FACULTY OF ENGINEERING

Academic Year 2023 – 2024

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FACULTY LIST

OFFICERS OF THE FACULTY

Abboud, Rami	Dean of the Faculty of Engineering & Vice President for Internationalization & Engagement (VP)
Assaad, Joseph	Associate Dean for Research & Innovation
Daaboul, Michel	Associate Dean for Learning & Teaching
Nakad, Mantoura	Assistant Dean for Administration & VP Office Manager
Dagher, Issam	Chairperson of Computer Engineering
Estephane, Jane	Chairperson of Chemical Engineering
Khaldi, Mohamad	Chairperson of Electrical Engineering
Nasr, Dana	Chairperson of Civil & Environmental Engineering
Rishmany, Jihad	Chairperson of Mechanical Engineering

CONSULTANTS TO THE DEAN

Alameddine, Abdul Menhem	Consultant to the Dean for OEA
Baroudi, Nazih	Retired Admiral, Consultant to the Dean for Army & Navy
Ibrahim, Ziad	Retired General, Consultant to the Dean for Army & Air Force
Manneh, Rima	Director of Life Cycle Assessment (LCA) Centre
Rouphael, Fadi	Director of Zeenni & Consultant for Equipment Maintenance
Semaan, Nabil	Director of the Masters of Engineering Management Program

STAFF OF THE FACULTY

Barakat, Walid	Store Keeper
Daoud, Nassif	Lecturer
Daou, Patrick	GIS Administrator
Farah, Yorgo	Laboratory Supervisor & Research Assistant
Greige, Nayla	Laboratory Supervisor & Instructor
Hamati, Lea	Administrative Assistant
Hanna, Simon	Workshop Technician
Hilal, Nina	Lecturer
Inaty, Lena	Laboratory Supervisor & Research Assistant
Ishac, Joy	Faculty Engagement Officer
Karam, Katia	Laboratory Supervisor & Instructor
Khoury, Richard	Senior Laboratory Technician
Moujaes, Nabil	Senior Laboratory Technician
Murr, Nicolas	GIS Technician
Saliba, Cherine	Laboratory Supervisor & Research Assistant
Sleiman, Mirna	Administrative Assistant
Wakim, David	Mechanical & Aeronautical Laboratory Manager
Yaacoub, Olga	Laboratory Supervisor & Instructor

FACULTY MEMBERS

Abboud, Rami	Ph.D., Biomedical & Rehabilitation Engineering, University of Dundee, Scotland, UK.
Abche, Antoine	Ph.D., Biomedical Engineering, Rutgers, The State University of New Jersey, USA.
Alameddine, Abdul Menhem	M.S.E.S., Computer Engineering, University of Southeastern Louisiana, USA.
Assaad, Joseph	Ph.D., Materials and Structural Engineering, University of Sherbrooke, Qc, Canada.
Assaf, Jean Claude	Ph.D., Chemistry and Microbiology, Lebanese University and Saint Joseph University, Lebanon.
Ayoubi, Rafic	Ph.D., Computer Engineering, University of Southwestern Louisiana, USA.
Bachawati, Makram	Ph.D., Materials Engineering, La Rochelle University, France.
Badawi El-Najjar, Maged	Ph.D., Electrical Engineering, Purdue University, USA.
Barraj, Firas	Ph.D., Transportation and Highway Engineering, Beirut Arab University, Lebanon.
Bitar Semaan, Angela	M.Sc., Aircraft Maintenance, Institut Universitaire Professionnalisé, Bordeaux, France.
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.
Ghanoum, Maria	Ph.D., Civil Engineering, Structures and Materials, Grenoble Alpes University, France.
Haddad, Nicolas	Ph.D., Electrical Engineering, Ohio University, Athens, Ohio.
Hamad, Wael	Ph.D., Chemical Processes and Material Science, ENCSI and the University of Limoges, France.
Hassan(El), Moustapha	Ph.D., Electrical Engineering, University of Bordeaux, France.
Iaaly, Amal	D.B.A., Business Administration, Grenoble Ecole de Management, France.
Imad, Rodrigue	Ph.D., Signal Processing and Telecommunications, IMT Atlantique, Brest, France.

Inaty, Elie	Ph.D., Optical Communications, Université Laval, Quebec City, Canada.
Jabali, Yasmine	Ph.D., Analytical Chemistry, The University of Strasbourg, France.
Jahami, Ali	Ph.D. Structural and Geotechnical Engineering, Beirut Arab University, Lebanon.
Khaldi, Mohamad	Ph.D., Electrical Engineering, Pennsylvania State University, USA.
Khalil, Nariman	Ph.D., Civil Engineering, Leeds University, England, UK.
Lahoud, Chawki	Ph.D., Energy Engineering, ESIB, Saint Joseph University, Lebanon.
Mezannar, Nay	Ph.D., Mechanics and Advanced Engineering Science, University of Bologna, Italy.
Mir(El), Abdulkader	Ph.D., Civil Engineering, Budapest University of Technology and Economics, Hungary.
Moussa, Maria	Ph.D., Electrical and Computer Engineering, American University of Beirut, Lebanon.
Nasr, Dana	Ph.D., Civil Engineering, American University of Beirut, Lebanon.
Nini, Robert	Ph.D., Civil Engineering, Ecole Centrale de Paris, France.
Rishmany, Jihad	Ph.D., Mechanical Engineering, Ecole Nationale Supérieure d'Ingénieurs de Constructions Aéronautiques, France.
Saba, Marianne	Ph.D., Civil Engineering, Polytech Lille, France, & the University of Balamand, Lebanon.
Saba, Nicolas	Ph.D., Mechanical Engineering, University of Kassel, Germany.
Sabat, Macole	Ph.D., Fluid Mechanics, Université Paris-Saclay, Centrale Supélec, France.
Salem, Michael	M.S., Engineering Management, University of Balamand, Lebanon.
Semaan, Nabil	Ph.D., Engineering & Construction Management, Concordia University, Canada.
Zakhem, Henri	Ph.D., Chemical Engineering (Food Quality Control), University of Technology of Compiègne, France.

PROGRAMS OF STUDY

The Faculty of Engineering offers two undergraduate degrees, a Bachelor of Science (BS) degree (three-year program) and a Bachelor of Engineering (BE) degree (five-year program) in the following departments:

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

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

The BS Programs in Chemical Engineering, Civil Engineering, Computer Engineering, Electrical Engineering, and Mechanical Engineering are ABET accredited. They are designed to prepare students for the professional job market through the pursuit of comprehensive studies in the field. It aims at equipping students with a solid knowledge of the engineering sciences and appropriate general and specialized skills, enabling them to develop into well-rounded engineers.

ABET Engineering Accreditation Commission

The BE Program augments the BS Program through imparting to students' in-depth knowledge in specific areas, thus augmenting their practical and general skills. Students are exposed to applied-learning experiences in synergy, which meet the requirements for registration in the Lebanese Order of Engineers & Architects.

The graduate may apply to advanced study leading to a Master of Science (MS) 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 Faculty Admissions Committee makes the final decision on acceptance to the Master of Science in Engineering. The Faculty of Engineering offers the following undergraduate degrees:

Degree	Years	Major	Status
Bachelor of Science (BS)	3	Chemical Engineering	Offered
		Civil Engineering	
		Computer Engineering	
		Electrical Engineering	
		Mechanical Engineering	
Bachelor of Engineering (BE)	5	Chemical Engineering	Offered
		Civil Engineering	
		Computer Engineering	
		Electrical Engineering	
		Mechanical Engineering	

The Faculty of Engineering offers two-year graduate programs leading to the MS degree in Engineering in the following departments:

Degree	Years	Major	Status
Master of Science (MS)	2	Computer Engineering	Offered
Master of Science (MS)	2	Electrical Engineering	Offered
Master of Science (MS)	2	Civil Engineering	Offered
Master of Science (MS)	2	Mechanical Engineering	Offered
Master of Science (MS)	2	Chemical Engineering	Offered

In addition, the Faculty of Engineering offers MS degree in Engineering Management.

The sequence of study in all these programs proceeds from an education in science fundamentals toward advanced training designed to give the student mastery of the principles and arts central to Engineering Science. The MS degree provides a deeper and more focused education aiming at preparing engineers with more specialized skills and a stronger research emphasis when compared to the BS and BE degrees. The final decision on acceptance to the Master's Degree program resides with the Faculty Admissions Committee.

1. Admission Requirements - Undergraduate Programs

1.1 Freshman Year:

The applicants who are, admitted to Freshman, should confer with their advisors to ensure that the number of credits and the types of subjects taken during their Freshman Year are in compliance with the requirements of the Lebanese Ministry of Education and Higher Education and the admission requirements for the Faculty of Engineering. These requirements are as follows:

Total number of credits	**Minimum of 30 credits**
Humanities and social sciences	minimum of 9 credits courses
Mathematics	minimum of 3 credits courses
Natural sciences	minimum of 3 credits courses + minimum of 1 credit Basic Sciences Laboratory

Whereby, the basic Science Laboratory course(s) may be chosen from:

a. BIOL 102 – Introduction to Biology Laboratory I
b. CHEM 101 – Introduction to Chemistry Laboratory I
c. PHYS 111 – Introduction to Physics Laboratory I
d. PHYS 113 – Introduction to Physics Laboratory II

1.2 BS and BE Programs:

Admission to undergraduate programs in the Faculty of Engineering is normally restricted to the first year. However, in exceptional cases, and with the approval of the Faculty 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 satisfies the University Admission requirements concerning English proficiency.
d. The Faculty Admissions Committee has evaluated the applicant's qualifications for academic success in scientific and engineering subjects and approved the transfer admission.
e. Applicants with non-scientific Baccalaureate qualifies him/her for conditional admission to the Faculty of Engineering provided he/she takes the following remedial courses:

SE-SB Economic Sciences-Science Base	SE-LB Economic Sciences-Literature Base	LH Literature & Humanities
Remedial Courses (10 credits)	Remedial Courses (16 credits)	Remedial Courses (22 credits)
CHEM 102 (3 cr) MATH 113 (3 cr) PHYS 102 (3 cr) PHYS 111 (1 cr)	CHEM 102 (3 cr) MATH 112 (3 cr) MATH 113 (3 cr) PHYS 100 (3 cr) PHYS 102 (3 cr) PHYS 111 (1 cr)	CHEM 100 (3 cr) CHEM 102 (3 cr) MATH 111 (3 cr) MATH 112 (3 cr) MATH 113 (3 cr) PHYS 100 (3 cr) PHYS 102 (3 cr) PHYS 111 (1 cr)

1.3 Dual Degrees:

a. Students who have a BS degree from a reputable university and with cumulative average of 70% or above, can be admitted to pursuing the BE degree in the same engineering field.
b. Students who have a BS degree - other than engineering or from different engineering fields - from a reputable university and with cumulative average of 70% or above, can be admitted to pursuing the BS or BE degree in engineering with remedial courses specified by Faculty Admissions Committee.
c. Students who have a BTech degree from a reputable university and with cumulative average of 70% or above, can be admitted to pursuing the BE degree in engineering with remedial courses specified by Faculty Admissions Committee.

1.4 Minor:

Students pursuing the BS or BE degree and are interested in having a minor in a specific engineering field can do so with remedial courses specified by Faculty Admissions Committee.

1.5 Change of Major:

Students who are interested in changing major and pursuing a BS or BE degree in a specific engineering field must have a cumulative average of at least 70% and must have obtained at least 70% in STEM courses to be eligible for consideration by the Faculty Admissions Committee.

1.6 Transfer Credits:

Transfer of credits are in line with the Ministry of Education and Higher Education directives.

2. Admission Requirements - Graduate Programs

BS and BE students with cumulative average of 78% but less than 80% can be admitted into the MS program on probation and who have 80% and above can be admitted on clear standing. The candidate must provide the following documents:

a. An official application to join the graduate program.
b. Official transcripts (and a copy of their degrees if applicable) from the universities attended during the last three years.
c. Letters of recommendation.
d. A personal statement.

The final decision regarding matriculation to the engineering graduate program is granted upon the Faculty Admissions Committee recommendation.

3. Academic Rules and Regulations

3.1 Time Limitations:

With careful planning, full-time students should normally be able to complete the,

a. BS program in a minimum of 3 years and a maximum of 5 years,
b. BE program in a minimum of 4 years (along with 3 mandatory summer semesters, otherwise 5 years) and a maximum of 7 years, and
c. MS program in a minimum of 2 years after the BS program and 1 year after the BE program and a maximum of 5 years.

BS students are admitted on a full-time basis only, where part-time students can complete the BE and MS degree after BS in up to 5 years.

If students decide to take a gap in their studies, this should not normally amount to more than 3 years in total. Course credits earned in the graduate study or accepted by transfer are valid for a maximum of 6 years unless the Faculty Admissions Committee grants an extension. Students should petition in writing to the Faculty Admissions Committee via the Registrar for such exceptions.

3.2 Passing Grade:

The passing grade of

a. 200-level and 300-level courses is 60%.
b. 400-level and 500-level courses is 70%.

3.3 Dean's Honor List:

To be placed on the Dean's Honor List at the end of a given Fall or Spring semester, a BS or BE student must:

a. be registered for at least 12 undergraduate credits (Graded numerically),
b. not be on Probation,
c. have a semester average of at least 85 or be ranked in the top 10 percent of the class and have a semester average of at least 80,
d. have no failing, withdrawals, repeated, or incomplete grades,
e. have no disciplinary action in his/her record, and
f. be deemed worthy by the Dean to be placed on the Honor List.

3.4 Full-Time Status:

The semester load for full-time MS students is no less than 9 credits and no less than 12 credits for the BS and BE students. Full-time students may accept employment only with the approval of the Dean and who are employed outside the University for more than 20 hours per week are not eligible to be classified as full-time students at the Faculty of Engineering.

3.5 Evaluation of Academic Performance:

Please refer to the Academic Regulations section of the Graduate Studies Manual.

3.6 Petitions:

A student may petition the Dean concerning any academic regulation. Petitions should be made only when a dispute cannot be resolved at the departmental level. All petitions should be submitted via the Registrar.

3.7 Laboratories:

Students taking a laboratory must furnish at his/her expense the necessary notebooks, blank forms, lab coats, and similar supplies. For regular students taking prescribed laboratory work, no charge is made for average amounts of expendable material used in connection with laboratory courses. Expendable materials are those that are 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 students, the cost of the additional material will be charged to the student or group of students responsible. Students will be charged for damage to instruments caused by negligence. The amount of the charge will be the actual cost of repair, and if the damage results in total loss of the apparatus, adjustments will be made considering the condition of the instruments.

3.8 GENG 221 and GENG 222:

GENG 221 and GENG 222 are 2 new core courses have been introduced in the Fall of 2023/2024 for BS and BE students with matriculation cards A22 onwards. As such, when these 2 courses are stated to be "Pre-Requisite" or "Co-Requisite" on listed courses, it will only be applicable for A22 students onwards.

DEPARTMENT OF CHEMICAL ENGINEERING

Bachelor of Science (BS) Degree – 109 Credits

Sem	Course Code	Course Title	Credit	Pre-Req	Co-Req
1	CHEM 202	Basic Chemistry	3		
1	CHEM 203	Basic Chemistry Laboratory	1		CHEM 202
1	CHEN 206	Instrumentation Lab And Research Methods	1		
1	CHEN 212	Chemical Engineering I	3		MATH 200
1	ENGL 203	English Communication Skills III	3		
1	MATH 200	Calculus I	3		
1	MATH 211	Linear Algebra I	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
2	CHEM 262	Physical and Chemical Kinetics	3	CHEM 202	
2	CHEN 290	Introduction to the Engineering Design Fundamentals	1		
2	CHEN 312	Mass Transfer	3	CHEN 212	
2	CSIS 206	Principles of Programming	3		
2	LISP 200	Information Skills and Search Techniques	1		ENGL 102
2	MATH 270	Differential Equations	3	MATH 200	
2	MECH 232 or CHEN 232	Thermodynamics	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
3	CHEM 242	Organic Chemistry I	3	CHEM 202	
3	CHEN 215	Materials Science and Engineering	3		
3	CHEN 303	Unit Operations	3	CHEN 312	MECH 243
3	GENG 221	Engineering Ethics	3	CHEN 290 ENGL 203	
3	MATH 202	Calculus II	3	MATH 200	
3	MECH 243	Fluid Mechanics	3	MECH 232	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
4	CHEM 244	Organic Chemistry II	3	CHEM 242	

4	CHEM 245	Organic Chemistry Laboratory	1	CHEM 242	
4	CHEN XXX	Option Elective	3		
4	CHEN 325	Chemical Reactions and Reactor Design	3	CHEN 312	CHEM 262
4	ENGL 2XX	English Elective	3	ENGL 203	
4	GENG 222	Sustainable Development for Engineers	3	CHEN 290 ENGL 203	
4	MATH 230	Numerical Analysis I	3	CSIS 206 MATH 200	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
5	CHEN XXX	Option Elective	3		
5	CHEN 322	Petroleum Refinery Engineering	3		CHEN 324
5	CHEN 324	Petroleum Engineering Lab	1		CHEN 322
5	CHEN 332	Safety, Health, and Environment	3	CHEN 303	
5	CHEN 362	Chemical Process Simulation and Design	1	CHEN 303	CHEN 391
5	CHEN 377	Chemical Engineering Thermodynamics II	3	MECH 232	
5	CHEN 391	Senior Design 1	2	CHEN 290 CHEN 325 CHEN 303 MATH 202 GENG 221 GENG 222	CHEN 362
5	MATH 246	Probability For Engineers	3	MATH 200	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
6	CHEN XXX	Option Elective	3		
6	CHEN 326	Chemical Engineering Lab	1		CHEN 392
6	CHEN 336	Separation Processes	3	CHEN 303	
6	CHEN 360	Chemical Process Control	3	MATH 270 CSIS 206	CHEN 361
6	CHEN 361	Process Control Lab	1		CHEN 360
6	CHEN 392	Senior Design 2	2	CHEN 391	CHEN 326
6	CSPR XXX	Cultural Studies	3	ENGL 203	
6	MECH 321	Heat Transfer	3	MECH 243	
		TOTAL	**109**		

Option Electives (9 credits from the following list)					
	CHEN 211	Fundamentals of Geology	3		
	CHEN 246	Chemical Engineering Instrumentation	3		
	CHEN 299	Introduction to Renewable Energy	3		
	CHEN 311	Petroleum Fluids	3		
	CHEN 321	Fundamentals of Petroleum 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		
Students can take only one elective course from outside the department from the following list: CIVE 212, CIVE 309, CIVE 311, GENG 311, MGMT 220 or an approved course by the department					

DEPARTMENT OF CHEMICAL ENGINEERING

Bachelor of Engineering (BE) Degree – 146 Credits

Sem	Course Code	Course Title	Credit	Pre-Req	Co-Req
1	CHEM 202	Basic Chemistry	3		
1	CHEM 203	Basic Chemistry Laboratory	1		CHEM 202
1	CHEN 206	Instrumentation Lab And Research Methods	1		
1	CHEN 212	Chemical Engineering I	3		MATH 200
1	ENGL 203	English Communication Skills III	3		
1	MATH 200	Calculus I	3		
1	MATH 211	Linear Algebra I	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
2	CHEM 262	Physical and Chemical Kinetics	3	CHEM 202	
2	CHEN 290	Introduction to the Engineering Design Fundamentals	1		
2	CHEN 312	Mass Transfer	3	CHEN 212	
2	CSIS 206	Principles of Programming	3		
2	LISP 200	Information Skills and Search Techniques	1		ENGL 102
2	MATH 270	Differential Equations	3	MATH 200	
2	MECH 232 or CHEN 232	Thermodynamics	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
3	CHEM 242	Organic Chemistry I	3	CHEM 202	
3	CHEN 215	Materials Science and Engineering	3		
3	CHEN 303	Unit Operations	3	CHEN 312	MECH 243
3	GENG 221	Engineering Ethics	3	CHEN 290 ENGL 203	
3	MATH 202	Calculus II	3	MATH 200	
3	MECH 243	Fluid Mechanics	3	MECH 232	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
4	CHEM 244	Organic Chemistry II	3	CHEM 242	

4	CHEM 245	Organic Chemistry Laboratory	1	CHEM 242	
4	CHEN XXX	Option Elective	3		
4	CHEN 325	Chemical Reactions and Reactor Design	3	CHEN 312	CHEM 262
4	ENGL 2XX	English Elective	3	ENGL 203	
4	GENG 222	Sustainable Development for Engineers	3	CHEN 290 ENGL 203	
4	MATH 230	Numerical Analysis I	3	CSIS 206 MATH 200	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
5	CHEN XXX	Option Elective	3		
5	CHEN 322	Petroleum Refinery Engineering	3		CHEN 324
5	CHEN 324	Petroleum Engineering Lab	1		CHEN 322
5	CHEN 332	Safety, Health, and Environment	3	CHEN 303	
5	CHEN 362	Chemical Process Simulation and Design	1	CHEN 303	CHEN 391
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Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
6	CHEN XXX	Option Elective	3		
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6	CHEN 336	Separation Processes	3	CHEN 303	
6	CHEN 360	Chemical Process Control	3	MATH 270 CSIS 206	CHEN 361
6	CHEN 361	Process Control Lab	1		CHEN 360
6	CHEN 392	Senior Design 2	2	CHEN 391	CHEN 326
6	CSPR XXX	Cultural Studies	3	ENGL 203	
6	MECH 321	Heat Transfer	3	MECH 243	
		TOTAL	**109**		

Option Electives (9 credits from the following list)					
	CHEN 211	Fundamentals of Geology	3		
	CHEN 246	Chemical Engineering Instrumentation	3		
	CHEN 299	Introduction to Renewable Energy	3		
	CHEN 311	Petroleum Fluids	3		
	CHEN 321	Fundamentals of Petroleum 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		
Students can take only one elective course from outside the department from the following list: CIVE 212, CIVE 309, CIVE 311, GENG 311, MGMT 220 or an approved course by the department					
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
7	CHEN 400	Chemical Process Synthesis and Design	3		
7	CHEN 404	Advanced Chemical Reactor Design	3		
7	CHEN 412	Industrial Catalytic Processes	3		
7	CHEN XXX	Specialized Area Elective	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
8	CHEN 413	Advanced Transport Phenomena	3		
8	CHEN XXX	Specialized Area Elective	3		
8	CHEN XXX	Specialized Area Elective	3		
8	GENG 400	Engineering Seminars	1		
8	GENG 490	Graduation Project	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
9	CHEN 480	Field Training	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
10	CHEN XXX	Specialized Area Elective	3		
10	CHEN XXX	Specialized Area Elective	3		
10	CHEN XXX	Specialized Area Elective	3		

10	GENG 490	Graduation Project (Reactivation)	0		
		TOTAL	**146**		
Specialized Area Elective (Based on Selected Area):					
Petroleum Engineering (18 credits from the following list)					
	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 543	Well testing	3		
	CHEN 551	Drilling Engineering	3		
	CHEN 579	Numerical Methods in Petroleum Industry	3		
Food Processing (18 credits from the following list)					
	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		

Industrial Processes Engineering (18 credits from the following list)					
	CHEN 418	Polymers and Polymer Engineering	3		
	CHEN 420	Food Process Engineering	3		
	CHEN 421	Advanced Petroleum Processing	3		
	CHEN 422	Surface and Colloid Chemistry	3		
	CHEN 424	Cement Manufacturing	3		
	CHEN 426	Reservoir Engineering	3		
	CHEN 427	Thermal Processes in the Heavy Industry	3		
	CHEN 430	Environmental Design and Life Cycle Assessment	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 450	Ecotoxicology for Engineers	3		
	CHEN 468	Mechanisms in Petroleum Engineering	3		
	CHEN 485	Fuel Cell Technology	3		
	CHEN 513	Subsurface Production Engineering	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 524	Food Laws and Regulations	3		
	CHEN 525	Powder Technology and Operating Design	3		
	CHEN 531	Oil Field Development	3		
	CHEN 532	Advanced Natural Gas Engineering	3		
	CHEN 541	Quality Control in Food and Bioprocessing	3		
	CHEN 542	Food Preservation	3		
	CHEN 543	Well Testing	3		
	CHEN 544	Nanofabrication	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 551	Drilling Engineering	3		
	CHEN 555	Emerging Food Technologies and Biotechnology	3		
	CHEN 566	Bioseparation Engineering	3		
	CHEN 577	Food Packing	3		
	CHEN 579	Numerical Methods in Petroleum Industry	3		
	CHEN 588	Food Analysis Techniques	3		
	CHEN 589	Waste Treatment Engineering	3		

DEPARTMENT OF CHEMICAL ENGINEERING

Master of Science (MS) Degree – 46 Credits

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

Sem	Course Code	Course Title	Credit	Pre-Req	Co-Req
7	CHEN 400	Chemical Process Synthesis and Design	3		
7	CHEN 404	Advanced Chemical Reactor Design	3		
7	CHEN 412	Industrial Catalytic Processes	3		
7	CHEN XXX	Specialized Area Elective	3		
7	GENG 450	Advanced Engineering Analysis and Research Methods	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
8	CHEN XXX	Specialized Area Elective	3		
8	CHEN XXX	Specialized Area Elective	3		
8	CHEN XXX	Specialized Area Elective	3		
8	GENG 599	Master's Thesis	6	GENG450	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
9	CHEN 480	Field Training	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
10	CHEN XXX	Specialized Area Elective	3		
10	CHEN XXX	Specialized Area Elective	3		
10	CHEN XXX	Specialized Area Elective	3		
10	CHEN 413	Advanced Transport Phenomena	3		
10	GENG 400	Engineering Seminars	1		
10	GENG 599	Master's Thesis (Reactivation)	0		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	
11	GENG 599	Master's Thesis (Reactivation)	0		
		TOTAL	**46**		

Specialized Area Elective (Based on Selected Area):					
Petroleum Engineering (15 credits from the following list and 6 credits from any CHEN specialized area elective)					
	CHEN 416	Chemical Engineering Optimization	3		
	CHEN 421	Advanced Petroleum Processing	3		
	CHEN 426	Reservoir Engineering	3		
	CHEN 468	Mechanisms in Petroleum Engineering	3		
	CHEN 478	Corrosion in Chemical Processes	3		
	CHEN 513	Subsurface Production Engineering	3		
	CHEN 531	Oil Field Development	3		
	CHEN 532	Advanced Natural Gas Engineering	3		
	CHEN 543	Well testing	3		
	CHEN 551	Drilling Engineering	3		
	CHEN 579	Numerical Methods in Petroleum Industry	3		
Food Processing (15 credits from the following list and 6 credits from any CHEN specialized area elective)					
	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		
Industrial Processes Engineering (15 credits from the following list and 6 credits from any CHEN specialized area elective)					
	CHEN 418	Polymers and Polymer Engineering	3		
	CHEN 420	Food Process Engineering	3		
	CHEN 421	Advanced Petroleum Processing	3		
	CHEN 422	Surface and Colloid Chemistry	3		
	CHEN 424	Cement Manufacturing	3		
	CHEN 426	Reservoir Engineering	3		
	CHEN 427	Thermal Processes in the Heavy Industry	3		
	CHEN 430	Environmental Design and Life Cycle Assessment	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 450	Ecotoxicology for Engineers	3		
	CHEN 468	Mechanisms in Petroleum Engineering	3		
	CHEN 485	Fuel Cell Technology	3		
	CHEN 513	Subsurface Production Engineering	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 524	Food Laws and Regulations	3		
	CHEN 525	Powder Technology and Operating Design	3		
	CHEN 531	Oil Field Development	3		
	CHEN 532	Advanced Natural Gas Engineering	3		
	CHEN 541	Quality Control in Food and Bioprocessing	3		
	CHEN 542	Food Preservation	3		
	CHEN 543	Well Testing	3		
	CHEN 544	Nanofabrication	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 551	Drilling Engineering	3		
	CHEN 555	Emerging Food Technologies and Biotechnology	3		
	CHEN 566	Bioseparation Engineering	3		
	CHEN 577	Food Packing	3		
	CHEN 579	Numerical Methods in Petroleum Industry	3		
	CHEN 588	Food Analysis Techniques	3		
	CHEN 589	Waste Treatment Engineering	3		

COURSE DESCRIPTIONS

CHEN 206 INSTRUMENTATION LAB AND RESEARCH METHODS 0.3: 1 cr. E
This laboratory introduces students to experimental work and the use of measurement instruments. The laboratory course also introduces the methodology of writing technical reports will be covered. Students will also learn to identify important and relevant information from different sources (books, journal papers, patents, etc.) and how to use practically use essential software tools (Microsoft Office Suite) 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 are also covered. The course discusses 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 engineering profession in general and the discipline of chemical engineering in particular. It gives an overview of the chemical engineering profession and career choices. This course is designed to introduce chemical engineering sophomores to basic principles in chemical engineering.
The material covered builds a foundation for subsequent courses in the program (e.g., thermodynamics, reaction engineering, fluid mechanics, process design, heat and mass transfer, etc.).

