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

GRADUATE CIRRICULUM

MS. in Energy Engineering

Core Courses

ENE 500	M.S. Thesis	(0-1)NC	26
*ENE 599	Research Seminar	(0-2)NC	8
ME 521	Advanced Thermodynamics	(3-0)3	8
**CE 508	Advanced Mechanics of Fluids	(3-0)3	8
**CHE 526	Advanced Fluid Flow	(3-0)3	8
**ME 534	Advanced Fluid Mechanics	(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)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.

** 1 course should be taken from the group.

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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

If students enrolled in the program choose the research area of "wind energy" or "building energy performance", should take research area core courses and elective courses listed below.

Area 1: Wind Energy

Core Courses

ENE 510	**Principles of Wind Energy Systems**	**(3-0)3**	**8**

Elective Courses

Minimum 3 elective courses must be taken from the elective course list given below.

Energy Engineering

ENE 511	**Wind Energy Meteorology**	**(3-0)3**	**8**
ENE 512	**Wind Turbine Aerodynamics I**	**(3-2)4**	**8**
ENE 513	**Wind Turbine Aerodynamics II**	**(3-2)4**	**8**
ENE 556	Energy Engineering Workshop	(1-4)3 Pre. Cont. of the Inst.	**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**

Mechanical Engineering

ME 511	Numerical Methods in Mechanical Engineering	(3-0)3	8
ME 516	Finite Element Analysis in Vibrations	(3-0)3	8
ME 518	Analytical Methods in Vibrations	(3-0)3	8
ME 519	Advanced Mechanics of Material	(3-0)3	8
ME 526	Theory of Turbulence	(3-0)3	8
ME 527	Turbulence-II : Experiments and Computations	(2-2)3	8
ME 536	Computational Fluid Dynamics	(3-0)3	8
ME 550	**Wind Power**	**(3-0)3**	**8**
ME 559	Plates and Panels	(3-0)3	8
ME 560	Sandwich Structures	(3-0)3	8
ME 563	Theory of Elasticity	(3-0)3	8
ME 570	Computational Intelligence	(3-0)3	8
ME 576	Computer Control of Machines	(3-0)3	8
ME 578	Probabilistic Reasoning	(3-0)3	8
ME 583	Industrial Fault Detection and Identification	(3-0)3	8
ME 587	Microcontroller Embedded Control	(3-0)3	8
ME 590	Analytical Methods in Engineering	(3-0)3	7

Electrical and Electronics Engineering

EE 502	Linear Systems Theory	(3-0)3	9
EE 503	Mathematics for Operations Research and Optimization	(3-0)3	9
EE 532	Stochastic Analysis and Estimation for Dynamical Systems	(3-0)3	9
EE 533	Digital Signal Processing	(3-0)3	9
EE 556	Nonlinear Systems Analysis	(3-0)3	9
EE 559	Nonlinear Control Design	(3-0)3	9

Civil Engineering

CE 501	Advanced Analytical Methods in Engineering	(3-0)3	8
CE 506	Hydrologic Time Series Analysis	(3-0)3	7
CE 507	Design of Hydraulic Structures	(3-0)3	7
CE 511	Coastal Engineering	(3-0)3	8
CE 513	Theory of Elasticity	(3-0)3	7
CE 518	Earthquake Engineering	(3-0)3	7
CE 519	Advanced Design of Steel Structures	(3-0)3	7
CE 521	Reinforced Concrete Members	(3-0)3	7
CE 526	Advanced Soil Mechanics II	(3-0)3	7
CE 527	Advanced Soil Mechanics I	(3-0)3	8
CE 528	Evaluation of Soil Behavior	(3-0)3	7

CE 541	Structural Reliability	(3-0)3	7
CE 543	Advanced Foundation Design and Construction	(3-0)3	7
CE 550	Geotechnical Earthquake Engineering	(3-0)3	8
CE 551	Optimization and Design	(3-0)3	7
CE 572	Structural Control	(3-0)3	8
CE 529	Soil Dynamics	(3-0)3	8

Other Departments

CENG 501	Introduction to Statistical Data Processing	(3-0)3	9
CP 790	Statistical Modelling and Forecasting	(3-0)3	7

Area 2: Building Energy Performance

Elective Courses

Minimum 5 elective courses must be taken from the elective course list given below.

