NAZARBAYEV UNIVERSITY
SCHOOL OF ENGINEERING AND DIGITAL SCIENCES

Bachelor of Engineering in Mechanical Engineering

Nazarbayev University

Degree requirements for the AY 2020-2021 Graduation Cohort

	Abbr/ Number	Courses	Credits ECTS
Major requirements (204 credits)	BENG 124	Engineering Mathematics I (or MATH 161)	6
	BENG 126	Programming for Engineers (or ENG 101)	6
	BENG 122	Engineering Materials (or ENG 102)	6
	BENG 145	Occupational & Environment Health and Safety (or ENG 100)	6
	BENG 201	Engineering Economy (or Fundamentals of Entrepreneurship and Management)	6
	BENG 147	Introduction to Fluid Mechanics and Thermodynamics (or ENG 100)	6
	BENG 148	Engineering Practice (or ENG 100)	6
	BENG 225	Engineering Mathematics II (or MATH 162)	6
	BENG 117	Engineering Mechanics (or PHYS 161)	6
	BENG 114	Introduction to Electrical Systems (or PHYS 162)	6
	BENG 228	Engineering Mathematics III (or ENG 200)	6
	BENG 215	Sensors and Actuators (or MAE 303 or another relevant MAE program elective)	6
	EME 254	Mechanics of Materials (or MAE 200/CEE 200)	6
	EME 464	Materials and Manufacturing 1 (or MAE 205)	6
	EME 253	Computer Aided Engineering (or MAE 201)	6
	EME 262	Machine Dynamics I (or MAE 206)	6
	EME 275	Fluid Mechanics 1 (or MAE 300)	6
	BENG 226	Engineering Thermodynamics (or MAE 301)	6
	EME 361	Machine Design (or MAE 302)	6
	BENG 219	Control Systems (or MAE 303)	6
	EME 357	Fluid Mechanics 2 (or MAE 305)	6
	EME 354	Advanced Control Systems (or MAE 459)	6
	EME 480	Industrial Automation (or MAE 459)	6
	EME 463	Machine Dynamics II (or MAE 307)	6
	EME 352	Computational Fluid Dynamics (or MAE 460)	6
	EME 358	Heat Transfer (or MAE 400)	6
	EME 300	Research Project (or ENG 300)	6
	EME 476	Materials and Manufacturing II (or MAE 456)	6
	EME 377	Mechanical Systems Design (or MAE)	6
	EME 410	Aerodynamics (or MAE 454)	6
	EME 451	Capstone Project 1	6
	EME 477	Capstone Project 2	18
General requirements (36 credits)	HST 100	History of Kazakhstan	6
	KAZ XXX	Kazakh Language Course	6
	KAZ XXX	Kazakh Language Course	6
	BENG 310	Internship	12
	BENG 405	Project Management (or ECON 120 Managerial Economics)	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**

NAZARBAYEV UNIVERSITY
SCHOOL OF ENGINEERING AND DIGITAL SCIENCES

List of ME Elective courses

EME 487 Mechatronics Systems Design
EME 489 Advanced Engineering Mathematics
EME 411 Air Conditioning and Fire Engineering
EME 456 Feasibility Assessment of Clean Energy Technologies
EME 479 Particulate technologies
EME 486 Oscillations of mechanical systems
EME 467 Vehicle Propulsion Systems
EME 412 Heating, Ventilating and Air Conditioning
EME 413 Computer Aided Geometric Design
CHME 454 Transport Phenomena and Operations

The following courses from MAE's undergraduate program may be also selected by students following the ME program

1. MAE 350 Structural Mechanics II
2. MAE 456 Materials and Manufacturing II
3. MAE 351 Vehicle Propulsion Systems
4. MAE 455 Flight Mechanics
5. MAE 450 Heating Ventilating & Air-Conditioning
6. MAE 453 Fire Engineering
7. MAE 457 Feasibility Analysis of Clean Energy Technologies
8. MAE 461 Advanced Heat Transfer
9. MAE 458 Fundamentals of Multi-Body Dynamics
10. MAE 459 Advanced Control Systems and Industrial Automation
11. MAE 451 Oscillations of Mechanical Systems
12. MAE 452 Computer Aided Geometric Design
13. MAE 460 Advanced Topics in Computational Fluid Dynamics

