING LIST):

Course Code	Course Title	Credit
CHEN 421	Advanced Petroleum Processing	3
CHEN 426	Reservoir Engineering	3
CHEN 468	Mechanisms in Petroleum Engineering	3
CHEN 513	Subsurface Production Engineering	3
CHEN 531	Oil Field Development	3
CHEN 532	Advanced Natural Gas Engineering	3
CHEN 551	Drilling Engineering	3
CHEN 579	Numerical Methods in Petroleum Industry	3

FOOD PROCESSING OPTION (15 CREDITS FROM THE FOLLOWING LIST):

Course Code	Course Title	Credit
CHEN 420	Food Process Engineering	3
CHEN 440	Food Creation and Development	3
CHEN 441	Food Sanitation	3
CHEN 442	Chemistry of Food and Bioprocessed Materials	3

CHEN 443	Food Microbial World	3
CHEN 444	Food Sensory Science	3
CHEN 517	Chemical-Process Dynamics and Control	3
CHEN 524	Food Laws and Regulations	3
CHEN 525	Powder Technology and Operating Design	3
CHEN 541	Quality Control in Food and Bioprocessing	3
CHEN 542	Food Preservation	3
CHEN 545	Processing Dairy Products	3
CHEN 546	Food Safety and Toxicology	3
CHEN 547	Lactation, Milk, and Nutrition	3
CHEN 550	Food Management and Marketing	3
CHEN 555	Emerging Food Technologies and Biotechnology	3
CHEN 566	Bioseparation Engineering	3
CHEN 577	Food Packing	3
CHEN 588	Food Analysis Techniques	3

COURSE DESCRIPTIONS

CHEN 206 INSTRUMENTATION LAB AND RESEARCH METHODS 0.3: 1 cr. E
This laboratory initializes students to the experimental work and to the use of measuring instruments. Methodology in writing technical reports will be covered. Student will learn also how to identify important and relevant information from different sources (books, journal papers, patents, etc.) and how to use practically essential softwares (Excell, Power point, Word, etc.) for experimental data processing.

CHEN 211 FUNDAMENTALS OF GEOLOGY 3.0: 3 cr. E
This course provides an introduction to Earth geology. Topics include plate tectonics, the makeup of continents and mountain building. Heat flow, magnetism, gravity, rock deformation, earthquakes and the earth's interior. Surface processes including weathering, erosion, transport and deposition. Landforms, rivers, groundwater, glaciers, ocean processes, and volcanoes. Minerals and rocks.

CHEN 212 CHEMICAL ENGINEERING I 3.0: 3 cr. E
This course provides an introduction to the discipline of chemical engineering. An introduction is provided to the first principles of chemical engineering, as well as environmental, health, safety and ethical issues in chemical engineering practice. An overview is provided of the chemical engineering profession, career choices, the course of study, and a survey of the chemical industry, e.g., polymer, pharmaceutical, food processing, electrochemical, biotechnology, process control, energy, and petroleum refining.
Prerequisite: MATH 200

CHEN 215 MATERIALS SCIENCE AND ENGINEERING 3.0: 3 cr. E
This course introduces fundamental concepts in materials science. The main purpose of this course is to provide a good undrestanding of the materials science and engineering. Topics covered include: atomic structure and interatomic bonding, crystalline structure, crystal defects, diffusion, phase diagrams, mechanical properties of metals, ceramic, polymers and composite materials, corrosion and degradation of materials.

CHEN 222 PROCESS SIMULATION AND MODELING 0.3: 1 cr. E
This course makes use of computers and software as problem solving aids in chemical engineering. The course provides an introduction to drawing software Autocad. It also focuses on the learning and application of process simulation, modeling and control software such as Labview.

CHEN 246 CHEMICAL ENGINEERING INSTRUMENTATION 3.0: 3 cr. E
This course presents the theory of optical, electro-analytical, and chromatographic methods of analysis, including

electronic aspects of modern instrumentation; fundamentals principles and methods used in measurement and control of process variables such as pressure, temperature and flow rate; as well as chemical transducers and statistical methods of data handling.

