NAZARBAYEV UNIVERSITY
SCHOOL OF ENGINEERING AND DIGITAL SCIENCES

Bachelor of Engineering in Electrical and Electronic Engineering

Nazarbayev University

Degree requirements for the AY 2020-2021 Graduation Cohort

	Abbr/Number	Courses	Credits ECTS
Major requirements (222 credits)	BENG 117	Engineering Mechanics	6
	BENG 124/MATH 161	Engineering Mathematics I OR Calculus I	6
	BENG 145	Occupational & Environmental Health and Safety	6
	BENG 146/ENG 101	Programming for Engineers	6
	BENG 221	Engineering Materials	6
	BENG 225	Engineering Mathematics II	6
	BENG 201	Engineering Economy	6
	BENG 147	Introduction to Fluid Mechanics and Thermodynamics	6
	BENG 148	Engineering Practice	6
	BENG 114	Introduction to Electrical Systems	6
	BENG 228	Engineering Mathematics III	6
	EEE 250	Microelectronic Devices and Circuits	6
	BENG 215	Sensors and Actuators	6
	EEE 212	Signal and Systems	6
	EEE 251	Electronic Engineering Design Principles	6
	EEE 341	Digital Electronic Systems Design	6
	EEE 340	Data Communication	6
	EEE 211	Computer System Architecture	6
	BENG 219	Control Systems	6
	EEE 210	Software Engineering	6
	EEE 238	Digital Signal and Image Processing	6
	EEE 345	Power Electronics	6
	EEE 384	Digital Integrated Circuits Design	6
	BENG 405	Project Management	6
	EEE 342	Electromagnetics	6
	EEE 343	Embedded Microcontrollers	6
	EEE 239	Communication Systems	6
	EEE 489	Analog Circuits Design	6
	EEE 381	Electrical Machines and Drives	6
	EEE 379	Power Systems Analysis	6
	EEE 493	Industry 4.0	6
	EEE 437	Capstone Project I	6
	EEE 480	Capstone Project II	18
	BENG 312	Internship	12
General requirements (18 credits)	HST 100	History of Kazakhstan	6
	KAZ XXX	Kazakh Language Course	6
	KAZ XXX	Kazakh Language Course	6
Specific Electives (30 credits)		Discipline Elective 1	6
		Discipline Elective 2	6
		Discipline Elective 3	6
		Discipline Elective 4	6
		Discipline Elective 5	6
Total credits			**270**

List of EEE/ECE Discipline Elective courses (January 2021)

Notes:

1. *Elective courses could be changed time to time to address the industry demand and the faculty expertise.*
2. *Elective courses codes are subject to change*
3. *Selected elective courses codes can be taken instead from other SEDS departments upon agreement of an academic advisor (CSCI, ROBT, MAE, CHME, CEE coded courses)*

Devices and Circuits

EEE 450 RF and Microwave Circuit Design

EEE 486 Photonics for Engineers

EEE 494 Modern Characterizations for Semiconductor Industry

EEE 495 Fundamentals of Biomedical Engineering and Biophysics

Power Engineering and Control Systems

EEE 448 Power Transmission and Distribution plants

EEE 452 Power Systems Protection

EEE 484 Electric Power Generation

EEE 485 Power Systems Operation and Control

EEE 452 Power System Automation

EEE 451 High Voltage Engineering

ELCE 451 Electric Drives and Motion Control Systems

Signal Processing and Communications Systems

EEE 411 Special Topics in Signal Processing

EEE 497 Signal Processing for Communication

Computer Engineering

EEE 490 Introduction to Big Data

EEE 488 Numerical Optimization Techniques and Computer Applications

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DETAILED COURSE DESCRIPTIONS

Year 1, Fall Semester

Course Title 6 ECTS	**Engineering Mathematics I**
Course Descriptor	Differential and Integral calculus of real valued functions of single variable. Sequences, infinite series and power series. Elements of linear algebra: matrices, Eigen functions. Vector algebra and three-dimensional analytic geometry. Polar and Cartesian coordinates
Course LOs	1) Articulate scientific reasoning utilizing the formalism of differential calculus of single variable functions. 2) Demonstrate advanced skills on integral calculus. 3) Assemble mathematical techniques concerning series and matrices for solving engineering problems. 4) Analyze geometrical problems with vector algebra. 5) Compute analytically mathematical problems with the help of mathematical software. 6) Appraise numerically mathematical tasks using mathematical software.

