

## **DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING**

|                                |  |
|--------------------------------|--|
| <b>Chairperson</b>             | <i>Ziad Osman</i>  |
| <b>Professors</b>              | <i>Soubhi Abou Chahine, Ali Haidar</i>   |
| <b>Associate Professors</b>    | <i>Mohamad Ayache, Hamza Issa, Mohamad Tarnini, Chadi Nohra,</i>   |
| <b>Assistant Professors</b>    | <i>Heba Halabi, Manal Fattoum , Rami Khodor, Abdallah Sabbagh, Abdallah Ghali, Bilal Youssef, Ziad Doughan, Amira Zaylaa, Alaa Daher, Majeed AbedRahman, Abdul rahman El falou</i> |
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### ***Communications and Electronics Engineering Program***

#### ***Mission***

The educational mission of Communications & Electronics Engineering (CEE) Program is to deliver high quality undergraduate education which combines balanced theoretical and practical topics in Communications & Electronics Engineering. Graduates of the program will have a mastery of fundamental knowledge in a variety of Communications & Electronics Engineering fields, management, and entrepreneurial skills. Graduates will be qualified to pursue successful careers in their profession or graduate studies in different areas.

#### ***Objectives***

The educational objectives of the program are determined to support career advancement of the graduates as they pursue their career goals. The graduates will:

1. Design, optimize and maintain communication systems in tune with community needs and environmental concerns
2. Be able to develop and integrate new technologies as they emerge
3. Engage in a technical/managerial role in diverse teams
4. Pursue entrepreneurial initiatives and launch startup companies
5. Communicate effectively and use resources skillfully in projects development

#### ***Learning Outcomes***

UPON COMPLETION OF THE PROGRAM GRADUATES SHALL HAVE:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

#### ***Degree Requirements***

The undergraduate curriculum for the degree of Bachelor of Engineering in Communications and Electronics Engineering consists of 150 credit-hours of course work + IC003+ 30 credits transferred from Lebanese Baccalaureate or equivalent.

#### ***Career opportunities***

The Communications and Electronics Career Field encompasses the functions of installing, modifying, maintaining,

repairing, and overhauling ground television, telephone and mobile equipment, ground weather equipment, air traffic control, aircraft control and warning, automatic tracking radar equipment, simulator and training systems, microwave, fixed and mobile radio equipment, space communications systems equipment, high-speed general and special purpose data processing equipment, automatic communications and cryptographic machine system, electromechanical equipment, and electronic equipment associated to all the previous mentioned systems. Most of these applications find place in several companies in Lebanon, the Arab world and the whole world in general, providing, hence, the possibility for the CEE program students to find jobs in the field they like most and almost everywhere in the world.

### Program Overview

The **Student's Study Plan** is given to every CEE student upon his/her enrollment. The CEE curriculum consists of the following components:

| <b>I. Common Requirements</b>                  | <b>Credits</b> |
|--|----------------|
| General Education Requirements                 | 20             |
| Basic Sciences and Mathematics                 | 26             |
| General Engineering topics                     | 9              |
| <b>II. CEE Program-Specific Requirements</b>   | <b>Credits</b> |
| A. Engineering topics from outside the program | 24             |
| B. CEE Core                                    | 54             |
| C. CEE Technical Electives                     | 12             |
| D. Final Year Project                          | 4              |
| E. Internship                                  | 1              |

#### I. Common Requirements

The list of the Common Requirement courses and their descriptions are presented in the introductory pages of the Faculty of Engineering section in this catalog. In particular, the CEE curriculum includes 9 credits offered as general engineering topics. These courses are listed in the table below.

| <b>Code</b> | <b>Name</b>         | <b>Crs.</b> |
|-------------|---------------------|-------------|
| MCHE 213    | Dynamics            | 3           |
| COMP 208    | Programming I       | 3           |
| INME 221    | Engineering Economy | 3           |

#### II. CEE Program-Specific Requirements

##### A. Engineering Topics from outside the major

This part of the CEE curriculum includes 24 credits courses offered by other engineering programs. These courses are listed in the table below.

| <b>Course</b> | <b>Title</b>                             | <b>Credits</b> | <b>Pre-/Co-requisites</b> |
|---------------|--|----------------|---------------------------|
| COMP 210      | Programming II                           | 3              | Pre: COMP 208             |
| COMP 225      | Digital Systems I                        | 3              |                           |
| COMP 226      | Digital Systems II                       | 3              | COMP 225                  |
| COMP 328      | CPU Design                               | 3              | COMP 226                  |
| COMP 426      | Microprocessor Interfacing               | 3              | COMP 328                  |
| POWE 212      | Electric Circuits I                      | 3              |                           |
| POWE 271      | Electromagnetic Fundamentals             | 3              | Pre: PHYS 281             |
| POWE 425      | Introduction to Electrical Power Systems | 3              | Pre: POWE 271             |

