**COURSE CONTENTS**

**Core Courses**

**PHYS 121 General Physics I (3-2)4 ECTS: 7**

Basic concepts of mechanics using vectors and calculus; Newton’s laws of motion; conservation of energy and momentum. Kinematics and dynamics of particles and rigid bodies undergoing rectilinear, rotational, and oscillatory motion. Weekly laboratory experiments complement the lecture.

**MATH 141 Basic Calculus I (3-2)4 ECTS: 5**

Functions, limits and continuity, derivatives and their applications, integral and their applications, exponential, logarithmic and trigonometric functions, inverse trigonometric and inverse hyperbolic functions.

**CHEM 121 General Chemistry I (3-0)3 ECTS: 5**

Matter, its properties and measurements. Introduction to atomic theory, stoichiometry. The structural and physical properties of matter. Gases, liquids and solids. Intermolecular forces. Atomic and molecular structure. Compounds, molecules and molecular formulas, ions and ionic compounds. Atomic electronic configurations and periodicity. Basic concepts of chemical bonding, ionic, covalent and metallic bonding.

**ENG 101 Development of Reading and Writing Skills I (3-0)3 ECTS: 3**

The reinforcement of reading and writing skills through reading selections with review of structural patterns and paragraph and summary writing.

**ESE 101 Introduction to Energy Systems Engineering (2-0)2 ECTS: 5**

Introduction to Energy Systems Engineering. Lectures by invited speakers. Lectures on how to give a seminar and how to write a report. Technical trips to various industrial sites. Work on a project, write a report and present the project.

**ME 113 Computer Aided Technical Drawing I (2-2)3 ECTS: 3**

Introduction to hand-held instrument and computer aided engineering drawing. Constructional geometry. Orthographic sketching and drawing. Three dimensional drawing. Principles of dimensioning. Sectional views. Auxiliary views, CAD Modeling, Introduction to Assembly drawings, Brief information of CAD tools.

**CHEM 141 General Chemistry Lab I (0-2)1 ECTS: 2**

Measurement and density, Stoichiometry of a reaction, titration of acids and bases, oxidation-reduction reaction, gas analysis based on molar volume, thermochemistry, precipitation reaction, gravimetric and volumetric analysis.

**PHYS 122 General Physics II (3-2)4 ECTS: 8**

Continuation of Physics I. The fundamentals laws of electricity and magnetism, including electromagnetic oscillation and applications to circuits and instruments. Coulomb’s law; electric fields; Gauss’s law; electric potential; capacitance. Simple circuits; RC circuits. Magnetic force; forces and magnetic dipoles; magnetic fields; Faraday’s law; self-inductance. Weekly laboratory experiments complement the lecture.

**MATH 142 Basic Calculus II (3-2)4 ECTS: 6**

Techniques of integration, polar coordinates and conic sections, infinite series, parametric curves and vectors in the plane, vectors, curves and surfaces in spaces, partial differentiation, multiple integrals, vector analysis.

**CHEM 122 General Chemistry II (3-0)3 ECTS: 5**

Chemical bonding, Liquids Solids and Intermolecular forces, Solutions and their physical properties, Chemical kinetics, Chemical equilibrium.

**CHEM 142 General Chemistry Lab II (0-2)1 ECTS: 2**

Determination of water hardness, soap synthesis, steam distillation, Molecular weight determination, kinetic study of reaction between ferric and iodide ions, Chemical equilibrium, weak acids weak bases and their salts, An investigation of voltaic cells

**ENG 102 Development of Reading and Writing Skills II (3-0)3 ECTS: 3**

A continuation of ENG 101.

**ESE 104 Introduction to Computer Programming (2-2) 3 ECTS: 4**

The course is based on the C programming language with homework. The student will be able to acquire basic knowledge of algorithms for memory usage and engineering applications.

**GCC 101 Career Planning and Development (2-0)NC ECTS:2**

IYTE Career, Leadership and Entrepreneurship Center (CLEC) provides the activities that support students’ skills enhancement. It also follows the course’s activities such as seminars, invitation of speakers, webinars, arrangements with guest lecturers and students’ communities. The supportive activities of IYTE Career, Leadership and Entrepreneurship Center (CLEC) designed to present core methods and tools used in professional job applications. Also the activities are designed in a way to use these methods and tools in most effective way in career planning and development. By collaboration with IYTE Alumni Office and IYTE Alumni Association, graduates share their experiences and introduce different businesses to the students. The course is constructed over 3 modules. Module 1: Internal stakeholders; IYTE Career, Leadership and Entrepreneurship Center (CLEC), IYTE Alumni Office, course lecturer participations. Career center presents available supplementary activities for IYTE students’ career planning and development. Module 2: Guest speakers; IYTE graduates, IYTE student communities, IYTE lecturers present career development opportunities present in IYTE campus. Module 3: Guest speakers and panels with external stakeholders; professionals from the public and private sector, academia, NGOs; sharing methods, tools and experiences about career planning and development.