Co-requisite: 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 understanding 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, corrosion and degradation of materials.

CHEN 232 THERMODYNAMICS 3.0: 3 cr. E
This is an introductory course which aims at providing engineering students with theoretical background necessary to perform classical engineering analysis of basic open and closed thermodynamic systems; Properties of pure substance; Heat; Work; First Law of Thermodynamics; Second Law of Thermodynamics; Entropy; Reversibility and Irreversibility; Power and Refrigeration Cycles.

CHEN 290 INTRODUCTION TO THE ENGINEERING DESIGN FUNDAMENTALS 0.3: 1cr. E
This course focuses on the engineering design process along with the utilization of standards and constraints. Students will be introduced to needs identification and solution finding, project management skills, technical writing and presenting, effective multidisciplinary teamwork, and will be exposed to the qualities and attributes of a modern day engineer as expected by professional engineering societies, including integrity, professionalism, ethical commitment and environmental requirements, as well as the role of the engineer in society.

CHEN 299 INTRODUCTION TO RENEWABLE ENERGY 3.0: 3 cr. E
This course covers renewable energy technologies and potentials (solar, wind, hydro, biomass, tidal and geothermal energy). It introduces a general engineering audience to the basic concepts of renewable energy. Illustrated examples for each lecture are from industrial developments and real world applications.

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

This course covers the design and analysis of unit operations with emphasis on distillation, absorption, and extraction. Topics include: design problems of batch and continuous operations of single and multistage equilibrium distillation processes with binary and multicomponent compositions, single and multi-cascade of co current and counter current liquid-liquid extraction. Graphical and analytical design techniques, efficiency and capacity of separation processes are covered.

Pre-requisite: CHEN 312
Co-requisite: 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; H_2O/hydrocarbon phase behavior; introduction to PVT phase behaviour; simulation software.

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

This course provides an introduction to the basic principles of mass transfer and applications. The principal topics covered include principles of molecular diffusion, Fick's law, molecular diffusion in fluids, diffusion in solids, convective mass transfer, interfacial mass transfer, mass transfer coefficient and fluxes, correlation of mass transfer coefficients, interphase mass transfer, theories of mass transfer, individual gas and liquid phase mass transfer coefficient, overall mass transfer coefficient, design and operation of equipment for absorption, mechanism of absorption, Kremser equation, packed tower design, height of column based on conditions in the gas film, height of column based on conditions in the liquid film, height of column based on overall coefficients, calculation of number of plates by graphical methods, total and minimum reflux ratio.

Pre-requisite: 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 introduces fundamental concepts in petroleum refinery processes. An overview of petroleum refinery, its feedstocks, and the processes employed to convert crude oil and intermediate streams into finished products are presented. Crude oil composition and classification, hydrocarbon chemistry, crude oil properties and preparation, refinery products quality and test methods are discussed. Every refining process is presented, including operating conditions and description, feedstock composition and catalyst selection, product yields, and the relationship between process parameters, unit performance and product output/properties. This course delivers major insights into several processes such as Atmospheric Distillation (CDU), Vacuum Distillation (VDU), Cracking, Hydrocracking, Catalytic Reforming, Coking, Visbreaking.

Co-requisite: CHEN 324

CHEN 324 PETROLEUM ENGINEERING LAB 3.0: 3 cr. E
The purpose of this lab course is to provide students with an understanding of Petroleum Chemistry. The lab course addresses the chemical composition and properties of petroleum (oil and gas), and provide knowledge of petroleum products and alternative fuels. Minimum of 20 experiments is to be conducted, testing of petroleum and its analysis. All experiments are demonstrated and manipulated by the students.

Co-requisite: CHEN 322

CHEN 325 CHEMICAL REACTIONS AND REACTOR DESIGN 3.0: 3 cr. E
This course explains the principles of chemical reactions and isothermal reactor design. Batch, continuous stirred-tank, plug flow and packed-bed reactors are introduced in addition to semi-batch and membrane reactors. Multiple reactions, enzymatic reactions and bioreactors are also studied.

Pre-requisite: CHEN 312
Co-requisite: CHEM 262

CHEN 326 CHEMICAL ENGINEERING LAB 3.0: 1 cr. E
This course covers experiments in the area of unit operations and chemical engineering reactor design including fluid-flow phenomena through various media such as: friction in conduits, filtration, pressure drop in packed towers and, fluidization of solids/drying. Moreover, basic chemical engineering concepts regarding heat and mass transfer processes in evaporation, absorption, extraction and distillation operations are covered.

Co-requisite: CHEN 392

CHEN 329 PLANT ECONOMICS 3.0: 3 cr. E
This course introduces concepts of 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 332 SAFETY, HEALTH, AND ENVIRONMENT 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.

Pre-requisite: CHEN 303

CHEN 333 FOOD CHEMISTRY AND TECHNOLOGY PRINCIPLES 3.0: 3 cr. E
This course aims to provide an introduction to the chemistry of the major food constituents carbohydrates, proteins, lipids, water, and minor components. This course introduces students to nutrition, food preservation, and different food processing technologies (wine fermentation, dairy products processing, poultry, meat, and seafood products processing, etc.).

CHEN 336 SEPARATION PROCESSES **3.0: 3 cr. E**
This course involves the analysis and design of separation processes involving adsorption, chromatography, membrane separation, and crystallization techniques. The basic mechanisms and the mathematical description of mass and heat transfer rates, and phase equilibria used for the design of these separation processes are addressed.

Pre-requisite: CHEN 303

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 360 CHEMICAL PROCESS CONTROL **3.0: 3 cr. E**
This course covers 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).

Pre-requisites: MATH 270, CSIS 206
Co-requisite: CHEN 361

CHEN 361 PROCESS CONTROL LAB **0.3: 1 cr. E**
This laboratory complements the theoretical concepts of chemical process control. The course involves extensive use of computer software such as MATLAB and Simulink. Topics include: dynamic simulation of linear and nonlinear mathematical models of chemical processes, design of PID controllers, tuning of controller to accommodate process model uncertainty.

Co-requisite: CHEN 360

CHEN 362 CHEMICAL PROCESS SIMULATION AND DESIGN **0.3: 1 cr. E**
This course introduces students to process simulation and design of various chemical and related process industries. Major emphasis is placed on the simulation of chemical engineering units (reactors, distillation columns, heat exchangers, etc.) used for plant design on Aspen Plus software. Proper unit sizing and cost analysis are covered to understand how various costs affect the process economics involved in industrial processes.

Pre-requisite: CHEN303
Co-requisite: CHEN 391

CHEN 377 CHEMICAL ENGINEERING THERMODYNAMICS II **3.0: 3 cr. E**
This course covers the second law of thermodynamics, entropy, thermodynamic properties of fluids and thermodynamic diagrams. Topics of application of thermodynamics to flow processes, power production, and refrigeration are also covered. Vapor-liquid equilibrium, solution thermodynamics, fugacity, and chemical reaction equilibria are explained.

Pre-requisite: MECH 232

CHEN 378 LIVING CELLS ENGINEERING 3.0: 3 cr. E
This course covers concepts of engineering of the living systems, biomolecules, biological catalysers, living cells, basic concepts and applications related to chemical engineering. The course also includes the topics of structure and role of the cellular components in bioprocesses, cell and enzyme types, kinetics of enzymatic reactions, cell growth, operating conditions, selection of bioreactors, and metabolic pathways and regulation. The course includes examples of bioprocesses using different types of cells and applications in biotechnology, environmental engineering, pulp and paper, food technology and energy.

CHEN 388 BIOFUEL ENGINEERING 3.0: 3 cr. E
This course emphasizes 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.

CHEN 391 SENIOR DESIGN 1 3.0: 2 cr. E
This course covers the first part of a capstone design project, for which teams of students are formed and real-world engineering problems are chosen. Students should identify the problem(s), scope, relevance, and objectives. Throughout this course, they conduct extensive research and literature review and learn to analyze and understand the design requirements, with consideration of different factors (i.e., public health, safety, ethics, and environment).

Pre-requisites: CHEN 290, CHEN 303, CHEN 325, GENG 221, GENG 222, LISP 200, MATH 202
Co- requisite: CHEN 362

CHEN 392 SENIOR DESIGN 2 3.0: 2 cr. E
This course constitutes the second semester of a year-long culminating senior project. In this course, the teams of students must complete the capstone project selected in CHEN391 to finish the second phase of the design process namely, (1) carry on the culminating design by selecting different case studies, (2) build, test, and evaluate the physical/virtual model and (3) optimize the final design by improving the process parameters (T, P, flowrate, etc.) and the topology of the process flowchart. At the end of the semester, teams will present/demonstrate their final design process/prototype/product and convey to the public their findings through a comprehensive report and presentation that synthesizes all steps of the simulation and design process and exhibits individual team members' contributions.

Pre-requisite: CHEN 391
Co-requisite: CHEN 326

CHEN 400 CHEMICAL PROCESS SYNTHESIS AND DESIGN 3.0: 3 cr. E
This course provides an introduction to the core technical skills and professional responsibilities common to all chemical processes and operations. The course also covers process synthesis, process flows and diagrams, chemical product design, process thermodynamics, chemical process reactions, process mass transfer, heat transfer and fluid flow, economic effectiveness and operations safety.

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. 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, hydrogenation and dehydrogenation of organic compounds, and oxidation of organic and inorganic compounds.

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, energy and mass transport. Shell momentum, heat and mass balances and equations of change are developed and used to determine velocity, temperature, and concentration distributions for laminar flow. Viscosity, thermal conductivity and mass diffusivity are also covered, as well as friction factors and macroscopic balances.

CHEN 416 CHEMICAL ENGINEERING OPTIMIZATION 3.0: 3 cr. E
This course introduces the application of optimization methods to important chemical engineering problems in thermodynamics, unit operations, separation processes, energy design, and optimization in industrial practice. This course includes continuous, linear and nonlinear, and mixed integer linear programing problems. The course emphasizes problem definition, model formulation and solution analysis, with sufficient details on existing algorithms and software to solve problems**.**

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
This course provides concepts of 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: atmospheric and vacuum crude oil distillation units, light end units, catalytic reforming process, fluid catalytic cracking process, and distillate hydro- cracking process. The course also includes concepts of hydro-treating processes, refinery gas treating processes, upgrading residues, and handling of hazardous materials and safety.

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.

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 both fundamental and applied reservoir engineering concepts. It provides students a detailed understanding of the rock and fluid properties, the PVT analysis and the Darcy's law and applications. It also focuses on the natural water influx models and reservoir drive mechanisms as well as the practical application of the material balance equations in oil and gas reservoirs.

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**

This course covers the life cycle thinking approach and details the four phases of life cycle assessment: Goal and scope definition, life cycle inventory, life cycle impact assessment, and life cycle interpretation. Tutorial sessions and a practical case study using a life cycle assessment software are also covered.

CHEN432 PETROLEUM ECONOMICS AND MANAGEMENT **3.0: 3 cr. E**

This course provides an introduction to financial reporting for oil companies. Capital budgeting: Cash flow analysis. Risk analysis: Probability theory and methods. Reserve estimation. Market theory: Supply and demand, oil price models, product prices, profit maximization, inflation and depreciation. The main geopolitical characteristics of the Energy Industry in the Gulf and Levant regions. Oil field project (Upstream and Downstream) management topics: project planning and scheduling techniques, project monitoring and control techniques. Overview of the factors that affect states' failure and success in management of petroleum resources. General knowledge of the regulation of pollution control.

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**
This course focuses on 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**
This 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 **0.0: 3 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.

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 531 OIL FIELD DEVELOPMENT 3.0: 3 cr. E
This course covers the fundamentals of petroleum geology, properties of reservoir rocks, petroleum fluids, source rocks, traps, black and volatile oils, petroleum geochemistry, the conditions under which petroleum occurs in nature, the main problems which have to be solved in the exploration and development of oilfields.

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

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, wastewater 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 543 WELL TESTING 3.0: 3 cr. E
This course teaches well completion from drilling in the pay zone to production start-up. It also covers the main methods for artificial lift, and well servicing. The student will learn the concepts and equipment that are indispensable for completion and servicing operations. Students will be able to understand the operational aspects and the process of completing oil and gas wells in order to perform the designated and various tasks needed in the oil and gas industry.

CHEN 544 NANOFABRICATION 3.0: 3 cr. E
This course provides 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 begins with an overview of drilling operations where students are introduced to: drilling equipment and mechanisms of accessories, rotary drilling rig components, drill strings, drill bits and, drilling fluids. Moreover, this course covers basic drilling engineering aspects associated to friction

pressure losses, drilling hydraulics, casing and /cementing, well blowout prevention and /control and in addition to (some) of the mostly encountered drilling problems and their respective (practical) solutions.

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
This course covers 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 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
This 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
This course introduces concepts of 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.

Refer to General Listing of Course Descriptions for:

CHEM XXX
Refer to Faculty of Arts and Sciences

CIVE XXX
Refer to the Department of Civil Engineering

CSIS XXX
Refer to Faculty of Arts and Sciences

CSPR XXX
Refer to the Faculty of Arts and Sciences

ENGL XXX
Refer to the Faculty of Arts and Sciences

ENMG XXX
Refer to the Department of Engineering Management

GENG XXX
Refer to the Faculty of Engineering Requirements

LISP XXX
Refer to the Faculty of Arts and Sciences

MATH XXX
Refer to the Faculty of Arts and Sciences

MECH XXX
Refer to the Department of Mechanical Engineering

MGMT XXX
Refer to the Faculty of Business and Management

MRKT XXX
Refer to the Faculty of Business and Management

DEPARTMENT OF CIVIL ENGINEERING

Bachelor of Science (BS) Degree – 109 Credits

Sem	Course Code	Course Title	Credit	Pre-Req	Co-Req
1	CIVE 201	Statics	3		
1	CSIS 206	Principles of Programming	3		
1	ENGL 203	English Communication Skills III	3		
1	MATH 200	Calculus I	3		
1	MATH 211	Linear Algebra I	3		
1		Elective 1	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
2	CIVE 202	Mechanics of Materials	3	CIVE 201	
2	CIVE 203	Engineering Drawing I	1		
2	ENGL 2XX	English Elective	3	ENGL 203	
2	CIVE 290	Introduction to the Engineering Design Process	1		
2	MATH 202	Calculus II	3	MATH 200	
2	MATH 270	Differential Equations	3	MATH 200	
2		Elective 2	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
3	CIVE 204	Construction Materials and Methods	3	CIVE 202	
3	CIVE 205	Theory of Structures I	3	CIVE 202	
3	CIVE 206	Engineering Drawing II	1	CIVE 203	
3	CIVE 310	Building Laws	2	CIVE 203	
3	GENG 221	Engineering Ethics	3	CIVE 290 ENGL 203	
3	MATH 230	Numerical Analysis I	3	MATH 200 CSIS 206	
3	MATH 246	Probability For Engineers	3	MATH 200	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
4	CIVE 208	Surveying	2	MATH 200	CIVE 214
4	CIVE 209	Reinforced Concrete I	3	CIVE 205	
4	CIVE 210	Strength of Materials Laboratory	1	CIVE 204	CIVE 209

4	CIVE 214	Surveying Laboratory	1	CIVE 203	CIVE 208
4	CIVE 243	Fluid Mechanics Laboratory	1		MECH 243
4	CIVE 301	Soil Mechanics	3		CIVE 209
4	GENG 222	Sustainable Development for Engineers	3	CIVE 290 ENGL 203	
4	LISP 200	Information Skills and Search Techniques	1		ENGL102
4	MECH 243	Fluid Mechanics	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
5	CIVE 303	Computer-Aided Design	1		CIVE 304
5	CIVE 304	Reinforced Concrete II	3	CIVE 209	
5	CIVE 306	Soil Mechanics Laboratory	1		CIVE 301
5	CIVE 309	Engineering Economy	3	MATH 200	
5	CIVE 312	Construction Management Fundamentals	2	CIVE 206 CIVE 209	
5	CIVE 316	Construction Management Modeling	1	CIVE 209	CIVE 312
5	CIVE 324	Structural Steel Design	3	CIVE 205	
5	CIVE 389	Senior Design I	2	CIVE 290 GENG 221 GENG 222	CIVE 209
5	CSPR XXX	Cultural Studies	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
6	CIVE 307	Shallow Foundation Analysis and Design	3	CIVE 209 CIVE 301	
6	CIVE 308	Transportation Engineering	3	CIVE 208	
6	CIVE 390	Senior Design II	2	CIVE 389	
6		Elective Lab 1	1		
6		Elective Lab 2	1		
6		Elective 3	2		
6		Elective 4	2		
6		Elective 5	2		
6		Elective 6	3		
		TOTAL	**109**		

Elective 1 (3 credits from the following list or any 3-credit course approved by the Department):					
	BIOL 207	General Ecology	3		ENGL 101
	EVSC 202	Fundamentals of Geology	3		ENGL 101
Elective 2 (3 credits from the following list):					
	CHEM 202	Basic Chemistry	3		
	MECH 221	Engineering Dynamics	3	CIVE 201	
Electives 3, 4, and 5 (6 credits from the following list or any equivalent approved by the Department):					
	CIVE 319	Revit for Civil Engineers	2	CIVE 206	
	CIVE 320	Structural Detailing	2	CIVE 206	CIVE 304 CIVE 307
	CIVE 321	Advanced Computer Aided Design	2	CIVE 303	
	CIVE 322	Technical Platform Computing for Civil Engineering	2	CSIS 206	
	CIVE 323	Introduction to Geographic Information System	2	CIVE 206 CIVE 208	
Elective 6 (3 credits from the following list):					
	CIVE 305	HVAC	3		
	CIVE 311	Sanitary Engineering	3	MECH 243	
Elective Labs 1 and 2 (2 credits from the following list, or any equivalent labs approved by the department):					
	CIVE 313	Transportation Engineering Modeling	1	CIVE 206	CIVE 308
	CIVE 315	Geotechnical Engineering Modeling	1		CIVE 307
	CIVE 318	Environmental Engineering Modeling	1		
	MECH 233	Workshop Technology	1		
	PHYS 214	Fundamentals of Physics II Laboratory	1		

DEPARTMENT OF CIVIL ENGINEERING

Bachelor of Engineering (BE) Degree – 146 Credits

Sem	Course Code	Course Title	Credit	Pre-Req	Co-Req
1	CIVE 201	Statics	3		
1	CSIS 206	Principles of Programming	3		
1	ENGL 203	English Communication Skills III	3		
1	MATH 200	Calculus I	3		
1	MATH 211	Linear Algebra I	3		
1		Elective 1	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
2	CIVE 202	Mechanics of Materials	3	CIVE 201	
2	CIVE 203	Engineering Drawing I	1		
2	ENGL 2XX	English Elective	3	ENGL 203	
2	CIVE 290	Introduction to the Engineering Design Process	1		
2	MATH 202	Calculus II	3	MATH 200	
2	MATH 270	Differential Equations	3	MATH 200	
2		Elective 2	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
3	CIVE 204	Construction Materials and Methods	3	CIVE 202	
3	CIVE 205	Theory of Structures I	3	CIVE 202	
3	CIVE 206	Engineering Drawing II	1	CIVE 203	
3	CIVE 310	Building Laws	2	CIVE 203	
3	GENG 221	Engineering Ethics	3	CIVE 290 ENGL 203	
3	MATH 230	Numerical Analysis I	3	MATH 200 CSIS 206	
3	MATH 246	Probability For Engineers	3	MATH 200	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
4	CIVE 208	Surveying	2	MATH 200	CIVE 214
4	CIVE 209	Reinforced Concrete I	3	CIVE 205	
4	CIVE 210	Strength of Materials Laboratory	1	CIVE 204	CIVE 209

4	CIVE 214	Surveying Laboratory	1	CIVE 203	CIVE 208
4	CIVE 243	Fluid Mechanics Laboratory	1		MECH 243
4	CIVE 301	Soil Mechanics	3		CIVE 209
4	GENG 222	Sustainable Development for Engineers	3	CIVE 290 ENGL 203	
4	LISP 200	Information Skills and Search Techniques	1		ENGL102
4	MECH 243	Fluid Mechanics	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
5	CIVE 303	Computer-Aided Design	1		CIVE 304
5	CIVE 304	Reinforced Concrete II	3	CIVE 209	
5	CIVE 306	Soil Mechanics Laboratory	1		CIVE 301
5	CIVE 309	Engineering Economy	3	MATH 200	
5	CIVE 312	Construction Management Fundamentals	2	CIVE 206 CIVE 209	
5	CIVE 316	Construction Management Modeling	1	CIVE 209	CIVE 312
5	CIVE 324	Structural Steel Design	3	CIVE 205	
5	CIVE 389	Senior Design I	2	CIVE 290 GENG 221 GENG 222	CIVE 209
5	CSPR XXX	Cultural Studies	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
6	CIVE 307	Shallow Foundation Analysis and Design	3	CIVE 209 CIVE 301	
6	CIVE 308	Transportation Engineering	3	CIVE 208	
6	CIVE 390	Senior Design II	2	CIVE 389	
6		Elective Lab 1	1		
6		Elective Lab 2	1		
6		Elective 3	2		
6		Elective 4	2		
6		Elective 5	2		
6		Elective 6	3		
Elective 1 (3 credits from the following list or any 3-credit course approved by the Department):					
	BIOL 207	General Ecology	3		ENGL 101
	EVSC 202	Fundamentals of Geology	3		ENGL 101

Elective 2 (3 credits from the following list):					
	CHEM 202	Basic Chemistry	3		
	MECH 221	Engineering Dynamics	3	CIVE 201	
Electives 3, 4, and 5 (6 credits from the following list, or any 2-credits approved by the Department):					
	CIVE 319	Revit for Civil Engineers	2	CIVE 206	
	CIVE 320	Structural Detailing	2	CIVE 206	CIVE 304 CIVE 307
	CIVE 321	Advanced Computer Aided Design	2	CIVE 303	
	CIVE 322	Technical Platform Computing for Civil Engineering	2	CSIS 206	
	CIVE 323	Introduction to Geographic Information System	2	CIVE 206 CIVE 208	
Elective 6 (3 credits from the following list):					
	CIVE 305	HVAC	3		
	CIVE 311	Sanitary Engineering	3	MECH 243	
Elective Labs 1 and 2 (2 credits from the following list, or any 1-credit Lab approved by the Department):					
	CIVE 313	Transportation Engineering Modeling	1	CIVE 206	CIVE 308
	CIVE 315	Geotechnical Engineering Modeling	1		CIVE 307
	CIVE 318	Environmental Engineering Modeling	1		
	MECH 233	Workshop Technology	1		
	PHYS 214	Fundamentals of Physics II Laboratory	1		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
7	CIVE 401	Theory of Structures II	3	CIVE 205	
7	CIVE 403	Deep Foundations	3	CIVE 307	
7	CIVE 404	Hydraulics	3		
7		Elective 7	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
8	CIVE 405	Prestressed Concrete	3	CIVE 304	
8	GENG 400	Engineering Seminars	1		
8	GENG 402	Project Management	3		

8	GENG 490	Graduation Project	3		
8		Elective 8	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
9	CIVE 480	Field Training	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
10	CIVE 503	Highway Design	3	CIVE 308	
10	GENG 490	Graduation Project (Re-activation)	0		
10		Elective 9	3		
10		Elective 10	3		
		TOTAL	**146**		
Elective 7 (3 credits from the following list):					
	CIVE 428	Construction Safety Management	3		
	CIVE 555	Special Topics in Engineering	3		
Elective 8 (3 credits from the following list):					
	CIVE 411	Introduction to Earthquake Engineering and Seismology	3		
	CIVE 443	Seismic Design of Reinforced Concrete Buildings	3		
Elective 9 (3 credits from the following list):					
	ENVE 401	Water Resources Engineering	3		
	CIVE 516	Advanced Geographic Information Systems	3	CIVE 323	
	CIVE 520	Principles of Environmental Engineering	3		
Elective 10 (3 credits from the following list):					
	ENVE 401	Water Resources Engineering	3		
	CIVE 410	Applied Hydraulics	3	CIVE 404	
	CIVE 411	Introduction to Earthquake Engineering and Seismology	3		
	CIVE 414	Earthquake Loss Estimations	3		
	CIVE 420	Construction Processes	3		
	CIVE 421	Seismic Design of Structures: Displacement Based	3		