Course Title 6 ECTS	**Engineering Mechanics**
Course Descriptor	This module consists of application of Newton's Laws to equilibrium of particle and rigid body and reactions developed internally and externally due to application of the loads and study of simple mechanical planar motion of a particle through consideration of forces, work, energy and momentum and its conservation using different coordinate systems.
Course LOs	1) Identify equilibrium conditions for a particle and rigid body. 2) Evaluate internal forces and moments developed in the rigid body due to external loading. 3) Apply the fundamentals of kinematics of particle in planar motion in different coordinate systems. 4) Analyze and evaluate motion of particle using work-energy and impulse-momentum concepts.

Course Title 6 ECTS	**Occupational, Environmental Health and Safety**
Course Descriptor	Introduction to Risk Management: Hazards Identification, Risk Assessment (Hazards Analysis) and Risk Control (including probabilities lectures) Occupational Health and Safety: Occupational Health Hazards, Ergonomics, Human Health Risk Assessment, Health and Safety Practice, Hazardous Chemicals, Personal Protective Equipment Environmental Health and Safety: Environmental Hazards, Indoor and Ambient Air Quality, Soil Pollution, Water Pollution, Solid Waste Management (including Hazardous Waste), Noise Pollution, Environmental Auditing and Impact Assessments, Guidelines, Standards and Regulations.
Course LOs	1) Identify what is Hazard, Risk, Barriers & Mitigation measures and perform hazard identification exercises 2) Apply Qualitative, semi-Quantitative and Quantitative/Probabilistic Risk Analysis methods 3) Identify and analyze the effects of toxic substances on health and the environment and how to implement appropriate environmental control measures 4) Develop employee health programs that will improve health in the work environment 5) Describe Occupational Hazards and explain the use of Personal Protective Equipment

Course Title 6 ECTS	**Engineering Materials**
Course Descriptor	The module covers the fundamentals of materials science and engineering. These include the understanding of the material structure from the atomic to micro to macro levels. The effects of the structure and the processing techniques on the material properties will be discussed. These concepts will be illustrated using metals to allow students to utilize the knowledge for materials selection in common engineering applications.
Course LOs	1) Explain the influences of microscopic structure and defects on material properties, including dislocation and strengthening mechanisms 2) Design and control heat treatment procedures to achieve a set of desirable mechanical characteristics for common metals 3) Evaluate the applications and processing of common engineering materials including metals & their alloys 4) Utilize the knowledge in materials selection processes taking further considerations of the economic, environmental and social issues

Course Title 6 ECTS	**Programming for Engineers**
Course Descriptor	This is an introductory course for programming essential for Engineering undergraduate study. The module would focus on the development of programming skills that can be directly applied to solve engineering problems where the computer is part of the system, or is used to model a physical or logical system. This module introduces programming as a tool for solving engineering problems through C and Java programming languages. This is an introductory course providing foundational programming to Chemical, Mechanical, Civil and Electrical Engineers.
Course LOs	1) Develop programming solutions to open ended engineering problems. 2) Infer alternate solutions to programming problems. 3) Develop software specifically using C and Java programming languages. 4) Apply knowledge of programming to solve practically relevant engineering problems. 5) Use the object-oriented concepts to write optimal and efficient codes.

Year 1, Spring Semester

Course Title 6 ECTS	**Engineering Mathematics II**
Course Descriptor	The calculus of multivariate functions The calculus of vector-valued functions Fourier series Elementary complex variable theory
Course LOs	1) Be able to differentiate a large array of multivariate functions using partial differentiation and the various partial derivative chain rules. 2) Use different functions, series and optimization methods. 3) Integrate scalar and vector fields along contours in three-dimensional space. 4) Express a line integral as a double integral, area integral as a triple integral. 5) Use *Mathematica/SAGE* to aid calculations and visualization.