*Descriptions of this group of courses are given below:*

**COMP 210 PROGRAMMING II (3Crs.: 2Lec, 2Lab):** Recursion. Arrays, sorting and searching. Pointers. Functions (call by reference). Character and strings. Structures, union, and bit manipulation. File operations, sequential and random. Preprocessing directives. *Pre-requisite.: COMP 208.*

**COMP 225 DIGITAL SYSTEMS I (3Crs.: 2Lec, 2Lab):** Number systems and coding, Binary systems. Conversion from decimal to other bases. BCD numbers. Boolean algebra. Logic gates. Function minimization,

Tabular method, Karnaugh mapping. Arithmetic functions and circuits designs (HA, FA, and ALU). Combinational functions and circuits design (decoder, encoder, multiplexer and de-multiplexer). Sequential circuits definitions and designs (Latches, RS-FF, D-FF, JK-FF, T-FF). Several laboratory experiments will be based on the simple logic gates.

**COMP 226 DIGITAL SYSTEMS II (3Crs.: 2Lec, 2Lab):** Latches and flip-flops. Synchronous and asynchronous sequential systems. Design of sequential circuits using state diagrams. Registers and Counters. Programmable logic devices (PAL and PLA). Control and Datapath units. Cache memory concept. Serial data transfer for multiple registers. Types of RAM and ROM. Cache memory concept. ALU functions and circuits. Binary multipliers. BCD functions and circuits. Several laboratory experiments and projects will be based on course topics. *Pre-req.: COMP 225.*

**COMP 328 CPU DESIGN (3Crs.:2Lec, 2Lab):** This course introduces the design of a generic central processing unit (CPU), focusing on its role as the core of computer systems. Topics include arithmetic logic unit design, control unit design, registers, address, data, and control buses, with reference to standard implementations. Single and multi-core processors. Machine and assembly languages of a standard microprocessor are used to illustrate the design and its interface with upper layers such as operating systems, control drivers, and compilers. Several laboratory experiments will be based on microcontrollers. *Pre-requisite.: COMP 226.*

**COMP 426 MICROPROCESSOR INTERFACING (3 Crs.: 2Lec,2Lab):** Topics include assembly language programming, microprocessor software applications, PPI and interfacing techniques: I/O port design and handshaking protocols; I/O programming, I/O interface design, Direct Memory Access, data communications, interrupt control systems; parallel and serial interfaces; timers. Several laboratory experiments will be based on microprocessors and/or microcontrollers. *Pre-requisite: COMP 328 or COMP 325.*

**POWE 212 ELECTRIC CIRCUITS I (3 Crs.: 3Lec, 0Lab):** Circuit variables: voltage, current, power, and energy. Circuit elements: resistors, inductors, capacitors, voltage sources, and current sources. Circuit reduction techniques: series and parallel resistors and delta-to-wye transformation. Ohm's law. Kirchhoff's laws. DC and AC circuit analysis techniques: node-voltage and mesh-current methods, source transformations, Thévenin and Norton equivalent circuits, and maximum power transfer. Self and mutual inductances. AC steady-state power calculations. Balanced three-phase circuits.

**POWE 271 ELECTROMAGNETIC FUNDAMENTALS (3 Crs.: 3Lec,0Lab):** Three-dimensional orthogonal coordinate systems: Cartesian, Cylindrical and Spherical. Vector Analysis: Gradient, Divergence and Curl of fields, Divergence theorem, Stokes's theorem. Fundamental Postulates of Electrostatics in free space, Coulomb's Law in space, Gauss's Law in space. Material Media: Conductors and Dielectrics, Polarization, Electric Flux Density. Boundary Conditions. Capacitors and Electrostatic Energy. Poisson's Equation, Laplace's Equation, Method of Images, Boundary Value Problems, Steady Electric Currents: conduction and convection currents, equation of continuity, boundary conditions for current density. Resistance and Power calculations. Fundamental Postulates of Magnetostatics in free space, Biot-Savart law in space, Ampere's Law in space. Magnetic materials: Magnetization, Inductance and Magnetostatic Energy. Magnetic circuit analysis. Introduction to Magnetic Forces and Torques. Time varying fields: Faraday's Law for Electromagnetic Induction (stationary circuit in a time-varying magnetic field, Transformers, moving circuit in steady and time-varying magnetic fields), Maxwell's Equations, Electromagnetic boundary conditions. *Pre-requisite.: PHYS 281.*

**POWE 425 INTRODUCTION TO ELECTRICAL POWER SYSTEMS (3 Crs.: 3 Lec):** Overview of power system structure, single-phase and three-phase transformers, synchronous generators, transmission lines and induction motors. Low-voltage power distribution in residential buildings. *Pre-req: POWE 271.*