**MATH 265 Basic Linear Algebra (3-0)3 ECTS: 4**

Matrices, determinants and systems of linear equations. Gaussian elimination. LU Decomposition. Vector spaces; subspaces, sum and direct sums of subspaces. Linear dependence, bases, dimension. rank and nullity, change of basis, canonical forms, inner product, Gram- Schmidt orthogonalization process, QR decomposition. Eigenvalues, eigenvectors, diagonalization, similarity. Quadratic Forms. Complex vector spaces, Complex eigenvalues, Unitary and Hermitian Matrices. Least-squares.

**ESE 201 Thermodynamics I (2-2)3 ECTS: 6**

Introduction and basic concepts of thermodynamics. Properties of pure substances. The first law of thermodynamics for closed and open systems. The second law of thermodynamics. Entropy. Exergy.

**MATH 255 Differential Equations (4-0)4 ECTS: 6**

Classification of Differential Equations, Initial and Boundary Value Problems. Exact and Separable Differential Equations, Linear Equations and Bernoulli Equations. Higher Order Differential Equations: Homogeneous Linear Equations with constant coefficients. The Method of Undetermined Coefficients, Variation of Parameters, The Cauchy-Euler Equation. Series Solutions of Linear Differential Equations. Bessel Differential Equations. The Laplace Transform.

**ME 221 Statics (3-0)3 ECTS: 5**

Vector Quantities, Forces and Moments acting on particles, State of Equilibrium. Elements of Structures: Trusses, Beams, Shafts and Cables. Friction. Principles of Virtual Work.

**MSE 211 Materials Science and Engineering (3-0)3 ECTS: 5**

Introduction to engineering materials such as metals, ceramics and glasses, polymers, and composites; crystalline structure, defects; elastic and plastic deformations of materials; basics of mechanical properties. Types and use of steel and cast iron. Heat treatment of metals and alloys. Non-ferrous metals and alloys and their use in engineering applications.

**HIST 201 Principles of Atatürk I (2-0)NC ECTS: 2**

The modernization of the Ottoman Empire during the nineteenth and early twentieth centuries, the spread of nationalism, and the revolutionary changes in Ottoman institutions and society that led to the Empire’s demise, the transitional period from the Empire to the national state and the foundation of the Turkish Republic following the national struggle led by Mustafa Kemal Atatürk

**TURK 201 Turkish Language I (2-0)NC ECTS: 2**

Definition of the language and the place and importance of language as a social institution in life, relationship with culture-language, language-society and thought-language, place among the world languages of Turkish, exchange of words between languages, vocabulary, basic grammatical features and evaluated the current status of present state

**ESE 202 Thermodynamics II (2-2)3 ECTS: 6** Gas Power Cycles. Vapour and Combined Power Cycles. Refrigeration Cycles. Thermodynamic Property Relations. Gas Mixtures. Gas-Vapour Mixtures and Air-Conditioning. Pre. Req. ESE 201

**ESE 204 Measurement Techniques (2-2)3 ECTS: 5**

Basic concepts of measurement methods, noise, calibration, resolution, classification of errors, signal characteristics, system behavior. Measurement devices and techniques that are used in energy systems.

