

**İZMİR 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 | 8  |
| ENE 501  | Fundamentals of Energy Engineering | (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**

|         |   |   |   |
|---------|---|---|---|
| ENE502  | Advanced Engineering Thermodynamics             | (3-0)3  | 8 |
| ENE508  | 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 |
| ENE542  | Modeling of Geothermal Reservoirs               | (3-0)3  | 8 |
| ENE 556 | Energy Engineering Workshop                     | (1-4)3 Pre. Req. Confirmation of the Instructor | 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.**

**İZMİR 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 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.

**ENE 599 Research Seminar (0-2)NC ECTS: 8**  
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 501 Fundamentals of Energy Engineering (3-0)3 ECTS: 8**  
The content of the course will include Wind, solar, Geothermal, Biomass, Wave Energy, Energy Efficiency, networks/grids and energy policies. Students will choose a subject after the mid-term as a project topic and work in groups to prepare a scientific report and presentation. The course will also be supported with site visits.

**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 aeroelasticity. 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 electrochemical cells, Thermoelectrochemical Cycles, Electrochemical Reforming and Sythesis, Fuel Cells, Electrolyzers, Batteries, Energy and exergy analysis of electrochemical energy systems , Economic 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 Instructor
- 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.