## B. Communications and Electronics Engineering Program Core

The CEE program core courses are listed in the table below:

| Course    | Title                       | Credits | Pre-/Co-requisites |
|-----------|-----------------------------|---------|--------------------|
| ENGR 002  | Introduction to Engineering | 2       |                    |
| COME 214  | Electric Circuits II        | 3       | Pre: POWE 212      |
| COME 212L | Electric Circuits Lab       | 1       | Co: COME 214       |
| COME 221  | Electronic Circuits I       | 3       | Pre: POWE 212      |
| COME 222  | Electronic Circuits II      | 3       | Pre: COME 221      |
| COME 222L | Electronic Circuits Lab     | 1       | Co: COME 222       |
| COME 372  | Propagation and Antennas I  | 4       | Pre: POWE 271      |

|           |                                     |   |                           |
|-----------|-------------------------------------|---|---------------------------|
| COME 381  | Signals and Systems                 | 3 |                           |
| COME 380  | Communication Theory and Systems I  | 3 | Pre: COME 381, MATH 381   |
| COME 384  | Digital Signal Processing           | 3 | Pre: COME 381             |
| COME 411  | Instrumentation                     | 3 | Pre: COME 221 or COME 223 |
| COME 473  | Propagation and Antennas II         | 3 | Pre: COME 372             |
| COME 473L | Propagation and Antennas Lab        | 1 | Co: COME 473              |
| COME 472  | Microwave Engineering               | 3 | Pre: COME 372             |
| COME 485  | Communication Theory and Systems II | 3 | Pre: COME 380             |
| COME 485L | Communication Lab                   | 1 | Co: COME 485              |
| COME 500  | Research Methodology                | 2 | Pre: ENGL 300             |
| COME 576  | Optical Communications              | 3 | Pre: POWE 271             |
| COME 573L | Microwave Lab                       | 1 | Pre: COME 472             |
| COME 580  | Communication Networks              | 3 | Pre: COMP 225             |
| COME 580L | Communication Networks Lab          | 1 | Co: COME 580              |
| COME 592  | Wireless Communication Systems      | 3 | Pre: COME 485             |
| COME 592L | Wireless Communications Lab         | 1 | Co: COME 592              |

### *Description of Core Courses*

**ENGR 002 INTRODUCTION TO ENGINEERING (2 Crs.: 2Lec, 0Lab):** Introduction the student to the engineering profession in general and the learning objectives that new students should attain, as aligned with the ABET requirements. Covering the basics of the engineering profession and engineering ethics. Introduction to the different engineering majors and to the learning objectives as specified by ABET. Insight into different engineering courses that are not technical in nature (e.g., engineering economy).

Engineering design tasks that allow the student to start thinking as engineers: problem definition, specification of constraints, investigation of different solution alternatives, implementation of best solution, writing technical reports. Fundamental tools and numerical software used in engineering. The tools and software covered could be generic or specific to a major.

**COME 214 ELECTRIC CIRCUITS II (3 Crs.: 3Lec, 0Lab):** Transient analysis, Laplace transform and its application to circuit analysis, two-port networks, frequency selective passive and active circuits. ***Pre-requisite: POWE 212.***

**COME 212L ELECTRIC CIRCUITS LAB (1 Cr.: 0Lec, 2Lab):** The content of this lab is directly related to the courses POWE 212, COME 214. ***Co-requisite: COME 214.***

**COME 221 ELECTRONIC CIRCUITS I (3 Crs.: 3Lec, 0Lab):** Introduction to semiconductor physics, junction diodes: construction, I-V characteristics, circuit models, applications, special purpose diodes: Zener diodes. Bipolar junction transistors (BJT) and field effect transistors (FET): types, physical structures, basic configurations, characteristic curves, circuit models, biasing circuits, small-signal amplifiers. ***Pre-requisite: POWE 212.***

**COME 222 ELECTRONIC CIRCUITS II (3 Crs.: 3Lec, 0Lab):** BJT and FET amplifiers: Types, circuit models, frequency response, differential and multistage amplifiers, large signal analysis and power amplifiers, operational amplifiers: Characteristics, applications, imperfections, feedback amplifiers, sinusoidal oscillators and multi-vibrators. ***Pre-requisite: COME 221.***

**COME 222L ELECTRONIC CIRCUITS LAB (1Cr.: 0Lec, 2Lab):** The content of this lab is directly related to the courses COME 221, COME 222. ***Co-requisite: COME 222.***