NAZARBAYEV UNIVERSITY
SCHOOL OF ENGINEERING AND DIGITAL SCIENCES

DETAILED COURSE DESCRIPTIONS

Year 1, Fall Semester

Course Title 6 ECTS	**Engineering Mathematics I**
Course Descriptor	*This module will cover:* Differential and Integral calculus of real valued functions of single variable. Sequences, infinite series and power series. Elements of linear algebra: matrices and 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	The module covers: 1) Introduction to Risk Management: Hazards Identification, Risk Assessment (Hazards Analysis) and Risk Control (including probabilities lectures). 2) Occupational Health and Safety: Occupational Health Hazards, Ergonomics, Human Health Risk Assessment, Health and Safety Practice, Hazardous Chemicals, Personal Protective Equipment. 3) 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 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 6 ECTS	**Engineering Mathematics II**
Course Descriptor	This module will cover: 1) The calculus of multivariate functions 2) The calculus of vector-valued functions 3) Fourier series 4) 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.

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.
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, and cost of capital, depreciation and tax considerations).

NAZARBAYEV UNIVERSITY
SCHOOL OF ENGINEERING AND DIGITAL SCIENCES

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: 1) 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. 2) Analogue electronics: Operational amplifiers, summers, differentiators, integrators, filters. 3) Digital electronics**:** Boolean algebra, Logic circuits.
Course LOs	1) Apply electrical engineering principles and applications. 2) Demonstrate ability to use circuit theory and analysis, 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.

Course Title 6 ECTS	**Engineering Mathematics III**
Course Descriptor	*This module will cover:* 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 Mathematica.

Year 2, Fall Semester

NAZARBAYEV UNIVERSITY
SCHOOL OF ENGINEERING AND DIGITAL SCIENCES

Course Title 6 ECTS	**Machine Dynamics 1**
Course Descriptor	This module consists of application of Newton's Laws to planar motion kinematics and kinetics of a particle and a rigid body using forces, work, energy and momentum and their conservation using different coordinate systems. Some elements of vibrational motion are also studied in this module.
Course LOs	1) Apply the fundamental kinematics and kinetics concepts to solve dynamics problems. 2) Analyze and evaluate the kinematics of rigid bodies in general planar motion. 3) Analyze and evaluate the dynamics of rigid bodies in general planar motion. 4) Apply theoretical knowledge to practice.

Course Title 6 ECTS	**Sensors and Actuators**
Course Descriptor	The aims of the module are: Develop thorough understanding of fundamentals and underlying principles of Sensors and Actuation Systems. Familiarize and introduce students to a quite comprehensive and span of wide range of topics commonly encountered in studying and practicing of Sensors and Actuators. Provide students with practical aspects sensors and actuator's development and implementation. Develop generic skills and abilities that are required for practicing engineer to perform the professional duties. Topics covered include: 1) *Sensors*: Introduction and sensor performance terminology; Distance, Movement, Proximity, Strain and stress, Force, Fluid flow/level/pressure, Light and Temperature sensors; Selection of Sensors. 2) *Signal conditioning*: Signal conditioning processes; 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. 3) *Electrical Actuation systems*: Relays, Solid state switches, Solenoids, DC motors, AC motors, Stepper motors. 4) *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	**Mechanics of Materials**
Course Descriptor	This course introduces students to the basic concepts of stresses based on the principles of mechanics. The course covers different types of stresses (axial, bearing, shear, and bending) as well as the deformation of structures or machine components caused by a typical stress component or combined loading conditions. Students would be able to develop their engineering capabilities through applications of the concepts in the analysis and design of engineering structures and machine components.
Course LOs	1) Relate the basic concepts of geometric compatibility and force-deformation as applied to simple deformable elements of structures and machines. 2) Determine stress, strain and deformation in a non-rigid body subjected to various types of loading including axial, torsion and bending. 3) Apply equations of static equilibrium, geometric compatibility and force-deformation to design simple machine or structural elements.

Course Title 6 ECTS	**Computer Aided Engineering**
Course Descriptor	The module gives the student an introduction to the use of computational tools to model and analyze 3D systems and components commonly encountered in engineering applications. Special emphasis will be paid to examples during lectures and problem-solving skill development during tutorials, based on engineering problems. Moreover, the student will have the opportunity to interact with engineering software such as SolidWorks in the Laboratory to enhance her/his capabilities in modeling mechanical components.
Course LOs	1) Apply fundamental knowledge of engineering, mathematics and science into building 2D and 3D mathematical and physical models. 2) Use modern tools and techniques to analyze physical models. 3) Design and develop engineering models to meet desired needs within realistic economic, environmental, social, ethical, safe manufacturing and sustainability constraints.