CHEN 303 UNIT OPERATIONS **3.0: 3 cr. E**

The course covers the principles of unit operations with emphasis on distillation, absorption, extraction, and fluid-solid systems. Property prediction of multi-component fluids. Cases will cover principles of heat-exchanger design, multi-component fractionation, absorption, stripping and extraction.
Prerequisites: CHEN 312, 325, 377, MECH 243.

CHEN 311 PETROLEUM FLUIDS **3.0: 3 cr. E**

This course covers properties of natural gases; properties of crude oils; fluid phase behavior; vapor-liquid equilibria; equations of state theory and applications; petroleum fluid characterization; petroleum product specifications; surface separations; H2O/hydrocarbon phase behavior; introduction to PVT phase behavior simulation software

CHEN 312 MASS TRANSFER **3.0: 3 cr. E**

This course covers topics on diffusion, convective and interfacial mass transfer, and its application to continuous contact operations; design of equilibrium-stage separation processes including distillation, gas-liquid absorption and stripping, liquid-liquid extraction, and humidification.
Prerequisites: MECH232, CHEN 212.

CHEN 321 FUNDAMENTALS OF PETROLEUM ENGINEERING **3.0: 3 cr. E**

This course provides an overview of petroleum engineering systems including: uses of petroleum products, exploration, exploitation subjects such as drilling, production, reservoir and formation evaluation, transportation and refining; design of the reservoir management plan; performance prediction; marketing; government regulation.

CHEN 322 PETROLEUM REFINERY ENGINEERING **3.0: 3 cr. E**

This course covers the following topics: petroleum composition, crude oil preparation, evaluation of oil stocks, refinery products and test methods, physical properties of petroleum oil, refinery equipments, and the main refinery operations in petroleum processing.
Prerequisite: CHEN 357.

CHEN 323 PLANT AND ENVIRONMENTAL SAFETY **3.0: 3 cr. E**

The course is designed to acquaint students to topics of the safety , health and environment (SHE) in the chemical plants like : temperature and pressure hazards, fire and explosion hazards, radioactive wastes hazards, equipment, energy and electrical hazards, construction and tool hazards, personal protective equipment hazards, engineering controls, administrative controls, vehicle and transportation hazards, working area and height hazards, hearing and noise hazards, fire, rescue, and emergency response equipment.
Prerequisite: CHEN 303.

CHEN 324 PETROLEUM ENGINEERING LAB **0.3: 1 cr. E**

Experiments on distillation of petroleum products, sulfur in oil analyzer unit, density meter, density of light hydrocarbons by pressure hydrometer, Reid vapor pressure cylinders, flash point Pensky-Martens closed cup tester, Saybolt viscosity, octane analyzer for spark ignition engine fuel, aniline point and mixed aniline point of petroleum products and hydrocarbon solvents, colorimeter, oxidation stability of aviation fuels/ potential residue method, corrosiveness to copper from petroleum products by copper strip, freezing point of aviation fuels, cone penetrometer, gum content in fuels by jet evaporation, Conradson carbon residue apparatus, cloud point and pour point apparatus, twin-column adsorption apparatus, flash series 8 ‘activecool’ closed cup tester, oil test centrifuge, automatic oil testers, foam dual twin foam test baths will be performed.
Corequisite: CHEN322.

CHEN 325 CHEMICAL REACTIONS AND REACTOR DESIGN **3.0: 3 cr. E**

This course covers the principles of chemical reactions and reactor design. It emphasizes on the construction of Chemical Reaction Engineering Algorithm starting from mole balances and considering the effects of heat and mass transfer.

Prerequisite: CHEN 312.

CHEN 327 CHEMICAL ENGINEERING LAB I **0.3: 1 cr. E**

Experiments covering fundamental mass, energy, momentum transport and purification processes. State-of-the-art equipment such as centrifugal pumps, fluid dynamics apparatus, pasteurization unit, press filter, fluidization-drying unit, heat exchangers and reverse osmosis membrane are demonstrated and manipulated by the students.

Prerequisites: CHEN325, MECH 243.

CHEN 328 CHEMICAL ENGINEERING LAB II **0.3: 1 cr. E**

Experiments covering advanced mass, energy, momentum transport and separation processes. State-of-the-art equipment such as polyvalent reactor, continuous reactors, crystallization unit, batch and continuous distillation columns, ebulliometer, liquid-liquid extractor and liquid-gas absorption column are demonstrated and manipulated by the students.