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Course Title 6 ECTS	**Engineering Economy**
Course Descriptor	This course gives the student an understanding of how the use of capital is perceived by individual stakeholders in project economic analysis. The course answers the questions, why and how a financial feasibility assessment is performed, who should be involved, where and when it should be performed, what data should be used and how financial assessments should be presented. Additionally, this course will involve creative cost control discussions and introduction to Value Engineering (VE) methodology.
Course LOs	1) Evaluate decision making processes for project feasibility 2) Use economic decision making tools, including present worth, annual worth, benefit cost analysis, capitalized costs, rate of return, payback/breakeven analysis 3) Apply the principles of Value Engineering through team led projects 4) Evaluate basic economic and financial principles and their effects on project economics (supply/demand, inflation, cost of capital, depreciation and tax considerations)

Course Title 6 ECTS	**Introduction to Fluid Mechanics and Thermodynamics**
Course Descriptor	This course provides to the engineering student an introduction to the basic principles of Fluid Mechanics and Thermodynamics, and how to apply them to analyze an engineering problem. It includes an introduction to Fluid Mechanics (fluid properties, conservation laws applied to fluid flow, Bernoulli equation, dimensional analysis, flow visualization, integral flow analysis and fluid transport through pipes) and Engineering Thermodynamics (first/second laws of thermodynamics and their applications).
Course LOs	1) Identify the properties of a fluid and classify fluids in categories. Calculate stress/strain of a Newtonian fluid and pressure/density/temperature of an ideal gas. 2) Calculate the pressure variation and compute the force on an immersed surface due to the presence of a static fluid. 3) Characterize fluid flow (laminar, turbulent, compressible, etc.) and use dimensional analysis to obtain the dimensionless groups associated with a physical problem and applies similarity to relate the conditions of the prototype with its model. 4) Perform a Control Volume Analysis and apply the Conservation Laws (mass, momentum, energy, Bernoulli equation) to analyze a problem (e.g., losses in pipes). 5) Explain and apply the first law of thermodynamics in closed and open systems.

Course Title 6 ECTS	**Engineering Practice**
Course Descriptor	It is the introductory lecture class for year 1 students. The course focuses on introduction to engineering and engineering disciplines, engineering ethics, communication skills, study skills and problem solving skills, design, computing skills, and fundamentals of engineering science.
Course LOs	1) Identify the various disciplines and the role of engineer in the society 2) Explain career planning in engineering 3) Explain engineering ethics 4) Implement schematic approach for engineering problem solving and engineering design 5) Illustrate engineering communication skills by writing technical reports and applying computer skills 6) Search for information via traditional and online sources

Course Title 6 ECTS	**Introduction to Electrical Systems**
Course Descriptor	The aim of the course is to provide an introduction to the principles of electrical and electronic engineering, to develop problem solving skills and to develop basic body of knowledge to serve as a foundation for more advanced studies in electrical and electronic engineering. Course content: Circuits: Electrical quantities, Kirchhoff's laws, resistive, capacitive and inductive circuits, transients, Thévenin and Norton equivalent circuits, steady state sinusoidal analysis, three phase circuits, frequency response, Bode plots and resonance. Analogue electronics: Operational amplifiers, summers, differentiators, integrators, filters. Digital electronics**:** Boolean algebra, Logic circuits
Course LOs	1) Apply electrical engineering principles and applications 2) Demonstrate ability to use the circuit theory and analyze analogue and digital electronic systems, magnetic circuit and transformers 3) Construct and analyze simple R-L-C, operational amplifier, and logic circuits 4) Use computer aided design tools to design and simulate electrical and electronic circuits

Year 2, Fall Semester

Course Title 6 ECTS	**Engineering Mathematics III**
Course Descriptor	Differential equations of first- and second-order Series solution of differential equations Laplace transforms and its application to the solution of initial value problems Some of the important special functions used in engineering. Introduction to probability and mathematical statistics
Course LOs	1) Solve a large class of first- and second-order differential equations analytically using standard techniques. 2) Model simple physical situations encountered in engineering using first- and second-order differential equations. 3) Use Laplace transform techniques to solve first- and second-order initial value problems. 4) Recognize and work with a number of the higher transcendental functions of mathematics. 5) Recognize and apply the fundamental axioms of probability. 6) Recognize and work with a range of discrete and continuous random variable probability distributions functions. 7) Calculate confidence intervals and understand when to use the Student t- and chi-squared distributions. 8) Develop skills in Mathematics.