**COME 372 ANTENNAS & PROPAGATION I (4 Crs.: 4Lec, 0Lab):** Review of Maxwell's equations. Plane waves in material media. Polarization of waves. Poynting vector. Reflection and transmission of waves. Normal and oblique incidence. Propagation of electromagnetic waves in the atmosphere. High frequency transmission lines. Smith chart. Matching techniques. Rectangular and cylindrical waveguides. Antennas: propagation mechanism. Antennas parameters and radiation potentials. Linear antennas (elementary dipole, short dipole, linear dipole), antenna arrays. ***Pre-requisite: POWE 271.***

**COME 381 SIGNALS AND SYSTEMS (3 Crs.: 3Lec, 0Lab):** Signals and systems properties and classifications. Continuous Linear Time-Invariant systems. Analytical and graphical convolution and correlation. Fourier series and

Fourier Transform. Hilbert transform, pre-envelope, complex envelope. Laplace transform. Frequency spectra, energy and power spectra. Frequency response and transfer function, impulse response and step response. Analog Filter design. Butterworth and Chebyshev filters.

**COME 380 COMMUNICATION THEORY AND SYSTEMS I (3 Crs.: 3Lec, 0Lab):** Transmission and reception of analog signals (AM, FM, PM). Performance of analog modulation schemes in the presence of noise. Building block of a digital transmission system and the differences with analog transmission. Digital communication concepts: analog to digital conversion, pulse coded modulation, transmission and reception of digital signals; pulse shaping and digital modulation. *Pre-requisite: COME 381, MATH 381.*

**COME 384 DIGITAL SIGNAL PROCESSING (3 Crs.: 2Lec, 2Lab):** Sampling, Quantization and SQNR. Signal Reconstruction and anti-aliasing filter. Discrete time signals. Difference equations and impulse responses. BIBO stability. Digital convolution. Discrete Fourier Transform and Fast Fourier Transform. Z-transform. Digital filter frequency response and transfer function. Z-plane stability. Realization of digital filters. Methods of FIR and IIR filter designs. Digital Butterworth and Chebyshev filter designs. *Pre-requisite: COME 381 .*

**COME 411 INSTRUMENTATION (3 Crs. : 2 lec, 2 lab) :** Different types of transducers and their applications. Instruments used in measuring electrical quantities. Display instruments. Signal generators. Digital to analog and analog to digital conversion. Data acquisition systems components, hardware and software. *Pre-requisite: COME 221 or COME 223.*

**COME 473 ANTENNAS & PROPAGATION II (3 Crs.: 3Lec,0Lab):** Coaxial transmission lines, Microstrip transmission lines. Cavity resonators. Special Antennas: Loop antenna, Traveling wave antenna. Helical antenna. Yagi antenna, Aperture principles. Microwave antennas: Horn, parabolic and microstrip antennas. Introduction to radar systems. Introduction to line of sight radio links. Introduction to satellite systems. *Pre-requisite: COME372.*

**COME 473L PROPAGATION AND ANTENNAS LAB (1 Cr.: 0Lec, 2Lab):** The contents of this lab are directly related to the courses COME 372, COME 473. *Co-requisite: COME 473.*

**COME 472 MICROWAVE ENGINEERING (3 Crs.: 3Lec,0Lab):** Scattering parameters. Microwave instrumentations: Reflection coefficient measurements, transmission coefficient measurements, S-parameters measurements, power measurements, dielectric constant measurements, and frequency measurements. Microwave passive components design: T-junction, attenuators, isolators, circulators, couplers, filters. Microstrip components: Power dividers, hybrid couplers, coupled transmission lines, filters. *Pre-requisite: COME372.*

**COME 485 COMMUNICATION THEORY AND SYSTEMS II (3 Crs.: 3Lec, 0Lab):** Data transmission through information theoretic concepts: entropy and its use in the design of source coding algorithms, mutual information and its use in the definition of channel capacity, channel coding. Spectral and power efficiency of digital modulation schemes and their performance in the presence of noise. Advanced Intersymbol interference mitigation techniques (e.g., equalizers). *Pre-requisite: COME 380.*

**COME 485L COMMUNICATION LAB (1 Cr.: 0Lec, 2Lab):** The contents of this lab are directly related to the courses COME 380, COME 485. *Co-requisite: COME 485.*

**COME 499 INTERNSHIP (1Cr):** This is a professional training which should not be less than four weeks. The training is followed by a presentation session where the students are supposed to present what they have learned. *Refer to the department policy for further details.*

**COME 500 RESEARCH METHODOLOGY (2 Crs.: 2Lec, 0Lab):** Why to Conduct Scientific Research, Stepping in: Research Methodology, formulating a research problem, conceptualizing a research design, constructing an instrument for data collection, selecting samples, writing a research proposal, collecting data, processing & displaying data, writing a research report. Conducting Scientific Research at the faculty of Engineering. *Pre-requisite: ENGL 300*

