

**İZMİR INSTITUTE OF TECHNOLOGY
THE GRADUATE SCHOOL
GRADUATE PROGRAMS AT THE DEPARTMENT OF ENERGY ENGINEERING**

GRADUATE CURRICULUM

Ph.D. in Energy Engineering

Core Courses

ENE 500	Ph.D. Thesis	(0-1)NC	26
ENE 698	Ph. D. Research Seminar	(0-2)NC	7
*ENE 501	Fundamentals of Energy Engineering	(3-0)3	8
**ME 599	Methods and Ethics in Engineering Research	(0-2)NC	3
**CHE 591	Technical Writing and Ethical Issues	(3-0)NC	8
**ENV	Technical Writing, Research Methods, and Ethics	(0-2)NC	7
**IWR	Research Seminar and Ethical Issues	(0-2) NC	8
ENE 8XX	Special Studies	(8-0)NC	4

* This course is not obligatory under the condition that is taken during master studies. An elective course should be taken instead.

** One course should be taken from the group. This course is not obligatory under the condition that is taken during the master studies.

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

Total credit (min.): 21 (for students with M.S. degree)

Number of courses with credit (min.): 7 (for students with M.S. degree)

Total ECTS credit (min): 240 (for students with M.S. degree)

Total credit (min.): 42 (for students with BSc degree)

Number of courses with credit (min.):14 (for students with BSc degree)

Total ECTS credit (min): 300 (for students with BSc degree)

Elective Courses

ENE502	Advanced Engineering Thermodynamics	(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 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 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
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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 PH.D.
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

A Seminar must be given by each student on his research area which is graded by academic member of staff. The topic of the seminar can be decided by the student and his 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.

ME 599 Methods and Ethics in Engineering Research (0-2)NC ECTS: 3

How to conduct a literature survey, how to design a study, how to analyze and present results of a study, how to prepare a manuscript, how the scientific publication system works, conflict of interest, environmental ethics, ethical issues in peer review and publication, human subjects research, research misconduct, responsible authorship, ethics of mentoring, and whistleblowing and obligation to protect the public.

CHE 591 Technical Writing and Ethical Issues (3-0)NC ECTS: 8

Introduction to technical writing, how to write the materials and methods section, how to write the results, how to design effective tables and illustrations, how to write the introduction, how to cite the references, use and misuse of english, avoiding jargons, how and when to use abbreviations, how to write the abstract, prepare the title, and list the authors and addresses, how to keyboard the manuscript, how to write the discussion, how to state the acknowledgements, how to write a review paper, how to write a conference report, how to write a book review, how to write a thesis, how to prepare a poster, how to submit and publish the manuscript, the review process, how to present a paper orally, ethics, rights, and permissions. a technical writing will be assigned to each student.

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 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 eletrochemical 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 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 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.