Year 2, Spring Semester

Course Title 6 ECTS	**Engineering Thermodynamics**
Course Descriptor	The module provides the students with important principles required in order to study the engineering required to design and operate safely, efficiently, and in a sustainable manner processes and machines associated with the mechanical engineering industry.
Course LOs	1) Apply understanding of the nature and operating principles of energy flows to systems encountered in engineering. 2) Describe and apply basic thermodynamic principles and laws of physics to analyzing and predicting performance of idealized forms of thermodynamic systems. 3) Describe and assess benefits of improvements to thermodynamics systems. 4) Relate idealized thermodynamic system models to corresponding real systems.

NAZARBAYEV UNIVERSITY
SCHOOL OF ENGINEERING AND DIGITAL SCIENCES

Course Title 6 ECTS	**Fluid Mechanics 1**
Course Descriptor	Engineering is becoming increasingly international and competitive and customers are expecting products of high quality and reliability. Knowledge of Fluid Mechanics is critical for any engineer involved in the design of mechanical components. After completion of this module students will gain an understanding of the integral form of the conservation laws for mass, momentum and energy, and the basic principles underlying the statics and dynamics of a fluid.
Course LOs	1) Use dimensional analysis to obtain the dimensionless groups. 2) Compute the forces and velocities in a moving fluid using conservation laws in control volume form, for steady flow. 3) Calculate the viscous losses associated with a pipe network hence estimate the necessary pressure/power to drive the flow. 4) Compute the forces exerted by a fluid over an immersed body. 5) Determine the velocity profile of some basic flows, both viscous and inviscid, free surface and pressurized flow.

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	**Materials and Manufacturing 1**
Course Descriptor	The course is intended to provide the students with the basic and intermediate skills to introduce the students to a wide variety of materials and theories outlining ferrous & non-ferrous materials, metals, composites, and ceramics; and to understand the principles of traditional and recently developed manufacturing processes.
Course LOs	1) Identify wide variety of application specific materials by correlating their material properties and characteristics with the requirements. 2) Explain the theory pertaining to ferrous and non-ferrous materials. 3) Design and apply heat treatments processes and phase diagram to develop materials with certain properties. 4) Evaluate traditional manufacturing processes and related quality control techniques. 5) Employ manual turning and milling machine to produce part product.

Course Title 6 ECTS	**Industrial Automation**
Course Descriptor	This course provides the student with basic knowledge of the industrial automation systems design, installation, modification, maintenance, and repair. The course provides information on applications of industrial automation systems, including identification of system requirements, equipment integration, motors, controllers, and sensors. Coverage of set-up, maintenance, and testing of the automated system.
Course LOs	1) Design logical automation diagrams. 2) Synthesize automation systems by combining sensors, actuators and relays. 3) Code in PLC programming. 4) Demonstrate experimental skills in handling automation system. 5) Implement Industrial Automation systems for various needs. 6) Critically analyze and suggest significant improvements to existing automation system.

Year 3, Fall Semester

Course Title 6 ECTS	**Advanced Control Systems**
Course Descriptor	This course reviews the classical control systems, advanced classical control method, state space representation, and continuous-time response and performance specifications. It elaborates State space analysis and design, advanced state space control system method. Finally, it deals with the projects based on problems drawn from mechatronics and mechanical systems.
Course LOs	1) Derive mathematical models of physical systems in state space representation. 2) Examine a system for stability, controllability and observability. 3) Design and analyze controller based on the modern control approach using various methods according to the specified criterion. 4) Evaluate and compare the performance of the designed modern control system. 5) Develop skills in MATLAB / Simulink as tool in the design and evaluation processes.

Course Title 6 ECTS	**Machine Design**
Course Descriptor	This module consists of application of previously studied principles of materials science and mechanics to the design of mechanical machine elements. This module will build the understanding of how machines and their mechanical elements work and how to design them to achieve desired properties and behaviors. It will contribute to the development of critical thinking and understanding of the cause-effect relationships involved in machine design and will set the groundwork for creative mechanical systems design.
Course LOs	1) Apply the art of machine element design. 2) Perform design analyses, creating new insights and innovation opportunities. 3) Predict and optimize machine element/ subsystem behavior. 4) Design machine elements/ subsystems to given quality specifications.