Prerequisites: CHEN327.

CHEN 329 PLANT ECONOMICS **3.0: 3 cr. E**

Design of equipment, systems and plants; discussion of factors important in chemical plant design such as: economics, cost estimation, profitability, process selection, materials of construction, process control, plant location and safety. Introduction to optimization and computer-aided design. Principles are illustrated with short industrial-type problems. Recommended background: thermodynamics; heat, mass and momentum transfer; inorganic and organic chemistry; chemical kinetics and reactor design.

CHEN 333 FOOD CHEMISTRY AND TECHNOLOGY PRINCIPLES **3.0: 3 cr. E**

The aim of this course is to provide an introduction to the chemistry of the major food constituents amino acids, proteins, enzymes, fats, carbohydrates and vitamins; analyze the major food groups; describe the main reactions of the major food constituents. This course emphasizes on the relationship of processing technology to keep quality, nutritional value, and acceptability of foods.

CHEN 336 SEPARATION PROCESSES **3.0: 3 cr. E**

This course covers concepts on the thermodynamics, mechanisms, processes and design of equilibrium separation processes such as membrane separations, adsorption, ion exchange, chromatography and crystallization.

Prerequisite: CHEN 303, 312, MECH 243

CHEN 340 FOOD ENGINEERING FUNDAMENTALS **3.0: 3 cr. E**

This course covers the multidisciplinary field of applied physical sciences which combines science, microbiology, and engineering education for food and related industries; the application of agricultural engineering and chemical engineering principles to food materials; many challenges to employ modern tools, knowledge and technology to develop new products and processes.

CHEN 350 METHODS OF FOOD PRESERVATION **3.0: 3 cr. E**

This course covers the common methods of preservation and techniques used in commercial food processing methods. These methods are used to treat and handle food to stop or greatly slow down microbial growth in order to preserve the foods quality and nutritive value.

CHEN 357 GAS ENGINEERING **3.0: 3 cr. E**

This course deals with the inflow performance. Material balance between the well, fracture and reservoir will be stated to deduce the pseudo-steady and steady state equations of the flow. Near well bore alterations and the

different flow regimes heading to the well bore will be studied. The two types of well drilling are explained: Vertical and Horizontal well. The influencing aspects on the wells performance as: Water conning, frack and gravel pack completions will be covered.
Prerequisite: MATH 270

CHEN 369 CONTINUOUS-TIME PROCESS CONTROL SYSTEMS 3.0: 3 cr. E
Continuous-time signal transformations and system classifications; Fourier series and transform; Laplace transform; block diagram algebra and signal flow graph; stability analysis techniques (Routh-Hurwitz Criterion); root locus; state space analysis; modern control design (State Feedback Control) and classical control design (PID and phase compensation).
Prerequisites: MATH 211, 270, CSIS 206

CHEN 370 PROCESS-MODELING AN|D CONTROL LAB 0.3: 1 cr. E
This course covers the modeling techniques of chemical engineering problems through the use of computer aided process design and simulation tools such as Aspen-plus and Hysys. This course is also intended to provide laboratory application of fundamental principles of chemical process dynamics and feedback control. This includes open-loop dynamics of typical chemical engineering processes such as distillation, fluid flow, chemical reactors and heated stirred tanks. Closed-loop experiments will involve control loop design, controller tuning, multivariable, and computer control. The tools discussed in this course are used in subsequent courses on the analysis and design of chemical reactors and mass transfer processes.
Prerequisite: CHEN 369

CHEN 378 LIVING CELLS ENGINEERING 3.0: 3 cr. E
Engineering of the living systems; Biomolecules, biological catalysers and living cells; Basic concepts and applications related to chemical engineering; Structure and role of the cellular components in bioprocesses; Cell and enzyme types; Examples of bioprocesses using different types of cells; Kinetics of enzymatic reactions; Nutrition and cell growth; Operating conditions and selection of bioreactors; Operations and conditions of asepsis; Biocaptors; Metabolic pathways and metabolic regulation; Applications in biotechnology, environmental engineering, pulp and paper, food technology and petroleum engineering.
Prerequisite: CHEN 312.