Course Title 6 ECTS	**Microelectronic Devices and Circuit**
Course Descriptor	The course provides introduction to modeling of microelectronic devices, basic microelectronic circuit analysis and design, physical electronics of semiconductor junction and MOS devices, relation of electrical behavior to internal physical processes, development of circuit models, and understanding the uses and limitations of various models

Course Title 6 ECTS	**Sensors and Actuators**
Course Descriptor	The entire course is expected to cover following topics: *Sensors*: Introduction and sensor performance terminology; Distance, Movement, Proximity, Strain and stress, Force, Fluid flow/level/pressure, Light and Temperature sensors; Selection of Sensors; *Signal conditioning and Data Acquisition*: Analog signal conditioning - passive circuits (divider, bridges, filters), active circuits (OP Amp); Digital signal conditioning (Sampling and Quantization, ADC, DAC, Frequency-based converters, Data-Acquisition Systems; *Electrical Actuation systems*: Relays, Solid state switches, Solenoids, DC motors, AC motors, Stepper motors; *Mechanical Actuation systems: Types of motion, Kinematic chains, Cams, Ratchets and pawl, Gear trains, Belt and chain drives, Bearings, Mechanical aspects of motor selection*
Course LOs	1) Demonstrate the knowledge of terminology and functionality of various types of sensors 2) Explain and describe the application and operation of contact and non-contact sensors 3) Design and apply the essential signal conditioning systems for sensors and actuators to interface with microcontroller 4) Explain and describe the application of various electrical and mechanical actuation systems 5) Design and apply various electrical and mechanical actuation systems

Course Title 6 ECTS	**Signal and Systems**
Course Descriptor	The objective of this course is to introduce fundamental properties of linear systems and transform techniques to analyze the behavior of linear systems. Students are also expected to gain an appreciation for the importance of linear system theory in electrical engineering. A tentative list of topics includes: Introduction to signals: classifications, transformations, and basic building-block signals. Introduction to systems: properties (linearity, time-invariance, causality etc.) and system interconnections. Time-domain analysis: convolution sum and convolution integral, linear constant-coefficient difference and differential equations. Frequency domain analysis: Fourier series (derivation, properties, and convergence), Continuous-time Fourier transform (derivation, properties, convergence), Discrete-time Fourier transform (derivation, properties, convergence). Laplace transform (properties, convergence), inverse Laplace transform. Introduction to Z transform (time-permitting).
Course LOs	1) Describe the classifications and perform basic manipulations of signals and systems. 2) Perform time-domain analysis of LTI systems using convolution as well as differential/difference equations. 3) Describe the Fourier-series representation for periodic signals and perform frequency-domain analysis of periodic signals using the Fourier series. 4) Explain the Transform-domain analysis based on Fourier and Laplace Transforms, and analyze signals and systems in these domains. 5) Use MATLAB simulation tool in lab for basic manipulations of signals and systems.

Course Title 6 ECTS	**Electronic Engineering Design Principles**
Course Descriptor	The course provides a unified methodical approach to engineering design projects by first examining project design principles, then illustrating their applications in circuit design. Product design concepts from idea to implementation will also be introduced.
Course LOs	1) Familiarize students with concepts, techniques, and tools that encourage creativity and innovation in their future design practices. 2) Provide students with the knowledge and understanding of workshop and laboratory practice. 3) Provide students with hands-on experience in electronics engineering design, measurement and troubleshooting tools. 4) Introduce students to codes of practices and standards: customer specifications, Industrial engineering specifications, engineering codes of practice, engineering standards.

Year 2, Spring Semester

Course Title 6 ECTS	**Digital Electronic Systems Design**
Course Descriptor	Course introduction, digital IC overview; Sampling; A/D and D/A converters; Device (MOSFET) review, device fabrication; SPICE models; CMOS inverter, VTC, processing; CMOS inverter, delay, power analysis; CMOS gates, delay; CMOS gates, power; Dynamic logic, pass transistor logic; Dynamic logic, domino effect, np-cmos; Ratioed Logic and Pass-transistor Logic; Dynamic Logic Introduction; Dynamic Logic; Low Power Design & Sequential Elements Introduction; Sequential Elements; Sequential Gates Wrap-up and Bipolar: BiCMOS; Memories, ROMS; Memories, SRAM; Memories, DRAM; Driving large capacitances, packaging issues;Interconnect Introduction; RLC parasitics; Interconnect issues-repeaters, noise, delay;Future trends, manufacturability; Textbook: • Digital Integrated Circuits: A Design Perspective, J. Rabaey, Prentice-Hall, 2003 (2nd edition).