**ESE 212 Numerical Methods in Energy Systems Engineering (3-2)4 AKTS: 6**

Course content: Quaternions and Vector Analysis. interpolations, numerical derivations, numerical integrations, non-linear equations, ordinary differential equations (ODEs), Eigenvalues and Eigenvectors, numerical integrations of ODEs: FE, BE, Runge-Kutta 2nd and 4th), partial differential equations (PDEs) Pre. Req. ESE 104 and MATH141

**ESE 230 Fundamentals of Electrical and Electronic Circuits (3-0)3 ECTS: 4**

Circuit variables; Circuit elements; Simple resistive circuits; Techniques of circuit analysis: Node-voltage / Mesh-current analysis, Source transformations, Thevenin and Norton equivalent of the circuits, Maximum power transfer, Superposition technique, Operational amplifier; Inductance, capacitance, mutual inductance; Response of 1st order RL and RC circuits; Natural and step responses of RLC circuits

**ESE 232 Probability and Statistics (3-0)3 ECTS: 5**

Introduction to statistics, probability, and stochastic processes: Measures of central tendency, Measures of Variability, Gaussian distribution, Probability and discrete distributions, continuous distributions, Monte-Carlo simulations, fractals, introduction to stochastic processes, Naïve stochastic simulation algorithm, Gillespie algorithm.

**HIST 202 Principles of Atatürk II (2-0)NC ECTS: 2**

The foundation of Turkish Republic, Principles of Atatürk and major events and changes that have taken place in politics, society, economy, and culture as a results of revolution for reorganization of state and society

**TURK 202 Turkish Language II (2-0)NC ECTS: 2**

Turkish writing expression, identification, discussion and practical training for oral and written expression

**ESE 300 Summer Practice I NC ECTS:7**

Internship course requires students to attend a workplace for 4 weeks. In this process, the student makes practical applications, recognizes the general structure of the company and participates in the projects made in that company. In order to successfully complete the internship, students should prepare their reports in accordance with the Internship Guide of IZTECH Engineering Faculty.

**ESE 301 Heat Transfer (4-0)4 ECTS: 6**

Heat conduction, heat diffusion equation, boundary conditions, one dimensional steady state heat conduction, thermal resistance, fins, unsteady one-dimensional heat conduction, multi-dimensional heat conduction, finite difference in heat transfer, convection heat transfer, boundary layer, heat transfer correlations for internal and external flows, correlations for natural convection, boiling and condensation, introduction to radiation heat transfer, black body, view factor, heat transfer between black bodies

**ESE 311 Fluid Mechanics I (3-0)3 ECTS: 6**

Definition of fluid and their types based on deformation rate. Concept of shear stress. Fluid statics. Stability of floating objects. Lagrangian and Eulerian approaches. Conservation of mass and momentum in integral sense.

**ESE 321 Mass and Energy Balances (3-0)3 ECTS: 5**

Mass and energy balance calculations in single unit, multiple unit, single phase, multiple phase, reactive and non-reactive processes.

**ESE 331 Electromechanical Energy Conversion (4-0)4 ECTS: 6**

Electromagnetic circuits. Properties of ferromagnetic materials. Single-phase and three phase transformers. Per Unit System. Principles of electromechanical energy conversion: Linear and nonlinear systems; singly and multiply excited translational and rotational systems. DC machines: Theory, generators, motors.

**ESE 312 Fluid Mechanics II (3-0) 3 ECTS: 6**

In this course, the student learns to use the information obtained from the first part of the course, flow analysis, internal and external flow calculations, energy systems engineering in special cases. Pre. Req. ESE 311

**ESE 322 Mass Transfer (3-0)3 ECTS: 6**

In this course, students will learn the fundamental theory and introductory practical applications of separation processes. The fundamental theory they will study includes molecular diffusion, convective mass transfer, interphase mass transfer, film and overall mass transfer coefficients and vapour-liquid equilibrium. Mass transfer theory is used to design and analyse unit operations for separation processes. These include flash and continuous distillation, gas absorption and stripping, solvent extraction, solid leaching and humidification. The methods used to study the unit operations are material balances for stage and continuous contact processes, McCabe-Thiele design methods, and packed tower design.

**ESE 342 Energy Systems Engineering Economics (3-0)3 ECTS: 5**

Introduction to economics. Basic economic analysis and terminology. The logic of markets. Economic decision making. Engineering Economics for Energy Projects. The time value of money. Economic equivalence. Decision making for individual projects. Rate of return methods. Project comparisons. Decision making under uncertainty. Markets for energy. Markets for electricity. The demand and supply for electricity. Energy policy.

**ME 352 System Analysis and Control (4-0)4 ECTS: 5**

Modeling and Analysis of the Dynamic Systems that include Mechanical, Hydraulic, Pneumatic, Thermal, Electrical and Electromechanical Elements. Response of Systems. Time and Frequency Domain Solutions. Servo and Regular Characteristics. Stability Analysis. Feedback Control: P, PD, PI and PID.