CHEN 388 BIOFUEL ENGINEERING 3.0: 3 cr. E
This course will emphasize the importance of biofuel engineering process technology. It will cover the following topics: the harvesting of energy from biochemical reactions, the modeling of biofuel production, the biofuel feedstocks, the ethanol production, the different kinds of biodiesel, the microbial fuel cell, and the methane production.
Prerequisite: CHEN 377.

CHEN 400 CHEMICAL PROCESS SYNTHESIS AND DESIGN 3.0: 3 cr. E
Strategy for the conceptual design and building up methods of industrial chemical processes; rules of thumb for chemical engineers, simulation to assist process synthesis, introduction to product design and molecular structure design, efficiency and sustainability in the chemical industry.

CHEN 404 ADVANCED CHEMICAL REACTOR DESIGN 3.0: 3 cr. E
This course deals with the interpretation of rate data and development of performance equations for single and multiple reactor systems. Course topics include: design of ideal reactors and deviations from ideality, multiple chemical reactions, steady state and unsteady-state operation, optimization of reactors, collection and analysis of rate law data and bioreactors.

CHEN 412 INDUSTRIAL CATALYTIC PROCESSES **3.0: 3 cr. E**
This course covers the fundamentals of catalytic science; catalyst properties, preparation and characterization, catalytic reactor design and catalyst deactivation. This part is followed by an overview of the most important industrial catalytic processes: Hydrogen Production and Synthesis Gas Reactions (Fischer-Tropsch Synthesis), Hydrogenation and dehydrogenation of organic compounds, Oxidation of organic and inorganic compounds.

CHEN 413 ADVANCED TRANSPORT PHENOMENA **3.0: 3 cr. E**
This course covers the fundamental theory of momentum, mass and energy transport in porous media for incompressible and compressible fluid flow; applications of steady-state balances and equations of change to fluid drag, piping system design, filtration, packed beds. Analogy between the three types of transport is presented.

CHEN 417 CHEMICAL INSTRUMENTATION AND MEASUREMENT **3.0: 3 cr. E**
This course covers the principles of chemical measurement systems from the sensor/transducer unit to the display unit; static and dynamic characteristics; accuracy; loading effects; signals and noise; reliability, choice and economics; sensing elements; signal processing, and software; data presentation. Applications selection from pressure measurement systems; flow measurement systems; heat transfer effects in measurement systems; optical measurement systems; ultrasonic measurement systems; gas/chemical measurement systems.

CHEN 418 POLYMERS AND POLYMER ENGINEERING **3.0: 3 cr. E**
This course provides a good understanding of the synthesis of polymers and their commercial applications. Important properties that these materials possess, including their molecular, physical, chemical, thermal, mechanical, and electrical properties are reviewed. The forming techniques for plastics (compression molding, injection molding…) and the different parameters leading to the degradation of polymers will also be covered.

CHEN 420 FOOD PROCESS ENGINEERING **3.0: 3 cr. E**
Advanced knowledge and understanding of process and engineering principles of various methods of heating, cooling, freezing, drying, and crystallization of foods; it covers water relations in foods and kinetics of physico-chemical changes during processing.

CHEN 421 ADVANCED PETROLEUM PROCESSING **3.0: 3 cr. E**
This course presents the following topics: The atmospheric and vacuum crude oil distillation units, the light end units, the catalytic reforming process, the fluid catalytic cracking process, the distillate hydro- cracking process, the hydro-treating processes, the refinery gas treating processes, upgrading residues, and the handling of hazardous materials and safety.
Prerequisite: CHEN 413.

CHEN 422 SURFACE AND COLLOID CHEMISTRY **3.0: 3 cr. E**
This course examines the factors underlying interfacial phenomena, with an emphasis on the thermodynamics of surfaces, structural aspects, and electrical phenomena. Some applications are studied in the areas of emulsification, detergency, foaming, fluidization, sedimentation, nucleation, wetting, adhesion, flotation, and electrophoresis.
Prerequisite: CHEN 418.