**COME 501 FINAL YEAR PROJECT I (1Cr) / COME 502 FINAL YEAR PROJECT II (3Crs):** After completing 120 credits of course work, the student becomes eligible to sign up for the Final Year Project (FYP) that extends over two semesters; beginning in Fall-semester and ending in the following Spring-semester. The FYP experience requires students to work in teams to complete a specific project, submit a technical report, and give a presentation on a significant, relevant, and comprehensive engineering problem. The FYP is intended to stimulate student creativity and critical thinking, and build skills in formulating, designing, developing, building,

communicating, and managing engineering projects. The project aims to provide students with a transitional experience from the academic world to the professional world. **Pre/Co-requisite: COME 500 , Coreq for COME 501, COME 501 Pre INME221\* ,COME501 Prereq for COME 502 . (\* starting from Spring2023-2024)**

**COME 576 OPTICAL COMMUNICATIONS (3 Crs.: 3Lec, 0Lab):** Review of basic communication systems. Introduction to optical communication systems. Fiber characteristics. Impact of different types of dispersion on bit rates. Optical transmitters and receivers. Lasers. Optical amplifiers. Long haul and multi-channel systems. **Pre-requisite: POWE 271.**

**COME 573L MICROWAVE LAB (1 Cr.: 0Lec, 2Lab):** The contents of this lab are directly related to the courses COME 472. **Pre-requisite: COME 472.**

**COME 580 COMMUNICATION NETWORKS (3 Crs.: 3Lec, 0Lab):** Networking topologies and architecture. TCP/IP protocol stack: application layer, transport layer, network layer, data link layer, physical layer. Network security. Implementation of networking concepts in current communication technologies. Introduction to emerging topics in communication networks. **Pre-requisite: COMP 225**

**COME 580L COMMUNICATION NETWORKS LAB (1 Cr.: 0Lec, 2Lab):** This lab covers topics discussed in COME 580. **Co-requisite: COME 580.**

**COME 592 WIRELESS COMMUNICATION SYSTEMS (3 Crs.: 3Lec, 0Lab):** Fundamental theoretical concepts in wireless communication systems. Characterization and modeling of the wireless channel, Performance of digital communication schemes over wireless fading channels, spread spectrum techniques, diversity techniques, orthogonal frequency division multiplexing (OFDM). multiple-input multiple output (MIMO). Introduction to emerging topics in wireless communications. **Pre-requisite: COME 485.**

**COME 592L WIRELESS COMMUNICATIONS LAB (1 Cr.: 0Lec, 2Lab):** This lab covers topics discussed in COME 592. **Co-requisite: COME 592.**

### C. Communications and Electronics Engineering Program Technical Electives

The CEE curriculum includes 12-credit hour courses as technical electives, 6 of them can be taken from other programs. The courses are chosen from the courses listed in the table below, with their descriptions given thereafter.

| Course   | Title  | Credits | Pre-/Co-requisites    |
|----------|--|---------|-----------------------|
| COME 423 | Digital Integrated Circuits                      | 3       | COME 221              |
| COME 470 | Acoustics  | 3       | COME 372              |
| COME 478 | Microwave Transmission Networks                  | 3       | COME 485              |
| COME 528 | Radio Frequency Communication Circuits           | 3       | COME 222, COME 473    |
| COME 520 | Advanced Antenna Design                          | 3       | COME 473              |
| COME 535 | Embedded Systems                                 | 3       | COMP 426              |
| COME 537 | VLSI Design                                      | 3       | COME 221 and COMP 225 |
| COME 564 | Semiconductor Devices                            | 3       |                       |
| COME 576 | Millimeter Wave Integrated Circuit (MMIC) Design | 3       | COME 472              |
| COME 589 | Cellular Communications                          | 3       | COME 485              |

#### Description of Technical Elective Courses

**COME 423 DIGITAL INTEGRATED CIRCUITS (3 Crs.: 3Lec, 0Lab):** Overview of switching characteristics of bipolar and field effect transistors. BJT digital ICs: TTL, Schottky TTL, ECL, IIL. MOS digital ICs: NMOS, CMOS. A/D and D/A converters. **Pre-requisite: COME 221.**

**COME 470 ACOUSTICS (3 Crs.: 3Lec, 0Lab):** Fundamentals of sound. Acoustic wave equation. Sound levels and Decibel. Perception of sound. Loudness. Reverberation. Control of interfering noise. Absorption of sound. Reflection, diffraction, and refraction of sound. Acoustics design of enclosed spaces. **Pre-requisite: COME 372.**

**COME 478 MICROWAVE TRANSMISSION NETWORKS (3 Crs.: 3Lec, 0Lab):** Network topologies, systems configurations, frequency bands, performance planning objectives and available ITU recommendations, path profile and line of sight analysis, link budget and link performance prediction, diversity (types and improvement calculation), radio equipment and microwave antennas, frequency planning and interference calculation, introduction to microwave links planning tools. *Pre-requisite: COME 485.*