Course Title 6 ECTS	**Heat Transfer**
Course Descriptor	This subject deals primarily with the field of Heat Transfer. Conduction, convection and radiation heat transfers are investigated using analytical and numerical methods. Applications including heat exchangers and heat sinks are studied. These topics are extremely important in engineering. Heat transfer plays a role in most systems, exists in life. In Mechanical Engineering education, this module forms one of the basic building blocks of the young engineer's thinking. A good understanding of the subject material and thinking processes will contribute tremendously to the student's abilities and knowledge.
Course LOs	1) Explain the basic heat transfer concepts such as heat transfer mechanisms, heat conduction, heat convection and heat radiation equations. 2) Solve numeric problems by applying the fundamental principles of heat transfer. 3) Analyze laboratory experimental data and synthesize these results with your knowledge in order to communicate your ideas and conclusions in the form of a laboratory report. 4) Analyze the heat transfer mechanisms of existing thermo-fluid systems and processes and contribute to new designs. 5) Analyze the current renewable energy sources and designing such systems for different locations considering the local requirements. and communicate the results in oral presentation and project report. 6) Relate and explain the role of thermodynamics and heat transfer science in building a sustainable society.

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; 5) Develop risk management plans.

Course Title 6 ECTS	**Machine Dynamics 2**
Course Descriptor	The module consists of analysis of machines and mechanisms operation with application of statics and dynamics principles. Application of these principles with analysis of operation of mechanisms provides background for design of machine elements.
Course LOs	1) Analyze and synthesize mechanisms and machines. 2) Design viable mechanism solutions to real, unstructured engineering problems. 3) Identify, formulate, solve and analyze simple vibration problems. 4) Apply knowledge for analysis of simple machine elements experimentally.

Year 3, Spring Semester

Course Title 6 ECTS	**Research Project**
Course Descriptor	This course focuses on application, synthesis and development of knowledge and skill in the program. Building upon previously acquired and developed mechanical engineering knowledge, students will be introduced real engineering problems or research topics. Students are required to provide viable solution using the latest technology and recent research findings.
Course LOs	1) conduct literature research 2) provide a solution to solve the identified engineering problems or to further the research findings by employing the latest technology and knowledge (e.g., analytical, numerical, experimental methods) appraise the solutions and summarize the findings".

Course Title 6 ECTS	**Computational Fluid Dynamics**
Course Descriptor	This is a module aimed at the third-year of the Mechanical Engineering program and contains the introduction to the most important numerical techniques applied to solving fluid mechanics, heat transfer and species problems. Also, this module introduces to the use of software mostly known in scientific and engineering applications.
Course LOs	1) Describe fluid dynamics equations in both vector and Cartesian-tensor notation and the common algorithms and methods used to solve them numerically, to the extent of being capable to read and understand engineering articles on CFD. 2) Build and solve approximate solutions to differential equations using common algorithms and methods. 3) Explain the limitations found in numerical solutions, as compared to analytical solutions, and the ways to tackle them in a engineering manner. 4) Learn to use and properly interpret results out of commercial CFD software, with emphasis on the use of commercial software (PHOENICS) to solve engineering problems. 5) Communicate in written and verbal manner the engineering results obtained via CFD.

Course Title 6 ECTS	**Materials and Manufacturing 2**
Course Descriptor	This module deals primarily with development of understanding of structure and property relationships of engineering materials and focuses on manufacturing processes for plastics and metal components. In Mechanical Engineering education, this module forms one of the basic building blocks of the young engineer's thinking. A good understanding of the module material and thinking processes will contribute tremendously to the student's abilities and knowledge.
Course LOs	1) Acquire knowledge of various methods of manufacturing processes and understanding the applications of machining processes in real life 2) Evaluate the economic analysis of metal cutting technology. 3) Employ CNC machines to fabricate the designed parts and be able to perform CNC coding, simulation using software 4) Safely conduct manufacturing experiments, analyze and interpret the results and errors and formulate conclusions as part of a team work 5) Apply knowledge and hands on skills that are in demand by the industry

Course Title 6 ECTS	**Mechanical Systems Design**
Course Descriptor	This module consists of application of previously studied principles of materials science and mechanics, including kinematics and basic dynamics, to design mechanical systems and machines. This module will build the understanding how mechanical systems and machines work and how to create them in order to achieve given desired properties and behaviors. It will contribute to development of competencies related to the systematic analysis and synthesis, creativity and decision-making and to the understanding of practical machinery.
Course LOs	1) Transform ordinary problems into engineering design problems that can then be readily solved and communicated. 2) Describe the role of methods and standards in engineering design and make use of them. 3) Use design theory to manage the design process and further develop creative solutions as an engineer. 4) Interpret poorly defined problems and determine the appropriate engineering knowledge and methods to solve those problems. 5) Manage the process of developing a design and then documenting it as part of a team.