Energy Engineering

ENE 556	Energy Engineering Workshop	(1-4)3 Pre. Cont. of the Inst.	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

Mechanical Engineering

ME 523	Heat Conduction	(3-0)3	8
ME 524	Experimental Design	(1-4)3	8
ME 532	Convective Heat Transfer	(3-0)3	8
ME 534	Advanced Fluid Mechanics	(3-0)3	8
ME 536	Computational Fluid Dynamics	(3-0)3	8
ME 590	Analytical Methods in Engineering	(3-0)3	7

Architecture

AR 581	Principles of Building Physics	(2-2)3	8
AR 582	Energy Efficient Design	(3-0)3	7
AR 583	Principles of Daylighting Design and Analysis	(3-0)3	7
AR 584	Introduction to Building Energy Simulation	(3-0)3	7
AR 585	Fundamentals of Energy in Buildings	(3-0)3	7
AR 586	Heat Transfer in Buildings	(3-0)3	7
AR 588	Introduction to Computational Heat Transfer and Fluid Flow in Building Applications	(3-0)3	7
AR 589	Energy Efficient Lighting Design	(3-0)3	7
AR 590	Integrated Design and Building Information Modelling	(3-0)3	7

Other Departments

CHE 539	Indoor Air Pollution	(3-0)3	7
CENG 501	Introduction to Statistical Data Processing	(3-0)3	9
CP 790	Statistical Modeling and Forecasting	(3-0)3	7

COURSE CONTENT

Core Courses

ENE 500 M.S. Thesis (0-1)NC AKTS: 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 AKTS: 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 AKTS: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.

ME 521 Advanced Thermodynamics (3-0)3 AKTS:8

Thermodynamic relations. Mixtures and gas solutions. Gas mixtures. Gas vapor mixtures and air conditioning. Chemical reactions. Introduction to phase and chemical equilibrium. Thermodynamics of high-speed fluid flow. Quantum mechanics. Molecular distributions and models. Statistical mechanics and thermodynamics. Applications of statistical thermodynamics.

CE 508 Advanced Mechanics of Fluids (3-0)3 AKTS:8

Rotational flows. Navier-Stokes equations and solutions for laminar flow. Boundary layer equations and solution techniques. Nature of turbulence. Reynolds equations. Introduction to turbulence modeling.

CHE 526 Advanced Fluid Flow (3-0)3 AKTS:8

Invisid fluid. Euler equation. Bernoulli equation. Kelvin's theorem. Irrational motion. Stoke's stream function. Vorticity. Analytical and numerical solutions of Navier- Stokes equation. Creeping flow equation. Introduction to lubrication theory. Vorticity transport equation. Laminar boundary layers. Turbulent boundary layers. Introduction to turbulence.

ME 534 Advanced Fluid Mechanics (3-0)3 AKTS:8

Fundamental concepts. Mathematical preliminaries. Fundamental equations of flow.Analysis of motion. Analysis of forces, stresses. Equations of flow theorems. Incompressible potential flow.

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

Area 1 : Wind Energy

Core Courses:

ENE 510 Principles of Wind Energy System (3-0)3 AKTS: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.

Elective Courses:

Energy Engineering

ENE 511 Wind Energy Meteorology (3-0)3 AKTS: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.

ENE 512 Wind Turbine Aerodynamics I (3-2)4 AKTS:8

The content of the course is design to connect the knowledge that the students gets 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 windturbine aeroelasticty.

ENE 513 Wind Turbine Aerodynamics II (3-2)4 AKTS: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.