	CIVE 422	Simulation of Construction Operations	3		
	CIVE 423	Assessment and Strengthening of Structures	3		
	CIVE 426	Building Construction Methods	3		
	CIVE 427	Construction Cost Management	3		
	CIVE 428	Construction Safety Management	3		
	CIVE 429	Construction Contracts Management	3		
	CIVE 430	Construction Equipment Management	3		
	CIVE 431	Civil Infrastructure Management	3		
	CIVE 432	Concrete Technology	3		
	CIVE 433	Earthquake Geotechnical Engineering	3		
	CIVE 436	Earthquake Design According to the IBC Code and Euro Code EC8	3		
	CIVE 438	Green Buildings and Sustainability	3		
	CIVE 444	Seismic Design of Foundations	3	CIVE 443	
	CIVE 451	Concrete Durability	3		
	CIVE 452	Cement Manufacturing and Hydration	3		
	CIVE 453	Concrete Materials for Sustainable Development	3		
	CIVE 504	Finite Element Analysis	3		
	CIVE 512	Pavement Design	3		CIVE 503
	CIVE 513	Traffic Engineering	3		
	CIVE 516	Advanced Geographic Information Systems	3	CIVE 323	
	CIVE 520	Principles of Environmental Engineering	3		
	CIVE 521	Wastewater Engineering Design	3	CIVE 520	
	CIVE 522	Water Resources and Water Quality	3		
	CIVE 523	Air Pollution Control	3		
	CIVE 524	Solid Waste Disposal	3		
	CIVE 525	Sanitary Landfill	3	CIVE 520	
	CIVE 526	Water Supply Engineering Design	3	CIVE 520	
	CIVE 527	Environmental Impact Assessment	3	CIVE 520	
	CIVE 528	Environmental Economics and Management	3	CIVE 520	
	CIVE 529	Environmental Chemistry	3		
	CIVE 530	Environmental Chemistry and Microbiology	3		

	CIVE 531	Environmental Sampling and Analysis	3		
	CIVE 532	Wastewater Treatment Plants: Processes, Design, and Operation	3		
	CIVE 540	Sustainable Roadway Design, Construction, and Operation	3		
	CIVE 541	Contemporary Cities	3		
	CIVE 542	Sustainable Development in Transportation Engineering	3		
	CIVE 543	Sustainable Development in Civil Engineering	3		
	CIVE 556	Bridge Design	3		
	CIVE 557	Advanced Structural Steel Design	3	CIVE 324	
	CIVE 558	Slope Stability and Embankment Design	3		
	CIVE 559	Pavement Reconstruction, Rehabilitation and Maintenance	3		
	CIVE 560	Transportation Management Systems	3		
	CIVE 561	Retaining Structures Design	3		
	CIVE 563	Advanced Soil Mechanics	3	CIVE 301	
	CIVE 564	Geosynthetics	3		
	CIVE 565	Soil-Structure Interaction	3		
	CIVE 566	Theory of Plates and Shells	3		
	CIVE 567	Physical Metallurgy of Steel	3		
Elective Lab (1 credit from the following list, or any 1-credit Lab approved by the Department):					
	CIVE 313	Transportation Engineering Modeling	1	CIVE 206	CIVE 308
	CIVE 315	Geotechnical Engineering Modeling	1		CIVE 307
	CIVE 318	Environmental Engineering Modeling	1		
	MECH 233	Workshop Technology	1		

DEPARTMENT OF CIVIL ENGINEERING

Master of Science (MS) Degree – 46 Credits

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

Sem	Course Code	Course Title	Credit	Pre-Req	Co-Req
7	CIVE 401	Theory of Structures II	3	CIVE 205	
7	CIVE 403	Deep Foundations	3	CIVE 307	
7	GENG 450	Advanced Engineering Analysis and Research Methodology	3		
7		Elective	3		
7		Elective	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
8	CIVE 402	Dynamics of Structures I	3	CIVE 401	
8	GENG 400	Engineering Seminars	1		
8	GENG 402	Project Management	3		
8	GENG 599	Master's Thesis	6	GENG 450	
8		Elective	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
9	CIVE 480	Field Training	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
10	CIVE 405	Prestressed Concrete	1	CIVE 304	
10	CIVE 503	Highway Design	3	CIVE 308	
10	GENG 599	Master's Thesis (Re-activation)	0		
10		Elective	3		
10		Elective	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	
11	GENG 599	Master's Thesis (Reactivation)	0		
		TOTAL	**46**		

Elective (15 credits from the following lists):					
Structural Track:					
	CIVE 411	Introduction to Earthquake Engineering and Seismology	3		
	CIVE 424	Advanced Mechanics of Materials for Civil Engineering	3	CIVE 202	
	CIVE 443	Seismic Design of Reinforced Concrete Buildings	3		
	CIVE 502	Theory of Elasticity	3		
	CIVE 504	Finite Element Analysis	3		
	CIVE 505	Dynamics of Structures II	3	CIVE 402	
	CIVE 555	Special Topics in Engineering	3		
	CIVE 556	Bridge Design	3		
	CIVE 557	Advanced Structural Steel Design	3	CIVE 324	
	CIVE 561	Retaining Structures Design	3		
	CIVE 562	Design of Timber Structures	3		
	CIVE 566	Theory of Plates and Shells	3		
Transportation Track:					
	CIVE 404	Hydraulics	3		
	CIVE 456	Fundamentals of Road Construction	3		
	CIVE 507	Boundary Surveys	3		
	CIVE 512	Pavement Design	3		CIVE 503
	CIVE 513	Traffic Engineering	3		
	CIVE 516	Advanced Geographic Information Systems	3	CIVE 323	
	CIVE 540	Sustainable Roadway Design, Construction, and Operation	3		
	CIVE 541	Contemporary Cities	3		
	CIVE 542	Sustainable Development in Transportation Engineering	3		
	CIVE 543	Sustainable Development in Civil Engineering	3		
	CIVE 556	Bridge Design	3		
	CIVE 559	Pavement Reconstruction, Rehabilitation and Maintenance	3		
	CIVE 560	Transportation Management Systems	3		
Environmental Track:					
	CIVE 438	Green Buildings and Sustainability	3		

	CIVE 520	Principles of Environmental Engineering	3		
	CIVE 521	Wastewater Engineering Design	3	CIVE 520	
	CIVE 522	Water Resources and Water Quality	3		
	CIVE 523	Air Pollution Control	3		
	CIVE 524	Solid Waste Disposal	3		
	CIVE 525	Sanitary Landfill	3	CIVE 520	
	CIVE 526	Water Supply Engineering Design	3	CIVE 520	
	CIVE 527	Environmental Impact Assessment	3	CIVE 520	
	CIVE 528	Environmental Economics and Management	3	CIVE 520	
	CIVE 529	Environmental Chemistry	3		
	CIVE 530	Environmental Chemistry and Microbiology	3		
	CIVE 531	Environmental Sampling and Analysis	3		
	CIVE 532	Wastewater Treatment Plants: Processes, Design, and Operation	3		
	ENVE XXX	Pre-approved by the Department	3		
Geotechnical Engineering Track:					
	CIVE 411	Introduction to Earthquake Engineering and Seismology	3		
	CIVE 433	Earthquake Geotechnical Engineering	3		
	CIVE 443	Seismic Design of Reinforced Concrete Buildings	3		
	CIVE 444	Seismic Design of Foundations	3	CIVE 443	
	CIVE 558	Slope Stability and Embankment Design	3		
	CIVE 561	Retaining Structures Design	3		
	CIVE 563	Advanced Soil Mechanics	3	CIVE 301	
	CIVE 564	Geosynthetics	3		
	CIVE 565	Soil-Structure Interaction	3		
Management Track:					
	CIVE 420	Construction Processes	3		
	CIVE 422	Simulation of Construction Operations	3		
	CIVE 426	Building Construction Methods	3		
	CIVE 427	Construction Cost Management	3		
	CIVE 428	Construction Safety Management	3		
	CIVE 429	Construction Contracts Management	3		
	CIVE 430	Construction Equipment Management	3		

	CIVE 431	Civil Infrastructure Management	3		
	CIVE 560	Transportation Management Systems	3		
	CIVE 568	Management of Civil Engineering Systems	3		
	ENMG XXX	Pre-approved by the Civil Engineering Department	3		
Water Resources Track:					
	CIVE 404	Hydraulics	3		
	CIVE 409	Hydrology	3		
	CIVE 410	Applied Hydraulics	3	CIVE 404	
	CIVE 558	Slope Stability and Embankment Design	3		
Earthquake Engineering Track:					
	CIVE 411	Introduction to Earthquake Engineering and Seismology	3		
	CIVE 414	Earthquake Loss Estimations	3		
	CIVE 421	Seismic Design of Structures: Displacement Based	3		
	CIVE 423	Assessment and Strengthening of Structures	3		
	CIVE 433	Earthquake Geotechnical Engineering	3		
	CIVE 436	Earthquake Design According to the IBC Code and Euro Code EC8	3		
	CIVE 443	Seismic Design of Reinforced Concrete Buildings	3		
	CIVE 444	Seismic Design of Foundations	3	CIVE 443	
	CIVE 505	Dynamics of Structures II	3	CIVE 402	
	CIVE 557	Advanced Structural Steel Design	3	CIVE 324	
Materials Track:					
	CIVE 432	Concrete Technology	3		
	CIVE 451	Concrete Durability	3		
	CIVE 452	Cement Manufacturing and Hydration	3		
	CIVE 453	Concrete Materials for Sustainable Development	3		
	CIVE 454	Concrete Testing and Repair	3		
	CIVE 456	Fundamentals of Road Construction	3		
	CIVE 567	Physical Metallurgy of Steel	3		

COURSE DESCRIPTIONS

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

Concept of forces, moments, and other vector quantities; analysis of force systems; conditions of equilibrium; analysis of simple structures; friction; centroids and moments of inertia; 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, combined stresses, deflections in beams, and analysis of columns.

Pre-requisite: CIVE 201

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

Concepts and practices in lettering, geometric construction, 2D multi-view and auxiliary projections, sections and connections, dimensioning, sketching wall sections, and perform architectural design. Emphasis on freehand sketching skills and learning AutoCAD (2D) basic drawing tools.

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

Physical and mechanical properties of construction materials; P/C concrete, asphalt, wood, ferrous metals, non-ferrous metals; proportioning of concrete mixes including admixtures with laboratory demonstrations. Finishing materials and methods.

Pre-requisite: CIVE 202

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

Stress resultants (reactions, axial forces, shear forces, and bending moments) for beams and framed structures. Deflections of beams and frames by geometric methods (moment-area theorems and applications; conjugate beam analogy), and energy methods (virtual work method, Castigliano's theorems). Influence lines functions and their applications. Criteria for moving loads. Analysis of statically indeterminate beams and frames by force methods (consistent deformations) and displacement methods (slope deflection and moment distribution). Structural analysis with software application.

Pre-requisite: CIVE 202

CIVE 206 ENGINEERING DRAWING II **0.3: 1 cr. E**

The course aims at preparing the future civil engineer to meet the growing needs of the local specifications, and to be able to understand and create architectural drawings of residential buildings. Learning this course is based on the ability of using CAD packages (Auto CAD). The course seeks to develop the student effective utilization of computer aided drafting (CAD) skills, using AutoCAD to quickly create professional-quality 3D models.

Pre-requisite: CIVE 203

CIVE 208 SURVEYING **3.0: 2 cr. E**

The course consists of measuring and determining boundaries, areas, and location through traversing techniques. In addition, it includes providing the types of surveying, the methods of traversing and adjustment of errors, mathematical and physical concepts, coordinate systems, leveling, contour lines, mapping, horizontal and vertical curves.

Pre-requisite: MATH 200
Co-requisite: CIVE 214

CIVE 209 REINFORCED CONCRETE I **3.0: 3 cr. E**
Fundamentals of reinforced concrete behavior, analysis and design of rectangular beams, T- beams and one-way slabs including flexural and shear behavior, development and anchorage of reinforcement, deflections and crack control.

Pre-requisite: CIVE 205

CIVE 210 STRENGTH OF MATERIALS LABORATORY **0.3: 1 cr. E**
This course is designed to provide students with the basic properties, testing and inspection of common civil engineering materials that include mineral aggregates, cement, concrete, steel reinforcement and asphalt. Students will experience the way concrete is designed, mixed, compacted and tested according to international standards, and will gain a comparative knowledge of material properties and possible applications in construction. Written reports and oral presentation of experimental results are required.

Pre-requisite: CIVE 204
Co-requisite: CIVE 209

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: CIVE 203
Co-requisite: CIVE 208

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; rainfall hydrograph; forces on gates; orifices; weirs; open channel flow; and pumps.

Co-requisite: MECH 243

CIVE 290 INTRODUCTION TO THE ENGINEERING DESIGN PROCESS **0.3: 1 cr. E**
This course serves as a general introduction to the engineering profession, its main objectives, and concerns. It focuses on the engineering design process, its phases, challenges and constraints. Additionally, students are exposed to the qualities and attributes of a modern day engineer as expected by professional engineering societies, including integrity, professionalism, ethical commitment, environmental requirements, and leadership, as well as the role of the engineer in society. This course aims at setting students on the way to future design and professional work.

CIVE 301 SOIL MECHANICS **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).

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. 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.

Co-requisite: CIVE 304

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

Analysis and design of reinforced concrete structures and components: short columns subject to axial loads as well as axial load with uniaxial and biaxial bending, slender columns, beams subject to torsion, and two-way slabs (flat slabs and slabs with beams). Design according to the most recent edition of ACI-318M Code.

Pre-requisite: CIVE 209

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. Design and layout of distribution ducts, pipes and outlets.

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

In this course, students will perform several field and laboratory test methods that are commonly used to determine the mechanical properties of soils. These properties are crucial for the design of the foundation of each construction. The course includes determination of critical soils index, classification of soils, moisture-density relationship, California bearing ratio and hydraulic conductivity tests.

Co-requisite: CIVE 301

CIVE 307 SHALLOW FOUNDATION ANALYSIS AND DESIGN **3.0: 3 cr. E**

Analysis and design of 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-requisites: CIVE 209, CIVE 301

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 level of service.

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; effective interest rate; economic worth 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 and after-tax cash flow.

Pre-requisite: MATH 200

CIVE 310 BUILDING LAWS **3.0: 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, as well as 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 **3.0: 2 cr. E**
Civil Engineers working on sites as construction managers need to know the basics of construction management. Planning, scheduling and control are the three basic tools for construction managers. This course introduces the basic planning principles and procedures. It also expands on project deterministic project scheduling: mainly bar charts, network schedules AON, AOA and CPM. The course tackles the principles of cost estimation and also the quantity take-off and bar bending schedule estimation. This course introduces students to the leadership skills the construction manager must acquire.

Pre-requisites: CIVE 206, CIVE 209

CIVE 313 TRANSPORTATION ENGINEERING MODELING **0.3: 1 cr. E**
Highway design using professional commercial software 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.

Pre-requisite: CIVE 206
Co-requisite: CIVE 308

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.

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.

Pre-requisite: CIVE 209
Co-requisite: CIVE 312

CIVE 318 ENVIRONMENTAL ENGINEERING MODELING 0.3:1 cr. E
Analysis and design using commercially available software: wastewater treatment plant; sizing of tanks; effluent concentration, results visualizations and assessment: cost analysis, operation and maintenance.

CIVE 319 REVIT FOR CIVIL ENGINEERS 3.0: 2 cr. E
The Autodesk Revit software is a Building Information Modeling (BIM) program that streamlines the design process through the use of a central 3D model, where changes made in one view update across all views and on the printable sheets. The first part of the course is designed to teach engineering students the Autodesk Revit functionality as they would work with it throughout the design process. Students begin by learning about the user interface and basic drawing, editing, and viewing tools; then learn design development tools including how to generate a structural model and interface with ETABS for analysis and design purposes. Finally, they learn the processes that take the model to the construction documentation phase. The second part of the course focuses specifically on the ability of the engineering students to design a well-coordinated project on Revit and then use the same Revit file for scheduling, management, quantity take-off, and planning either using the Revit software or by connecting the Revit file to different management software such as Primavera or MS Project.

Pre-requisite: CIVE 206

CIVE 320 STRUCTURAL DETAILING 3.0: 2 cr. E
A computer-aided drafting technique and drawings generation course using CAD programs. It includes generating drawings based on the conventions of engineering graphical communication with applications to different Civil Engineering areas of specialty. The course concentrates on the detailing and shop drawings preparation of Reinforced Concrete members according to ACI-315. A required project at the end of the course introduces the students to the preparation of execution drawings and consideration of production methods.

Pre-requisite: CIVE 206
Co-requisites: CIVE 304, CIVE 307

CIVE 321 ADVANCED COMPUTER AIDED DESIGN 3.0: 2 cr. E
Advanced modeling techniques using ETABS/SAFE Software packages. 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 global and local coordinates; the ETABS concept for the Pattern Live Load; 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. Introduction to temperature loads. Design of all types of Foundations using SAFE.

Pre-requisite: CIVE 303

CIVE 322 TECHNICAL PLATFORM COMPUTING FOR CIVIL ENGINEERING 3.0: 2 cr. E
This course develops computing skills using the technical computing platform Mathematica. Topics include: introduction to Mathematica, symbolic, numeric, 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-requisite: CSIS 206

CIVE 323 INTRODUCTION TO GEOGRAPHIC INFORMATION SYSTEM 3.0: 2 cr. 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, civil and 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. The course will be based on the recently released ESRI ArcGIS 10.5.

Pre-requisites: CIVE 206, CIVE 208

CIVE 324 STRUCTURAL STEEL DESIGN 3.0: 3 cr. E
The primary objective of the course is to provide the student with solid background in the fundamentals of structural steel design. Steel will be used for typical civil engineering structures such as trusses, bridges, and framed structures. Structural design establishes the configuration, details and dimensions for standard AISC rolled shapes. The course addresses the design of simple individual structural elements (truss members, beams and columns in braced frames) and the design of simple connections of structural elements (welded and bolted).

Pre-requisite: CIVE 205

CIVE 389 SENIOR DESIGN I 3.0: 2 cr. E
In this course, first of two "Senior Design" courses, students shall work in multi-disciplinary teams to design a civil engineering project under the supervision of a Project Advisor. Projects will contain components of several civil engineering disciplines in order to integrate many elements of the curriculum. This includes some of the following: Structures, Geotechnical, Transportation, Topography, Sanitary, Hydrology and Water resources, Environmental, and/or Project Management. Each team shall define the project objectives and scope, locate relevant codes and identify related software packages, determine design specifications according to specific local and international standards, formulate a design criteria subject to constraints such as the impact on the local community and the environment, perform project/site analyses for possible alternate solutions, and finally present the preliminary design in the form of a written report and a verbal presentation.

Pre-requisite: CIVE 290, GENG 221, GENG 222
Co-requisite: CIVE 209

CIVE 390 SENIOR DESIGN II 3.0: 2 cr. E
This course is the second of two-course "Senior Design" sequence that comprises the final year capstone design experience. In this course students working as multi-disciplinary teams shall perform a complete integrated design of a civil engineering project, with all the parameters set forth in the CIVE389 course. Students shall practice team effort and develop communication skills, where each shall take a responsibility in a variety of roles and be able to combine all efforts to produce a final deliverable culminating design project with proper engineering professionalism and ethics. The project shall be presented to the department faculty on the "Projects Day" via a written report and a verbal presentation which include several deliverables such as: Calculations, Drawings, Computer models, Specifications, and/or any other considerations that contributed to the development and the success of the project.

Pre-requisite: CIVE 389

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. Estimating deflections. Analysis of beam, truss, and frame

structures using the unit load method and the direct stiffness method. Influence lines of determinate and indeterminate continuous beams.

Pre-requisite: CIVE 205

CIVE 402 DYNAMICS OF STRUCTURES I **3.0: 3 cr. E**
Introduction to basics of dynamics: lumped mass dynamics with various loading functions. Response to general dynamic loading with and without damping; free vibration, harmonic, impulsive, and arbitrary excitations. Develop the dynamic equations of motion for the single degree of freedom system (SDF) and multi-degree of freedom systems (MDF). Response spectrum analysis. Modal analysis of linear systems.

Pre-requisite: CIVE 401

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.

Pre-requisite: CIVE 307

CIVE 404 HYDRAULICS **3.0: 3 cr. E**
The course consists of the design and analysis of water supply networks including transmission and distribution pipes, reservoirs, tanks, pumps and pump selection, using the conservation of mass, momentum, and energy equations; design and analysis of open channels including gradually varied flows, backwater computations, and water surface profiles using the Manning equation; design and analysis of box culverts with inlet and outlet control.

CIVE 405 PRESTRESSED CONCRETE **3.0: 3 cr. E**
Fundamentals of prestressed concrete behavior. Analysis and design of pre-tensioned and post tensioned reinforced concrete members. Prestressed concrete is used to construct light, durable, and economical structures by pre-compressing the concrete that has high compressive strength using high strength pre-stressing steel. Preloading the tensile zone of the structural concrete members results in a self-equilibrating system of internal stresses under expected loads.

Pre-requisite: CIVE 304

CIVE 409 HYDROLOGY **3.0: 3 cr. E**
The course consists of describing the hydrologic cycle, precipitation and the water budget equation, interception and depression storage, infiltration, evaporation, transpiration, stream flow, groundwater, probability and statistics with frequency of occurrence, hydrographs, routing, with hydrologic modeling.

CIVE 410 APPLIED HYDRAULICS **3.0: 3 cr. E**
The course consists of describing the complete design and construction process of storm water networks including ponds, sewerage networks, water supply networks, irrigation networks, box culverts, open ditches, and scour analysis for bridges over waterways, and understanding of the Navier-Stokes equations.

Pre-requisite: CIVE 404

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 is 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 414 EARTHQUAKE LOSS ESTIMATIONS 3.0: 3 cr. E
In the last few decades, a dramatic increase in the losses caused by natural catastrophes has been observed worldwide. The reasons for the increased losses are manifold, though certainly include the increase of world population, the development of new "super-cities" (with population greater than 2 millions), many of which are located in zones of high seismic hazard, and the high vulnerability of modern societies and technologies, such as the built environment. This course deals with the treatment of exposure, hazard, and vulnerability in earthquake loss models for urban areas and the propagation of the uncertainties within such models. Various case study applications involving the state-of-the art in catastrophe loss assessment will be presented.

CIVE 420 CONSTRUCTION PROCESSES 3.0: 3 cr. E
This course provides an overview of various construction processes. It focuses on several specific construction methods and engineering fundamentals of underground and aboveground construction, especially earthmoving operations. It focuses on the earthmoving operations' equipment: shovels, backhoes, clamshells, draglines, loaders, dozers scrapers and compactors. Course concentrates on the productivity evaluation of the construction processes, both deterministic, and using the queuing theory.

CIVE 421 SEISMIC DESIGN OF STRUCTURES: DISPLACEMENT BASED 3.0: 3 cr. E
The approach is based on determination of the optimum structural strength to achieve a given performance limit state, related to a defined level of damage, under a specific level of seismic intensity. Fundamental of displacement-based design, seismic input for displacement based design, analytical tools for displacement based design. The course considers a wide range of structural types, including among other; frame buildings, wall buildings, dual wall / frame buildings.

CIVE 422 SIMULATION OF CONSTRUCTION OPERATIONS 3.0: 3 cr. E
This course provides an overview of the quantitative stochastic methods used for the design and analysis of construction operations, in order to maximize the productivity and resource utilization through discrete event simulation. The course provides an introduction to queuing theory, and then focuses on simulation for construction operation analysis. Specific emphasis is placed on modeling building construction, heavy and highway construction, and underground construction technologies. Micro-CYCLONE simulation languages are used for the design of the construction operations.

CIVE 423 ASSESSMENT AND STRENGTHENING OF STRUCTURES 3.0: 3 cr. E
Assessment of seismic vulnerability of classes of buildings: force-based and displacement-based methodologies. Typical response of individual buildings: capacity design concepts, analysis of well-designed buildings. Typical response of existing buildings: problems in analysis, damage and safety evaluation. Strength, deformation and dissipation capacity of elements and joints: flexural and shear problems, beam-column joints, infill panels. Assessment of global response: expected damage and failure modes, global strength, deformation and dissipation capacity, displacement based assessment methods. Strengthening of reinforced concrete buildings: modification of element and global response, redesign, safety re-evaluation.

CIVE 424 ADVANCED MECHANICS OF MATERIALS FOR CIVIL ENGINEERING 3.0: 3 cr. E
Concept of tensors of various degrees and dimensions using dynamics and the transformation of their components. Review of Mohr circle. Strain tensor, its properties and strain- displacement relations. Traction, stress tensor, their properties and stress equilibrium equations. Stress-strain relations for linear elastic materials and the role of symmetry. Overall formulation of small strain linear elasticity. Plane stress and plane strain with example solutions. Stress concentrations. Principle of virtual work and other derived, specialized principles. Torsion of non-circular cross-sections. Unsymmetrical bending. Stresses in thin-walled axisymmetric pressure vessels.

Pre-requisite: CIVE 202

CIVE 426 BUILDING CONSTRUCTION METHODS 3.0: 3 cr. E
New Construction methods in tunneling, excavations and buildings. Immersed, cut and cover, top down methods of tunneling construction. Tunnel boring, trenchless technology, vibroflotation, jet grouting and deep water drilling are explained. Different building methods are reviewed: underpinning of foundations, earthquake resisting systems and components, new and existing formwork technologies, tilt-up wall and lift slab construction, pneumatic wedge method of concrete dome construction, volumetric construction, 3-D printing of concrete and steel, tremie concrete and underwater construction, concrete canvas, foamcrete, thin joint mortar types, polyurea, smart bricks, rammed earth, drones and robots in construction, insulated concrete forms block, cellular light concrete block and other block types.