Course Title 6 ECTS	**Data Communication**
Course Descriptor	This module covers the underlying concepts and techniques used in Data Communication. In this subject, we discuss various principles, standards for Communication over different type of Communication Media and networks layers. Topics covered in this module include: Introduction to Data Communications and Networking Data Communications and Architecture Layers' model Application Layer Transport Layer The Network Layer The Link Layer Mobile Networks Network Security Network Simulation Business Information and Data Communication
Course LOs	1) Explain data communication principles and applications 2) Analyze and distinguish between the network protocols and applications' needs through OSI model layers 3) Demonstrate the programming proficiency to monitor data and traffic through the network 4) Apply knowledge to control data flow, quality of services and network security 5) Use simulation software tools to design and simulate data communication and networking 6) Demonstrate the ability in designing different data communication and networking scenarios based on technical and business considerations

Course Title 6 ECTS	**Computer System Architecture**
Course Descriptor	The aim of this module is to introduce fundamental concepts of computer architecture and study factors influencing the performance of a computer system. The module provides students with skills to computer systems architecture. Topics include data representation, assembly language, central processing unit architecture, memory architecture, input/output (I/O) architecture, pipelining, data-level and thread-level parallelisms. Computer architecture considers the behavior and structure of various modules of the computer systems and how they interact to provide the processing needs of the user. This is achieved through careful organization and design of hardware and software elements of computer systems through innovative mechanisms and techniques. This module introduces fundamental aspects of computer architecture with an emphasis on cost-performance-energy tradeoffs. Topics covered in this module include: • Introduction to Computer Systems Architecture • Computer Arithmetic and Digital Logic • Architecture and Organization • Instruction Set Architectures • Performance – meaning and metrics • Processor Control • Cache Memory and virtual memory • Main memory • Secondary storage • Input/output • Processor Parallelism

Course Title 6 ECTS	**Control Systems**
Course Descriptor	This is a core module. It covers the use of mathematical modeling for the analysis of system dynamics. The students' ability and creativity in the subject will be developed through lectures, HW assignments, and computer laboratory exercises.
Course LOs	1) Explain the concept of modeling dynamic systems and the use of different representations 2) Derive mathematical models of various dynamic systems 3) Represent the system in various forms such as block diagrams, transfer functions and state space descriptions 4) Use the system models to study the behavior in the time and frequency domains 5) Use modern computer tools to simulate and analyze dynamic system behaviors

Course Title 6 ECTS	**Software Engineering**
Course Descriptor	Due to the continuous technology advancements and customer demands, software systems have become larger and more complex. The discipline of software engineering has been introduced to handle the development of large and complex software systems. The aim of this module is to introduce the discipline of Software Engineering using various powerful concepts used in object oriented programming (OOP) as well as Unified Modeling Language (UML). We choose Java as the OOP language used throughout this course as it is a simple, complete, and enormously popular. The course is being offered for second-year students in the Electrical and Electronic Engineering program most of whom have no or little background in OOP. As a result, the course is designed to provide students with a firm understating of OOP concepts that are being vigorously used in Software Engineering discipline. Throughout the course and after introducing each concept, the students will be provided with the knowledge of the UML, which can be used in modeling, analysis and design of software systems. Topics covered include: Object Oriented Programming Methods Objects, Classes, and Data Encapsulation Thinking in Objects Inheritance and Polymorphism Abstract Classes and Interfaces Generics Data Structures Developing Requirements and domain analysis
Course LOs	1) Describe various concepts of Object-Oriented Programming. 2) Explain and construct UML class diagrams. 3) Construct a software system using Java. 4) Perform domain analysis, modeling, and implementing the software. 5) Explain the value of code reviews, and to write constructive and helpful reviews of code written by others. 6) Explain why code that is easy to test is easy to maintain, and make use of test code smells in identifying and correcting design flaws (design for testability).