**COME 528 RADIO FREQUENCY COMMUNICATION CIRCUITS (3 Crs.: 3Lec, 0Lab):** Radio frequency (RF) passive integrated circuit components: resistors, capacitors, inductors. Noise in electronic circuits. Low noise amplifier (LNA) design. RF mixers. RF power amplifiers. RF phase locked loops. RF oscillators and synthesizers. Use of computer aided design tools for RF design and simulation. *Pre-requisite: COME 222 and COME 473.*

**COME 520 ADVANCED ANTENNA DESIGN (3 Crs.: 3Lec, 0Lab):** Antenna measurements. Antenna arrays design and feeding networks. Smart antennas. Antennas beamforming. Antennas for wireless cellular networks. High power microwave antennas. *Pre-requisite: COME 473.*

**COME 535 EMBEDDED SYSTEMS (3 Crs.: 3Lec, 0Lab):** Overview of embedded systems: architecture, custom single purpose processors. Peripherals: Digital I/O, timers, counters, watchdog timers, interrupts, real time clocks, Serial protocols, interfacing, programming, interrupt driven routines, Applications. *Pre-requisite: COMP 426.*

**COME 537 VLSI DESIGN (3 Crs.: 3Lec, 0Lab):** MOS and BiCMOS technology. MOS and BiCMOS circuit design processes: MOS layers, Stick diagrams, design rules and layout. Basic VLSI circuit concepts: layer sheet resistance, layer area capacitance, delay unit, propagation delays, wiring capacitances. Structured design of combinational and sequential logic circuits. VLSI testability. Use of computer aided design tools for VLSI design and simulation. *Pre-requisite: COME 221 and COMP 225.*

**COME 564 SEMICONDUCTOR DEVICES (3 Crs.: 3Lec, 0Lab):** Carrier transport phenomena in semiconductors. Operation principles and device modeling of p-n junctions, metal-semiconductor contacts, bipolar and MOS transistors, and related devices. Silicon device fabrication technology: crystal growth, oxidation, diffusion, lithography, contacts and interconnections.

**COME 570 MILLIMETER WAVE INTEGRATED CIRCUIT (MMIC) DESIGN (3 Crs.: 3Lec, 0Lab):** Introduction to mm-Wave systems and applications. Introduction to MMIC Design: Merits, Limitations and Applications. Types of MMICs. Types of MMICs, Fabrication Techniques and Processes. Passive MMIC Elements: Capacitors, Inductors, Transmission line, Via holes, Power Dividers/Combiners and Couplers. Testing Passive MMIC Elements. Introduction to mmWave active elements. *Pre-requisite: COME 472.*

**COME 589 CELLULAR COMMUNICATIONS (3 Crs.: 3Lec, 0Lab)**

Cellular concept, cellular architecture and terminology, cellular network dimensioning, radio network planning and optimization. Cellular handover types that occur in real cellular systems. Drivers and advanced techniques for cellular evolution. Properties of 2G,3G, 4G technologies. Introduction to beyond 5G cellular technologies. *Pre-requisite: COME 485.*

#### **Description of Technical Electives Courses from outside the program**

**INME 482 ENGINEERING PROJECT MANAGEMENT (3 Crs.: 3 Lec):** The course covers the characteristics, techniques and challenges associated with initiating, planning, executing, controlling and closure of projects. Project management skills are discussed as they apply to projects, with special focus on leadership, teaming, and coordinating individual and group efforts. MS Project is introduced to provide hands-on practical skills with building a project plan, scheduling tasks, assigning resources, managing dependencies, monitoring progress and costs, keeping projects on track, and communicating project data through Gantt charts. *Prerequisite: ENGL 300.*

**COMP 424 Artificial Intelligence and Robotics for Engineers (3 Crs.: 3 Lec, 0Lab):** Introduction to artificial intelligence and machine learning. Introduction to robotics. Programming in Python: data type, expressions, functions, loops and control. Data plotting and analysis. Smart agent models. Supervised and unsupervised learning. Knowledge representation and reasoning. *Pre-requisite: COMP 208.*

**POWE 435 ELECTRIC MACHINERY I (3 Crs.: 3 Lec):** History of Electric Machinery. Magnetic circuits. Principles of energy conversion. Single-phase transformers: construction, theory of operation, equivalent circuit, power flow, regulation and testing, autotransformer, tap-change transformer. Three-phase transformers: connections, per-unit equivalent circuit and special connections. DC Machines: construction, theory of operation, armature reaction and commutation, induced voltage, developed torque and equivalent circuits for separately excited, series, parallel and compound DC generators and DC motors, starting methods of DC motors. PMDC motors and brushless DC motors: construction, theory of operation and applications. Introduction to DC motor drives. *Pre-req.: POWE 271.*