ENE 556 Energy Engineering Workshop (1-4)3 AKTS: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. Consent of the Instructor

ENE 572 Energy Economics and Management (3-0)3 AKTS: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 AKTS:8

Directed group study of special topics in energy engineering

ENE 590 Technical Report Writing (0-2)NC AKTS: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.

Mechanical Engineering:

ME 511 Numerical Methods in Mechanical Engineering (3-0)3 AKTS:8

Overview of basic numerical methods. Types of partial differential equations. Boundary and initial conditions. Discretisation process by finite differences. Explicit and implicit methods. Alternating direction implicit method. Multigrain and multilevel methods. General formulation of weighted residual methods. Finite volume method. Finite element method and interpolation. Sturm-Liouville equation. Spectral method.

ME 516 Finite Element Analysis in Vibrations (3-0)3 AKTS:8

Formulation of the equation of the motion. Element energy functions. Finite element displacement method. In-plane vibration of plates. Vibration of solids. Flexural vibration of plates. Analysis of free vibration. Forced response.

ME 518 Analytical Methods in Vibrations (3-0)3 AKTS:8

Behavior of systems, Advanced principles of dynamics, Special concepts for vibration study, Natural modes of vibration: Discrete systems-Continuous systems-Approximate methods, Undamped system response, Transform method solutions of continuous systems-Wave solutions, Damped systems, Vibration under combined effects.

ME 519 Advanced Mechanics of Materials (3-0)3 AKTS:8

An overview of Mechanics of Materials, Theories of stress and strain, Stress-strain relations, Inelastic behavior, Energy methods, Torsion, Nonsymmetrical bending and shear center of beams, Curved beams, Beams on elastic foundation, Thick-walled cylinders and rotating disks, Stability of columns, Plates and shells.

ME 526 Theory of Turbulence (3-0)3 AKTS:8

To demonstrate the derivation of the equations of motions for turbulent flows and to give solid arguments for understanding the mechanisms that become apperant in the equatoions. Disscusion and comprehension of Von Karmans hypothesis and log-law's, Kolmogorov's ideas, and cascade theory. To demonstrate the theory of dynamics of turbulence. To discuss wall bounded and free shear flows. To disscuss and built comprehension for the statistical nature of turbulence. To give theory of Specral Dynamics

ME 527 Turbulence-II: Experiments and Computations (2-2)3 AKTS:8

Quick recap of the turbulent flows. Fundamentals of common experimental techniques in Turbulence: Hot-wire, Laser Dopler –LDA- and Partical Image Anemometry PIV. Introduction to closure problem and Algebric models. One and Two equation models. Discussion on boussinesq type approximations . Introduction to Large Eddy Simulation -LES-

ME 536 Computational Fluid Dynamics (3-0)3 AKTS:8

Governing equations of fluid dynamics, dimensionless form of equations, boundary conditions, simplification of governing equations based on flow type, mathematical classification of flows, vorticity-stream function approach, primitive variable approach, pressure equation, finite difference method, finite difference form of diffusion, convection and source terms, implementation of boundary conditions, finite volume method, SIMPLER algorithm and related procedure, turbulent flows and governing equations, standard k-Є model, grid generation.

ME 550 Wind Power (3-0)3 AKTS:8

Theory of wind turbines. Theory of wind streams. Types of wind turbines. Design of wind turbines. Wind farms. Economic analysis of wind power plants. Technical potentials.

ME 559 Plates and Panels (3-0)3 AKTS:8

Plates and panels of isotropic materials; Equations of linear elasticity in Cartesian coordinates. Derivation of the governing equations for isotropic rectangular plates. Solutions to problems of isotropic rectangular plates. Thermal stress in plates. Circular isotropic plates. Buckling of isotropic plates. Vibrations of isotropic plates. Theorem of minimum potential energy, Hamilton's principle and their applications. Reissner's variation theorem and its applications. Plates and panels of composite materials; Anisotropic elasticity and

composite laminate theory. Plate equilibrium equations. The bending of composite material laminated plates. Navier and Levy solutions. Transverse shear deformation effects. Elastic instability of composite plates. Linear and nonlinear vibration of composite plates. Energy methods.