Year 3, Fall Semester

Course Title 6 ECTS	**Digital Signal and Image Processing**
Course Descriptor	This course is designed to familiarize students with the fundamental concepts in digital signal processing (DSP). A tentative list of topics includes: Introduction to DSP Review of signals and systems (convolution vs Correlation). Fourier domain analysis, and Discrete Fourier Transform (DFT), Properties of DFT, Circular Convolution, linear vs circular convolution. Z-Transform and its applications in signal processing. Sampling & digital processing of continuous time signals. Transform-domain analysis of LTI systems. Structures for implementation of digital filters. IIR Digital filter design & FIR filter design. Applications: Fundamentals of Digital Image Processing, Basic Image Operations, Spatial Domain Image Enhancement, Frequency Domain Image Enhancement
Course LOs	1) Explain the basics of discrete-time signals and systems, and sampling and sampling-rate alteration 2) Perform transform-domain analysis using Discrete Fourier Transform and Z-Transform 3) Design digital (FIR and IIR) filters, and develop various structures for their realization 4) Apply and integrate knowledge in practice during the lab experiments (MATLAB)

Course Title 6 ECTS	**Power Electronics**
Course Descriptor	The general purpose of the module is to have the students exposed to basic AC-DC, DC-DC, and DC-AC power converter topologies, their operation principles, methods of analysis, computer simulation and laboratory testing.
Course LOs	1) Explain the types and topologies of basic power electronic converters and analyze their operation 2) Analyze and assess performance of basic power electronic converters in terms of voltage and current ripples and harmonic distortions 3) Analyze power converter components electromagnetic stress and losses for making an educated selection of converter components 4) Make computer simulations and physical results interpretation for various power electronic converters steady-state operation waveforms 5) Explain different methods of power converters regulation

Course Title 6 ECTS	Digital Integrated Circuits Design
Course Descriptor	The digital integrated circuits cover a broad range of topics related to applications of circuit analysis in the design of digital gates and systems. Topics covered include: MOS device models including Deep Sub-Micron effects; circuit design styles for logic, arithmetic and sequential blocks; estimation and minimization of energy consumption; interconnect models and parasitics; device sizing and logical effort; timing issues (clock skew and jitter) and active clock distribution techniques; memory architectures, circuits (sense amplifiers) and devices; testing of integrated circuits. The course employs extensive use of circuit layout and SPICE in design projects. The course is divided into two sections, with first section (week 1-7) covering the theory and the second section focusing on the practice (week 8-12).
Course LOs	1) Explain applications of digital IC design in implementation of logic and arithmetic operations 2) Calculate various performance metrics for analysis of logic gates 3) Determine alternative designs for the circuits such as Boolean operations 4) Obtain optimal design parameters for minimizing area on chip, delays and power 5) Explain the differences between various digital circuit design configurations 6) Apply physical design rules for drawing circuit layouts using physical design tools 7) Explain the necessity of lower power, area on chip and delays in digital ICs 8) Describe the difference between behavior models (HDL) with that of physical models of logic gates (Layout tools)

Course Title 6 ECTS	Project Management
Course Descriptor	The purpose of this module is to introduce theoretical and practical perspectives to project management and understanding of project management principles. The module introduces students to five basic process groups of the Project Management Body of Knowledge (PMBOK) guide and ISO 21500, namely, the Initiation, Planning, Execution, Monitoring and Control and Closing of projects. Students will learn people skills; practices and processes for more effective project management and how to apply project management tools to ensure planned time, budget, and performance are achieved per project owner requirement.
Course LOs	1) Explain the process of project management and its application in delivering various successful projects; 2) Develop the scope of work, cost estimate, and baseline plan for project evaluation; 3) Identify the resources required for a project to produce a work plan and resource schedule; 4) Analyze project risk factors and develop risk management plans.

Course Title 6 ECTS	**Electromagnetics**
Course Descriptor	The Electromagnetics course provide insights on the methodologies for the analysis of wave propagation in free space and waveguides, and its applications in the engineering framework. The course revolves around 4 pillars: (1) transmission lines and their analysis, including Smith-chart methodology; (2) statics, solution of Maxwell equations in time-invariant fields; (3) time-varying fields and their solutions, in terms of propagating waves; (4) applications and simulation methods, with real-case scenarios.
Course LOs	1) Explain differential and integral forms of Maxwell's equations and boundary conditions and how to solve them via software. 2) Solve basic electrostatic and magneto static problems using line, area, volume integrals, and vector calculus using software. 3) Explain time-varying electromagnetic fields. 4) Solve electromagnetic wave propagation problems using solutions that include plane waves. 5) Apply transmission line theory and use of Smith charts for solving impedance matching problems and designing impedance matching networks with software. 6) Apply Electromagnetic theory and equations to basic microwave applications