CHEN 424 CEMENT MANUFACTURING **3.0: 3 cr. E**
This course covers the fundamentals of cement manufacturing steps, raw materials management, cement quality control concept, quarrying and its environmental aspect, grinding technology, clinker manufacture (chemical and thermodynamics aspect), firing systems, classic and alternative fuels, clinker properties, manufacturing performance evaluation, cement applications.

CHEN 426 RESERVOIR ENGINEERING **3.0: 3 cr. E**

This course covers the fundamentals of oil and gas reservoirs; reservoir volumetrics; material balance; Darcy's law and equation of continuity; diffusivity equation; streamlines; well models and testing; decline curve analysis; natural water influx; properties of reservoir rocks and homogeneous and multiphase fluid flow in reservoirs; capillary phenomena, relative permeability, compressibility, and fluid saturation distribution.
Prerequisite: CHEN 412.

CHEN 427 THERMAL PROCESSES IN THE HEAVY INDUSTRY **3.0: 3 cr. E**

The focus of this course is to transmit the Competence of materials and energy use and transformation in the heavy industry as well as the product formulation. Combustion engineering, heat and materials balances, materials transformation, emissions controlling, gas properties and de-dusting systems are as well covered in this course. Automatic process control (PID, LINKman, online gamma analyzers….) and manual process control (gas and materials measures) are also covered in this course.

CHEN 430 ENVIRONMENTAL DESIGN AND LIFE CYCLE ASSESSMENT **3.0: 3 cr. E**

Introduction to environmental issues and to the concept of sustainable development. Environmental design and engineering: Life cycle assessment, design of a life cycle, industrial ecology. Analysis of processes: exchange of mass and energy, green chemistry. Definition and type of life cycle assessment. Definition of a functional unit and identification of system boundaries. Computation of a life cycle inventory. Application of environmental tools to various case studies.

CHEN 433 CATALYSIS LAB **0.3: 1 cr. E**

Introduction to environmental issues and to the concept of sustainable development. Environmental design and engineering: Life cycle assessment, design of a life cycle, industrial ecology. Analysis of processes: exchange of mass and energy, green chemistry. Definition and type of life cycle assessment. Definition of a functional unit and identification of system boundaries. Computation of a life cycle inventory. Application of environmental tools to various case studies.

CHEN 433 CATALYSIS LAB **0.3: 1 cr. E**

Experiments covering advanced mass, energy, momentum transport, and separation processes. State-of-the-art equipment such as Solid-liquid Adsorption Desorption unit, Filtration Drying Collection and Weighting unit, Mobile Waste Treatment unit, and Juice Production and Bottling processes, are demonstrated and manipulated by the students.

CHEN 434 CATALYSIS LAB **0.3: 1 cr. E**

In this lab, students will apply the concepts they learned in the Industrial Catalytic Processes starting from thermodynamic simulation of reactants and products concentration, synthesis of catalytic supports, addition of active phase/promoter, calcination, shaping of catalysts, characterization by N2 sorption, X-Ray diffraction, H2 chemisorption as well as catalytic activity testing.
Prerequisite: CHEN 412.

CHEN 440 FOOD CREATION AND DEVELOPMENT **3.0: 3 cr. E**

This course covers the techniques involved in systematic food product creation, development, and process technology of specialty, fabricated, and synthetic foods. The complete process of bringing a new product to the market; it involves the idea generation, product design and detail engineering market research and marketing analysis.

CHEN 441 FOOD SANITATION **3.0: 3 cr. E**

This course covers hygienic practices, requirements for sanitation programs, and modern sanitation practices in food processing facilities. Topics include need for food safety training, cause of food borne illness; biological food contamination; chemical and physical contamination; purchasing and receiving; storing foods; preparing,

cooking, and serving food; cleaning and sanitizing; hazard analysis critical control points (HACCP) and facilities self-inspection.

CHEN 442 CHEMISTRY OF FOOD AND BIOPROCESSED MATERIALS 3.0: 3 cr. E
The course focuses on the properties of biological molecules (e.g., proteins, enzymes lipids, carbohydrates and pigments) found in foods and pharmaceuticals. The course also presents basic elements of molecules, such as structure and reactive groups, in regard to how they affect the properties of foods and pharmaceuticals; and reactions such as Maillard browning and lipid oxidation in regard to mechanisms, products and controlling processes.