ME 560 Sandwich Structures (3-0)3 AKTS:8

Sandwich structures: origins, advantages, and uses. Anisotropic Elasticity and Composite Laminate Theory. Derivation of the Governing Equations for Sandwich Plates (Panels). The governing equations for flat sandwich panels. Beams, Columns, and Rods of Composite Materials. Energy Methods for Sandwich Structures. The theorem of Minimum Potential Energy and Reissner's Variation Theorem. Solutions for Rectangular Sandwich Plates. Dynamic Effects on Sandwich Panels. Thermal and Moisture Effects on Sandwich Structures. Thermoelastic problems of sandwich structures, and for polymer matrix materials the hygrothermal considerations.

ME 563 Theory of Elasticity (3-0)3 AKTS:8

Analysis of stress and strain. Constitutive equations. Plane problems of elasticity. Torsion and flexure of beams. Variation methods, theorems of minimum potential energy and complementary energy. Approximate solution by means of variation methods. Introductions to plate theory.

ME 570 Computational Intelligence (3-0)3 AKTS:8

Introduction to conventional AI topics, and recently surging intelligent optimization schemes. From the theory of Neural Networks, to the scheduled cooling in parameter optimization in SA. Inductive and Deductive decision making, simulation of natural processes where nature is at her best : The evolution. It is intended to cover a range of topics from classical to modern computational intelligence.

ME 576 Computer Control of Machines (3-0)3 AKTS:8

Computer organization: Binary logic1 instruction and data processing. Computer interfacing : Digital-to-analog conversion, analog-to-digital conversion interrupt interfacing.Sensors for computer control. Command generation in machine control: Use for linear and cubic polynomials and spline functions, open-loop position control of step motors.

ME 578 Probabilistic Reasoning (3-0)3 AKTS:8

Introduction to probabilistic reasoning tools that are prevalent in conventional AI topics. Decision making by often incomplete prior probabilities. Methods to handle inconsistent and ambiguous data. Modeling of sensors and noise. Optimizing sensory data by filters in noisy environments. Entropy as a possible decision making tool in connection with information theory. Probabilistic reasoning is a mathematical way of inference that is already in use as an agent (robot) reasoning, which is the best alternative to rock-rigid deterministic paradigms in a noisy, stochastic agent milieu.

ME 583 Industrial Fault Detection and Identification (3-0)3 AKTS:8

Introduction to Fault Detection and Identification.General Aspects of Time and Frequency Domain Analyses.Parameter Estimation Methods. Nonparametric Characterization Tools; Entropy Based Methods (Information Theory, FIM),Nonlinear Analyses (Chaos, Fractals), Probabilistic Techniques (Bayesian

Decision Theory, etc), Advanced Spectral Analyses (HOS, Hilbert Transform, Bispectrum,Cepstrum, etc). Reliability. Distributed Sensing.

ME 587 Microcontroller Embedded Control (3-0)3 AKTS:8

Microcontrollers, embedded control, microcontroller architectures, programming techniques and a selected physical control application by the student on a specific machine/equipment.

ME 590 Analytical Methods in Engineering (3-0)3 AKTS:7

Ordinary differential equations. Series solutions of ordinary differential equations. Method of Frobenius. Laplace transform. Fourier series. Boundary conditions. Partial differential equations. Separation of variables. Bessel, Gamma functions. Legendre polynomials.