Year 3, Spring Semester

Course Title 6 ECTS	**Embedded Microcontrollers**
Course Descriptor	This course broadly discusses the development aspects of embedded systems. The course discusses with an introduction to microcontrollers and gradually develops other topics such as assembly-level programming, embedded C based programming, real-time systems, real-time operating systems, system-on-chip design, internet of things, system reliability and security Topics covered include: • Introduction to embedded System • Embedded systems development cycle • 8051 Architecture and Programming Model • Embedded communication • Real-time systems • Reliability • Secure embedded systems • Zynq APSoC-based system design This course will have a heavy emphasis on laboratory practicums and all theory aspects will be covered in the corresponding labs.
Course LOs	1) The student should be able to describe the architecture of an embedded system 2) Students should be able to identify the factors effecting embedded systems development 3) Students should be able to identify whether an application is suitable for hardware-software code sign and system partitioning. 4) Students should be able to design simple to moderately complex embedded C program targeting microcontrollers 5) Students should be able to design simple system on chip applications.

Course Title 6 ECTS	**Communication Systems**
Course Descriptor	This course covers a wide range of topics in analog and digital communication systems including; amplitude modulation types and demodulation, angle modulation and demodulation, sampling and quantization, additive white Gaussian noise, and baseband and passband digital modulation techniques. Laboratory assignments train students in design aspects and performance analysis of different systems, techniques and methods in modern communication systems.
Course LOs	describe the fundamental components of a communication system analyze amplitude and angle modulation schemes identify different trade-offs of communication systems such as compromise between power and bandwidth analyze baseband and passband digital modulation schemes implement analog to digital conversion through sampling and quantization use modern hardware and simulation tools for evaluating the performance of communication systems describe the role of communication systems in technology, culture and society.

Course Title 6 ECTS	**Analog Circuits Design**
Course Descriptor	This course focuses on the schematic and physical design of analog integrated circuits. The specific focus is on the circuits such as current mirrors, amplifiers, operational amplifiers, PLLs and mixers. The course details the IC design issues, performance analysis and verification. It is expected that students learn various aspects of design and analysis of circuits including power analysis, electromagnetics, and thermal analysis. The students will be expected to gain a thorough understanding of physical design of analog integrated circuits.

Course Title 6 ECTS	**Electrical Machines and Drives**
Course Descriptor	The general purpose of the module is to have the students exposed to the fundamentals of magnetics and electromagnetic energy conversion and its applications to basic electrical machines and drives. Topics covered include: Fundamentals of electricity, magnetism and electromagnetic energy conversion, Torque generation principles, DC motors and generators, efficiency and heating of electrical machines, Ideal transformers, practical transformers, three-phase transformers, Armature Windings, polyphase Synchronous motors and generators, permanent magnet motors, polyphase Asynchronous motors, stepper motors, Applications of electrical machines and drives, Controls of DC motors, brushless DC and AC motors, Variable Speed Drives (VSD).
Course LOs	1) To provide fundamental knowledge of transformers to study the electromechanical energy conversion process in machines in general and related phasor diagrams. 2) To illustrate basic principles of voltage generation and toque production applicable to both the AC and DC machines and how all kinds of electrical machines work on the same basic principles. 3) To provide knowledge of basic machine types: DC machines, AC machines, different types of transformers, electrical-to- mechanical energy conversion basics, stepper motors applications of electrical machines supplied from power electronic converters.