**ENG 302 Technical Writing and Communication (3-0)3 ECTS: 3**

This course has been designed to improve students’ communication skills in business life and in other courses. During the course, students will work on different genres of technical writing and will deliver oral presentations about some specific subjects related to their fields. Students will produce and analyze a number of technical writing genres ranging from technical reports, business letters/e-mail, letters of intent, technical definitions, to CVs and proposals. In addition to technical writing, students are expected to deliver oral presentations about a specific subject from their fields.

**ESE 400 Summer Practice II NC ECTS:7**

Internship course requires students to attend a workplace for 4 weeks. In this process, the student makes practical applications, recognizes the general structure of the company and participates in the projects made in that company. In order to successfully complete the internship, students should prepare their reports in accordance with the Internship Guide of IZTECH Engineering Faculty.

**ESE 401 Energy Systems Engineering Design I (3-2)4 ECTS: 8**

This first part of the design course provides students with the knowledge to design an energy system and act in accordance with ethical values, realism of innovation, entrepreneurship and consultancy.

**ESE 402 Energy Systems Engineering Design II (2-4)4 ECTS: 11**

This second part of the design course is the realization of the work designed and planned in ESE 401. Pre. Req. ESE 401.

**MAN 211 Communicational and Management Skills for Engineers (3-0)NC ECTS: 3**

Recruitment process, organizational structure and culture, developing communication and management skills, customer relations management and ethical issues in a global world and growing economies

**Elective Courses:**

**ESE 404 Engineering Mathematics (3-0)3 AKTS: 5**

The overall goal of the course is to provide the students with sufficient exposure to mathematical methods and tools that are relevant to theoretical and mathematical aspects of engineering research. The course covers matrices, eigen values and eigen vectors, sequences and series, calculus, partial differentiation, and applications for the development of mathematical models, problem-solving, optimization, and effective communication. Prerequisite/Corequisite: MATH255

**ESE 405 Heat Exchanger Design (3-0)3 ECTS: 5**

Introduction to heat exchangers. Heat transfer mechanism. Flow arrangements. Basic design methods: log-mean temperature difference, the effectiveness-NTU method. Double pipe heat exchangers. Heat exchanger pressure drop. Fouling of heat exchangers. Shell-and-tube heat exchangers. Plate type heat exchangers. Condensers and evaporators

**ESE 406 Introduction to Geothermal Energy (3-0)3 ECTS: 5**

Introduction to geothermal energy. Application areas of geothermal energy. Electricity generation. Direct use applications: space and district heating, space cooling, greenhouse heating, heat pumps, aquaculture, industrial applications. Environmental impacts of geothermal applications. Geothermal laws and regulations. Field trips to a geothermal power plant and some geothermal direct use applications. Term project

**ESE 407 Energy Efficiency (3-0)3 ECTS: 5**

General overview of energy efficiency: Energy consumption, efficiency measures, laws and regulations. Energy efficiency in buildings. Energy efficiency in industry. Energy efficiency in transportation. Building energy efficiency: Thermal comfort in buildings. Low Carbon Buildings. Energy survey, monitoring of buildings. Energy Management. Energy efficient control of buildings. Dynamic Building energy modelling. Laboratory works. Project.

**ESE 408 Exergy (3-0)3 ECTS: 5**

Exergy and Energy Analyses, Exergy, Environment and Sustainable Development, Applications of Exergy in Industry, Exergy Analysis of Heat Pump Systems, Exergy Analysis of Thermal Energy Storage Systems, Exergy Analysis of Renewable Energy Systems, Exergy Analysis of Steam Power Plants, Exergy Analysis of Cogeneration and District Energy Systems, Exergy Analysis of Fuel Cell Systems, Exergoeconomic analysis, Exergetic Life Cycle Assessment.

**ESE 409 Heating, Ventilating and Air Conditioning (3-0)3 ECTS: 5**

Fundamentals, air properties, psychometry, basic processes, and summer and winter air conditioning. Comfort, IAQ, equipment analysis and selection, load estimation, ventilation methods and system design, national and international standards for HVAC systems. Pre. Req. ESE 312

**ESE 410 Introduction to Wind Energy (3-0) 3 ECTS: 5**

In the course, students will learn about all the layers of wind energy other than economy.

**ESE 411 GIS for Energy Systems Engineers (3-0) 3 ECTS: 5**

The course is taught using two open source GIS software. SAGA GIS and qGIS. The student can choose one of these two software with similar features or choose to use both together. Students will learn how to produce decision support mechanisms by learning all the GIS digital definitions and processing the raw data.