CHEN 443 FOOD MICROBIAL WORLD 3.0: 3 cr. E
This course covers food relevant microorganisms and their metabolic activities; sources of microbial contamination during food production, processing and storage; microbial spoilage; pathogens; physical and chemical destruction of microorganisms in foods and the kinetics involved; conversions of raw foods by microorganisms into food products.

CHEN 444 FOOD SENSORY SCIENCE 3.0: 3 cr. E
This course covers the principles and procedures for sensory evaluation of food. Appropriate uses of specific tests will be discussed, along with physiological, psychological, and environmental factors affecting sensory verdicts; it applies principles of experimental design and statistical analysis to the use of human senses for the purposes of evaluating consumer products.

CHEN 450 ECOTOXICOLOGY FOR ENGINEERS 3.0: 3 cr. E
Toxic agents and implication of pollutants in the conception and operation of processes. Transport of contaminants in the environment and exposure modes. Evaluation tools. Dose-response relationship. Chronic/ acute effects. Implication of ecotoxicological risk in the protection of the environment and industrial sanitation. Industrial ecology and re-engineering. Importance of impact assessment in the design of plants and processes.

CHEN 468 MECHANISMS IN PETROLEUM ENGINEERING 3.0: 3 cr. E
Course covers the three main aspects of production mechanisms used in the Petroleum Industry: 1) Primary Production which depends on decreasing reservoir pressure, 2) Secondary Recovery that uses water injection as a displacing fluid and for pressure maintenance, and 3) Tertiary Recovery which covers thermal operations using steam, miscible or immiscible gas injection, and polymer waterflood. Classification and reserve estimates based on material balance; steady-state and transient fluid flow in permeable reservoir rocks as applied to subsurface engineering problems will be reviewed.

CHEN 478 CORROSION IN CHEMICAL PROCESSES 3.0: 3 cr. E
This course describes the principles of corrosion engineering from the basic principles of electrochemistry and chemical thermodynamics to the prevention of corrosion problems in relation with material cost, reduced performance, reliability, and impact on the environment. The different forms of corrosion are described as well as their prevention control. Case studies from petrochemical industries are also covered.

CHEN 480 FIELD TRAINING 2.0: 4 cr. E
Eight weeks of training in a field related to chemical engineering.

CHEN 485 FUEL CELL TECHNOLOGY 3.0: 3 cr. E
The course provides an overview of the various types of fuel cells followed by a detailed discussion of the proton-exchange membrane (PEM) fuel cell fundamentals: thermodynamics relations including cell equilibrium, standard potentials, and Nernst equation; transport and adsorption in proton-exchange membranes and supported liquid electrolytes; transport in gas-diffusion electrodes; kinetics and catalysis of electrocatalytic reactions including kinetics of elementary reactions, the Butler-Volmer equation, reaction routes and

mechanisms; kinetics of overall anode and cathode reactions for hydrogen and direct methanol fuel cells; and overall design and performance characteristics of PEM fuel cells.
Prerequisite: CHEN 404.

CHEN 513 SUBSURFACE PRODUCTION ENGINEERING **3.0: 3 cr. E**
This course covers the advanced theories and techniques of tubing and packer design; hydraulic fracturing and acidizing; oil and gas well performance; vertical lift and choke performance; systems analysis; production operations.

CHEN 514 AIR-POLLUTION PROBLEMS AND CONTROL **3.0: 3 cr. E**
This course presents advanced concepts on air-pollutant identification and control technology; estimation of pollutant transport, dispersion, and conversion; design of control units using computer simulation applications.

CHEN 515 DYNAMICS OF PARTICULATE SYSTEMS **3.0: 3 cr. E**
This course analyzes systems of discrete particles which grow in size or in some other characteristic variable (e.g., age, molecular weight); reaction engineering and population balance analyses are discussed for batch and continuous systems; steady state and transient system dynamics are covered. Application topics may be selected from crystallization, latex synthesis, polymer molecular weight distribution, fermentation/ ecological systems and gas-solid systems.