Course Title 6 ECTS	**Power Systems Analysis**
Course Descriptor	Power system analysis is the core knowledge required for understanding, planning, and operating a power system. This unit introduces students to the core knowledge of power systems analysis and modelling. The unit will begin by introducing concepts related to the operation of plant equipment and the deregulation of the energy industry. This is followed by a detailed study into current, voltage, capacitance and impedance relations on a short, medium and long distance transmission line. Power-flow calculations for various symmetrical and unsymmetrical fault conditions will be investigated using the methods of Gauss-Seidel, Newton-Raphson and Fast Decoupled. Other aspects covered include power system stability, control, contingency analysis and economic operation.
Course LOs	1) Calculate and analyze power line parameters in per-unit format. 2) Analyze Ybus and Zbus for different power system networks, and evaluate three-phase system. 3) Perform network calculations of admittance and impedance circuits through Ybus and Zbus modification of matrices and utilize power-flow calculations for different network configurations. 4) Create, calculate and analyze Gauss-Seidel power flow over different power network. 5) Utilize Newton-Raphson Power flow over different power network. 6) Simulate Gauss- Seidel and Newton-Raphson models using the Power World software.

Course Title 12 ECTS	**Summer Internship**
Course Descriptor	This module will provide an opportunity for students to develop the professional skills and gain initial experience of application of theoretical knowledge in real engineering work.
Course LOs	1) Relate engineering principles and/or experiments to industry practices as well as solutions of practical problems in professional settings 2) Communicate and function effectively within industry systems and practices 3) Assume the professional, ethical and social responsibilities in industrial settings 4) Evaluate the appropriateness of acquired techniques, skills, and modern engineering tools, as well as reflect on the work experience and its implications for continuous improvement 5) Demonstrate the ability to work with technical uncertainties in engineering environments

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Year 4, Fall Semester

Course Title 6 ECTS	**Capstone Design Project I**
Course Descriptor	The capstone project provides students to have a culminating experience of applying the knowledge and skills gained from student's engineering program. This is a year-long and substantial engineering project or research project in a discipline of their specialization. The project is led by the student, who take the responsibility of planning, organizing, and carrying out various project task under the supervision of professor. The students will be expected to understand research methods as part of this activity. Wherever possible, projects will be sourced from industry partners. Projects may be undertaken by individual students or in small teams. This course focuses on the research, scoping, designing, planning and preliminary results of the project. Project proposals, preliminary results and final reports will be presented as a report as well as end-of-semester oral presentation.
Course LOs	1) Propose a problem through critical review and analysis 2) Extensively use and apply engineering research methods to evaluate feasibility of a diverse set of solutions 3) The design and research outcomes to meet client specifications following the synthesis, prototype, critically analyze and/or test project designs 4) Effective project management and implementation 5) Produce a range of high quality professional and technical documents including a project proposal and presentations 6) Communicate with all stakeholders in an ethical and professional manner and confidently defend ideas and proposals to the project client and university audiences

Course Title 6 ECTS	**Industry 4.0**
Course Descriptor	The main objective of this course is to introduce to students the concept of industry 4.0 which is the current trend of automation and data exchange in manufacturing technologies through Cyber Physical System (CPS). Industry 4.0, which is referred to as the fourth industrial revolution will expose students to understanding Cyber Physical System (CPS), and the enabling technologies that make multiple innovative application processes a reality where the boundaries between the real and virtual worlds disappear. The digitization and interconnection of products, value chains and business models would be discussed.
Course LOs	1) Discuss role of digitization, automation and data in Industry 4.0 2) Apply machine learning tools for implementation of Industry 4.0 3) Design architecture of Industrial Internet of Things (IIoT) 4) Perform conceptual design of Industrial Internet Systems

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Year 4, Spring Semester

Course Title 18 ECTS	**Capstone Design Project II**
Course Descriptor	The capstone project is the culminating experience of the student's engineering program and provides students with the opportunity to apply and integrate their knowledge and skills gained from earlier years. This is achieved in a context of a year-long and substantial engineering project related to the student's discipline area. Students will take the responsibility to organize, plan and carry-out the various tasks required for successful completion of the project. Wherever possible, projects will be sourced from industry partners. Projects may be undertaken by individual students or in small teams. At the completion of the unit, students will hand over their project deliverables and present project outcomes in a report as well as end-of-semester oral presentation and defense.
Course LOs	1) Propose a problem through critical review and analysis 2) Extensively use and apply engineering research methods to evaluate feasibility of a diverse set of solutions 3) The design and research outcomes to meet client specifications following the synthesis, prototype, critically analyze and/or test project designs 4) Effective project management and implementation 5) Produce a range of high quality professional and technical documents including a project proposal and presentations 6) Communicate with all stakeholders in an ethical and professional manner and confidently defend ideas and proposals to the project client and university audiences.