CIVE 427 CONSTRUCTION COST MANAGEMENT 3.0: 3 cr. E
This course focuses on (i) estimating different costs of projects, (ii) perform life cycle cost analysis for projects, (iii) study the different financing methods for both owners and contractors, (iv) understand cost control and monitoring of budgets, and (v) how to include costs in different contract types.

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 429 CONSTRUCTION CONTRACTS MANAGEMENT 3.0: 3 cr. E
Types of construction contracts; types of project delivery systems; different contract administration; contract accounting; and claims and disputes.

CIVE 430 CONSTRUCTION EQUIPMENT MANAGEMENT 3.0: 3 cr. E
The aim of this course is to train students in types of construction equipment management, mainly machine power estimation; equipment selection and utilization; equipment costs; and life cycle costs of equipment.

CIVE 431 CIVIL INFRASTRUCTURE MANAGEMENT 3.0: 3 cr. E
This course provides an overview of various civil infrastructure. It focuses on the main categories of civil infrastructure; condition assessment of different infrastructure (pipes, sewers, buildings, bridges, transit); deterioration methodologies (regression, Markov Chain, reliability); rehabilitation methods; optimization of maintenance; and budget allocation.

CIVE 432 CONCRETE TECHNOLOGY 3.0: 3 cr. E
Concrete components. Cementitious materials and chemical admixtures and their role in modifying concrete properties. Hot weather and cold weather concreting. High-performance concrete. Virtual cement and concrete testing laboratory. 3D concrete printing. A research project that gives students a wider exposure to Concrete Technology through their internet search is required.

CIVE 433 EARTHQUAKE GEOTECHNICAL ENGINEERING 3.0: 3 cr. E
The practice of geotechnical earthquake engineering principally involves the application of seismic analysis methodologies in the design and assessment of geotechnical structures. Analysis methodologies focus primarily on evaluation of site response and possible occurrence of liquefaction in modifying the seismic hazard at a site, and the consequences on the design of geotechnical structures such as shallow and deep foundations, slopes, embankments and earth retaining structures. The behavior of these structures under dynamic loading is also performed using the finite element software PLAXIS 2D.

CIVE 436 EARTHQUAKE DESIGN ACCORDING TO THE IBC CODE AND EURO CODE EC8 3.0: 3 cr. E
This course allows the students to design structures following the most recent codes in the United States known as the International Building Code (IBC) and in Europe known as the Euro code EC8.

CIVE 438 GREEN BUILDINGS AND SUSTAINABILITY 3.0: 3 cr. E
This course addresses the sustainability principles applied to site planning, building design, construction, operation, and management. It combines elements from various engineering disciplines and addresses the emerging trends in Leadership in Energy and Environmental Design (LEED) certification by US Green Building Council (USGBC).

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 (IBC-2012) and (UBC-1997). Earthquake resisting structural systems with plan and vertical irregularities. Design and detailing of seismic resistant reinforced concrete shear walls including boundary elements and coupling beams. Design and detailing of Moment Resisting Frames. All designs are based on the ACI-318M-14 (Ch 18) Seismic Provisions as well as the ACI-352 Beam-to-Column Connections. Recommendations.

CIVE 444 SEISMIC DESIGN OF FOUNDATIONS 3.0: 3 cr. E
This course concentrates on the modifications that foundations must be subjected to when they support structures designed for earthquakes forces. The detailing of the column-to-footing connections, shearwall-to-footing connections, and pile-to-pilecap connections according to ACI318M-14 Ch.18, are addressed. The effect of grade beams, tie beams and strap beams. Verification of punching shear under axial load and moment. The design of footings subjected to partial uplift. The seismic design of combined footings, strip footings, mat foundations and pilecaps using SAFE. Introduction to Base Isolation.

Pre-requisite: CIVE 443

CIVE 451 CONCRETE DURABILITY 3.0: 3 cr. E
Bases of durable concrete formulation. Early-age cracking control. The normative context regarding durability. Major durability problems: alkali–aggregate reaction in concrete, sulfate attack, steel corrosion, freeze–thaw. Durability issue in a marine environment. Consideration of durability in concrete structure design. Fire exposure.

CIVE 452 CEMENT MANUFACTURING AND HYDRATION 3.0: 3 cr. E
The main steps of cement manufacturing. The wet, dry, semi-dry and semi-wet process. Clinker burning and Cement grinding. Quality control and Bogue calculation. Portland cement hydration. Equilibrium curves. Nucleation and growth. Heat release during hydration. Portland cement hydrates. Set regulator. Green cement.

CIVE 453 CONCRETE MATERIALS FOR SUSTAINABLE DEVELOPMENT 3.0: 3 cr. E
Design for sustainability. Role of supplementary cementing materials in reducing greenhouse gas emissions. Recycling of demolished concrete and masonry. Glasscrete: Concrete with glass aggregate. Large-scale separation, treatment and value-added utilization of waste in concrete.

CIVE 454 CONCRETE TESTING AND REPAIR 3.0: 3 cr. E
This course familiarizes the students with the basis of inspections of concrete structures, destructive vs. non-destructive testing methods and the rehabilitation of concrete structures. Guidelines for conducting visual inspection of concrete in service are presented in this course along with several methods for assessing the strength of concrete structures. Assessment of characteristic in-situ compressive strength by testing of cores, indirect testing (Rebound hammer test, ultrasonic pulse velocity measurement and pull-out test) and others are described.

CIVE 456 FUNDAMENTALS OF ROAD CONSTRUCTION 3.0: 3 cr. E
This course covers an introduction to fundamental concepts in road materials and pavement construction including surface and sub-base layers. Flexible and rigid pavement construction are addressed in different stages: earthwork preparation, construction materials, drainage, surface preparation, and surface treatments. Students will be able to identify different test procedures to characterize bitumen binders and learn the method of the SUPERPAVE grading system. They will gain a working knowledge of soil/subbase behavior in addition to the geotechnical input needed for the design of road pavements.

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

CIVE 502 THEORY OF ELASTICITY 3.0: 3 cr. E
Introduction to basic elastic theory and its application to material structures. Definition of stress, strain, tensors, generalized Hooke's law, and field equations of elasticity. Equilibrium and compatibility conditions, and the formulation of boundary value problems. Application of the stress function method and the Green's function approach for 2D and 3D problems. Prediction of defects, internal forces and failure of simple solids and structural components. Solution of elasticity problems analytically.

CIVE 503 HIGHWAY DESIGN 3.0: 3 cr. E
The course provides a good understanding of terms and concepts that are used in highway engineering design such as location and geometric design, highway drainage, geotechnical, bituminous materials, design of flexible pavements, design of rigid pavements, operation and maintenance, noise pollution evaluation and control, and introduction to bridges. The course provides a thorough understanding of the role of highway engineering in society and the engineer's role in planning, design and operation of transportation systems, consideration of system constraints, cost, and basic design criteria.

Pre-requisite: CIVE 308

CIVE 504 FINITE ELEMENT ANALYSIS 2.1: 3 cr. E
This course presents finite element theory and methods for general linear and nonlinear analyses. Reliable and effective finite element procedures are discussed with their applications to the solution of general problems in structural applications. The governing continuum mechanic equations, conservation laws, and virtual work are used to establish effective finite element discretization. Furthermore, the stability, accuracy, and convergence of finite element modes are discussed. The general-purpose finite element analysis program ABAQUS is utilized to apply the theory and model structural sections.

CIVE 505 Dynamics of Structures II **3.0: 3 cr. E**

Formulation of the equations of motion for buildings with unsymmetrical plan and for continuous beams with multiple support excitations, construction of damping matrix, reduction of degrees of freedom by Rayleigh-Ritz Method, earthquake response of systems with distributed mass and elasticity, response history analysis (RHA) and response spectrum analysis (RSA) for multistory buildings, earthquake analysis and response of linearly elastic and inelastic buildings, earthquake dynamics of base isolated buildings.

Pre-requisite: CIVE 402

CIVE 507 BOUNDARY SURVEYS **3.0: 3 cr. E**

Land surveying, registration laws, history, survey systems, legal principles, boundary calculations, boundary descriptions, and evidence interpretation.

CIVE 512 PAVEMENT DESIGN **3.0: 3 cr. E**

The course on "Pavement Design" is designed to cover various theoretical and practical aspects of design of pavements. Different types of pavements commonly adopted for construction of low and high volume roads are introduced. The need for considering the structural and functional performance of pavements is explained. Various inputs required for design of new pavements such as climatic and traffic considerations, material characterization, analytical tools, etc. are discussed in detail. Different methods of analysis and design of bituminous and concrete pavements are discussed. Evaluation of in-service pavements and design of overlays for in-service pavements are covered in this course**.**

Co-requisite: CIVE 503

CIVE 513 TRAFFIC ENGINEERING **3.0: 3 cr. E**

This course aims at providing the student with a clear and thorough presentation of the theory and applications of Traffic Engineering. It aims at providing an understanding of the basic principles, and the ability to apply those principles. These include the traffic operations (characteristics of the driver, the pedestrian, the vehicle, and the road), traffic data collection (traffic terms and accidents) with application (traffic lights and interchanges, and level of service), and the transportation planning (the process, forecasting travel demand, evaluating transportation alternatives, and the transportation system management).

CIVE 516 ADVANCED GEOGRAPHIC INFORMATION SYSTEMS **3.0: 3 cr. E**

Geographic Information Systems (GIS) are important for Civil and Infrastructure Engineering works. This advanced GIS course discusses the ArcGIS Pro and ArcGIS Online and their applications in the planning and engineering fields, network creation and management, spatial planning applications, and implementation issues. The objective is to introduce core concepts of GIS and geospatial analysis, including coordinate systems, spatial data formats, and openly available geospatial data resources. Also, this course provides hands-on experience with an industry-standard GIS to perform practical tasks that include spatial analysis and extending core GIS functionality by using ArcGIS Online. The class includes a field data collection component to expose students to GIS data creation and Global Positioning Systems (GPS).

Pre-requisite: CIVE 323

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 521 WASTEWATER ENGINEERING DESIGN .0: 3 cr. E

Sources and characteristics of wastewater. Collection works design. Theory and application of commonly used processes. Design of sludge treatment and disposal facilities. Process combinations to produce treatment systems. Case studies.

Pre-requisite: CIVE 520

CIVE 522 WATER RESOURCES AND WATER QUALITY 3.0: 3 cr. E

Water resources in Lebanon and around the world; Water resources regulation; Water resources usage issues; Water quality analysis and pollution control; Impacts of development on water resources and changes in water supply and availability; Water resources management.

CIVE 523 AIR POLLUTION CONTROL 3.0: 3 cr. E

Air Pollution Effects, Measurement and Control. The influence of man-caused pollution on the atmosphere, globally and locally. Evaluation of human health, economic, and aesthetic effects of air pollution. Techniques for measurement of atmosphere pollutant concentrations and determination of local and regional air quality. Detailed presentation of air pollution sources and methods for their control. The role of local, state and federal government in air pollution control.

CIVE 524 SOLID WASTE DISPOSAL 3.0: 3 cr. E

Generation of solid wastes. Onsite handling, storage and processing. Collection, transfer and transport of solid Wastes. Processing techniques and equipment. Recovery of resources, conversion products and energy. Disposal methods for solid wastes and residual matter: sanitary landfill, incineration, composting, and other techniques.

CIVE 525 SANITARY LANDFILL 3.0: 3 cr. E

Disposal of solid wastes on land. Effect of leachate on groundwater pollution. Theory and current practice regarding design, construction, and monitoring of sanitary landfill. Landfill operation and economic analysis.

Pre-requisite: CIVE 520

CIVE 526 WATER SUPPLY ENGINEERING DESIGN 3.0: 3 cr. E

Concepts in engineering, concepts in engineering design, concepts in branch design, phases of engineering designs, case studies. water characteristics, quality criteria and standards need for treatment, water treatment plant hydraulics and sludge disposal, storage and distribution system design, intake and transmission system design, computer applications for design, economic considerations in water supply engineering design.

Pre-requisite: CIVE 520

CIVE 527 ENVIRONMENTAL IMPACT ASSESSMENT 3.0: 3 cr. E

Concepts of environmental impact assessment. Planning and management of impact studies. Methods of impact identifications-matrices, network and checklists. Description of environmental setting. Environmental indices and indicators for describing the affected environment. Prediction and assessment of impacts on the air, soil, water, noise, visual, socioeconomic, biological and cultural environment. Decision methods for evaluation of alternatives. Public participation in environmental decision making. Case studies.

Pre-requisite: CIVE 520

CIVE 528 ENVIRONMENTAL ECONOMICS AND MANAGEMENT 3.0: 3 cr. E
Introduction to environmental economic problems; Modeling the Market Process and Failure. Conventional and Economic Solutions to environmental problems. Environmental decision making. Environmental risk analysis. benefits and costs assessment and analysis for environmental decision making. Case studies of major environmental problems and policy solutions.

Pre-requisite: CIVE 520

CIVE 529 ENVIRONMENTAL CHEMISTRY 3.0: 3 cr. E
Theory and practice of water chemistry. Principles of chemical kinetics and thermodynamics applied to fundamental understanding of aqueous environmental samples including natural waters, wastewaters, and treated waters; factors controlling chemical concentrations, acid-base equilibria, solubility equilibria, complex formation, electrochemistry, adsorption phenomena and corrosion.

CIVE 530 ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY 3.0: 3 cr. E
Chemistry of organic and inorganic contaminants in the environment. Natural chemical cycles in the biosphere, geosphere, hydrosphere and atmosphere, and consequences of anthropogenic disturbances. Chemical equilibrium and kinetics. Fundamentals of aquatic, atmospheric and soil chemistry. The fate of hazardous, refractory and heavy metal pollutants in the environment. Introduction to microbial taxonomy, ecology and growth kinetics of microorganisms. The microbes of public health importance in water, soil and air, including their detection, occurrence, transport, and survival in the environment. Introduction to the application of different processes to remove contaminants in natural and engineered systems.

CIVE 531 ENVIRONMENTAL SAMPLING AND ANALYSIS 3.0: 3 cr. E
Principles and methods for sampling and analysis of environmental tests such as surface water, groundwater, soil, air, and solid wastes. Physical, chemical, and biological laboratory methods for samples analyses. Sampling design for basic statistical concepts including data variability and detection of significant differences among sample sets. Data presentation and interpretation of data management methods. Off-campus lectures and demonstrations at laboratories.

CIVE 532 WASTEWATER TREATMENT PLANTS: PROCESSES, DESIGN, AND OPERATION 3.0:3cr. E
Well-designed and operated wastewater treatment plants are of tremendous benefit to municipalities, industries, public health, and the environment. This course combines engineering principles, practical know-how, and useful case studies to help you improve your knowledge of the wastewater treatment process. This course explains the various methods of the wastewater treatment process and the conditions where each method is implemented best.

CIVE 540 SUSTAINABLE ROADWAY DESIGN, CONSTRUCTION, AND OPERATION 3.0: 3 cr. E
Sustainable development is a concept that seeks to ensure that economic, environmental, and social, and cultural factors are central to the way development is taken forward to ensure the needs of society are addressed in both the present day, and in the longer term. In order for the concept of sustainable development to become embedded in national policy and legislation, the importance of sustainable development in relation to the design, operation, and construction of infrastructure has to be recognized and successfully applied. Integrating sustainable development into design enhances the performance of assets and infrastructure. The sustainable development of road projects can deliver sustainable benefits for the environment, the economy, and the society in general.

CIVE 541 CONTEMPORARY CITIES **3.0: 3 cr. E**

The "Contemporary Cities" course aims to prepare the students for the new themes of city development that are measured by new technologies and the "Urban Future". These themes are particularly related to the principles of "Sustainable Mobility" and the concept of "Smart Growth".

CIVE 542 SUSTAINABLE DEVELOPMENT IN TRANSPORTATION ENGINEERING 3.0: 3 cr. E

The course of "Sustainable Development in Transportation Engineering" aims to introduce the students to two interconnected general themes, "Sustainable Development" and "Transport Engineering", the latter being the branch of engineering that deals with the various modes of transport in their various aspects.

CIVE 543 SUSTAINABLE DEVELOPMENT IN CIVIL ENGINEERING **3.0: 3 cr. E**

This course aims at providing a broad overview of the current challenges of the civil engineering sector to accomplish the expected transition to sustainable development strategies. The course starts with an overview of the usual boundary conditions of every civil engineering project and shows a procedure to carry out multidisciplinary engineering projects: the engineering design process. Next, the materials – energy – carbon relationship is covered, providing a range overview of current global issues concerning the building industry and the use of materials. The units pursue to reflect a Life-Cycle thinking. As a result of this course, students ought to become more aware of global issues and to what extent civil engineering plays an important role on tackling them. The student shall develop a more holistic vision of infrastructures, considering the entire construction cycle and being aware of positive and negative economic, social, or environmental impacts of the different infrastructures. Terms such as the sustainable development goals (SDGs), resource management, embodied energy, resilience, life-cycle will after this course sound more familiar to students.

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.

CIVE 556 BRIDGE DESIGN **3.0: 3 cr. E**

This course will focus on the fundamental behavior and design of reinforced and prestressed concrete bridge elements in the short and medium span range. Basic concepts of prestressing from the prestressed concrete course, commonly used methods and general design philosophy will be discussed. Service-load and ultimate-strength design of concrete bridge girders for flexure, shear and torsion effects will be studied, including serviceability constraints for control of deflection and cracking. Students will gain skills and competence in bridge design through practical design examples, presentations and a project assignment.

CIVE 557 ADVANCED STRUCTURAL STEEL DESIGN **3.0: 3 cr. E**

Introduction to plastic mechanism analysis; LRFD design of more complex structural components found in typical steel buildings; composite beams and columns, beam-to-column connections, column base plates, cover-plated beams, and built-up girders; computer applications to three-dimensional modeling techniques for steel structures; projects on structural analysis and design of trusses and frames to resist lateral wind and seismic loads.

Pre-requisite: CIVE 324

CIVE 558 SLOPE STABILITY AND EMBAKMENT DESIGN 3.0: 3 cr. E
This course is designed to provide the knowledge in groundwater seepage and contaminant transport in saturated and unsaturated soils. Flow nets for homogeneous and layered soils. Design and stability analysis of embankments and earth dams.

CIVE 559 PAVEMENT RECONSTRUCTION, REHABILITATION AND MAINTENANCE 3.0: 3 cr. E
This course is designed to provide techniques for reconstruction, rehabilitation and maintenance of flexible and rigid pavements including recycling, preventive maintenance, routine maintenance and soil stabilization design, and construction considerations.

CIVE 560 TRANSPORTATION MANAGEMENT SYSTEMS 3.0: 3 cr. E
This course is designed to provide the knowledge to conduct the project and network-level pavement management processes, to identify the data to be collected, and to define the conditions of the transportation system.

CIVE 561 RETAINING STRUCTURES DESIGN 3.0: 3 cr. E
Rigid and flexible earth retaining structures: rigid, anchored bulkhead, braced cut, tie-back cut, slurry trench and MSE (metallic and geosynthetic) walls with applications to infrastructure projects.

CIVE 562 DESIGN OF TIMBER STRUCTURES 3.0: 3 cr. E
This course is designed to provide the fundamentals of design of timber structures and application to simple structures.

CIVE 563 ADVANCED SOIL MECHANICS 3.0: 3 cr. E
This course is designed to provide a theoretical framework for the analysis of deformation and failure of soils with application to several practical problems. These include elasticity for linear deformation, plasticity models (including critical state model) for non-linear deformation and limit equilibrium analyses for important geotechnical problems.

Pre-requisite: CIVE 301

CIVE 564 GEOSYNTHETICS 3.0: 3 cr. E
Use of geosynthetics in civil and environmental engineering design for separation, reinforcement, and filtration, in slopes, embankments, roads, and foundations and for erosion control.

CIVE 565 SOIL-STRUCTURE INTERACTION 3.0: 3 cr. E
Interaction between ground and structure, exchange of mutual stress between structure and foundation ground, interface of the major structural elements within a structure and the foundation material, methods of analysis and modeling, beam on elastic foundations, effect of ground movement. Site response analysis, numerical modeling of complex engineering structures interacting with soil by taking into account an effect of nonlinear soil behavior, simple elasto-plastic models for soils, groundwater flow, consolidation and other rheological phenomena. Numerical Seismic analysis and modeling for underground structures, soil-structure interaction under extreme loading conditions including performance during earthquakes, floods, landslides, large deformations due to tunneling, deep excavations, and subsidence due to dewatering and cavernous rocks.

CIVE 566 THEORY OF PLATES AND SHELLS 3.0:3 cr. E
This course introduces students to basic theory of plates including stresses and deformations, bending of plates, energy solutions, small and large displacement theories, buckling and post-buckling of plates, and behavior of plates under shear. It also familiarizes students with the characteristics of shells, the

general theory of elastic shells, and membrane and bending theories for common shapes of axisymmetric structural shells. Additionally, analysis of plates and shells is performed using the finite element software ABAQUS.

CIVE 567 PHYSICAL METALLURGY OF STEEL 3.0: 3 cr. E
This course presents the students with the metallurgy of different metals/alloys including the heat treatments, phase transformations, and properties. This course familiarizes the students with common alloys such as: carbon steels, stainless steels, high-strength low alloys steels, heat treated steels, and advanced high strength steels. This course explains the effect of alloys addition on steel properties including martensitic quench and hardenability issues. This course describes the thermo-mechanical processing of alloys, the surface treatment and coating of steel products.

CIVE 568 MANAGEMENT OF CIVIL ENGINEERING SYSTEMS 3.0: 3 cr. E
This course introduces students to the different methodologies used in managing civil engineering systems. This course focuses on: i) Optimization methods, mainly Lagrange multipliers method, linear programming with graphical and simplex method, integer programming and network programming (shortest path, minimum spanning tree, maximum flow, minimum cost flow and transportation problems); ii) Queueing theory; iii) Decision trees; iv) Markov decision process; v) Reliability; and vi) Monte Carlo simulation.

Refer to General Listing of Course Descriptions for:

BIOL XXX
Refer to Faculty of Arts and Sciences

CHEM XXX
Refer to Faculty of Arts and Sciences

CSIS XXX
Refer to the Faculty of Arts and Sciences

CSPR XXX
Refer to the Faculty of Arts and Sciences

ENGL XXX
Refer to the Faculty of Arts and Sciences

ENMG XXX
Refer to the Department of Engineering Management

EVSC XXX
Refer to the Faculty of Arts and Sciences

GENG XXX
Refer to the Faculty of Engineering Requirements

LISP XXX
Refer to the Faculty of Arts and Sciences

MATH XXX

Refer to the Faculty of Arts and Sciences

MECH XXX
Refer to the Department of Mechanical Engineering

MGMT 220, MRKT 456
Refer to the Faculty of Business and Management

PHYS XXX
Refer to the Faculty of Arts and Sciences

DEPARTMENT OF COMPUTER ENGINEERING

Bachelor of Science (BS) Degree – 109 Credits

Sem	Course Code	Course Title	Credit	Pre-Req	Co-Req
1	CSIS 200	Introduction to Computers and Programming	3		CSIS 285
1	CSIS 285	Basic Programming Lab	1		
1	ELCP 211	Engineering Drawing	1		
1	ELEN 201	Instrumentation Lab	1		
1	ENGL 203	English Communication Skills III	3		
1	MATH 200	Calculus I	3		
1	MATH 211	Linear Algebra I	3		
1		Engineering Breadth Elective	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
2	CPEN 211	Introduction to Digital Logic Design	3	CSIS 200 Or CSIS 206	
2	CSIS 215	Object-Oriented Programming	3	CSIS 200	CSIS 286
2	CSIS 286	Object Oriented Programming Lab	1	CSIS 200	CSIS 215
2	ELCP 290	Introduction to the Engineering Design Fundamentals	1		
2	ELEN 202	Electrical Simulation and Design	1	CSIS 200 Or CSIS 206	ELEN 221
2	ELEN 221	Circuits Analysis I	3	MATH 200 MATH 211 ELEN 201	ELEN 202
2	MATH 202	Calculus II	3	MATH 200	
2	MATH 270	Differential Equations	3	MATH 200	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
3	CPEN 202	Logic Lab	1		CPEN 212
3	CPEN 212	Logic Circuits	3	CPEN 211	CPEN 202
3	CPEN 220	Programming for Engineering Solutions	3	CSIS 200	MATH 230
3	GENG 221	Engineering Ethics	3	ELCP 290 ENGL 203	

3	ELEN 231	Electronics I	3	ELEN 221	
3	ENGL 2XX	English Elective	3	ENGL 203	
3	MATH 230	Numerical Analysis I	3	CSIS 200 MATH 200	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
4	CPEN 213	Microprocessors	3	CPEN 212	
4	ELEN 222	Signals and Systems Theory	3	ELEN 221 MATH 270	
4	CPEN 313	Computer Embedded System	3	CPEN 212	CPEN309
4	GENG 222	Sustainable Development for Engineers	3	ELCP 290 ENGL 203	
4	ELEN 303	Circuits Analysis Lab	1	ELEN 221 ELEN 202	
4	ELEN 304	Electronics Lab	1	ELEN 231	
4	LISP 200	Information Skills and Search Techniques	1		ENGL 102
4	CPEN 309	Embedded Controllers Lab	1		CPEN 313
4	MATH 246	Probability for Engineers	3	MATH 200	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
5	CPEN 305	Microcontrollers Lab	1	CPEN 213	
5	CPEN 307	PLC Lab	1		CPEN 324
5	CPEN 314	Computer Architecture	3	CPEN 313	
5	CPEN 324	Programmable Logic Controllers	3		CPEN 307
5	CPEN 241	Information Networking I	3		
5	ELCP 391	Senior Design 1	2	LISP 200 ELCP 290 GENG 221 GENG 222	
5	ELEN 341	Telecommunications	3	MATH 246 ELEN 222	
		Specialized Area Elective	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
6	CPEN 310	Cybersecurity Lab	1		
6	CPEN 341	Cybersecurity	3		
6	CSPR XXX	Cultural Studies	3		
6	ELCP 392	Senior Design 2	2	ELCP 391	

