IZMIR INSTITUTE OF TECHNOLOGY
THE GRADUATE SCHOOL
GRADUATE PROGRAMS AT THE DEPARTMENT OF ENERGY ENGINEERING

GRADUATE CURRICULUM

MS. in Energy Engineering

Core Courses

ENE 500	M.S. Thesis	(0-1)NC	26
*ENE 599	Research Seminar	(0-2)NC	11
ENE 503	Advanced Engineering Mathematics	(3-0)3	8
ENE 8XX	Special Studies	(8-0)NC	4

*All MS students must register Research Seminar course until the beginning of their 4th semester.

Students in interdisciplinary programs register in the 8XX course in the department of their advisors.

Total minimum credit (min): 21
Number of courses with credit (min): 7

Elective Courses

ENE 502	Advanced Engineering Thermodynamics	(3-0)3	8
ENE 508	Flow Through Porous Media	(3-0)3	8
ENE 509	Numerical Fluid Mechanics	(3-0)3	8
ENE 510	Fundamentals of Wind Energy Systems	(3-0)3	8
ENE 511	Wind Energy Meteorology	(3-0)3 Pre. Req. ENE 510	8
ENE 512	Wind Turbine Aerodynamics I	(3-2)4 Pre. Req. ENE 510	8
ENE 513	Wind Turbine Aerodynamics II	(3-2)4 Pre. Req. ENE 510 ve ENE 512	8
ENE 520	Biomass Energy and Technologies	(3-0)3	8
ENE 521	Thermochemical Conversion of Biomass	(3-0)3	8
ENE 522	Modelling and Simulation of Bioenergy Processes	(3-0)3 Pre. Req. ENE 521	8
ENE 523	Electrochemical Energy Systems	(3-0)3	8
ENE 524	Catalysis for Sustainable Energy Conversion	(3-0)3	8
ENE 530	Fundamentals of Photovoltaic Systems	(3-0)3	8
ENE 531	Power Systems Analysis	(3-0)3	8
ENE 532	Power System Stability and Dynamics	(3-0)3	8
ENE 540	Geothermal Energy and Environment	(3-0)3	8
ENE 541	Geothermal Power Plants	(3-0)3	8
ENE 542	Modeling of Geothermal Reservoirs	(3-0)3	8
ENE 556	Energy Engineering Workshop	(1-4)3 Pre. Req. Confirmation of the Instructer	8
ENE 572	Energy Economics and Management	(3-0)3	8
ENE 580	Special Topics in Energy Engineering	(3-0)3	8
ENE 590	Technical Report Writing	(0-2)NC	8

Note : The elective course list does not cover all the courses relevant to our program. Students are advised to consider all courses offered by other departments before enrollment. Students can enroll for the elective courses that are agreed by their advisors.

IZMIR INSTITUTE OF TECHNOLOGY
THE GRADUATE SCHOOL
MASTER OF SCIENCE PROGRAM IN ENERGY ENGINEERING

COURSE CONTENT

Core Courses

ENE 500 M.S. Thesis (0-1)NC ECTS: 26
A research topic which can be experimental and/or theoretical has to be pursued. It should fulfill the requirements stated in the rules set by İzmir Institute of Technology for Master Program.

ENE 503 Advanced Engineering Mathematics (3-0)3 ECTS: 8
This course deals with advanced Engineering Mathematics topics which provide students with the relevant mathematical tools required in the analysis of physical problems related to engineering. The main topic areas covered are differential equations, vector calculus, Fourier series and partial differential equations with an emphasis on using mathematical modelling techniques to solve problems. The mathematical skills derived from this course will enable students to solve specific application problemsencountered in the program.

ENE 599 Research Seminar (0-2)NC ECTS: 11
In the first two weeks of the course, effective oral/written reporting of scientific results will be explained. Ethical and unethical behavior in science and scientific studies will be discussed. Moreover, awareness of the students about scientific plagiarism will be created. A seminar must be given by each student on his/her research area. The topic of the seminar can be decided by the student and his/her supervisor. The student conducts a literature survey, collects data, analyzes, reports and presents the results of the study under the supervision of his/her supervisor.