Course Title 6 ECTS	**Fluid Mechanics 2**
Course Descriptor	The unit will assist students to gain an understanding of fluid mechanic's concepts and their applications. Students will explore the principles of fluid through dimensional reasoning, drag and lift considerations, boundary layer theory, compressible flow theory, measurement techniques, and pump and turbine theory. Students will also develop an appreciation of the design principles of thermo-fluid systems. Students will apply the knowledge to analyze existing thermo-fluid systems and to contribute to new designs.
Course LOs	1) Identify drag and lift of different bodies in the flow. 2) Use boundary layer approach for consideration of external flow over bodies. 3) Calculate compressible flow arrangements for the practical applications. 4) Analyze turbomachinery arrangements and design practical applications.

Year 4, Fall Semester

Course Title 6 ECTS	**Capstone Project I**
Course Descriptor	The Capstone Project in Mechanical Engineering department is a supervised design, simulation and/or experimental project involving the definition of a design problem, carrying out the research and design, and demonstrating results. Teams consist of 3-4 students. Capstone provides students the opportunity to demonstrate good judgment, challenge and enhance their ability to solve open-ended design problems, and improve team work skills. Solving real industrial problems is encouraged and is facilitated by course coordinators and project supervisors. The project spans two semesters, beginning with the development of a project plan, whereby students define end-user needs, client needs, design objectives and constraints, and metrics for success. Proceeding through concept generation and selection, and then through the system- and component-level design stages,

	each team ultimately produces a working prototype that is tested and refined to meet the project objectives.
Course LOs	1) Understand the importance of identifying the objectives and context of the design in terms of: business requirements; technical requirements; sustainable development; safety, health and environmental issues; appreciation of public perception and concerns. 2) Understand that design is an open-ended process, lacking a predetermined solution, which requires: synthesis, innovation and creativity; decision making based on incomplete and contradictory information; working with uncertainty and multiple objectives; justification of the decisions taken. 3) Be able to work in a team and understand and manage the processes of: planning, prioritizing and organizing team activity; peer challenge; the discipline of mutual dependency. 4) Have a comprehensive understanding of design processes and methodologies and an ability to apply and adapt them in unfamiliar situations. 5) Be able to work with information that may be incomplete or uncertain, quantify the effect of this on the design and, where appropriate, use theory or experimental research to mitigate deficiencies. 6) Have the ability to generate an innovative design for processes, systems and products to fulfil new needs with data that may be unreliable or limited.

Course Title 6 ECTS	**Mechatronics Systems Design**
Course Descriptor	Mechatronics is a relatively new discipline that brings together areas of technology involving sensors and measurement systems, drive and actuation systems, analysis of the behavior of systems, control systems, and microprocessor systems. The integration across the traditional boundaries of mechanical engineering, electrical engineering, electronics and control engineering has to occur at the earliest stages of the design process if cheaper, more reliable, and more flexible systems are to be developed. This is something that many forward-thinking designers and engineers are doing for years. The integrated approach to engineering is emphasized in the subject content. The subject would help to produce engineers that are capable of operating and communicating across a range of engineering disciplines and linking with those having more specialized skills.
Course LOs	1) Design mechanical and electrical/electronic systems given specifications and constraints. 2) Apply the knowledge and skills obtained to the solution of real-world problems involving the integration of mechanical and electronic systems 3) Demonstrate team skills in project co-ordination and management