6	ELEN 306	Telecommunications Lab	1	ELEN 341	
6	ELEN 326	Digital Signal Processing	3	ELEN 222	
6		Specialized Area Elective	3		
		TOTAL	**109**		
Specialized Area Elective (based on selected area):					
Telecommunications and Networking Track (6 credits from the following list):					
	ELEN 223	Electricity and Electromagnetism	3	MATH 202 MATH 270 ELEN 221	
	ELEN 340	Signal Transmission	3	ELEN 223	
Cyber Systems Track (6 credits from the following list):					
	CPEN 347	Teletraffic	3	CSIS 222	
	CSIS 216	Data Structure	3	CSIS 215	
	CSIS 221	Operating Systems	3	CSIS 215	
	CSIS 270	Databases	3	CSIS 200	
Artificial Intelligence and Machine Learning Track (6 credits from the following list):					
	CPEN 349	Artificial Intelligence for Engineers	3	CSIS 200 or CSIS 206	
	CSIS 221	Operating Systems	3	CSIS 215	
	CSIS 216	Data Structure	3	CSIS 215	
	CSIS 235	Mobile Programming	3	CSIS 215	
	CSIS 260	Introduction to Artificial Intelligence	3	CSIS 216	
	CSIS 270	Databases	3	CSIS 200	
Engineering Breadth Elective (3 credits from the following list):					
	MECH 221	Engineering Dynamics	3	CIVE 201	
	MECH 232	Thermodynamics	3		
	CIVE 201	Statics	3		

DEPARTMENT OF COMPUTER ENGINEERING

Bachelor of Engineering (BE) Degree – 146 Credits

Sem	Course Code	Course Title	Credit	Pre-Req	Co-Req
1	CSIS 200	Introduction to Computers and Programming	3		CSIS 285
1	CSIS 285	Basic Programming Lab	1		
1	ELCP 211	Engineering Drawing	1		
1	ELEN 201	Instrumentation Lab	1		
1	ENGL 203	English Communication Skills III	3		
1	MATH 200	Calculus I	3		
1	MATH 211	Linear Algebra I	3		
1		Engineering Breadth Elective	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
2	CPEN 211	Introduction to Digital Logic Design	3	CSIS 200 Or CSIS 206	
2	CSIS 215	Object-Oriented Programming	3	CSIS 200	CSIS 286
2	CSIS 286	Object Oriented Programming Lab	1	CSIS 200	CSIS 215
2	ELCP 290	Introduction to the Engineering Design Fundamentals	1		
2	ELEN 202	Electrical Simulation and Design	1	CSIS 200 Or CSIS 206	ELEN 221
2	ELEN 221	Circuits Analysis I	3	MATH 200 MATH 211 ELEN 201	ELEN 202
2	MATH 202	Calculus II	3	MATH 200	
2	MATH 270	Differential Equations	3	MATH 200	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
3	CPEN 202	Logic Lab	1		CPEN 212
3	CPEN 212	Logic Circuits	3	CPEN 211	CPEN 202
3	CPEN 220	Programming for Engineering Solutions	3	CSIS 200	MATH 230
3	GENG 221	Engineering Ethics	3	ELCP 290 ENGL 203	

3	ELEN 231	Electronics I	3	ELEN 221	
3	ENGL 2XX	English Elective	3	ENGL 203	
3	MATH 230	Numerical Analysis I	3	CSIS 200 MATH 200	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
4	CPEN 213	Microprocessors	3	CPEN 212	
4	ELEN 222	Signals and Systems Theory	3	ELEN 221 MATH 270	
4	CPEN 313	Computer Embedded System	3	CPEN 212	CPEN309
4	GENG 222	Sustainable Development for Engineers	3	ELCP 290 ENGL 203	
4	ELEN 303	Circuits Analysis Lab	1	ELEN 221 ELEN 202	
4	ELEN 304	Electronics Lab	1	ELEN 231	
4	LISP 200	Information Skills and Search Techniques	1		ENGL 102
4	CPEN 309	Embedded Controllers Lab	1		CPEN 313
4	MATH 246	Probability for Engineers	3	MATH 200	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
5	CPEN 305	Microcontrollers Lab	1	CPEN 213	
5	CPEN 307	PLC Lab	1		CPEN 324
5	CPEN 314	Computer Architecture	3	CPEN 313	
5	CPEN 324	Programmable Logic Controllers	3		CPEN 307
5	CPEN 241	Information Networking I	3		
5	ELCP 391	Senior Design 1	2	LISP 200 ELCP 290 GENG 221 GENG 222	
5	ELEN 341	Telecommunications	3	MATH 246 ELEN 222	
		Specialized Area Elective	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
6	CPEN 310	Cybersecurity Lab	1		
6	CPEN 341	Cybersecurity	3		
6	CSPR XXX	Cultural Studies	3		
6	ELCP 392	Senior Design 2	2	ELCP 391	

6	ELEN 306	Telecommunications Lab	1	ELEN 341	
6	ELEN 326	Digital Signal Processing	3	ELEN 222	
6		Specialized Area Elective	3		
Specialized Area Elective (based on selected area):					
Telecommunications and Networking Track (6 credits from the following list):					
	ELEN 223	Electricity and Electromagnetism	3	MATH 202 MATH 270 ELEN 221	
	ELEN 340	Signal Transmission	3	ELEN 223	
Cyber Systems Track (6 credits from the following list):					
	CPEN 347	Teletraffic	3	CSIS 222	
	CSIS 216	Data Structure	3	CSIS 215	
	CSIS 221	Operating Systems	3	CSIS 215	
	CSIS 270	Databases	3	CSIS 200	
Artificial Intelligence and Machine Learning Track (6 credits from the following list):					
	CPEN 349	Artificial Intelligence for Engineers	3	CSIS 200 or CSIS 206	
	CSIS 216	Data Structure	3	CSIS 215	
	CSIS 221	Operating Systems	3	CSIS 215	
	CSIS 235	Mobile Programming	3	CSIS 215	
	CSIS 260	Introduction to Artificial Intelligence	3	CSIS 216	
	CSIS 270	Databases	3	CSIS 200	
Engineering Breadth Elective (3 credits from the following list):					
	MECH 221	Engineering Dynamics	3	CIVE 201	
	MECH 232	Thermodynamics	3		
	CIVE 201	Statics	3		

Sem	Course Code	Course Title	Credit	Pre-Req	Co-Req
7		Core Course Elective	3		
7		Core Course Elective	3		
7		Directed Elective	3		
7		Directed Elective	3		
7		Specialized Area Course	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
8	GENG 400	Engineering Seminars	1		
8	GENG 490	Graduation Project	3		
8		Specialized Area Elective	3		
8		Specialized Area Elective	3		
8		Specialized Area Elective	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
9	CPEN 480	Field Training	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
10	GENG 490	Graduation Project (Reactivation)	0		
10		Specialized Area Course	3		
10		General Elective	3		
		TOTAL	**146**		
Core Course Electives (6 credits from the following list):					
	ELEN 400	Linear Systems	3		
	ELEN 401	Optimization Theory	3		
	ELEN 402	Stochastic Theory	3		
Directed Electives (6 credits from the following list):					
	CPEN 441	Information Networking II	3	CPEN241	
	CSIS 375	Software Engineering	3		
	ELEN 417	Measurement Systems	3		
	ELEN 443	Digital Communication	3		

Specialized Area Courses (15 credits from each of the following lists):					
Cyber Systems Track:					
	CPEN 442	Network Programming	3	CPEN241	
	CPEN 445	Biometrics	3		
	CPEN 446	Network Management and Security	3	CPEN310	
	CPEN 447	Advanced Teletraffic	3	ELEN 443	
	CPEN 448	Cloud Computing and Big Data	3		
	CPEN 546	Wireless Networks	3		
	CPEN 549	Intelligent Networks	3	ELEN 443 CSIS 321	
	CSIS 375	Software Engineering	3		
Artificial Intelligence and Machine Learning Track:					
	CPEN 425	Neural Networks Design	3		
	CPEN 426	Deep Learning	3	CSIS 200 Or CSIS 206	
	CPEN 445	Biometrics	3		
	CPEN 448	Cloud Computing and Big Data	3		
	CPEN 452	Advanced Microcontroller Applications	3	CPEN 213 CPEN 220	
	CPEN 528	Machine Vision	3		
	ELEN 411	Mechatronics Systems	3		
	ELEN 466	Industrial Intelligent Networks	3		
	ELEN 525	Mobile Robots	3		
	ELEN 527	Fuzzy Logic Control	3		
	ELEN 544	Speech Technologies	3	ELEN 402	
	MECH 513	Robotics	3	MECH 221	
Telecommunications and Networking Track:					
	CPEN 441	Information Networking II	3	CPEN241	
	CPEN 442	Networking Programming	3	CPEN241	
	CPEN 546	Wireless Networks	3		
	ELEN 441	Information Theory and Error Correction	3		
	ELEN 443	Digital Communication	3		
	ELEN 446	Telecom Electronics	3		
	ELEN 472	Fiber Optics	3		

	ELEN 542	Wireless Communication Systems	3		
	ELEN 572	Satellite and Radar Communication	3		
	ELEN 574	Optical WDM Networks	3		
General Elective (3 credits from any Specialized Area Courses or from the following list):					
	CPEN 425	Neural Networks Design	3		
	CPEN 452	Advanced Microcontroller Applications	3	CPEN 213 CPEN 220	
	CPEN 545	Cryptography	3	ELEN 402	
	CSIS 374	Advanced Database Applications	3		
	ELEN 446	Telecom Electronics	3		
	ELEN 459	Engineering Image Processing	3		
	ELEN 525	Mobile Robots	3		
	ENMG 460	Decision and Risk Management	3		
	ENMG 555	Decision and Planning of Engineering Systems	3		
	ENMG 585	Quality Assurance and Control	3		
	GENG 402	Project Management	3		
	MECH 513	Robotics	3	MECH 221	

DEPARTMENT OF COMPUTER ENGINEERING

Master of Science (MS) Degree – 46 Credits

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

Sem	Course Code	Course Title	Credit	Pre-Req	Co-Req
7	ELEN 401	Optimization Theory	3		
7	GENG 450	Advanced Engineering Analysis and Research Methods	3		
7		Directed Elective	3		
7		Directed Elective	3		
7		Specialized Area Course	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
8	ELEN 402	Stochastic Theory	3		
8	GENG 599	Master's Thesis	6	GENG 450	
8		Specialized Area Course	3		
8		Specialized Area Course	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
9	CPEN 480	Field Training	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
10	ELEN 400	Linear Systems	3		
10	GENG 400	Engineering Seminars	1		
10	GENG 599	Master's Thesis (Reactivation)	0		
10		Specialized Area Course	3		
10		Specialized Area Course	3		
10		General Elective	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	
11	GENG 599	Master's Thesis (Reactivation)	0		
		TOTAL	**46**		

Directed Electives (6 credits from the following list):					
	CPEN 441	Information Networking II	3	CPEN241	
	CSIS 375	Software Engineering	3		
	ELEN 417	Measurement Systems	3		
	ELEN 443	Digital Communication	3		

COURSE DESCRIPTIONS

CPEN 202 LOGIC LAB **0.3: 1 cr. E**

This laboratory provides hands-on experiments on digital circuits, supplementing the concepts presented in the digital course. The lab covers both combinational and sequential logic. Students are exposed to the conventional discrete gates as well as the highly integrated programmable logic devices such as FPGAs. Students implement and simulate their designs using computer aided design tools.

Co-requisite: CPEN 212

CPEN 211 INTRODUCTION TO DIGITAL LOGIC DESIGN **3.0: 3 cr. E**

This course is the first of a two-course series on digital design. It covers both combinational and sequential logic, equipping the students with the skills to design and analyze complex digital circuits. It covers a wide range of topics, including Boolean algebra, Karnaugh maps (K-maps), multiplexers, adders, decoders, flip-flops, registers, counters, and more. Through a combination of theoretical concepts and hands-on practical exercises, students will develop the skills necessary to design and analyze digital circuits and systems effectively.

Pre-requisites: CSlS 200 or CSlS 206

CPEN 212 LOGIC CIRCUITS **3.0: 3 cr. E**

This course is the second in a two-course series on digital design. The focus of this course is on designing combinational and sequential circuits. Design examples include Timing analysis, Registers, Register File, State-Machines, Arithmetic units etc... Several real-world applications will be discussed. Computer aided design tools and educational platforms such as FPGAs will be used throughout semester.

Pre-requisite: CPEN 211
Co-requisite: CPEN 202

CPEN 213 MICROPROCESSORS **3.0: 3 cr. E**

This course covers the concept of microcontrollers and their applications through an in-depth exposure to the Microchip PIC18F45K22 processor. The class emphasizes the following concepts: efficient software design techniques in Assembly and C languages, input/output ports, I/O devices (keypad, LCD, 7-segment displays, etc.), interrupts, timers, A/D and D/A conversion, asynchronous serial communications.

Pre-requisite: CPEN 212

CPEN 220 PROGRAMMING FOR ENGINEERING SOLUTIONS **3.0: 3 cr. E**

This course will teach students the skills to write assembly and C code to solve engineering problems. It will start with the basics of assembly language and gradually progress to advanced topics in C. By the end of the course, students will be able to write efficient and robust code that can be used to solve a wide range of engineering problems.

Co-requisite: MATH230
Pre-requisite: CSlS 200 or CSIS 206

CPEN 241 INFORMATION NETWORKING I **3.0: 3 cr. E**

This course covers: 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 lab aims at applying the various concepts taught in CPEN 213 (Microprocessors). The primary goal is to teach students how to design and implement working prototypes of various applications of the PIC18 microcontrollers such as: digital voltmeter, digital thermometer, programmable timer, LM12864L Graphics LCD, 4-Wire Resistive Touch-Screen Panel, Serial Communications and the UART, etc.

Pre-requisite: CPEN 213

CPEN 307 PLC LAB **0.3: 1 cr. E**
The ability of describing the communication links involved with PLC systems, the protocols, and networking methods. This Lab will permit the student to develop ladder programs involving internal relays, timers, counters, shift registers, sequencers, and data handling, safety issues with PLC systems, testing, and debugging.

Co-requisite: CPEN 324

CPEN 309 EMBEDDED CONTROLLERS LAB **0.3: 1 cr. E**
The lab complements the Embedded Systems course and gives students hands-on experience on the materials presented in the course. The set of experiments devised for the lab are based on Intel FPGA with NIOS II embedded processor. Experiments involve both hardware and software, leading to a complete system on a chip (SoC). Software will be developed in C/C++ for the NIOS embedded processor, whereas the hardware will be described using System Verilog HDL.

Co-requisite: CPEN 313

CPEN 310 CYBERSECURITY LAB **0.3: 1 cr. E**
The lab provides a hands-on learning experience in a safe environment covering current topics on the cybersecurity basics and applications of infrastructure security, network security, security devices, local network security, and access control monitoring systems.

CPEN 313 COMPUTER EMBEDDED SYSTEMS **3.0: 3 cr. E**
This course provides an introduction to embedded computing systems and their interface to memory and peripherals. The course is based on FPGA technology, where hardware interfaces with software leading to a complete system on a chip (SoC). Software will be developed mainly in C/C++ for the embedded processor, whereas the hardware will be described using System Verilog HDL.

Pre-requisite: CPEN 212

CPEN 314 COMPUTER ARCHITECTURE **3.0: 3 cr. E**
This course is an introduction to the organization and design of computer systems, assembly language programming, and the hardware/software interface. 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. Topics covered include performance evaluation, RISC-based instruction set architecture, single cycle, multi-cycle, and pipelined processor design, and memory hierarchy: cache and virtual memory.

Pre-requisite: CPEN 313

CPEN 324 PROGRAMMABLE LOGIC CONTROLLERS **3.0: 3 cr. E**
The student will be able to identify and explain the main design characteristics, internal architecture, and operating principles of programmable logic controllers. Also, the student will be capable of identifying

the characteristics of commonly used input and output devices. The ability of describing the communication links involved with PLC systems, the protocols, and networking methods. This course will permit the student to develop ladder programs involving internal relays, timers, counters, shift registers, sequencers, and data handling, safety issues with PLC systems, testing, and debugging.

Co-requisite: CPEN 307

CPEN 341 CYBERSECURITY **3.0: 3 cr. E**
This course introduces learners to the interdisciplinary field of cybersecurity by discussing the evolution of information security into cybersecurity. Learners 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 347 TELETRAFFIC **3.0: 3 cr. E**
This course 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.

Pre-requisite: CSlS 222

CPEN 349 ARTIFICIAL INTELLIGENCE FOR ENGINEERS **3.0: 3 cr. E**
This course introduces Artificial Intelligence (AI) to engineering students, both the basic topics and state-of-art algorithms. The course will look into a variety of AI subareas such as problem solving, reasoning and machine learning. Modern tools will be used to implement and evaluate different AI techniques and synthesize solutions to real-world engineering problems.

Pre-requisite: CSlS 200 or CSIS 206

CPEN 425 NEURAL NETWORKS DESIGN **3.0: 3 cr. E**
This course focuses on Neural dynamics: architecture and signals, activation model, unsurprised learning, surprised learning, architectures and equilibrium. It also covers the Hopfield model and recurrent networks; the self- organizing map and Adaptive resonance theory.

CPEN 426 DEEP LEARNING **3.0: 3 cr. E**
This course introduces students to the theory and practice of deep learning, a subfield of machine learning that involves training artificial neural networks with multiple layers. Topics include Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN), Generative Adversarial Networks (GAN), autoencoders and Reinforcement learning. In this course, students will gain hands-on experience with deep learning algorithms and frameworks, and learn how to apply them to real-world problems in image recognition, natural language processing, and more.

Pre-requisite: CSIS200 or CSIS206.

CPEN 441 INFORMATION NETWORKING II **3.0: 3 cr. E**
This course presents the different aspects of computer networks. In this course, we follow the bottom up model starting from the physical layer and going towards the application layer. However, when presenting the application layer, a top down presentation will be followed in order to close the loop.

Upon successful completion of the course the students shall be able to: - Describe the TCP/IP stack in details - Discuss the technological choices in a networking protocol - Suggest a network design and configuration - Discuss advanced networking protocols - Select Network Protocol for Applications: HTTP, POP3, SMTP, DNS - Develop Basic Networking Programs - Identify the needs and propose new networking protocols - Setup a VLAN

Pre-requisite: CPEN241

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

This course gives the students a fundamental knowledge and hands-on exercise of the networking software design and client/server applications development. Topics include the Common Gateway Interface (CGI), PHP, Servlets, JSP, RPC, CORBA, XML (parsing), SOAP, Web Service Development Language (WSDL), RESTful, RMI, EJB. They are grouped in three parts of the course: i/ web development, ii/ remote procedure calling and, iii/ distributed programming. Drupal is also introduced as a content management system (CMS). Notions of client-side programming are also introduced (JavaScript, AJAX).

Pre-requisite: CPEN241

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 and/or Python. Topics include: Identity recognition (verification, identification), biometric modalities (Face, fingerprint, voice, iris, handgeometry, 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 details different aspects of network management and network security. This is a lecture oriented class really composed of two parts the network management and the network security. :
At the end of the course the students will be able to:

- Design a Firewall and a Network Security Policy
- Build and setup a Firewall
- Design a security solution
- Discuss and share cryptographic information
- Use open source network management and security solutions
- Integrate advanced network security protocols with applications
- Design a network management solution based on SNMP protocol
- Connect to a network management console component
- Add management capabilities to some components.

Pre-requisite: CPEN310

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.

Pre-requisite: ELEN 443

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

This course is divided into two parts tightly connected: Cloud Computing and Big Data. In the first part the course introduces the concepts of cloud computing and covers the different models: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). Different existing open source clouds are introduced with a focus on OpenStack. The different types of clouds are covered: private, public and hybrid clouds with examples of the most popular clouds today. MapReduce algorithm and Hadoop framework will be presented as well as several Big Data tools in particular Hive. Finally, this part shall introduce Data Warehousing. The second part of the course is dedicated to machine learning algorithms. Data analytics and data mining will be detailed as well. The course also stresses on the importance of data preparation and preprocessing.

CPEN 452 ADVANCED MICROCONTROLLER APPLICATIONS 3.0:3 cr. E

This course covers advanced topics in microcontroller applications. It covers the following topics: UART, SPI, I2C, 1-wire protocol, Capture/Compare/PWM modules, A/D conversion, D/A conversion, interface to sensors, human machine interface, software state machines, home automation concepts and advanced software techniques. Essentially, the course teaches students to design microcontroller-based automation modules and how to network them together to form a complete home automation system.

Pre-requisite: CPEN 213 and CPEN 220

CPEN 528 MACHINE VISION 3.0: 3 cr. E

This course introduces 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 cryptography in its algorithmic sides. The course starts with a definition of cryptosystems using simple examples (shift cipher, affine cipher, hill cipher, Vigenere cipher.). A small review of Shannon 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, MDs, .). At the end of the course, students will become aware of cryptography and of the strength and weakness of every cryptosystem.

Pre-requisite: ELEN 402

CPEN 546 WIRELESS NETWORKS 3.0: 3 cr. E

This graduate course introduces existing and currently developed Networking technologies used in Wireless systems. This covers both mobile and wireless networks. This is a lecture oriented class. The students will acquire knowledge and competences on how to design and build wireless networks and using which generation. The course has parts. In a first part we briefly review the wireless communication systems. In part2 cellular systems from 2G till 4G are covered. Part3 is dedicated to Wireless LAN. Part4 covers satellite communication and localization. Ad hoc networks and sensor networks are provided in Part5. Part 6 is dedicated to Internet of Things and Artificial Intelligence.

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

This course presents intelligent networks in details. The underlying communication protocols (lNAP) 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.

Pre-requisites: ELEN 443, CSlS 321

ELCP 211 ENGINEERING DRAWING **0.3: 1 cr. E**

The course prepares students to use AutoCAD to create complete, concise, and accurate engineering drawings. Students will also use the AutoCAD Electrical Toolset that offers automated drafting tools for designing wiring, circuiting, PLC modules, panels and more. They will also learn the interface and the workflow of developing accurate electrical schematics and drawings.

ELCP 290 INTRODUCTION TO THE ENGINEERING DESIGN FUNDAMENTALS 3.0: 1 cr. E

The course serves as a general introduction to the engineering profession, its main objectives, and concerns. It introduces the engineering design process, its phases, challenges and constraints, the qualities, and attributes of a modern-day engineer as expected by professional engineering societies, including integrity, professionalism, ethical commitment, and environmental requirements, as well as the role of the engineer in society. In addition, students will be introduced to project management skills, technical writing, and effective multidisciplinary teamwork. The course aims to set students on the way to future design and professional work in Electrical and Computer Engineering.

ELCP 391 SENIOR DESIGN 1 **0.3: 2 cr. E**

The course constitutes the first semester of a year-long culminating senior design project. In the course, small groups of two to four students are requested to form multidisciplinary teams and solve a relatively open-ended engineering design problem. Each team follows an iterative design process to propose a system/solution that meets the desired requirements, specifications, and constraints. The design should abide to the appropriate realistic constraints i.e., ethical, environmental, financial, safety health and technical, as well as the set standards, codes, and protocols. Students employ engineering design tools, documentation and previously acquired Engineering, Science and Mathematics knowledge for the complete conceptual phase of the design process. Namely, (1) understanding and formulating the problem (objectives, scope, elements, purpose), (2) define the design constraints and specifications (3) Performing a literature review and gathering the appropriate technical documentations, (4) analyzing the various components of the system, (5) selecting the appropriate hardware/software needed and (6) proposing a solution. At the end of the semester, teams will present a detailed design and convey to the public their findings through a comprehensive report that synthesizes all steps of the design process and exhibits individual team members' contributions.

Pre-requisites: ELCP 290, GENG 221, GENG 222, LISP 200

ELCP 392 SENIOR DESIGN 2 **0.3: 2 cr. E**

The course constitutes the second semester of a year-long culminating senior project. In this sequel course to ELCP391, the teams of students must complete the chosen capstone projects to complete the second phase of the design process namely, (1) carry on the culminating design by synthesis and analysis, and (2) build, test, and evaluate the physical/virtual model. At the end of the semester, teams will present/demonstrate their final design prototype/product and convey to the public their findings through a comprehensive report and presentation that synthesizes all steps of the design process and exhibits individual team members' contributions.

Pre-requisite: ELCP 391

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

Prior to graduation, students are expected to undergo 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.