ENE 8XX Special Studies (8-0)NC ECTS: 4
M.S. Students choose and study a topic under the guidance of a faculty member normally his/her advisor

Elective Courses:

ENE 502 Advanced Engineering Thermodynamics (3-0)3 ECTS: 8
First law of thermodynamics, second law of thermodynamics, destruction of exergy, single-phase systems, exergy generalised, multiphase systems

ENE 508 Flow Through Porous Media (3-0)3 ECTS: 8
Characterization of the morphology and connectivity of porous media. A general overview of the pore-scale flow mechanisms. Basic principles and governing equations for single- and two-phase flow through porous media. Simultaneous displacement of immiscible fluids at steady state flow regime percolation theory of capillary-controlled flow in porous media. Wettability effects on capillary pressure and relative permeability hysteresis. Pore-scale models for flow in porous media. Upscaling approach to interpreting experimental data.

ENE 509 Numerical Fluid Mechanics (3-0)3 ECTS: 8
Internal and External flows, linear and non-linear equations, Navier Stokes equations and introduction to the numerical turbulence models and knowledge on the topics.

ENE 510 Fundamentals of Wind Energy Systems (3-0)3 ECTS: 8
This course includes the history and near future of wind energy, the status of wind energy in turkey and around the globe, basic information about sub-topics of wind energy (i) meteorology (ii) aerodynamics and (iii) control. The content is supported with a site visit. The course gives knowledge and understanding on wind turbine peripherals/sections such as blades, rotor, gearbox, generator, brakes, nacelle, tower, grid connection and wind measurements.

ENE 511 Wind Energy Meteorology (3-0)3 ECTS: 8
At the end of the course, it is expected that the student has knowledge on wind data analysis, atmospheric boundary layer, Monin-Obukhov length, similarity principle, stability analysis, turbulence, wakes and modelling wind flow. Pre. Req. ENE 510.

ENE 512 Wind Turbine Aerodynamics I (3-2)4 ECTS: 8
The content of the course is design to connect the knowledge that the students get from generic fluid mechanics courses and carry it to the aerodynamic design of the wind turbines. With the methodology that is followed in the course - Blade Element momentum (BEM) - the student can get the necessary knowledge for wind turbine prototype. Furthermore, students also get extra attention on important sub-topics of the wind turbine aerodynamics (e.g. vortex, tip loss, rotor and tower effects). The course naturally also includes large amount of knowledge on introduction to wind turbine aeroelasticty. Pre. Req. ENE 510.

ENE 513 Wind Turbine Aerodynamics II (3-2)4 ECTS: 8
Within the course, students learn dynamic wake, dynamic stall and blade design updates, material usages, vortex generators and their calculation. Parallel to this yaw/tilt mechanisms, wind simulation techniques and fatigue analysis are performed. Pre. Req. ENE 510 ve ENE 512.

ENE 520 Biomass Energy and Technologies (3-0)3 ECTS: 8
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. Catalytic and high pressure applications in biomass conversion. Biorefineries.

ENE 521 Thermochemical Conversion of Biomass (3-0)3 ECTS: 8
Biomass resources and properties are considered with special attention for environmental impact and aspects of sustainability. Although biological conversion routes are not a topic in this course, the relation between biological and thermochemical process routes will be clarified. In modern biorefinery concepts, both process types are often combined. Combustion, carbonization, gasification, pyrolysis, and hydrothermal conversion. Biorefineries and biorefinery integration. Techno-economic analysis. Engineering calculations related to thermochemical conversion of biomass.

ENE 522 Modelling and Simulation of Bioenergy Processes (3-0)3 ECTS: 8
Thermochemical conversion of biomass and related process configurations, modelling the processes with solid feedstocks, modelling of unit operations, flowsheeting, mass and energy balance calculations. Pre. Req. ENE 521.