Year 4, Spring Semester

NAZARBAYEV UNIVERSITY
SCHOOL OF ENGINEERING AND DIGITAL SCIENCES

Course Title 18 ECTS	**Capstone Project II**
Course Descriptor	The Capstone Project in Mechanical Engineering department is a supervised design, simulation and/or experimental project involving the definition of a design problem, carrying out the research and design, and demonstrating results. Teams consist of 3-4 students. Capstone provides students the opportunity to demonstrate good judgment, challenge and enhance their ability to solve open-ended design problems, and improve team work skills. Solving real industrial problems is encouraged and is facilitated by course coordinators and project supervisors. The project spans two semesters, beginning with the development of a project plan, whereby students define end-user needs, client needs, design objectives and constraints, and metrics for success. Proceeding through concept generation and selection, and then through the system- and component-level design stages, each team ultimately produces a working prototype that is tested and refined to meet the project objectives.
Course LOs	1) Understand the importance of identifying the objectives and context of the design in terms of: business requirements; technical requirements; sustainable development; safety, health and environmental issues; appreciation of public perception and concerns. 2) Understand that design is an open-ended process, lacking a predetermined solution, which requires: synthesis, innovation and creativity; decision making based on incomplete and contradictory information; working with uncertainty and multiple objectives; justification of the decisions taken. 3) Be able to work in a team and understand and manage the processes of: planning, prioritizing and organizing team activity; peer challenge; the discipline of mutual dependency. 4) Have a comprehensive understanding of design processes and methodologies and an ability to apply and adapt them in unfamiliar situations. 5) Be able to work with information that may be incomplete or uncertain, quantify the effect of this on the design and, where appropriate, use theory or experimental research to mitigate deficiencies. 6) Have the ability to generate an innovative design for processes, systems and products to fulfil new needs with data that may be unreliable or limited.

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

Course Title 6 ECTS	**Elective - Turbulent Flow**
Course Descriptor	This module gives the student a thorough review of the turbulence phenomenon and its modeling and measuring in scientific and engineering applications. Close analytical solutions to simplified cases are derived to show the physics that lies within classical turbulent flows. However, special emphasis is paid to solving engineering problems using numerical tools for which extensive modeling techniques are presented. Moreover, the student will have the opportunity to interact with engineering software such as ANSYS-CFD or similar in the Laboratory to enhance her/his capabilities in solving complex engineering problems involving turbulence phenomena.
Course LOs	1) Apply fundamental knowledge of fluid mechanics, engineering, mathematics and science into building 1D, 2D and 3D mathematical and physical models of turbulent flows. 2) Use modern tools and techniques to approach the solution of complex physical models. 3) Perform necessary verification and validation procedures of numerical models to assess their validity limitations and present reports with thorough analyses of complex turbulent flows. 4) Present and communicate effectively his/her own and second-party reports on turbulence assessment of engineering turbulent flows performed using analytical and/or numerical tools.

Course Title 6 ECTS	**Elective - Vehicle Propulsion Systems**
Course Descriptor	The following will be included in this elective module: Fuel consumption and drivability models of the most important vehicle propulsion systems, which are IC engines, electric motors, short range energy storages, batteries and fuel cells, drive trains and vehicles, etc. Mathematical optimization methods (parameter and control), including computer aided tools (e.g. CFD, FEA). Several examples of novel power train systems (hybrid electric vehicles, fuel cell vehicles, etc.) and their optimization. A major case study of optimization of a novel vehicle propulsion system.
Course LOs	1) Explain the structure of conventional propulsion systems. 2) Explain the structure of new propulsion systems 3) Analyze and evaluate the working principles of conventional propulsion systems. 4) Analyze and evaluate the working principles of new propulsion systems. 5) Perform system optimization and controller design for vehicles. 6) Describe (quantitatively) propulsion systems.

Course Title 6 ECTS	**Elective - Feasibility Analysis of Clean Energy Technologies**
Course Descriptor	This module gives the student an introduction to the preparation of pre- and feasibility studies of clean energy technologies, which includes: energy efficiency measures and technologies based on renewable energies. Special emphasis will be paid to analysis of real case studies, for which the outcome is thoroughly known and for hypothetic and academic case studies of engineering interest, as much as possible. Moreover, the student will have the opportunity to interact with specialized software such as RETScreenTM in the Laboratory to enhance her/his capabilities in setting up and analyzing the feasibility of simple and complex clean energy technology systems.
Course LOs	1) Analyze data sources of generation and consumption of energy (eg. IEA, EIA, etc.). 2) Review of legal aspects associated with the implementation of clean energy technologies. 3) Combine technical, economic, financial and atmospheric emission concepts to analyze viability of energetic problems, including sensibility and risk analyses. 4) Use of specialized tools to assess complex clean energy technology systems. 5) Work and communicate effectively in multi-task teams.

Course Title 6 ECTS	**Elective - Oscillations of mechanical systems**
Course Descriptor	This is an elective module to mechanical engineering programs and the most important methods and techniques that are typically used in engineering and industrial applications.
Course LOs	1) Describe the principles of dynamic simulation of mechanical systems 2) Use analytical and numerical methods for solving the equations of motion 3) Use a dynamic system analysis for the design of reliable and durable mechanical systems.