Refer to General Listing of Course Descriptions for:

CSIS XXX
Refer to the Faculty of Arts and Sciences

CSPR XXX
Refer to the Faculty of Arts and Sciences

ELEN XXX
Refer to the Department of Electrical Engineering

ENGL XXX
Refer to the Faculty of Arts and Sciences

ENMG XXX
Refer to the Faculty of Engineering

GENG XXX
Refer to the Faculty of Engineering

LISP XXX
Refer to the Faculty of Arts and Sciences

MATH XXX
Refer to the Faculty of Arts and Sciences

MECH XXX
Refer to the Department of Mechanical Engineering

DEPARTMENT OF ELECTRICAL ENGINEERING

Bachelor of Science (BS) Degree – 109 Credits

Sem	Course Code	Course Title	Credit	Pre-Req	Co-Req
1	CSIS 206	Principles of Programming	3		
1	ELCP 211	Engineering Drawing	1		
1	ELEN 201	Instrumentation Lab	1		
1	ENGL 203	English Communication Skills III	3		
1	MATH 200	Calculus I	3		
1	MATH 211	Linear Algebra I	3		
1	ELCP 290	Introduction to the Engineering Design Fundamentals	1		
1		Engineering Breadth Elective	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
2	GENG 221	Engineering Ethics	3	ELCP 290 ENGL 203	
2	ENGL 2XX	English Elective	3	ENGL 203	
2	CPEN 211	Introduction to Digital Logic Design	3	CSIS 206	
2	ELEN 202	Electrical Simulation and Design	1	CSIS 206	ELEN 221
2	ELEN 221	Circuits Analysis I	3	MATH 200 MATH 211 ELEN 201	ELEN 202
2	MATH 202	Calculus II	3	MATH 200	
2	MATH 270	Differential Equations	3	MATH 200	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
3	CPEN 202	Logic Lab	1		CPEN 212
3	CPEN 212	Logic Circuits	3	CPEN 211	CPEN 202
3	CPEN 220	Programming for Engineering Solutions	3	CSIS 206	MATH 230
3	ELEN 222	Signals and Systems Theory	3	ELEN 221 MATH 270	
3	ELEN 223	Electricity and Electromagnetism	3	ELEN 221 MATH 202 MATH 270	
3	ELEN 231	Electronics I	3	ELEN 221	

3	MATH 230	Numerical Analysis I	3	MATH 200 CSIS 206	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
4	LISP 200	Information Skills and Search Techniques	1		ENGL 102
4	GENG 222	Sustainable Development for Engineers	3	ENGL 203 ELCP 290	
4	ELEN 303	Circuits Analysis Lab	1	ELEN 221	
4	ELEN 304	Electronics Lab	1	ELEN 231	
4	CPEN 213	Microprocessors	3	CPEN 212	
4	ELEN 324	Circuits Analysis II	3	ELEN 221	
4	ELEN 332	Electronics II	3	ELEN 231	
4	MATH 246	Probability for Engineers	3	MATH 200	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
5		Elective	3		
5		Elective Lab	1		
5	CSPR XXX	Cultural Studies	3		
5	CPEN 305	Microcontrollers Lab	1	CPEN 213	
5	ELEN 341	Telecommunications	3	ELEN 222 MATH 246	
5	ELEN 350	Control Systems	3	ELEN 222	
5	ELEN 361	Electric Machines	3	ELEN 223	
5	ELCP 391	Senior Design 1	2	ELCP290 LISP200 GENG 221 GENG 222	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
6		Elective	3		
6	ELEN 306	Telecommunications Lab	1	ELEN 341	
6	ELEN 308	Electric Machines Lab	1	ELEN 361	
6	ELEN 325	Electrical Installations	3	ELEN 303	
6	ELEN 326	Digital Signal Processing	3	ELEN 222	
6	ELEN 362	Power Electronics	3	ELEN 231 ELEN 361	
6	ELCP 392	Senior Design 2	2	ELCP 391	
		TOTAL	**109**		

Engineering Breadth Elective (3 credits from the following list):					
	CIVE 201	Statics	3		
	MECH 221	Engineering Dynamics	3	CIVE 201	
	MECH 232	Thermodynamics	3		
Elective Lab (1 credit from the following list):					
	CPEN 307	PLC Lab	1		CPEN 324
	CPEN 309	Embedded Controllers Lab	1		CPEN 313
	CPEN 310	Cybersecurity Lab	1		
	ELEN 307	Control Lab	1		
Electives (6 credits from the following list):					
	BMEN 301	Introduction to Biomedical Engineering	3		
	CPEN 241	Information Networking I	3		
	CPEN 313	Computer Embedded Systems	3	CPEN 212	CPEN 309
	CPEN 314	Computer Architecture	3	CPEN 313	
	CPEN 324	Programmable Logic Controllers	3		CPEN 307
	CPEN 341	Cybersecurity	3		
	CPEN 349	Artificial Intelligence for Engineers	3	CSIS 206	
	ELEN 340	Signal Transmission	3	ELEN 223	
	ELEN 351	Digital Control Systems	3	ELEN 350	
	GENG 311	Engineering Management and Economics	3		

DEPARTMENT OF ELECTRICAL ENGINEERING

Bachelor of Engineering (BE) Degree – 146 Credits

Sem	Course Code	Course Title	Credit	Pre-Req	Co-Req
1	CSIS 206	Principles of Programming	3		
1	ELCP 211	Engineering Drawing	1		
1	ELEN 201	Instrumentation Lab	1		
1	ENGL 203	English Communication Skills III	3		
1	MATH 200	Calculus I	3		
1	MATH 211	Linear Algebra I	3		
1	ELCP 290	Introduction to the Engineering Design Fundamentals	1		
1		Engineering Breadth Elective	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
2	GENG 221	Engineering Ethics	3	ELCP 290 ENGL 203	
2	ENGL 2XX	English Elective	3	ENGL 203	
2	CPEN 211	Introduction to Digital Logic Design	3	CSIS 206	
2	ELEN 202	Electrical Simulation and Design	1	CSIS 206	ELEN 221
2	ELEN 221	Circuits Analysis I	3	MATH 200 MATH 211 ELEN 201	ELEN 202
2	MATH 202	Calculus II	3	MATH 200	
2	MATH 270	Differential Equations	3	MATH 200	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
3	CPEN 202	Logic Lab	1		CPEN 212
3	CPEN 212	Logic Circuits	3	CPEN 211	CPEN 202
3	CPEN 220	Programming for Engineering Solutions	3	CSIS 206	MATH 230
3	ELEN 222	Signals and Systems Theory	3	ELEN 221 MATH 270	
3	ELEN 223	Electricity and Electromagnetism	3	ELEN 221 MATH 202 MATH 270	
3	ELEN 231	Electronics I	3	ELEN 221	

3	MATH 230	Numerical Analysis I	3	MATH 200 CSIS 206	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
4	LISP 200	Information Skills and Search Techniques	1		ENGL 102
4	GENG 222	Sustainable Development for Engineers	3	ENGL 203 ELCP 290	
4	ELEN 303	Circuits Analysis Lab	1	ELEN 221	
4	ELEN 304	Electronics Lab	1	ELEN 231	
4	CPEN 213	Microprocessors	3	CPEN 212	
4	ELEN 324	Circuits Analysis II	3	ELEN 221	
4	ELEN 332	Electronics II	3	ELEN 231	
4	MATH 246	Probability for Engineers	3	MATH 200	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
5		Elective	3		
5		Elective Lab	1		
5	CSPR XXX	Cultural Studies	3		
5	CPEN 305	Microcontrollers Lab	1	CPEN 213	
5	ELEN 341	Telecommunications	3	ELEN 222 MATH 246	
5	ELEN 350	Control Systems	3	ELEN 222	
5	ELEN 361	Electric Machines	3	ELEN 223	
5	ELCP 391	Senior Design 1	2	ELCP290 LISP200 GENG 221 GENG 222	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
6		Elective	3		
6	ELEN 306	Telecommunications Lab	1	ELEN 341	
6	ELEN 308	Electric Machines Lab	1	ELEN 361	
6	ELEN 325	Electrical Installations	3	ELEN 303	
6	ELEN 326	Digital Signal Processing	3	ELEN 222	
6	ELEN 362	Power Electronics	3	ELEN 231 ELEN 361	
6	ELCP 392	Senior Design 2	2	ELCP 391	

Sem	Course Code	Course Title	Credit	Pre-Req	Co-Req
7	ELEN 401	Optimization Theory	3		
7	ELEN 417	Measurement Systems	3		
7	ELEN 437	Power Systems I	3		
7		Specialized Area Elective	3		
7		Specialized Area Elective	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
8	GENG 400	Engineering Seminars	1		
8	GENG 490	Graduation Project	3		
8		Specialized Area Elective	3		
8		Specialized Area Elective	3		
8		Specialized Area Elective	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
9	ELEN 480	Field Training	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
10	GENG 490	Graduation Project (Reactivation)	0		
10		General Elective	3		
10		Specialized Area Elective	3		
		TOTAL	**146**		

Engineering Breadth Elective (3 credits from the following list):					
	CIVE 201	Statics	3	CIVE 201	
	MECH 221	Engineering Dynamics	3		
	MECH 232	Thermodynamics	3		
Elective Lab (1 credit lab from the following list):					
	CPEN 307	PLC Lab	1		CPEN 324
	CPEN 309	Embedded Controllers Lab	1		CPEN 313
	CPEN 310	Cybersecurity Lab	1		
	ELEN 307	Control Lab	1		
Electives (6 credits from the following list):					
	BMEN 301	Introduction to Biomedical Engineering	3		
	CPEN 241	Information Networking I	3		
	CPEN 313	Computer Embedded Systems	3	CPEN 212	CPEN 309
	CPEN 314	Computer Architecture	3	CPEN 313	
	CPEN 324	Programmable Logic Controllers	3		CPEN 307
	CPEN 341	Cybersecurity	3		
	CPEN 349	Artificial Intelligence for Engineers	3	CSIS 206	
	ELEN 340	Signal Transmission	3	ELEN 223	
	ELEN 351	Digital Control Systems	3	ELEN 350	
	GENG 311	Engineering Management and Economics	3		
General Elective (3 credits from the following list):					
	ENMG 422	Project Life Cycle Cost Management	3		
	ENMG 460	Decision and Risk Management	3		
	ENMG 555	Decision and Planning of Engineering Systems	3		
	ENMG 585	Quality Assurance and Control	3		
	GENG 402	Project Management	3		
		Specialized Area Elective			
Specialized Area Electives (15 credits from the following list):					
	BMEN 467	Musculoskeletal Biomechanics	3		
	CPEN 425	Neural Networks Design	3		
	CPEN 441	Information Networking II	3	CPEN 241	
	CPEN 442	Networking Programming	3	CPEN 241	

	CPEN 445	Biometrics	3		
	CPEN 448	Cloud Computing and Big Data	3		
	CPEN 452	Advanced Microcontroller Applications	3	CPEN 213 CPEN 220	
	CPEN 528	Machine Vision	3		
	CPEN 546	Wireless Networks	3		
	ELEN 402	Stochastic Theory	3		
	ELEN 411	Mechatronics Systems	3		
	ELEN 435	Advanced Electric Machines	3		
	ELEN 443	Digital Communication	3		
	ELEN 459	Engineering Image Processing	3		
	ELEN 462	Biomedical Instrumentation I	3		
	ELEN 463	Medical Imaging I	3		
	ELEN 466	Industrial Intelligent Networks	3		
	ELEN 472	Fiber Optics	3		
	ELEN 523	Optimal Control Systems	3		
	ELEN 527	Fuzzy Logic Control	3		
	ELEN 536	Power Systems Control	3		
	ELEN 537	Power Systems II	3		
	ELEN 539	Power Quality	3		
	ELEN 542	Wireless Communication Systems	3		
	ELEN 562	Biomedical Instrumentation II	3		
	ELEN 564	Medical Imaging II	3		
	ELEN 572	Satellite and Radar Communication	3		
	ELEN 574	Optical WDM Networks	3		

DEPARTMENT OF ELECTRICAL ENGINEERING

Master of Science (MS) Degree – 46 Credits

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

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

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

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

COURSE DESCRIPTIONS

BMEN 301 INTRODUCTION TO BIOMEDICAL ENGINEERING 3.0: 3 cr. E
This course provides 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 467 MUSCULOSKELETAL 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.

ELCP 211 ENGINEERING DRAWING 0.3: 1 cr. E
This course prepares students to use AutoCAD to create complete, concise, and accurate engineering drawings. Students will also use the AutoCAD Electrical Toolset that offers automated drafting tools for designing wiring, circuiting, PLC modules, panels and more. They will also learn the interface and the workflow of developing accurate electrical schematics and drawings.

ELCP 290 INTRODUCTION TO THE ENGINEERING DESIGN FUNDAMENTALS 3.0: 1cr. E
This course serves as a general introduction to the engineering profession, its main objectives, and concerns. It introduces the engineering design process, its phases, challenges and constraints, the qualities, and attributes of a modern-day engineer as expected by professional engineering societies, including integrity, professionalism, ethical commitment, and environmental requirements, as well as the role of the engineer in society. In addition, students will be introduced to project management skills, technical writing, and effective multidisciplinary teamwork. The course aims to set students on the way to future design and professional work in Electrical and Computer Engineering.

ELCP 391 SENIOR DESIGN 1 0.3: 2 cr. E
This course constitutes the first semester of a year-long culminating senior design project. In the course, small groups of two to four students are requested to form multidisciplinary teams and solve a relatively open-ended engineering design problem. Each team follows an iterative design process to propose a system/solution that meets the desired requirements, specifications, and constraints. The design should abide to the appropriate realistic constraints i.e., ethical, environmental, financial, safety health and technical, as well as the set standards, codes, and protocols. Students employ engineering design tools, documentation and previously acquired Engineering, Science and Mathematics knowledge for the complete conceptual phase of the design process. Namely, (1) understanding and formulating the problem (objectives, scope, elements, purpose), (2) define the design constraints and specifications (3) Performing a literature review and gathering the appropriate technical documentations, (4) analyzing the various components of the system, (5) selecting the appropriate hardware/software needed and (6) proposing a solution. At the end of the semester, teams will present a detailed design and convey to the public their findings through a comprehensive report that synthesizes all steps of the design process and exhibits individual team members' contributions.

Pre-requisites: ELCP 290, LISP 200, GENG 221, GENG 222

ELCP 392 SENIOR DESIGN 2 **0.3: 2 cr. E**

This course constitutes the second semester of a year-long culminating senior project. In this sequel course to ELCP391, the teams of students must complete the chosen capstone projects to complete the second phase of the design process namely, (1) carry on the culminating design by synthesis and analysis, and (2) build, test, and evaluate the physical/virtual model. At the end of the semester, teams will present/demonstrate their final design prototype/product and convey to the public their findings through a comprehensive report and presentation that synthesizes all steps of the design process and exhibits individual team members' contributions.

Pre-requisite: ELCP 391

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**

This course introduces electrical engineering students to static electric and magnetic fields basic laws such as Coulomb, Faraday, Gauss, Ampere, Biot-Savart, and boundary conditions which leads to the ability of deriving Maxwell's equations. In addition, deep theoretical insights will be given to electromagnetic related issues such as energy, potential, current, magnetic force/torque, magnetic vector potential, and magnetic circuits.

Co-requisite: ELEN 221
Pre-requisites: CSIS 200 or CSIS 206

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

This course provides students with a 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.

Co-requisite: ELEN 202
Pre-requisites: ELEN 201, MATH 200, 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-requisites: ELEN 221, MATH 270

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

This course introduces electrical engineering students to static electric and magnetic fields basic laws such as Coulomb, Faraday, Gauss, Ampere, Biot-Savart, and boundary conditions which leads to the ability of deriving Maxwell's equations. In addition, deep theoretical insights will be given to electromagnetic related issues such as energy, potential, current, magnetic force/torque, magnetic vector potential, and magnetic circuits.

Pre-requisites: ELEN 221, MATH 202, MATH 270

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

This course covers the physics and operation of semiconductor devices such as diodes and transistors. It also covers two-port networks, small-signal models, operational amplifiers, and circuit analysis at intermediate frequencies.

Pre-requisites: ELEN 221

ELEN 303 CIRCUITS ANALYSIS LAB **.3: 1 cr. E**

This laboratory prepares students to verify the basic laws of circuit analysis by designing, analyzing, and implementing DC/AC networks.

Pre-requisites: ELEN 221

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

This laboratory provides practical experience in telecom through a series of experiments in analog communications and illustrates various methods of modulation/demodulation of an information signal, namely, AM, DSB, SSB, FM, and stereophonic FM.

Pre-requisite: 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.

Pre-requisite: ELEN 341

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

This laboratory analyses, simulates, and designs LTI systems and then verifies experimentally. It primarily determines 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 and modern controllers (PID, phase compensation, SFC). The students use MATLAB/Simulink and NI Multisim for simulation. They also use Quanser's Rotary Servo and Ball-and-Beam modules to model, design, simulate, and implement control systems.

Pre-requisite: ELEN 350

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

This laboratory covers electric machines where the students tend to do electrical and mechanical measurements and basic operation characteristics of transformers (single and three phase), DC machines used as motor and as generators and AC machines (induction and synchronous).

Pre-requisite: ELEN 361

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

This course covers characteristics of sinusoids; phasor relationships; instantaneous and average power; RMS values, complex power, and power measurements; Three-phase Circuit Analysis, magnetically coupled networks; ideal transformers; frequency response; MultiSim applications of all topics.

Pre-requisites: ELEN 221

ELEN 325 ELECTRICAL INSTALLATIONS **3.0: 3 cr. E**
This course exposes students to residential and industrial wiring systems and techniques in conformance with the National Electrical Code (NEC) and local codes.

Pre-requisite: ELEN 303

ELEN 326 DIGITAL SIGNAL PROCESSING **3.0: 3 cr. E**
This course covers sampling, quantization, and reconstruction of signals; Discrete Fourier Transform (DFT); z-transform analysis. It also introduces the design of IIR, FIR, and recursive digital filters by transforming a suitable continuous filter (Butterworth, Chebyshev type I and II) to satisfy the given digital specifications (Impulse Invariant method, Bilinear Transformation).

Pre-requisite: ELEN 222

ELEN 332 ELECTRONICS II **3.0: 3 cr. E**
This course covers the behavior and operating limitations and efficiency of operational amplifiers, multistage amplifiers, current mirrors, feedback amplifiers, power amplifiers, low and high-frequency amplifications, active filters, and large-signal and small-signal behavior and limitations of differential amplifiers.

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 bandpass analog communication; linear demodulation AM, DSB, SSB, VSB; envelope detection, coherent/non-coherent demodulation, super-heterodyne receiver; angular (nonlinear) modulation, Phase Modulation (PM), Frequency Modulation (FM), angular demodulation, different types of discriminators pre-emphasis and de-emphasis, and performance analysis using Signal to Noise Ratio (SNR), and Frequency Division Multiplexing (FDM). It also involves the study of some baseband digital signaling such as the pulse modulation, PAM, PWM, PPM, PCM, Line coding, and Time Division Multiplexing (TDM).

Pre-requisites: ELEN 222, MATH 246

ELEN 349 INTRODUCTION TO CONTROL SYSTEMS **3.0: 3 cr. E**
This course covers continuous-time signal types and transformations; system classifications and analysis in both time and frequency domains; Laplace transform pairs, properties, and applications; Linear Time Invariant real physical dynamical continuous-time systems analysis such as convolution and ODE; block diagram algebra and signal flow graph; stability analysis techniques (Routh-Hurwitz stability test); state space analysis; classical control systems design (PID and phase compensation).

Pre-requisites:

- For Electrical Engineering Students: MATH 270, ELEN 202, ELEN 221
- For Mechanical Engineering Students: MATH 270, MECH 241, MECH 231

ELEN 350 CONTROL SYSTEMS 3.0: 3 cr. E

This course covers control systems analysis and design; block diagram algebra and signal flow graph; stability analysis and the Routh-Hurwitz stability test, root locus, time and frequency domains design criterion; Bode, Nyquist, and Nicholas plots; Gain and Phase Margins; classical control design (PID and phase compensation); state space analysis and design.

Pre-requisites: 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.

Pre-requisite: ELEN 350

ELEN 360 ELECTRIC MOTORS AND DRIVES 3.0: 3 cr. E

This course covers the fundamentals of electromagnetic circuits; AC three-Phase Circuits; Construction and operation: fundamentals of AC machines, operation of Synchronous generators; induction motors: construction and principle of operation, power, torque, and efficiency; AC drives: starting and speed regulation, plugging and regenerative breaking; DC motor types and control strategies, stepper motors: types, operational characteristics, drivers configurations.

Pre-requisites:

- For Electrical Engineering Students: MATH 211, ELEN 221
- For Mechanical Engineering Students: MATH 211, MECH 231

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

ELEN 362 POWER ELECTRONICS 3.0: 3 cr. E

This course covers the applications of power semiconductor devices; circuit analysis; signal analysis and energy of AC/DC, DC/DC, DC/AC, AC/AC conversions. These generic converters are applied as controlled rectifiers, switching power supplies, motor drives, HVDC transmission, induction heating, and others.

Pre-requisite: ELEN 231

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

This course deals with orthonormal expansions, effect of additive noise in electrical communications, vector channels, waveform channels, matched filters, bandwidth, and dimensionality. Optimum

receiver structures, probability of error, bit and block signaling, introduction to coding techniques. Protocols for error control, signaling, addressing, fault management, and security control. Block, cyclic, and convolutional codes; circuits and algorithms for decoding; application to reliable communication and fault-tolerant computing.

ELEN 443 DIGITAL COMMUNICATION **3.0:3 cr. E**

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

ELEN 446 TELECOM ELECTRONICS **3.0: 3 cr. E**

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

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

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

ELEN 462 BIOMEDICAL INSTRUMENTATION I **3.0: 3 cr. E**

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

ELEN 463 MEDICAL IMAGING I **3.0: 3 cr. E**

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

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

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

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

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

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

This course requires students to undergo a two- to four-month training program at an institution whereby they get exposed and engaged in activities related to their field of studies, thereby gaining experience and demonstrating their skills.

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

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

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

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

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

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

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

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

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

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

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

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

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

This course aims to present wireless communication systems in general. It is a graduate course that covers several aspects of wireless communication starting from the general concepts and going towards specific wireless networking protocols. Different propagation models, modulation techniques, multiple access approaches will be deepened. Speech coding and data transmission approaches will be introduced. Examples on the GSM, DECT and satellite communication will be given. As a result, the students will have a good knowledge of the most common wireless communication systems which permits them to easily start any study in this area.

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

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

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

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

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

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

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

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

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

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

Refer to General Listing of Course Descriptions for:

CPEN XXX
Refer to the Department of Computer Engineering

CSIS XXX
Refer to the Faculty of Arts and Sciences

CSPR XXX
Refer to the Faculty of Arts and Sciences

ENGL XXX
Refer to the Faculty of Arts and Sciences

ENMG XXX
Refer to the Faculty of Engineering

GENG XXX
Refer to the Faculty of Engineering

LISP XXX
Refer to the Faculty of Arts and Sciences

MATH XXX
Refer to the Faculty of Arts and Sciences

MECH XXX
Refer to the Department of Mechanical Engineering

DEPARTMENT OF MECHANICAL ENGINEERING

Bachelor of Science (BS) Degree – 109 Credits

Sem	Course Code	Course Title	Credit	Pre-Req	Co-Req
1	CIVE 201	Statics	3		
1	CSIS 206	Principles of Programming	3		
1	ENGL 203	English Communication Skills III	3		
1	MATH 200	Calculus I	3		
1	MATH 211	Linear Algebra I	3		
1	MECH 211	Mechanical Drawing I	1		
1	MECH 212	Instrumentation and Experimentation I	1		
1	MECH 233	Workshop Technology	1		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
2	CHEM 202	Basic Chemistry	3		
2	CIVE 202	Mechanics of Materials	3	CIVE 201	
2	MATH 202	Calculus II	3	MATH 200	
2	MATH 246	Probability for Engineers	3	MATH 200	
2	MECH 221	Engineering Dynamics	3	MATH 200	
2	MECH 290	Introduction to the Engineering Design Process	1		
2	ENGL 2XX	English Elective	3	ENGL 203	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
3	GENG 221	Engineering Ethics	3	ENGL 203 MECH 290	
3	MATH 230	Numerical Analysis I	3	CSIS 206 MATH 200	
3	MATH 270	Differential Equations	3	MATH 200	
3	MECH 222	Science of Materials	3		ENGL 101
3	MECH 231	Circuit Fundamentals	3	MATH 211	
3	MECH 232	Thermodynamics	3		
3	MECH 234	Mechanical Drawing II	1	MECH 211	

Sem	Course Code	Course Title	Credit	Pre-Req	Co-Req
4	GENG 222	Sustainable Development for Engineers	3	ENGL 203 MECH 290	
4	GENG 311	Engineering Management and Economics	3		
4	LISP 200	Information Skills and Search Techniques	1		ENGL 102
4	MECH 241	Computational Techniques in Mechanical Engineering	3	CSIS 206 MATH 230 MECH 221	MATH 270 MECH 243
4	MECH 242	Engineering Vibrations	3	MATH 270 MECH 221	
4	MECH 243	Fluid Mechanics	3		MATH 202
4	MECH 244	Instrumentation and Experimentation II	1	MECH 212	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
5	ELEN 201	Instrumentation Lab	1		
5	ELEN 349	Introduction to Control Systems	3	MATH 270 MECH 231 MECH 241	
5	MECH 311	Mechanical Design I	3	CIVE 202	
5	MECH 314	Gas Dynamics	3	MECH 243	
5	MECH 328	Basic Manufacturing	3	MECH 222 MECH 234	MECH 387
5	MECH 387	Design Tools in Mechanical and Aeronautical Engineering	3	CIVE 202 MECH 243 MECH 234	
5	MECH 389	System Design	3	MECH 290 GENG 221 GENG 222	MECH 387
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
6	CSPR XXX	Cultural Studies	3		
6	ELEN 360	Electric Motors and Drives	3	ELEN 221 or MECH 231 and MATH 211	
6	MECH 315	Mechanics of Machines	3	MATH 230 MECH 221	
6	MECH 321	Heat Transfer	3	MECH 243	

6	MECH 324	Steam and Gas Turbines	3	MECH 232	
6	MECH 325	Instrumentation and Experimentation III	1	MECH 244	
6	MECH 390	Undergraduate Design Project	1	MECH 389 or AERO 316	LISP 200
		TOTAL	**109**		
The BS program in Mechanical Engineering does not offer any elective course. It is highly advisable that mechanical engineering students take CIVE 201 prior to MECH 221, and MECH 232 prior to MECH 243.					