CHEN 517 CHEMICAL-PROCESS DYNAMICS AND CONTROL **3.0: 3 cr. E**
This course provides the tools for designing a strategy for operating a plant and the hardware (sensors, control valves, computer controllers) to make it work. This course focuses on the applications of dynamic process responses based on the principles of material and energy balances, fluid flow, heat transfer, separation processes, and reaction kinetics. The course also covers the elements of a feedback control system including sensors, control valves, and computer-based controllers (feed forward control, cascade control, dead time compensation, and de-couplers)

CHEN 524 FOOD LAWS AND REGULATIONS **3.0: 3 cr. E**
This course covers the legislation in the form of directives and regulations which are put by government or regulatory agencies to control food safety; Controlled Designation of Origin CDO regulations; official inspections of specific design features, and certification of food handlers.

CHEN 525 POWDER TECHNOLOGY AND OPERATING DESIGN **3.0: 3 cr. E**
This course deals with the fundamentals of powder technology: production, handling, modification, and use of a wide variety of particulate materials, both wet and dry, in sizes ranging from nanometers to centimeters. The first part concerns particulate characterization: granulometric analysis and mechanical properties of powders. It is followed by the design of operating systems using powders: mixing, storage in silos, fluidization, granulation, crystallization, grinding, pneumatic transport and spraying techniques.

CHEN 527 GRINDING TECHNOLOGY **3.0: 3 cr. E**
This course covers all the topics related to grinding processes. Materials properties(grindability), resizing and grinding. Preblending, feeding systems, mill sizing and filling degree, dryers, mills ventilation and cooling. Materials and heat balance in the mill is covered in the course. Mill types (ball mills, VRM) and process controlling system related to the product quality are also covered.

CHEN 530 ENVIRONMENTAL MODELING OF TOXIC EMISSIONS **3.0: 3 cr. E**
Modeling of environmental impacts due to toxic emissions. Life cycle impact assessment. Fate and exposure to contaminants and effects on human health. Methodological framework of multimedia modeling. Mass balances, first order kinetics of degradation. Equilibrium, steady-state and dynamic multimedia models. Advection and adsorption of pollutants. Exposure modeling, introduction to the concept of the intake fraction. Carcinogen

and non-carcinogen effects. Use of physico-chemical data bases for the evaluation of human health impacts. Toxicity indicators.

CHEN 531 OIL FIELD DEVELOPMENT **3.0: 3 cr. E**
This course studies the properties of petroleum fluids and reservoir rocks; geophysical environment and exploration methods; drilling and completion methods; well testing; producing mechanisms; evaluation methods.
Prerequisite: CHEN 426.

CHEN 532 ADVANCED NATURAL GAS ENGINEERING **3.0: 3 cr. E**
This course covers the properties of natural gases and condensate systems; gas flow in porous media; gas reservoir engineering; gas field development; gas condensate reservoirs; natural gas transportation and storage.
Prerequisite: CHEN 421.

CHEN 541 QUALITY CONTROL IN FOOD AND BIOPROCESSING **3.0: 3 cr. E**
This course covers the principles of quality control in the food and bioprocessing industries; regulations and process control to maintain safety and quality; evaluation of physical, microbiological, chemical, sensory, and stability testing for food and bioprocessed materials; risk assessment, hazard analysis and critical control point, process control, water quality, waste water analysis and reduction; cleaning and sanitation and compliance inspection.

CHEN 542 FOOD PRESERVATION **3.0: 3 cr. E**
This course covers the methods employed in food preservation; emphasis on thermal, freezing, drying and fermentation processes and corresponding physical, chemical, and organoleptic changes in product; relationship of these preservation techniques to development of an overall processing operation.

CHEN 544 NANOFABRICATION **3.0: 3 cr. E**
Basic engineering principles of nanofabrication. Topics include: photo-, electron beam and nanoimprint lithography, block copolymers and self-assembled monolayers, colloidal assembly, and biological nanofabrication.

CHEN 545 PROCESSING DAIRY PRODUCTS **3.0: 3 cr. E**
This course covers unit operations in dairy processing. Topics include formulation, processing, packaging and evaluation of fluid milk and manufactured products.