**ESE 420 Introduction to Bioenergy (3-0)3 ECTS: 5**

Biomass energy and types of biomass. Heat and power generation from biomass. Methods and technologies for biofuels production in solid, liquid and gaseous forms. Utilization of organic municipal waste using biomass conversion technologies.

**ESE 421 Unit Operations in Energy Processes (3-0)3 ECTS: 5**

This course provides detailed coverage of several unit operations and unit processes employed in energy related processes. Each operation/process is presented starting from the fundamentals to the recent advances. The course deals with Material and Energy balances, Heat transfer and design of Heat Exchangers, Diffusional Mass transfer and Gas – Liquid Absorption, Simultaneous heat and mass transfer, Extraction and Adsorption and Reactor design.

**ESE 423 Hydrogen Energy and Fuel Cell Systems (3-0)3 ECTS: 5**

This course provides an introduction to basic principles and theory of hydrogen production and storage technologies and fuel cell systems. The course includes a detailed analysis hydrogen production and storage Technologies and their energetic, economic and environmental evaluations. Basic principles of fuel cells, fuel cell thermodynamic, reaction kinetic, charge transfer, mass transfer, fuel cell modelling, fuel cell types, technical, economic and environmental evaluations of fuel cell systems are covered. Pre. Req. ESE201 and ESE202

**ESE 431 Introduction to Power System Analysis (3-0)3 ECTS: 5**

Basic structure of electrical power systems. Electrical characteristics of transmission lines, transformers and generators. Representation of power systems. Per Unit System. Symmetrical three-phase faults. Symmetrical components. Unsymmetrical faults.

**ESE 432 Power System Analysis and Control (3-0)3 ECTS: 5**

Matrix analysis of power systems networks and methods of solution. Load flow and short circuit analysis. Transient stability analysis.Pre. Req. ESE 431

 **ESE 440 Introduction to Computational Fluid Dynamics (2-2) 3 ECTS: 5**

Students will gain knowledge and the ability to use finite difference/volume methods for solving the Navier-Stokes and energy equations. The following topics will be covered; governing equations of flow and heat transfer, introduction to numerical methods (finite difference), finite difference solution of 1D diffusion and convection-diffusion problems, 2D convection-diffusion problems, modeling turbulent flows, natural convection flows, aerodynamic design, and turbomachinery. Ön koşul ESE301 VE ESE311

**ESE 441 Introduction to Flow Through Porous Media (3-0)3 ECTS: 5**

The fundamentals of fluid flow dynamics in porous media. Structural and physico-chemical properties of porous materials. The governing equations of steady and unsteady flow in porous media. Simultaneous flow of immiscible fluids. The effect of pore structure and surface wettability on hysteresis in relative permeability and capillary pressure. Both analytical and numerical solutions of flow equations and their applications to engineering problems. Pre. Req. ESE 311

**ESE 442 Chemistry in Geothermal Systems (3-0)3 ECTS: 5**

Introduction to geothermal systems, geothermal fluids and gases, solution theory and thermodynamics, chemical potentials and open systems, Gibbs phase rule, Duhem's phase rule, Clausius-Clapeyron equations, Van't Hoff equations, ideal solutions – Non-ideal solutions, the effects of dissolution/precipitation of minerals on the porosity and porosity-permeability relationship in the rocks, reactive transport modeling, CO2 capture, and storage techniques.

**ESE 498 Supplementary Curricular Courses (3-0)3 AKTS:5**

This course covers the evalution of contents of courses taken from digital online platforms, online and classroom certificate programs, national or international summer schools and the evalutaion of student’s success level in these courses. The related course should support the student’s careers and they should not be in the curriculum of the Energy Systems Enginering undergraduate program. The eligibility of courses are determined by the department.

**ESE 499 Cooperative Education Course (0-6)3 ECTS: 5**

Within the scope of this course, at the beginning of each semester, students will receive an introductory course at the university site for the first two weeks covering the topics of learning outcomes and objectives of the cooperative education and the evaluation procedure. Following this, students are placed in the company. Students are obliged to work for one day a week through the semester. Students summarize their daily workloads and duties in a notebook journal and prepare a report at the end of the semester with respect to the notebook. The student will provide the notebook and defend his/her report in front of the jury at the end of the semester.