**POWE 433 POWER ELECTRONIC CIRCUITS I (3 Crs.: 3 Lec):** Introduction to power switches: diode, thyristor, triac, diac, GTO, BJT, MOSFET, IGBT, characteristics, modes of operation, selection of switches, firing circuit design and application, analysis and design of suitable circuits and subsystems for practical applications such as dimmer circuit and dc motor control circuit, calculation of switching losses, evaluation of THD and associated power losses. Rectifying circuits: single-phase and three-phase, uncontrolled, halfcontrolled and fully-controlled rectifiers for different types of passive loads, evaluation and demonstration of steady state voltages and currents, calculation of efficiency, PF and THD of such converters. Circuit analysis software such as PSIM, PROTEUS or MATLAB. *Pre-req.: COME 221.*

**POWE 342 CONTROL SYSTEMS I (3 Crs.: 3 Lec):** History and role of control systems. Transfer function models. Block diagram representation and reduction. Transient and steady-state response analyses. Rootlocus analysis and design. Frequency-response analysis and design. Simulation using MATLAB. *Pre-req.: MATH 283, COME 214.*

**COMP 215 PROGRAMMING FOR ENGINEERS (3Crs.: 2Lec, 2Lab):** Programming in Python for engineers: language, use of external libraries, runtime analysis, applications from data analysis and engineering. Topics include: Control statement and program development, functions, sequences: list and tuples, dictionaries and sets, a deeper look on strings, Array-Oriented Programming with NumPy, and plotting using Matplotlib. *Pre-req.: COMP 208*

*Note: Other courses can be added to the technical elective courses pool from outside the program as long as the pre-requisite of the specified course is already taken by the student.*

**Study Plan****Bachelor of Engineering in Communications and Electronics Engineering (150 Credits)**

| <b>First Semester (17 Credits)</b>  |                              | <b>Crs.</b> | <b>Pre/Co-requisites</b> |
|-------------------------------------|------------------------------|-------------|--------------------------|
| MATH 281                            | Linear Algebra               | 3           | -                        |
| MATH 282                            | Calculus                     | 3           | MATH_111                 |
| MCHE 213                            | Dynamics                     | 3           |                          |
| PHYS 281                            | Electricity and Magnetism    | 3           |                          |
| ENGR 002                            | Introduction to Engineering  | 2           |                          |
| BLAW001                             | Human Rights                 | 1           |                          |
| ARAB001                             | Arabic Language              | 2           |                          |
| <b>Second Semester (17 Credits)</b> |                              | <b>Crs.</b> | <b>Pre/Co-requisites</b> |
| COMP 225                            | Digital Systems I            | 3           |                          |
| MATH 283                            | Differential Equations       | 3           | Pre: MATH 281, MATH 282  |
| PHYS 282                            | Material Properties and Heat | 3           |                          |
| COMP 208                            | Programming I                | 3           |                          |
| POWE 212                            | Electric Circuits I          | 3           |                          |
| ENGL001                             | General English              | 2           |                          |
| <b>Summer I (9 Credits)</b>         |                              | <b>Crs.</b> | <b>Pre/Co-requisites</b> |
| CHEM 241                            | Principles of Chemistry      | 3           |                          |
| ENGL 211                            | Advanced Writing             | 2           | Pre: ENGL001             |
|                                     | Elective(General)            | 2           |                          |
|                                     | Elective(General)            | 2           |                          |
| <b>Third Semester (16 Credits)</b>  |                              | <b>Crs.</b> | <b>Pre/Co-requisites</b> |
| COMP 210                            | Programming II               | 3           | Pre: COMP 208            |
| COME 221                            | Electronic Circuits I        | 3           | Pre: POWE 212            |
| COME 214                            | Electric Circuits II         | 3           | Pre: POWE 212            |
| COME 212L                           | Electric Circuits LAB        | 1           | Co: COME 214             |
| POWE 271                            | Electromagnetic Fundamentals | 3           | Pre: PHYS281             |
| COMP 226                            | Digital Systems II           | 3           | Pre: COMP 225            |
| <b>Fourth Semester (18 Credits)</b> |                              | <b>Crs.</b> | <b>Pre/Co-requisites</b> |
| MATH 381                            | Probability and Statistics   | 3           | Pre: MATH 282            |
| MATH 284                            | Numerical Analysis           | 3           | Pre: MATH 283            |
| COMP 328                            | CPU Design                   | 3           | Pre: COMP 226            |
| COME 222                            | Electronic Circuits II       | 3           | Pre: COME 221            |
| COME 222L                           | Electronic Circuits LAB      | 1           | Co: COME 222             |
| INME 221                            | Engineering Economy          | 3           |                          |
| ENGL 300                            | Speech Communications        | 2           | Pre: ENGL 211            |