DEPARTMENT OF MECHANICAL ENGINEERING

Bachelor of Engineering (BE) Degree – 147 Credits

Sem	Course Code	Course Title	Credit	Pre-Req	Co-Req
1	CIVE 201	Statics	3		
1	CSIS 206	Principles of Programming	3		
1	ENGL 203	English Communication Skills III	3		
1	MATH 200	Calculus I	3		
1	MATH 211	Linear Algebra I	3		
1	MECH 211	Mechanical Drawing I	1		
1	MECH 212	Instrumentation and Experimentation I	1		
1	MECH 233	Workshop Technology	1		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
2	CHEM 202	Basic Chemistry	3		
2	CIVE 202	Mechanics of Materials	3	CIVE 201	
2	MATH 202	Calculus II	3	MATH 200	
2	MATH 246	Probability for Engineers	3	MATH 200	
2	MECH 221	Engineering Dynamics	3	MATH 200	
2	MECH 290	Introduction to the Engineering Design Process	1		
2	ENGL 2XX	English Elective	3	ENGL 203	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
3	GENG 221	Engineering Ethics	3	ENGL 203 MECH 290	
3	MATH 230	Numerical Analysis I	3	CSIS 206 MATH 200	
3	MATH 270	Differential Equations	3	MATH 200	
3	MECH 222	Science of Materials	3		ENGL 101
3	MECH 231	Circuit Fundamentals	3	MATH 211	
3	MECH 232	Thermodynamics	3		
3	MECH 234	Mechanical Drawing II	1	MECH 211	

Sem	Course Code	Course Title	Credit	Pre-Req	Co-Req
4	GENG 222	Sustainable Development for Engineers	3	ENGL 203 MECH 290	
4	GENG 311	Engineering Management and Economics	3		
4	LISP 200	Information Skills and Search Techniques	1		ENGL 102
4	MECH 241	Computational Techniques in Mechanical Engineering	3	CSIS 206 MATH 230 MECH 221	MATH 270 MECH 243
4	MECH 242	Engineering Vibrations	3	MATH 270 MECH 221	
4	MECH 243	Fluid Mechanics	3		MATH 202
4	MECH 244	Instrumentation and Experimentation II	1	MECH 212	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
5	ELEN 201	Instrumentation Lab	1		
5	ELEN 349	Introduction to Control Systems	3	MATH 270 MECH 231 MECH 241	
5	MECH 311	Mechanical Design I	3	CIVE 202	
5	MECH 314	Gas Dynamics	3	MECH 243	
5	MECH 328	Basic Manufacturing	3	MECH 222 MECH 234	MECH 387
5	MECH 387	Design Tools in Mechanical and Aeronautical Engineering	3	CIVE 202 MECH 243 MECH 234	
5	MECH 389	System Design	3	MECH 290 GENG 221 GENG 222	MECH 387
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
6	CSPR XXX	Cultural Studies	3		
6	ELEN 360	Electric Motors and Drives	3	ELEN 221 or MECH 231 and MATH 211	
6	MECH 315	Mechanics of Machines	3	MATH 230 MECH 221	
6	MECH 321	Heat Transfer	3	MECH 243	

6	MECH 324	Steam and Gas Turbines	3	MECH 232	
6	MECH 325	Instrumentation and Experimentation III	1	MECH 244	
6	MECH 390	Undergraduate Design Project	1	MECH 389 or AERO 316	LISP 200
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
7	MECH 411	Advanced Mechanics of Materials	3	CIVE 202 MECH 311	
7	MECH 412	Mechanics of Composite Materials	3	CIVE 202	
7	MECH 413	Internal Combustion Engines	3	MECH 232	
7		Elective	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
8	GENG 400	Engineering Seminars	1		
8	GENG 490	Graduation Project	3		
8	MECH 421	Refrigeration and Air Conditioning	3	MECH 321	
8	MECH 422	Mechanical Design II	3	MECH 311 CIVE 202	
8	MECH 423	Advanced Manufacturing Processes	3	MECH 323	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
9	MECH 480	Field Training	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
10	GENG 490	Graduation Project (Reactivation)	0		
10	MECH 410	Material Characterization Lab.	1	CIVE 202 MECH 222 MECH 325	
10	MECH 415	Turbomachinery	3	MECH 324 or AERO 344	
10	MECH 517	Finite Element Methods in Mech. and Aero. Eng.	3	CIVE 202	
10		Elective	3		
		TOTAL	**147**		

The BE program in Mechanical Engineering does not offer any tracks.

It is highly advisable that mechanical engineering students take CIVE 201 prior to MECH 221, and MECH 232 prior to MECH 243.

*One of the BE electives has to be a technical elective to be selected from courses from within the Mechanical Engineering Department. Any 300, 400 or 500-level MECH course (with prerequisite taken) that is not a required BS or BE course can be taken as a technical elective. The other BE elective can be either a technical elective from within the department (as defined above), or a course from outside the department with prior approval of the Chairperson of the Mechanical Engineering Department.

DEPARTMENT OF MECHANICAL ENGINEERING

Master of Science (MS) Degree – 46 Credits

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

Sem	Course Code	Course Title	Credit	Pre-Req	Co-Req
7	MECH 422	Mechanical Design II	3	MECH 311 CIVE 202	
7	MECH 450	Advanced Engineering Analysis for Mechanical Engineers	3	MATH 230 MATH 202	
7	MECH 511	Computational Fluid Dynamics	3	MECH 314	
7	MECH 521	Modern Thermo-Mechanical Treatment Processes	3	MECH 222	
7		Specialized Area Elective or General Elective	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
8	MECH 412	Mechanics of Composite Materials	3	CIVE 202	
8	MECH 413	Internal Combustion Engines	3	MECH 232	
8	MECH 517	Finite Element Methods in Mech. and Aero. Eng.	3	CIVE 202	
8	GENG 599	Master's Thesis	6	MECH 450 or GENG 450	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
9	MECH 480	Field Training	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
10	GENG 400	Engineering Seminars	1		
10	GENG 599	Master's Thesis (Reactivation)	0		
10		Specialized Area Elective or General Elective	3		
10		Specialized Area Elective or General Elective	3		
10		Specialized Area Elective or General Elective	3		

10		Specialized Area Elective or General Elective	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	
11	GENG 599	Master's Thesis (Reactivation)	0		
		TOTAL	**46**		
Specialized Area Elective (Based on Selected Area):					
General (15 credits from any Mechanical Engineering discipline)					
Thermo-fluids (9 credits from the following list)					
	AERO 421	Gas Turbine Propulsion Systems	3	AERO 344	
	MECH 414	Process Control Systems	3		
	MECH 415	Turbomachinery	3	MECH 324 or AERO 344	
	MECH 421	Refrigeration and Air Conditioning	3	MECH 321	
	MECH 426	Plumbing Engineering	3	MECH 314	
	MECH 428	Special Topics in Thermal Sciences	3	MECH 232	MECH511
	MECH 512	Solar Energy	3	MECH 232	
	MECH 526	Advanced Fluid Mechanics	3	MECH 243	
	MECH 528	Advanced Numerical Analysis	3	MATH 230	
Manufacturing (9 credits from the following list)					
	MECH 414	Process Control Systems	3		
	MECH 423	Advanced Manufacturing Processes	3	MECH 323	
	MECH 425	Mechatronics	3		
	MECH 427	Facility Planning and Control	3		
	MECH 513	Robotics	3	MECH 221	
	MECH 522	Metal Forming Technologies	3	MECH 521	
	MECH 523	Forming Machines and Materials	3	MECH 521	
	MECH 525	Composites Processes and Applications	3		
Solid-Mechanics (9 credits from the following list)					
	MECH 411	Advanced Mechanics of Materials	3	CIVE 202 MECH 311	
	MECH 514	Fatigue and Fracture Mechanics Design	3	CIVE 202	
	MECH 525	Composites Processes and Applications	3		
	MECH 527	Introduction to Continuum Mechanics	3	CIVE 202	
	MECH 529	Theory of Plates and Shells	3	CIVE 202	

	MECH 530	Multi-Rigid Body Dynamics I	3	MECH 221	
	MECH 531	Multi-Rigid Body Dynamics II	3	MECH 530	
	MECH 532	Theory of Elasticity	3	CIVE 202	
Management (15 credits from the following list)					
	ENMG 422	Project Life Cycle Cost Management	3		
	ENMG 435	Operations Management	3		
	ENMG 460	Decision and Risk Management	3		
	ENMG 555	Design and Planning of Engineering Systems	3		
	ENMG 585	Quality Assurance and Quality Control	3		
	MGMT 440	Management of Organizations	3		
	MGMT 446	Managing Organizational Behavior	3	MGMT 440	
	MGMT 541	Operations Management	3		
	MGMT 548	Total Quality Management	3		
	MRKT 450	Marketing Management	3		
	MRKT 456	New Product Development	3	MRKT 450	

DEPARTMENT OF MECHANICAL ENGINEERING

Bachelor of Science (BS) Degree – 109 Credits

Aeronautical Engineering Specialty

Sem	Course Code	Course Title	Credit	Pre-Req	Co-Req
1	AERO 211	Aircraft Basic Science	3		
1	CIVE 201	Statics	3		
1	ENGL 203	English Communication Skills III	3		
1	MATH 200	Calculus I	3		
1	MATH 211	Linear Algebra I	3		
1	MECH 211	Mechanical Drawing I	1		
1	MECH 212	Instrumentation and Experimentation I	1		
1	MECH 290	Introduction to the Engineering Design Process	1		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
2	AERO 221	Airframe Workshop	1	AERO 211	
2	CIVE 202	Mechanics of Materials	3	CIVE 201	
2	CSIS 206	Principles of Programming	3		
2	ENGL 2XX	English Elective	3	ENGL 203	
2	MATH 202	Calculus II	3	MATH 200	
2	MATH 246	Probability for Engineers	3	MATH 200	
2	MECH 221	Engineering Dynamics	3	MATH 200	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
3	AERO 234	Fundamentals of Aircraft Structures	3	MECH 221 AERO 211	CIVE 202
3	MATH 230	Numerical Analysis I	3	CSIS 206 MATH 200	
3	MATH 270	Differential Equations	3	MATH 200	
3	MECH 222	Science of Materials	3		ENGL 101
3	MECH 231	Circuit Fundamentals	3	MATH 211	

3	MECH 232	Thermodynamics	3		
3	MECH 234	Mechanical Drawing II	1	MECH 211	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
4	AERO 232	Aerodynamics of Flight	3	AREO 211	MECH 243
4	AERO 244	Aero-Engines Workshop	1		
4	AERO 245	Aircraft Instruments and Systems	3	AERO 211	
4	GENG 221	Engineering Ethics	3	ENGL 203 MECH 290	
4	LISP 200	Information Skills and Search Techniques	1		ENGL 102
4	MECH 242	Engineering Vibrations	3	MATH 270 MECH 221	
4	MECH 243	Fluid Mechanics	3		MATH 202
4	MECH 244	Instrumentation and Experimentation II	1	MECH 212	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
5	AERO 231	Aircraft Dynamics and Control	3	AERO 232	
5	AERO 316	Fundamentals of Aircraft Design	3	AERO 232 AERO 234 GENG 221 GENG 222 MECH 290	MECH 387
5	AERO 344	Aircraft Propulsion Systems	3	MECH 232	
5	GENG 222	Sustainable Development for Engineers	3	ENGL 203 MECH 290	
5	MECH 241	Computational Techniques in Mechanical Engineering	3	CSIS 206 MATH 230 MECH 221	MATH 270, MECH 243
5	MECH 387	Design Tools in Mechanical and Aeronautical Engineering	3	MECH 243 CIVE 202 MECH 234	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
6	AERO 343	Helicopter Fundamentals	3	AERO 211 MECH 221	
6	AERO 346	Safety Management Systems	3		
6	CSPR XXX	Cultural Studies	3		
6	MECH 314	Gas Dynamics	3	MECH 243	

6	MECH 321	Heat Transfer	3	MECH 243	
6	MECH 325	Instrumentation and Experimentation III	1	MECH 244	
6	MECH 390	Undergraduate Design Project	1	AERO 316 or MECH 389	LISP 200
		Total	**109**		

The BS program in Mechanical Engineering (AERONAUTICAL SPECIALTY) does not offer any elective course.

It is highly advisable that mechanical engineering students (Aeronautical specialty) take CIVE 201 prior to MECH 221, and MECH 232 prior to MECH 243.

DEPARTMENT OF MECHANICAL ENGINEERING

Bachelor of Engineering (BE) Degree – 147 Credits

Aeronautical Engineering Specialty

Sem	Course Code	Course Title	Credit	Pre-Req	Co-Req
1	AERO 211	Aircraft Basic Science	3		
1	CIVE 201	Statics	3		
1	ENGL 203	English Communication Skills III	3		
1	MATH 200	Calculus I	3		
1	MATH 211	Linear Algebra I	3		
1	MECH 211	Mechanical Drawing I	1		
1	MECH 212	Instrumentation and Experimentation I	1		
1	MECH 290	Introduction to the Engineering Design Process	1		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
2	AERO 221	Airframe Workshop	1	AERO 211	
2	CIVE 202	Mechanics of Materials	3	CIVE 201	
2	CSIS 206	Principles of Programming	3		
2	ENGL 2XX	English Elective	3	ENGL 203	
2	MATH 202	Calculus II	3	MATH 200	
2	MATH 246	Probability for Engineers	3	MATH 200	
2	MECH 221	Engineering Dynamics	3	MATH 200	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
3	AERO 234	Fundamentals of Aircraft Structures	3	MECH 221 AERO 211	CIVE 202
3	MATH 230	Numerical Analysis I	3	CSIS 206 MATH 200	
3	MATH 270	Differential Equations	3	MATH 200	
3	MECH 222	Science of Materials	3		ENGL 101
3	MECH 231	Circuit Fundamentals	3	MATH 211	

3	MECH 232	Thermodynamics	3		
3	MECH 234	Mechanical Drawing II	1	MECH 211	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
4	AERO 232	Aerodynamics of Flight	3	AREO 211	MECH 243
4	AERO 244	Aero-Engines Workshop	1		
4	AERO 245	Aircraft Instruments and Systems	3	AERO 211	
4	GENG 221	Engineering Ethics	3	ENGL 203 MECH 290	
4	LISP 200	Information Skills and Search Techniques	1		ENGL 102
4	MECH 242	Engineering Vibrations	3	MATH 270 MECH 221	
4	MECH 243	Fluid Mechanics	3		MATH 202
4	MECH 244	Instrumentation and Experimentation II	1	MECH 212	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
5	AERO 231	Aircraft Dynamics and Control	3	AERO 232	
5	AERO 316	Fundamentals of Aircraft Design	3	AERO 232 AERO 234 GENG 221 GENG 222 MECH 290	MECH 387
5	AERO 344	Aircraft Propulsion Systems	3	MECH 232	
5	GENG 222	Sustainable Development for Engineers	3	ENGL 203 MECH 290	
5	MECH 241	Computational Techniques in Mechanical Engineering	3	CSIS 206 MATH 230 MECH 221	MATH 270, MECH 243
5	MECH 387	Design Tools in Mechanical and Aeronautical Engineering	3	MECH 243 CIVE 202 MECH 234	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
6	AERO 343	Helicopter Fundamentals	3	AERO 211 MECH 221	
6	AERO 346	Safety Management Systems	3		
6	CSPR XXX	Cultural Studies	3		
6	MECH 314	Gas Dynamics	3	MECH 243	

6	MECH 321	Heat Transfer	3	MECH 243	
6	MECH 325	Instrumentation and Experimentation III	1	MECH 244	
6	MECH 390	Undergraduate Design Project	1	AERO 316 or MECH 389	LISP 200
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
7	AERO 411	Advanced Aerodynamics	3	AERO 232 MECH 314	
7	AERO 413	Advanced Aircraft Structures	3	AERO 234	
7	MECH 412	Mechanics of Composite Materials	3	CIVE 202	
7	MECH 415	Turbomachinery	3	MECH 324 or AERO 344	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
8	AERO 421	Gas Turbine Propulsion Systems	3	AERO 344	
8	AERO 422	Aircraft Design II	3	AERO 316	
8	GENG 400	Engineering Seminars	1		
8	GENG 490	Graduation Project	3		
8	MECH 517	Finite Element Methods in Mech. and Aero. Eng.	3	CIVE 202	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
9	MECH 480	Field Training	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
10	GENG 490	Graduation Project (Reactivation)	0		
10	MECH 410	Material Characterization Lab.	1	CIVE 202 MECH 222 MECH 325	
10		Elective *	3		
10		Technical Elective*	3		
10		Technical Elective*	3		
		TOTAL	**147**		

The BE program in Mechanical Engineering (AERONAUTICAL SPECIALTY) does not offer any tracks.

It is highly advisable that mechanical engineering students (Aeronautical specialty) take CIVE 201 prior to MECH 221, and MECH 232 prior to MECH 243.

*One of the BE electives has to be a technical elective to be selected from courses from within the Mechanical Engineering Department. Any 300, 400 or 500-level MECH course (with prerequisite taken) that is not a required BS or BE course can be taken as a technical elective. The other BE elective can be either a technical elective from within the department (as defined above), or a course from outside the department with prior approval of the Chairperson of the Mechanical Engineering Department.

DEPARTMENT OF MECHANICAL ENGINEERING

Master of Science (MS) Degree – 46 Credits

Aeronautical Engineering Specialty

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

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

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

COURSE DESCRIPTIONS

AERO 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 **0.3: 1 cr. E**

This course 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.

Pre-requisite: AERO 221

AERO 231 AIRCRAFT DYNAMICS AND CONTROL **3.0: 3 cr. E**

This course covers the 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.

Pre-requisite: AERO 232

AERO 232 AERODYNAMICS OF FLIGHT **3.0: 3 cr. E**

This course presents the science of aerodynamics and its impact on aerial flight. The Standard Atmosphere and the definitions of Altitude (Geopotential, Geometric, Pressure, Temperature & Density). Conservation Equations and their applications in the modeling and measurement of incompressible and compressible flows. Wind Tunnels. Airfoils and wings and their pertinent aerodynamic parameters. High Lift devices. Aerodynamics of cylinders and spheres. Impact of aerodynamics on airplane performance.

Pre-requisite: AERO 211
Co-requisite: MECH 243

AERO 234 FUNDAMENTALS OF AIRCRAFT STRUCTURES **3.0: 3 cr. E**

This course aims to provide fundamentals of Structural System, Load classification, Basic Flight Loading Conditions, Flight Vehicle Aerodynamic Loads, Flight Vehicle Inertia Loads, Load Factors for Translational Acceleration, Velocity-Load Factor Diagram, Gust Load Factors, Stresses, Stress Equilibrium Equations, Strains and Strain-Displacement Relationships, Compatibility Equations for Plane Stress, Stress-Strain Relationships, Mechanical Properties of Materials, Fatigue, Strength-Weight Comparisons of Materials, Sandwich Construction, Force-Stress Relationships, Normal Stresses in Beams, Shear Stresses in Beams, Shear Center, Torsion of Closed-Section Box Beams, Work and Complementary Work, Strain and Complementary Energies, Principle of Virtual Displacements, Principle of Virtual Forces, Redundant Structures and the Unit-Load Method.

Pre-requisite: AERO 211, MECH 221
Co-requisite: CIVE 202

AERO 244 AERO-ENGINES WORKSHOP **0.3: 1 cr. E**

This course deals with engine constructions, identification of engine parts, assembly 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**

This course introduces the concepts of flight control systems, navigation instruments, engine control systems, fuel systems, hydraulic systems, pneumatic systems, mechanical and hydraulic systems, propulsion control systems, radar radio aids, cockpit displays, guidance and communication systems

Pre-requisite: AERO 211

AERO 316 FUNDAMENTALS OF AIRCRAFT DESIGN **3.0: 3 cr. E**

This course introduces the phases of Aircraft Design (Conceptual, Preliminary, Detail), Aircraft Conceptual Design Process, Empty Weight Estimation, Fuel Fraction Estimation, Mission Profiles, Lift to Drag ration Estimation, Takeoff Weight Calculation, Airfoil Selection, Wing Geometry (Aspect Ratio, Wing Sweep, Taper Ratio, Twist, Wing Incidence, Dihedral, Wing vertical location, Wing Tips), Biplane Wings, Tail Geometry and Arrangement-Tail Functions, Passenger Preferences, Passenger cabin layout, Fuselage Geometry, Airworthiness, Systems, Thrust-to-Weight Ratio, Power Loading and Horsepower-To-Weight, Statistical Estimation of T/W, Thrust Matching, Wing Loading, Stall Speed, Takeoff Distance, Catapult Takeoff, Landing Distance, Wing Loading, Tail Volume Coefficient, Control Surface Sizing, Configuration Layout & Loft, Aerodynamic considerations, Structural considerations, Radar detectability, Special Considerations, Propulsion Selection, Jet-Engine Integration, Propeller-Engine Integration, Fuel System, Landing Gear Arrangements, Tire Sizing, Shock Absorbers, Castoring-Wheel Geometry, Gear-Retraction Geometry, Seaplanes, Subsystems.

Pre-requisites: AERO 232, AERO 234, GENG 221, GENG 222
MECH 290Co-requisite: MECH 387

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, momentum theory blade element analysis, and basic helicopter performance.

Pre-requisites: AERO 211, MECH 221

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

This course covers basic principles of aircraft propulsion. Basic theory of thrust generation, Differences between propeller and jet driven aircraft. Piston engines and propeller power-plants as used on light aircraft, Gas Turbine engines of the various types. Of particular importance is the thermodynamics performance analyses as well as thrust calculations for the different engines.

Pre-requisites: MECH 232

AERO 346 SAFETY MANAGEMENT SYSTEMS **3.0: 3 cr. E**

This course introduces the students to the basic concepts of safety and the modern approach to safety management. The course will go through the process of planning and implementing a SMS by discussing each of the components and elements and showing how they fit in the management system. Students will learn what makes each element important and how to ensure it is efficient and effective.

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

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

Pre-requisites: AERO 232, MECH 314

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

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

Pre-requisite: AERO 234

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

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

Pre-requisite: AERO 344

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

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

Pre-requisite: AERO 316

MECH 211 MECHANICAL DRAWING I **1.2: 1 cr. E**

Engineering drawings are the language of the engineers and technicians. Therefore, the intent of this course is to equip students with the fundamentals of this unique language, to give them the necessary skills, and to prepare complete, concise, and accurate communications through engineering drawings using AutoCAD.

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

This lab course, the first in a series, is designed to introduce students to instrumentation and experimentation, in order to apply learnt methodologies and techniques to various experimental cases and build lab competencies through practical experiments. Typical experiments are in the areas of Basic Physics, Science of Materials, Engineering Dynamics, Mechanics of Materials, Mechanical Testing, Mechanisms, etc. Special emphasis is exercised on safety within a mechanical engineering laboratory environment, on modern data acquisition techniques as well as data presentation and reporting. The course also helps students develop the ability to work within a team and understand the measurement theory and confidence in measurement.

MECH 221 ENGINEERING DYNAMICS **3.0: 3 cr. E**

This course covers the concepts of kinematics and kinetics of particles: Force, acceleration, work, energy and momentum. Two-dimensional kinematics and kinetics of rigid bodies, translational and rotational motions.

Pre-requisite: MATH 200

MECH 222 SCIENCE OF MATERIALS **3.0: 3 cr. E**

Historically, the development and advancement of societies have been intimately tied to the members' ability to produce and manipulate materials to fill their needs. In fact, early civilizations have been designated by the level of their materials' development (Stone Age, Bronze Age, and Iron Age). This course covers introductory and fundamental concepts of materials, their science, their engineering and their different application, with a special focus on metals, ceramics and composites.

Co-requisite: ENGL 101

MECH 231 CIRCUIT FUNDAMENTALS **3.0: 3 cr. E**

This is an introductory course to electric circuit theory and electronics. Topics covered include fundamental definitions and laws; DC circuit analysis; mesh and nodal analysis; circuit theorems and analysis tools, AC circuit analysis, three-phase circuits, and basic electronic circuits and devices.

Pre-requisite: MATH 211

MECH 232 THERMODYNAMICS **3.0: 3 cr. E**

This is an introductory course which aims at providing students with theoretical background and the practical knowledge necessary to perform classical engineering analysis of basic open and closed thermodynamic systems.

The course is concerned with:

- the meaning of Thermodynamics and its areas of application,
- the various approaches to the study of Thermodynamics,
- concepts of open and closed Thermodynamic systems,
- the phases and properties of pure substances, states, processes and cycles,
- Work and Heat, laws of mass conservation and energy conservation (1st law of Thermodynamics),

Directional flow of Energy, Heat Engines and Refrigerators, The 2nd law of Thermodynamics, Efficiency, COP, Carnot Cycles, Irreversibility, Entropy.

MECH 233 WORKSHOP TECHNOLOGY **0.3: 1 cr. E**

This course constitutes a general introduction to the different activities in a mechanical engineering workshop environment. In addition to safety considerations, topics include metal and sheet metal work including cleaning, sizing, tolerances, marking, scribing, cutting, shaping, filing, drilling, grinding, tapping, joining, welding, riveting, surface finishing, cleaning, storing, etc. Students are given tasks on the above in the form of engineering drawings and need to conclude them using different hand tools, power tools and various other manufacturing machines.

MECH 234 MECHANICAL DRAWING II **0.3: 1 cr. E**

Engineers often need to provide assembled drawings and to give detailed information related to surface quality and tolerance. In addition, the elements of special machines such as fasteners and gears need to be provided in some engineering drawings. Therefore, the course aims to equip the students with 3D solid mechanical modeling knowhow. Learning this course is based on the ability to use SolidWorks.

Pre-requisite: MECH 211

MECH 241 COMPUTATIONAL TECHNIQUES IN MECHANICAL ENGINEERING **3.0: 3 cr. E**

This course intends to enhance the students' computational capacities by exposing them to 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-requisites: MATH 230, CSIS 206, MECH 221
Co-requisites: MECH 243, MATH 270

MECH 242 ENGINEERING VIBRATIONS 3.0: 3 cr. E
"Vibration is the branch of engineering that deals with repetitive motion of mechanical systems from machine parts to large structures". This course covers fundamental principles of mechanical vibrations. The basic concepts of understanding vibrations, analyzing vibrations and predicting the behavior of vibrating systems form the topics of this course.

Pre-requisites: MECH 221, MATH 270

MECH 243 FLUID MECHANICS 3.0: 3 cr. E
This course covers fundamental fluid properties; pressure distribution; hydrostatic forces on surfaces; buoyancy; integral relations for a control volume; Reynolds transport theorem, conservation of mass, linear momentum equation, Bernoulli and energy equations; differential relations for fluid flow; fluid acceleration field, mass conservation, linear momentum and energy equations; stream function; vorticity and irrotationality; frictionless irrotational flows, dimensional analysis and similarity; principle of dimensional homogeneity, Pi theorem, non-dimensionalization of the basic equations; modelling and its pitfalls; viscous flow in ducts; Reynolds number regimes, head loss, friction factor, minor or local losses in pipe systems.

Co-requisite: MATH 202

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 Fluid Mechanics, Thermodynamics, Steam Engine and Mechanics of Materials, etc. Special emphasis is exercised on modern data acquisition techniques as well as data presentation and reporting.

Pre-requisite: MECH 212

MECH 290 INTRODUCTION TO THE ENGINEERING DESIGN PROCESS 0.3: 1 cr. E
This course is a general introduction to the engineering profession, its main attributes, its design process, and its evolution over time. It emphasizes the engineering design process, its phases, challenges and constraints. The qualities and attributes of a modern day engineer as expected by professional engineering societies and boards; including integrity, professionalism, ethical conduct, care for the environment, as well as the role of the engineer in society are treated.

MECH 311 MECHANICAL DESIGN I 3.0: 3 cr. E
This course covers concept of stress, and principal stresses. Static failure theories for ductile and brittle materials and their applications. Curved beams, deflection of structural members, analysis and design of pressure vessels, columns, and shafts.

Pre-requisite: CIVE 202

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

This course is composed of two parts; 1-D Compressible Flows and Boundary Layers:

Part I: Boundary Layer Theory

The Boundary Layer Phenomenon (Observations, Causes, Forms and Effects), Boundary Layer Properties, Fundamental Equations for Viscous Flows (Navier-Stokes Equations & Momentum Integral Equation), The Boundary Layer Approximation, Exact Solution of Laminar Boundary Layers (Blasius), Approximate Solution Laminar Boundary Layers (Von-Karman), Turbulent Boundary Layers, Prandtl's Mixing Length Theory, Solution of Turbulent Boundary Layer.