CHEN 546 FOOD SAFETY AND TOXICOLOGY **3.0: 3 cr. E**
This course covers issues and developments related to the relationship between food safety and public health, including emerging food-borne pathogens; virulence and pathogenicity; food-borne toxins; epidemiological techniques used in the investigation of food-borne disease; rapid detection methods; and quantitative microbial risk assessment in food safety.

CHEN 547 LACTATION, MILK, AND NUTRITION **3.0: 3 cr. E**
This course focuses on issues related to the nutritional properties of milk as a high-quality food with nutritional diversity; principles of physiology, biochemistry and cell biology in the mammary gland; procedures of milk production and milk collection for milk quality and nutrition; impacts of biotechnology and food safety on dairy production.

CHEN 550 FOOD MANAGEMENT AND MARKETING **3.0: 3 cr. E**
This course provides the student with realistic managerial experience. Staffing, merchandising, and cost control procedures are integral parts of the course. Marketing principles, theories and strategic concepts such as leadership, business definition, situation assessment, planning and objectives in specialized food sectors.

CHEN 551 DRILLING ENGINEERING **3.0: 3 cr. E**
This course covers the equipment and mechanisms of rotary drilling, drilling fluids, friction pressure losses, drilling hydraulics, casing and cementing, well blowout prevention and control and drilling problems and solutions.
Prerequisite: CHEN 426.

CHEN 555 EMERGING FOOD TECHNOLOGIES AND BIOTECHNOLOGY **3.0: 3 cr. E**
This course covers new and emerging food technologies and food biotechnology; develops ways to process, preserve, package, or store food, according to industry, specifications, and regulations; studies the physical, microbiological, and chemical makeup of food.

CHEN 566 BIOSEPARATION ENGINEERING **3.0: 3 cr. E**
Principles of bioseparation engineering including specialized unit operations not normally covered in regular chemical engineering courses. Processing operations downstream of the initial manufacture of biotechnology products, including product recovery, separations, purification, and ancillary operations such s sterile processing, clean-in place and regulatory aspects. The principles of chromatography will be emphasized. Ion exchange, and affinity-based separation will be discussed in detail.

CHEN 577 FOOD PACKING **3.0: 3 cr. E**
This course covers the packaging of food; the main objectives of packaging from physical protection, barrier protection, containment, information transmission, marketing, convenience, to portion control; different types of food packages and containers.

CHEN 579 NUMERICAL METHODS IN PETROLEUM INDUSTRY **3.0: 3 cr. E**
The course covers theory and practice of numerical simulation in the Geological (static) and Reservoir Engineering (dynamic) systems. The course describes methods, tools, and uses of numerical methods and computers in petroleum problems. The use of 2 Dimensional and 3 Dimensional models will be covered and examples provided. Mathematical equations governing fluid flow in reservoirs; numerical methods to solve the equations; numerical reservoir simulation; treatment of wells and history matching methods will be reviewed.

CHEN 588 FOOD ANALYSIS TECHNIQUES **3.0: 3 cr. E**
This course studies the theory and practice of the analysis of food components, including their chemical separation, identification and quantification comparing classical to modern instrumental food analysis techniques.

CHEN 589 WASTE TREATMENT ENGINEERING **3.0: 3 cr. E**
Physico-chemical, thermal, and biological methods for purification of solid waste and wastewater, and conversion to bioproducts/industrial products, energy and clean water. Industrial pollution sources, treatment methods, and legal requirements are examined.

CHEM 202, 203, 240, 242, 244, 245, 247, 262
Refer to the Department of Chemistry.

CIVE 201, 309
Refer to the Department of Civil Engineering.

CSIS 206
Refer to the Department of Computer Science.

CSPR 201, 202, 203, 204
Refer to the Civilization Sequence Program.

ELEN 201, 401, 523
Refer to Department of Electrical Engineering.

ENGL 203, ENGL 2XX
Refer to the Division of English Language and Literature.

GENG 311, 390, 400, 402,190, 590, 599
Refer to the Faculty of Engineering Requirements.

MATH 200, 202, 210, 211, 230, 246, 270
Refer to the Department of Mathematics.

MECH 212, 221, 231, 232, 243, 321, 511
Refer to the Department of Mechanical Engineering.