Electrical and Electronics Engineering:

EE 502 Linear Systems Theory (3-0) 3 AKTS:9

Linear spaces, normed linear spaces, metric spaces, Hilbert spaces. Matrix representation of Linear Transformations, change of basis. Fundamental theorem of differential equations. Dynamical systems. State transition matrix, impulse response matrix. Variational equation. Dynamic interpretation of eigenvalue-eigenvectors. Minimal polynomials, function of a matrix, bounded-input bounded-output stability, equilibrium points, stability in the sense of Liapunov. Algebraic equivalence, controllability, observability, minimal realization.

EE 503 Mathematics for Operations Research an Optimization (3-0)3 AKTS:9

Groups and fields, vector spaces, Linear transformations, Gauss-Jordan pivoting, Gram-Schmidt procedure, unitary space. Hyperplanes. Convex polyhedron, linear inequalities. Tucker's theorem for positive solutions. Minkowski's theorem. Eigenvector-eigenvalue problem. Definiteness. Jordan Canonical form theorem. Optimization theory on R^n: Constrained minimization problem, linear programming problem, Lagrange Multiplier Theorem, Kuhn-Tucker Conditions for Inequality constraints, convex programming.

EE 532 Stochastic Analysis and Estimation for Dynamical Systems (3-0)3 AKTS:9

Linear Algebra and linear systems review; Concepts in Estimation Theory: maximum likelihood (ML), maximum a-posteriori (MAP), least squares (LS), minimum mean square (MMSE) estimation; bias, variance, mean squared error, consistency, efficiency; Linear Estimation for Static Systems: LS estimation , polynomial fitting; Linear Dynamic Systems with Random inputs; State Estimation for linear dynamical systems: Kalman Filter; State Estimation in Non-linear Dynamical systems: extended Kalman filter, particle filtering, unscented Kalman filter; Stochastic differential equations.

EE 533 Digital Signal Processing (3-0)3 AKTS:9

Sampling and quantization of continuous-time signals. Multirate processing of digital signals. Transform analysis of linear time-invariant systems: frequency response of rational system functions, stability and casuality. Digital filter design techniques: FIR and IIR filters. Effects of finite register length. Properties of

windowing and short-time Fourier Transform analysis. Introduction to time-frequency representations. Computation of DFT, FFT techniques. DSP application project.

EE 556 Nonlinear Systems Analysis (3-0)3 AKTS:9

Nonlinear differential equations, Induced norms and matrix measures. Second order systems. Linearization methods. Approximate analysis methods. Describing functions. Singular perturbations. Lyapunov stability, the Lur'e problem. Input-Output stability. Linear time-invariant feedback systems. Differential geometric methods. Frobenius Theorem. Reachability and observability. Feedback linearization. Stabilization of linearizable systems.

EE 559 Nonlinear Control Design (3-0) 3 AKTS:9

This course provides the advantages of nonlinear control over linear control. The Lyapunov stability techniques will be presented for control of nonlinear systems. The course will cover various nonlinear control techniques such as adaptive, robust, sliding mode, learning, passivity-based, and filter-based control.

Civil Engineering:

CE 501 Advanced Analytical Methods in Engineering (3-0)3 AKTS:8

Heat flow. The method of separation of variables. Fourier series. Nonlinear partial differential equations. The method of characteristics. Fourier and Lap lace transforms.

CE 506 Hydrologic Time Series Analysis (3-0)3 AKTS:7

Application of statistical methods for analysis and modeling of hydrologic series. Statistical simulation and prediction of hydrologic sequences using time series methodology.

CE 507 Design of Hydraulic Structures (3-0)3 AKTS:7

Hydraulic design criteria and problems of reservoirs, spillways, outlet works, river training, and regulation, transition structures, conduit systems, and hydraulic machinery. Application of multiple purpose designs involving flood control, water supply, irrigation, recreation, drainage and navigation. Coastal engineering, estuaries, and harbors.

CE 511 Coastal Engineering (3-0)3 AKTS:8

An introduction to coastal engineering with emphasis on the interaction between oceanic dynamic processes (waves, currents, and tides) and coastal regions (beaches, harbors, structures, and estuaries) and on the engineering approaches necessary to prevent adverse effects caused by this interaction.