| <b>Summer II (9 Credits)</b> |                       | <b>Crs.</b> | <b>Pre/Co-requisites</b> |
|------------------------------|-----------------------|-------------|--------------------------|
| CHEM 405                     | Solid State Chemistry | 2           |                          |
| ENGR 001                     | Engineering Ethics    | 1           |                          |
|                              | Elective(General)     | 2           |                          |
| MGMT 002                     | Entrepreneurship      | 2           |                          |
|                              | Elective (General)    | 2           |                          |

| <b>Fifth Semester (16 Credits)</b> |  | <b>Crs.</b> | <b>Pre/Co-requisites</b> |
|------------------------------------|--|-------------|--------------------------|
| COME 411                           | Instrumentation                          | 3           | COME 221 or COME 223     |
| COMP 426                           | Microprocessor Interfacing               | 3           | Pre: COMP 328            |
| POWE 425                           | Introduction To Electrical Power Systems | 3           | Pre: POWE 271            |
| COME 372                           | Propagation and Antennas I               | 4           | Pre: POWE 271            |
| COME 381                           | Signals and Systems                      | 3           |                          |

| <b>Sixth Semester (17 Credits)</b> |                                    | <b>Crs.</b> | <b>Pre/Co-requisites</b> |
|------------------------------------|------------------------------------|-------------|--------------------------|
| COME 473                           | Propagation and Antennas II        | 3           | Pre: COME 372            |
| COME 473L                          | Propagation and Antennas Lab       | 1           | Co: COME 473             |
| COME 380                           | Communication Theory and Systems I | 3           | Pre: COME 381, MATH 381  |
| COME 580                           | Communication Networks             | 3           | COMP 225                 |
| COME 580L                          | Communication Networks LAB         | 1           | Co: COME 580             |
| COME384                            | Digital Signal Processing          | 3           | Pre: COME 381            |
|                                    | Technical Elective                 | 3           |                          |

| <b>Summer III (1 Credits)</b> |  | <b>Crs.</b> | <b>Pre/Co-requisites</b> |
|-------------------------------|--|-------------|--------------------------|
| COME 499                      | Internship (Approved Experience / Independent Study) | 1           |                          |

| <b>Seventh Semester (16 Credits)</b> |                                     | <b>Crs.</b> | <b>Pre/Co-requisites</b>       |
|--------------------------------------|-------------------------------------|-------------|--------------------------------|
| COME 576                             | Optical Communications              | 3           | Pre: POWE 271                  |
| COME 472                             | Microwave Engineering               | 3           | Pre: COME 372                  |
| COME 485                             | Communication Theory and Systems II | 3           | Pre: COME 380                  |
| COME 485L                            | Communication LAB                   | 1           | Co: COME 485                   |
| COME 500                             | Research Methodology                | 2           | Pre: ENGL 300                  |
| COME 501                             | Final Year Project I                | 1           | Pre/Co: COME 500,*Pre: INME221 |
|                                      | Technical Elective                  | 3           |                                |

| <b>Eighth Semester (14 Credits)</b> |                                | <b>Crs.</b> | <b>Pre/Co-requisites</b> |
|-------------------------------------|--------------------------------|-------------|--------------------------|
| COME 502                            | Final Year Project II          | 3           | Pre: COME 501            |
| COME 592                            | Wireless Communication Systems | 3           | Pre: COME 485            |
| COME 592L                           | Wireless Communications LAB    | 1           | Co: COME 592             |
| COME 573L                           | Microwave LAB                  | 1           | Pre: COME 472            |
|                                     | Technical Elective             | 3           |                          |
|                                     | Technical Elective             | 3           |                          |

\*: Starting from Spring 2023-2024

## **Courses offered to other majors**

**COME 480 DISCRETE-TIME SIGNALS AND SYSTEMS (3 Crs.: 3 Lec):** Digital signal processing scheme, sampling and quantization, digital signals properties and useful operations, digital systems properties and classifications, digital convolution. Discrete Fourier transform, fast Fourier transform,  $z$ -transform: properties, solution of difference equation and convolution using  $z$ -transform. Difference equations and digital filters,  $z$ -plane pole-zero plot stability, digital filter frequency response. Design of digital filters: FIR using Fourier transform design and window method, IIR using bilinear transformation design method. *Pre-req: POWE 342.*

**COME 221L ELECTRONIC CIRCUITS I LAB (1 Cr.: 2 Lab):** This lab serves the COME 221 course. *Co-req.: COME 221.*

**COME 223 DIGITAL ELECTRONICS (3 Crs.:2 Lec, 2 Lab):** Characteristics of bipolar and field effect transistors. Switching mode of operation. BJT digital families: TTL, Schottky TTL, ECL. MOS digital families: NMOS, CMOS. A/D and D/A converters. *Pre-req.: POWE 212.*

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