Part II: Compressible Flows

Tools of the Trade: Revision of some basic concepts from Thermo-Fluids, Speed of Sound and Mach Number, Classification of Flows, Stagnation Properties, Isentropic Flows, Effect of area change on fluid speed & Mach number, Energy Equation for compressible flows, isentropic Flow Relations, Choking, Converging-Diverging Nozzles, Gas Tables, Normal Shock Waves and Operating Characteristics of Converging-Diverging Nozzles, Adiabatic Flow in Constant Area Ducts with Friction (Fanno Flows), Frictionless Flow in Constant Area Ducts with Heat Transfer (Rayleigh Flows).

Pre-requisite: MECH 243

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

This course provides principles of degrees of freedom of mechanisms. Kinematic analysis of linkages. Cam synthesis, kinematic requirements, and graphical and analytical design. Gear and gear trains. Introduction to synthesis of mechanisms.

Pre-requisite: MATH 230, MECH 221

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

This course covers fundamental concepts of Conduction, Convection, and Radiation. Students should identify the physical origins of transport processes, perform Heat Transfer Engineering calculations, apply Heat Transfer principles to tackle real-life applications, and perform problems-solving techniques applying appropriate simplifying assumptions.

Co-requisite: MECH 243

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

This course concentrates on power producing cycles, it is the second course in Thermodynamics. It is concerned with practical cycle variations leading to efficiency and/or work ratio augmentation. The course starts with a quick review of basic thermodynamics. It then presents different heat engine cycles, the basis of internal combustion engines. It also covers gas turbine units for power generation and aircraft propulsion applications. Steam power plants are also investigated based on Rankine cycle and their different modifications. Finally, combined steam-gas cycles are covered.

Pre-requisite: MECH 232

MECH 325 INSTRUMENTATION AND EXPERIMENTATION III **0.3: 1 cr. E**

This lab course, the third in a series, consolidates 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, Mechanical Testing, Vibrations, Mechanisms, etc. Special emphasis is exercised on modern data acquisition techniques as well as data presentation and reporting.

Pre-requisite: MECH 244

MECH 328 BASIC MANUFACTURING 3.0: 3 cr. E

The choice and design of manufacturing processes are key functions for the quality and cost-effectiveness of industrial production. Therefore, knowledge of manufacturing techniques is essential for mechanical engineers. Process designers should also have an understanding of this field because the responsibility for production costs begins with them. The students should be enabled to understand and evaluate work content and to plan simple manufacturing tasks. Knowledge should be conveyed in the following areas: Information about various processes and facilities for the production of individual parts, and mass production, as well as the integration of knowledge from the economic, and materials science fields.

Pre-requisites: MECH 222, MECH 234
Co-requisites: MECH 387

MECH 387 DESIGN TOOLS IN MECHANICAL AND AERONAUTICAL ENGINEERING 3.0: 3 cr. E

This computer-based course introduces the Finite Element Method and Computational Fluid Dynamics tools for designing, modelling, simulating, and analyzing practical engineering problems with hands-on experience using commercial software packages used in the industry. It tackles hand sketching, CAD modeling and CAE analysis in both FEM and CFD domains. The students are expected to self-learn certain topics not covered in the lectures. They are also expected to demonstrate their design skills through homework and a final group design project. This course also focuses on communication and teamwork skills through different assessments, especially through the group design project.

Pre-requisites: CIVE 202, MECH 234, MECH 243

MECH 389 SYSTEM DESIGN 3.0: 3 cr. E

This course, the first in a series of two (MECH 389 and MECH 390), provides mechanical engineering students with some applied practical experience in various design aspects of engineering. In a typical class, 12 to 15 students will start working together on a major system design project that has to be defined, discussed, and agreed upon at the beginning of the semester. They will conduct a literature survey on the subject, analyzing its components, and developing the materials necessary for its execution. The class will then be subdivided into small groups (3 to 4 students per group) with each group concentrating on a specific component of the global system. By the end of this course, the groups should be ready to integrate their acquired knowledge and their contributed parts into the global system in order to deliver the intended product and report on it by the end of the following semester under MECH 390 course.

Pre-requisites: GENG 221, GENG 222, MECH 290
Co-requisite: MECH 387

MECH 390 UNDERGRADUATE DESIGN PROJECT 0.3: 1 cr. E

This course encompasses the Bachelor of Science degree project executed by a group of students, usually 3-4 in a group. It is a capstone project with a culminating design experience that is typically offered in the second semester of the senior year. The students apply an integrated knowledge from their program of study to design a system in order to meet a desired need. This course builds on the System Design course, MECH 389, and allows students the opportunity to execute their design. Student teams revisit and complete the Embodiment and the Detail Design phases of the Engineering Design Process. Students revisit as well identified codes and standards and apply such knowledge to the development of their design. Student teams produce a design solution subject to realistic constraints by taking into consideration public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. Mathematical formulation of the problem is developed as well as a simulation and or

a physical prototype is developed. The team-design project is communicated to the public via three means: A Poster, a presentation, and a technical report.

Pre-requisite: MECH 389 or AERO 316
Co-requisite: LISP 200

MECH 410 MATERIAL CHARACTERIZATION LAB. 0.3: 1 cr. E
This course introduces the theoretical and practical framework for different methods used in the characterization of engineering materials. The laboratory portion of this course offers intensive instruction in the most widely practiced light microscopy methods and associated sample preparation. Particular emphasis will be placed on Microstructure characterization: grain sizing, phase identification, fiber orientation and fractography: cracks, fracture type, loading.

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

MECH 411 ADVANCED MECHANICS OF MATERIALS 3.0: 3 cr. E
This course provides theories of stress and strains. Linear elastic general anisotropic, orthotropic and isotropic material behaviors. Formulation of elasticity and boundary conditions. Plane stress and plane strain. Navier equations. Calculus of variations and its application to elasticity. Energy formulation. Unsymmetrical bending and shear center. Torsion of beams of noncircular cross-sections. If time permits, beams on elastic foundations will be covered as well.

Pre-requisites: MECH 311, CIVE 202

MECH 412 MECHANICS OF COMPOSITE MATERIALS 3.0: 3 cr. E
This course offers an introduction to composite materials, macromechanics of a lamina, 3-D constitutive equations, plane stress, lamina constitutive equations, thin plate theory, classical lamination theory, thermo-elastics lamination theory, failure analysis and design of laminate.

Pre-requisite: CIVE 202

MECH 413 INTERNAL COMBUSTION ENGINES 3.0: 3 cr. E
This course provides the fundamentals of how the design and operation of spark-ignition engines affect their performance and fuel requirements. We will study fluid flow, thermodynamics, combustion, heat transfer and friction phenomena, and fuel properties, relevant to engine power, efficiency, and emissions. We will also examine the design features and operating characteristics of different types of engines: Spark-ignition and diesel engines.

Pre-requisite: MECH 232

MECH 414 PROCESS CONTROL SYSTEMS 3.0: 3 cr. E
The course builds upon the foundation developed in previous course in Control System Theory. It covers advanced topics in analysis of process control systems such as Feedback control; Modeling and computer simulation of control systems; Discrete time models; Process control techniques; State Space methods applied to process control systems; Logic programming and devices.

MECH 415 TURBOMACHINERY 3.0: 3 cr. E
This course covers fundamental principles of turbomachinery. The objective is to introduce students to several types of turbomachines. Basic concepts and performance of turbines (gas, steam, wind, and hydraulic), compressors, fans, and pumps are incorporated. Axial and radial turbomachines are covered. Students are expected to have solid background in fluid mechanics and thermodynamics.

Pre-requisite: MECH 324 or AERO 344

MECH 421 REFRIGERATION AND AIR CONDITIONING 3.0: 3 cr. E
The course covers basic refrigeration cycles, psychrometrics and psychrometric processes, ventilating, U-values, heating and cooling loads, air-conditioning systems, ducts and pipe design.

Pre-requisite: MECH 321

MECH 422 MECHANICAL DESIGN II 3.0: 3 cr. E
This course aims to develop working ability for analysis, synthesis, and design with various mechanical elements such as permanent and nonpermanent joints, springs, bearings, breaks, clutches, flywheels, belts, shafts and axles.

Pre-requisites: MECH 311, CIVE 202

MECH 423 ADVANCED MANUFACTURING PROCESSES 3.0: 3 cr. E
This course teaches students different areas of manufacturing processes. It introduces students to Metal cutting, ASTM Standards, Surface finishing, Casting, Extrusion, Planning, Quality Control, Production and large volume manipulation. It also covers statistical techniques and decision-making. Students will develop professional and practical skills of different manufacturing and production areas to assist them in obtaining jobs.

Pre-requisite: MECH 323

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

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

Pre-requisite: MECH 314

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

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

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

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

Pre-requisite: MATH 230, MATH 202

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

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

Pre-requisite: MECH 314

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

Pre-requisite: MECH 232

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

Pre-requisite: MECH 221

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

Pre-requisite: CIVE 202

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

Pre-requisite: CIVE 202

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

Pre-requisite: MECH 222

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

Pre-requisite: MECH 521

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

Pre-requisite: MECH 521

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

MECH 526 ADVANCED FLUID MECHANICS 3.0: 3 cr. E
Analysis of important inviscid flows, Potential Flows, Stokes' Theorem, Circulation, Vorticity, Velocity Potentials and Stream Functions, Uniform Flows, Sources and Sinks, Vorticies and Doublets, Superposition, Lift and Drag over Cylinders, Transformations. Further Considerations of Viscous Flows,

Boundary Layers in External and Bounded Flows and Subject to Pressure Gradients, Boundary Layer Separation and Separation Control. Advanced experimental Techniques in Flow Measurement.

Pre-requisite: MECH 243

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

Pre-requisite: CIVE 202

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

Pre-requisite: MATH 230

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

Pre-requisite: CIVE 202

MECH 530 MULTI-RIGID BODY DYNAMICS I 3.0: 3 cr. E
This course provides concepts of vector differentiation. Kinematics: angular velocity, angular acceleration, differentiation in various reference frames, generalized speeds, partial angular velocities, and partial velocities. Mass distribution. Generalized forces and generalized inertia forces.

Pre-requisite: MECH 221

MECH 531 MULTI-RIGID BODY DYNAMICS II 3.0: 3 cr. E
This course introduces several energy functions: potential energy and contributing potential energy, dissipative functions, kinetic energy. Formulation of equations of motions: Dynamical equations and their linearization, systems at rest in a Newtonian reference frame and steady motion. Extraction of information from equations of motion: Energy integral and momentum integrals. Numerical integration of differential equations of motion.

Pre-requisite: MECH 530

MECH 532 THEORY OF ELASTICITY 3.0: 3 cr. E
This course covers Three-dimensional stress and strain at a point; equations of elasticity in Cartesian and curvilinear coordinates; methods of formulation of equations for solution; plane stress and plane strain; energy formulation. Solutions to problems of interest in Cartesian and curvilinear coordinates.

Pre-requisite: CIVE 202

Refer to General Listing of Course Descriptions for:

CHEM XXX
Refer to the Faculty of Arts and Sciences

CIVE XXX
Refer to the Department of Civil Engineering

CSIS XXX
Refer to the Faculty of Arts and Sciences

CSPR XXX
Refer to the Faculty of Arts and Sciences

ELEN XXX
Refer to the Department of Electrical Engineering

ENGL XXX
Refer to the Faculty of Arts and Sciences

ENMG XXX
Refer to the Department of Engineering Management

GENG XXX
Refer to the Faculty of Engineering Requirements

LISP XXX
Refer to the Faculty of Arts and Sciences

MATH XXX
Refer to the Faculty of Arts and Sciences

MGMT XXX
Refer to the Faculty of Business and Management

MRKT XXX
Refer to the Faculty of Business and Management

ENGINEERING MANAGEMENT PROGRAM

Master of Science (MS) Degree – 30 Credits

PROGRAM REQUIREMENTS

In order to be eligible for the Master in Engineering Management Program, a student must have had:

a. Minimum Entry Requirements: Bachelor of Engineering (BE) degree in either Civil, Mechanical, Electrical, Computer or Chemical Engineering,
b. or a Master of Science (MS) in either Civil, Mechanical, Electrical, Computer or Chemical Engineering, or a Master of Architecture (MArch),
c. Satisfy the requirements of the University of Balamand for admission into engineering graduate studies.

PROGRAM OF STUDY

All students pursuing a Master's Degree in Engineering Management must complete 30 credits as follows:

Course Type	Number of Courses	Total Credits
Core Courses	4	12
Elective Courses	4	12
Graduate Thesis	1	6
Total		**30**

Master of Science (MS) in Engineering Management (30 credits after BE of which a maximum of 9 credits may be transferred as electives)

Sem	Course Code	Course Title	Credit	Pre-Req	Co-Req
7	ENMG 422	Project Life Cycle Cost Management	3		
7	ENMG 555	Design and Planning of Engineering Systems	3		
7	GENG 450	Advanced Engineering Analysis and Research Methodology	3		
7		Elective	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
8	ENMG 460	Decision and Risk Management	3		
8	ENMG 435	Operations Management	3		
8	GENG 599	Master's Thesis	6	GENG 450	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
9					

Sem	Course Code	Course Title	Credit	Pre-Req	Co-Req
10		Elective	3		
10		Elective	3		
10	GENG 599	Master's Thesis (Re-activation)	0		
		TOTAL	**30**		
Elective (9 credits from the following lists or any graduate course from the Faculty Of Engineering):					
Structural Track:					
	ENMG 412	Engineering Deterministic Modeling	3		
	ENMG 413	Engineering Decision Modeling	3		
	ENMG 423	Financial Management of Projects	3		
	ENMG 424	Project Procurement Management	3		
	ENMG 432	Modern Techniques in Human Resources Management	3		
	ENMG 514	Engineering Network Modeling	3		
	ENMG 515	Engineering Stochastic Modeling			
	ENMG 516	Advanced Topics in Engineering Modeling	3		
	ENMG 517	Advanced Engineering Statistics	3		
	ENMG 520	Project Management for Professionals	3		
	ENMG 521	Project Risk Management	3		
	ENMG 522	Maintainability and Reliability Management	3		
	ENMG 523	Advanced Topics in Project Management	3		
	ENMG 536	Leadership and Professional Responsibility			
	ENMG 585	Quality Assurance and Control			
	CIVE 422	Simulation of Construction Operations			
	CIVE 427	Construction Cost Management			
	CIVE 428	Construction Safety Management			
	CIVE 429	Construction Contract Management			
	CIVE 431	Civil Infrastructure Management			
	CIVE 438	Green Building and Sustainability			
	CIVE 568	Management of Civil Engineering Systems			
	GENG 402	Project Management			
	Or any CIVE, MECH, CHEM, ELEN, COMP, AERO and ARCH graduate course				

COURSE DESCRIPTIONS

ENMG 412 ENGINEERING DETERMINISTIC MODELING 3.0: 3 cr. E.
This course focuses on the main deterministic models of engineering problems, and on methods of solutions. The course consists of:

- math modeling of linear programming models, linear programming and simplex method, duality of linear programming models, sensitivity analysis of linear programming models
- math modeling of binary integer programming and mixed integer programming models, intuitive solution method of integer programming method, and branch and bound solution method of integer programming models

ENMG 413 ENGINEERING DECISION MODELING 3.0: 3 cr. E.
This course focuses on the multi-criteria decision making methods, and their application to engineering problems. The course consists of modeling and solving:

- the multi-attribute utility theory models
- the simple multi-attribute rating theory
- the analytic hierarchy process
- the p reference ranking organization method for enrichment of evaluations
- the technique for order of preference by similarity to ideal solution
- group decisions methods
- sensitivity analysis in decision making

ENMG 422 PROJECT LIFE CYCLE COST MANAGEMENT 3.0: 3 cr. E.
The course focuses on the cost and economics analysis of engineering projects. It consists of:

- capital cost estimation
- maintenance cost estimation
- advanced engineering economy
- life cycle cost analysis
- replacement analysis
- break-even analysis
- depreciation
- taxes evaluation

ENMG 423 FINANCIAL MANAGEMENT OF PROJECTS 3.0: 3 cr. E.
This course focuses on the financial evaluation, and accounting of engineering projects. The course consists of:

- accounting procedures
- financial statements
- evaluation of financial ratios
- administration of projects

ENMG 424 PROJECT PROCUREMENT MANAGEMENT 3.0: 3 cr. E.
The course consists of:

- overview of project organizations
- the design-build project delivery approach
- the build-operate-transfer project delivery approach
- innovative delivery approaches, financial schemes, and associated contracts
- allocation of risks in contracts
- bidding phase characteristics

- components of the proposal package
- evaluation of the financial, and technical components
- contract formation and agreement closure.

ENMG 432 MODERN TECHNIQUES IN HUMAN RESOURCES MANAGEMENT 3.0: 3 cr. E.
The purpose of this course is to provide an overview of human resource management, with particular emphasize on the modern approach of total quality management in performance assessment, leadership skills, and the motivation and reward systems. The course aims at providing the following benefits:

- understand human resource management from a systemic, strategic perspective,
- describe the field of "human resource management" and understand its relevance to managers and employees in work organizations
- recognize basic human resource management tools such as performance appraisal forms, and understand some of the technical details of human resource management practices
- analyze business challenges involving human resource systems

ENMG 435 OPERATIONS MANAGEMENT 3.0: 3 cr. E.
This course focuses on business processes, procedures, analytic methods and strategies used to transform various inputs into finished goods and services. The main course aim is to familiarize students with the problems and issues confronting operations managers, and provide them with language, concepts, insights and tools to deal with these issues in order to gain competitive advantage through operations. Operational issues include designing, acquiring, operating, and maintaining the facilities and processes; purchasing raw materials; controlling and maintaining inventories; and providing the proper labour needed to produce a good or service so that customers' expectations are met.

ENMG 460 DECISION AND RISK MANAGEMENT 3.0: 3 cr. E.
This course introduces risk and decision analysis, with special attention to the decisions in project management. This course is divided into 3 parts:

- Part 1: introduction to risk and decision analysis
- Part 2: modeling and inputs
- Part 3: special topics

It deals with decision analysis process, decision policy, utility and multi-criteria decision, decision tress, Monte Carlo simulation, probability distribution types, and other topics.

ENMG 514 ENGINEERING NETWORK MODELING 3.0: 3 cr. E.
Engineering network problems, a subclass of linear programming, have wide-ranging applications in domains such as transportation, manufacturing, supply chains, and project management. This course focuses on the theory and specialized algorithms for the minimum cost network flow problem and its special cases, such as the shortest path and maximum flow problems, the minimum cost flow problem, and the multi-commodity flow problem as well as some extensions. Network flows is probably the most relevant graph theoretic topic for practical applications. A large number of practical problems can be formulated and solved efficiently as a flow problem.

ENMG 515 ENGINEERING STOCHASTIC MODELING 3.0: 3 cr. E.
This course focuses on the main stochastic models of engineering problems. The course consists of:

- modeling and solving decision trees
- modeling and solving queuing models
- modeling and solving markov chain models
- modeling and solving models using Monte Carlo simulation

ENMG 516 ADVANCED TOPICS IN ENGINEERING MODELING 3.0: 3 cr. E.
This course covers two important aspects of artificial intelligence: The theory of fuzzy sets and its use in decision making, and fuzzy logics such as Boolean logic, multi-valued logics, and approximate reasoning. It introduces applications of fuzzy logic in several areas such as fuzzy control and fuzzy decision making.

ENMG 517 ADVANCED ENGINEERING STATISTICS 3.0: 3 cr. E.
This course focuses on how to manipulate and analyze design of experiments for different areas of engineering problems. It introduces students to planning, experiments control, production and large volume manipulation. It also covers statistical techniques such as discriminant analysis, and decision making. The course covers the following topics:

- practical tools for effective experimentation
- optimizing processes using response surface methods for design of experiments,
- mixture design, response modeling, statistical analysis and numerical optimization
- practical aspects of algorithmic design of physical experiments
- graphical optimization and interactions

ENMG 520 PROJECT MANAGEMENT FOR PROFESSIONALS 3.0: 3 cr. E.
This course is designed for project managers/students to revise, advance their skills, and prepare for the PMI certification exam. The student will go through the key skills needed to ensure a successful project delivery. Course contents include the following: starting an advanced project successfully, building the macro plan, building the detailed project plan, building the project team, how to run the project on day-to-day basis, monitoring and controlling the project, successfully shutting down the project, and emergency actions. The course exams reflect the PMP examination methods.

ENMG 521 PROJECT RISK MANAGEMENT 3.0: 3 cr. E.
This course focuses on identifying and evaluating risks in projects, and preparing mitigation plans. The course tackles risk in the scope of work, in the schedule, in the cost, in human resources. Moreover, the course teaches quantitative and qualitative assessment methods of risk, and Monte Carlo simulation technique.

ENMG 522 MAINTAINABILITY AND RELIABILITY MANAGEMENT 3.0: 3 cr. E.
This course focuses on reliability-centered maintenance of engineering systems. It deals of types of maintenance actions, schedule of maintenance actions, asset replacement, resource requirements of the maintenance operation, optimization issues in asset management. The course consists of:

- reliability theory
- areas of maintenance and replacement
- optimization models and analysis
- preventive replacement intervals
- condition-based maintenance actions
- capital equipment replacement
- maintenance resource requirements

ENMG 523 ADVANCED TOPICS IN PROJECT MANAGEMENT 3.0: 3 cr. E.
This course focuses on advanced topics in project management (that may change from term to term). The course deals with important topics such as:

- trade off analysis
- critical chain management
- learning curves
- claims and disputes

ENMG 536 LEADERSHIP AND PROFESSIONAL RESPONSIBILITY 3.0:3 cr. E.
This course is designed to teach three primary components of leadership: group behavior, hard skills and logistical aspects of leadership and professional responsibility. This course considers:

- the role of business in society, on a local, national, and global basis
- economic and ethical aspects of acting as a business professional and the responsibilities that these imply
- several models or themes of "leadership" and their application to business

ENMG 555 DESIGN AND PLANNING OF ENGINEERING SYSTEMS 3.0:3 cr. E.
This course is designed to assist engineers in understanding engineering systems theory concepts. Emphasis is placed on engineering problem formulation, model development, system analysis methods and techniques, problem solving methods and solution implementation.

ENMG 585 QUALITY ASSURANCE AND CONTROL 3.0: 3 cr. E
This is a practical course in quality management, quality standards and their application in engineering. The course provides a set of tools that can be used in any business to define, monitor, and control quality. Statistical quality control techniques, quality control specifications and standards, benchmarking, and quality function deployment will be covered.

FACULTY OF ENGINEERING GENERAL COURSES

ENVE 401 WATER RESOURCES ENGINEERING **3.0: 3 cr. E**

This course covers the principles of ground-water development. Techniques for analyzing rainfall, runoff, fluid flow, reservoir siting, aquifer and groundwater flows. Design of reservoirs, conduits, water distribution systems, well fields, transmission lines, sewers, and drains. Well pumps. Stresses in pipes; materials and design of pipes; Metallic corrosion. Storage and distributing reservoirs, construction and maintenance. Water supply system appurtenances and special structures. Population growth and its effects on water supply requirements.

GENG 221 ENGINEERING ETHICS **3.0: 3 cr. E**

This course introduces and reinforces the concepts, theories, and practice of engineering ethics and aims at providing basic knowledge of ethics for engineers in different types of work roles. It prepares the engineering students for identifying, taking responsibility for, and finding solutions to potential ethical problems/cases. It provides students with an interactive study of ethical theory and the development of professionalism and helps them think more clearly and deeply about ethical issues of the natures that engineers often face in professional practice, and explore resources, strategies, and options for dealing with such complications. Students review case studies of ethical conflicts in engineering practice. The course also covers engineering codes of ethics and requires students to resolve theoretical situations through the application of ethical codes.
(A core BS course as of 2023/24 to replace a CSPR XXX course for students who started from year 2022/2023. Previous students can take it as an equivalent of a CSPR XXX course if they have not already taken the required 3 CSPR XXX courses)

Pre-requisite: CHEN/CIVE/ELCP/MECH/290 (according to discipline), ENGL 203

GENG 222 SUSTAINABLE DEVELOPMENT FOR ENGINEERS **3.0: 3 cr. E**

This course introduces the fundamental and advanced concepts of sustainable development. It transitions students' understanding of the UN Sustainable Development Goals (SDGs) to focus specifically on the critical role of engineers in achieving these SDGs. Students should then be able to resolve problems by adopting sustainability principles, which should in turn reflect on the students' multidisciplinary design ability to ensure a proper sustainable design process to improve and preserve the quality of life for future generations.
(A core BS course as of 2023/24 to replace a CSPR XXX course for students who started from year 2022/2023. Previous students can take it as an equivalent of a CSPR XXX course if they have not already taken the required 3 CSPR XXX courses)

Pre-requisite: CHEN/CIVE/ELCP/MECH/290 (according to discipline), ENGL 203

GENG 311 ENGINEERING MANAGEMENT AND ECONOMICS **3.0: 3 cr. E**

Engineers with excellent managerial skills and superior economic acumen are needed as leader of the new century engineering world. This course prepares engineers to fulfill their managerial responsibilities and acquire useful economic perspectives. This course is organized to contain two major parts: (I) Functions of engineering management, and (II) Economic fundamentals for engineering managers. Part (I) introduces the basic functions on engineering management such as planning, organizing, leading and controlling, while part (II) covers the fundamentals of engineering economics.

GENG 400 ENGINEERING SEMINARS **2.0: 1 cr. E**

This module consists of lectures and seminars covering recent research and advances in various fields and applications of engineering disciplines.

GENG 402 PROJECT MANAGEMENT **3.0: 3 cr. E**

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

GENG 450 ADVANCED ENGINEERING ANALYSIS AND RESEARCH METHODS 3.0: 3cr. E

The aim of this course is to train MS students in the methodologies used for research. Starting from existing literature, students will learn the formulation and development of original research problems in engineering management and civil engineering. The focus of the course is how to plan, prepare and present research manuscripts, such theses, and papers. Overview of the most popular modeling techniques, and statistical sampling methods used for engineering research.

GENG 490 GRADUATION PROJECT **3.X: 3 cr. E**

An approved final design project.

GENG 599 MASTER'S THESIS **6.X: 6 cr. E**

An approved final thesis project.