CE 513 Theory of Elasticity (3-0)3 AKTS:7

Fundamental equations of elasticity. Plane stress and plane strain. Flexure and torsion of bars of various shapes. Introduction to variational and approximate methods.

CE 518 Earthquake Engineering (3-0)3 AKTS:7

Earthquake characteristics. Seismic loads. Elastic and inelastic response. Analysis and design of buildings for earthquakes.

CE 519 Advanced Design of Steel Structures (3-0)3 AKTS:7

Design considerations for steel column and frame buckling. Steel-plate girder design. Steel-concrete composite design. Design of connections.

CE 521 Reinforced Concrete Members (3-0)3 AKTS:7

Behavior of reinforced concrete members. Critical review of specifications. Limit states. Anchorage and development of reinforcement. Shear. Torsion.

CE 526 Advanced Soil Mechanics II (3-0)3 AKTS:7

Concept of failure. Failure theories. Mohr-Coulomb failure criterion. Shear resistance between soil particles. Shear testing methods. Pore pressure parameters. Shear strength of cohesionless and cohesive soils. Stability analysis types.

CE 527 Advanced Soil Mechanics I (3-0)3 AKTS:8

The nature of soils. Stresses within a soil mass. States of stress. Mohr circle. Stress paths. Effective stress principle. Stress-strain relationships. Concepts from elastic theory. Capillarity in soil. Swelling and shrinkage. Consolidation theory. Settlement in sands.

CE 528 Evaluation of Soil Behavior (3-0)3 AKTS:7

The microscopic nature of soil. Application of physico-chemical principles for the behavior of clay soils. Clay minorology. Properties of double layer. Soil fabric and structure. Soil formation and characteristics of soil deposits. Soil behavior with respect to soil structure and composition.

CE 529 Soil Dynamics (3-0)3 AKTS:8

Foundation vibrations. Design of foundations for machinery. Stress strain behavior of soil during transient and repeated loadings. Effects of earthquakes upon structures. Amplification by a soil layer. Effect of foundation upon building response. Dynamics of lumped systems as applied to problems in soil dynamics.

CE 541 Structural Reliability (3-0)3 AKTS:7

This course aims to present theoretical and design developments in the growing field of structural reliability. Fundamental concepts related to structural reliability, safety measures, load model, resistance models, system reliability, optimum safety levels, and optimization of design codes.

CE 543 Advanced Foundation Design and Construction (3-0)3 AKTS:7

Design and construction of shallow and deep foundations for various structures. Slab-on-grade foundations, individual combined footings, continuous footings(piled/non-piled),mat foundations, bored piles, prefabricated and cast-in-situ displacement piles, piles for retaining or anchorages purposes.

CE 550 Geotechnical Earthquake Engineering (3-0)3 AKTS:8

The basic concepts of seismology, earthquakes, and strong ground motions are introduced. Basic principles of wave propagation are used to develop procedures for ground response analysis and to provide insight into such important problems as liquefaction, seismic design of slope stability, and retaining structures.

CE 551 Optimization and Design (3-0)3 AKTS:7

Introduction to operation research. Optimization techniques such as linear programming, dynamic programming, and non-linear programming. Application in water quality, air quality and waste management.

CE 572 Structural Control (3-0)3 AKTS:8

Control application to structural systems is best utilized with a good understanding of the fundamentals of complex system response. This is established by giving a background in analysis and algebra as needed. Controllability and observability properties will be evaluated, and by using feedback and optimal control methods, structures will be bound to react against earthquakes and wind effects, based on their designs. At the end of this course, students will be able to design optimal controllers and feedback observers for various structural systems.