ENE 523 Electrochemical Energy Systems (3-0)3 ECTS: 8
Introduction to electrochemical energy conversion and storage systems. Theory and basic principles of eletrochemical cells, Thermoelectrochemical Cycles, Electrochemical Reforming and Sythesis, Fuel Cells, Electrolyzers, Batteries, Energy and exergy analysis of electrochemical energy systems , Economıc and enviromental evulation of electrochemical energy systems.

ENE 524 Catalysis for Sustainable Energy Conversion (3-0)3 ECTS: 8
Introduction to renewable catalytic technologies, Catalytic production of transportation fuels, Utilization of biogas as a renewable carbon Source: Dry reforming of methane, Catalysis for thermochemical conversion of biomass, Alcohol reforming for hydrogen production, Catalytic biodiesel production, Catalysis for fuel

cells, Electrocatalysis for electrolysis and chemical production, Catalyst Characterization, Catalytic Reaction Systems.

ENE 530 Fundamentals of Photovoltaic Systems (3-0)3 ECTS: 8
Semiconductor materials and their electronic, optical, physical and chemical properties, electronic structures, 1st and 2nd generation solar cells, design and modeling of c-Si based solar cells, solar panel design and installation principles.

ENE 531 Power Systems Analysis (3-0)3 ECTS: 8
Introduction to power systems (Turkish and EU systems as examples, grid codes, integration of renewable power plants), fundamental concepts, power in single and three-phase circuits (Transmission lines, transformers, synchronous machines, wind turbines, PV units), load flow analysis, symmetrical three-phase short circuit calculations, contributions of wind turbines to symmetrical three-phase faults, power system stability, using a simulation tool for load flow and short circuit analysis.

ENE 532 Power System Stability and Dynamics (3-0)3 ECTS: 8
Introduction to power system stability and control, Stability Analysis, Steady-state and Transient-state Stability, Power-Angle equations, Rotor dynamics and swing equations, synchronizing power coefficients, Equal-area criterion of stability, System dynamic analysis, Frequency control in power systems.

ENE 540 Geothermal Energy and Environment (3-0)3 ECTS: 8
Geothermal energy, distribution of geothermal system in the World, utilization of geothermal energy, tectonic properties of geothermal system, conception model of geothermal system, hydrogeochemical properties of geothermal system, environmental concerns and environmental impact assessment

ENE 541 Geothermal Power Plants (3-0)3 ECTS: 8
Introduction to geothermal energy. Cycles: geothermal power cycles, energy and exergy analysis. Fluid mechanics, single and two phase pipe flow.Mass transfer and waste heat rejection: cooling towers, condensers. Gas extraction systems. Field trip. Term project.

ENE 542 Modeling of Geothermal Reservoirs (3-0)3 ECTS: 8
Classification of geothermal systems. The fundamentals of fluid and heat flow within fractured-porous geothermal reservoirs. Well test analysis for geothermal reservoir characterization. Principle and methodologies in numerical geothermal reservoir modeling. Applications of modeling methods for simulating flow regimes near wellbore and in geothermal reservoir conditions. Reservoir history matching and future performance forecasting.

ENE 556 Energy Engineering Workshop (1-4)3 ECTS: 8
A group/individual design project. The design effort will integrate many aspects of the student's engineering background, including design concepts, technical analyses, economic and safety considerations, etc. A formal report and oral presentation are required.
Pre. Req. Confirmation of the Instructer

ENE 572 Energy Economics and Management (3-0)3 ECTS: 8
Introduction to energy economics and management. Economics and decision making. Investment decisions and analysis. Techniques used in energy economics and management. Break-even analysis. Linear programming. Special problems of linear programming. Pricing.

ENE 580 Special Topics in Energy Engineering (3-0)3 ECTS: 8
Directed group study of special topics in energy engineering.

ENE 590 Technical Report Writing (0-2)NC ECTS: 8
Conducting and preparing journal papers, reports and thesis. Methods of research. Procedures for drafting, outlining and revision. Design of layouts. Extensive writing. Practice with journal papers and reports.