Other Departments:

CENG 501 Introduction to Statictical Data Processing (3-0)3 AKTS:9

Organization and application of computers and statistical techniques to data processing. Data handling in terms of coding, preperation, acquisition (with and without computers), screening and reduction; summarization, tabulation and analysis; random variables, statistical estimation and hypothesis testing, enumerated data analysis, linear models(regression, correlation, analysis of variance)

CP 790 Statistical Modelling and Forecasting (3-0)3 AKTS:7

Introduction to matrix algebra. Basic econometrics and its applications. Functional forms. Seemingly unrelated regressions. Simple simultaneous equations models. Frontier cost and production functions. Discrete choice. Transport demand. Governmental preferences. Nested logit models. Hedonic price theory and applications, and time series models.

Area 2: Building Energy Performance

Elective Courses

Energy Engineering

ENE 556 Energy Engineering Workshop (1-4)3 AKTS: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. Consent of the Instructor

ENE 572 Energy Economics and Management (3-0)3 AKTS: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 AKTS:8

Directed group study of special topics in energy engineering

ENE 590 Technical Report Writing (0-2)NC AKTS: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.

Mechanical Engineering:

ME 523 Heat Conduction (3-0)3 AKTS:8

Heat Conduction Fundamentals. The Separation of Variables in the Rectangular, Cylindrical and Spherical Coordinate Systems. The use of Duhamel's Theorem. One Dimensional Composite Medium.

ME 524 Experimental Design (1-4)3 AKTS:8

Introduction. Basics of statistics. Use of spreadsheets for laboratory calculations. The nature of experimental variation. Using spreadsheets to make charts and graphs. Introduction to ANOVA tables. Using spreadsheets to analyze Latin-square experimental design, Factorial experimental designs, Box-Hunter experimental designs, and Ruggedness designs.

ME 532 Convective Heat Transfer (3-0)3 AKTS:8

Forced convective heat transfer in laminar and turbulent boundary layer flows is studied, as well as internal and external flows with arbitrary variations of surface temperature and heat flux. Exact and approximate formulations using similarity solutions, separation of variables, integral methods and superposition are investigated. The topics of turbulent transport processes, Reynolds analogy, and empirical results; high velocity flow; heat exchanger, and free convection are also addressed.

ME 534 Advanced Fluid Mechanics (3-0)3 AKTS:8

Fundamental concepts. Mathematical preliminaries. Fundamental equations of flow.Analysis of motion. Analysis of forces, stresses. Equations of flow theorems. Incompressible potential flow.

ME 536 Computational Fluid Dynamics (3-0)3 AKTS:8

Governing equations of fluid dynamics, dimensionless form of equations, boundary conditions, simplification of governing equations based on flow type, mathematical classification of flows, vorticity-stream function approach, primitive variable approach, pressure equation, finite difference method, finite difference form of diffusion, convection and source terms, implementation of boundary conditions, finite volume method, SIMPLER algorithm and related procedure, turbulent flows and governing equations, standard k-Є model, grid generation.

ME 590 Analytical Methods in Engineering (3-0)3 AKTS:7

Ordinary differential equations. Series solutions of ordinary differential equations. Method of Frobenius. Laplace transform. Fourier series. Boundary conditions. Partial differential equations. Separation of variables. Bessel, Gamma functions. Legendre polynomials.

Architecture:

AR 581 Principles of Building Physics (2+2)3 AKTS:8

This is an introductory course presenting the fundamentals on the basic issues of building physics, i.e. thermal behavior of buildings, architectural lighting and acoustics, and conducting research methods for these topics. The education method is based on lectures with working assignments and practical exercises.

Students will conduct research into each issue of building physics in simple problems and report them. The aim is to set a strong link with practice and practical problems.

AR 582 Energy Efficient Design (3-0)3 AKTS:7

The course covers the principle criteria for energy efficient design, the active and passive utilization of solar energy in buildings and different configurations of building envelope. It is supplemented with environmentally-friendly buildings consuming less energy, low energy, zero energy and plus energy building examples.

AR 583 Principles of Daylighting Design and Analysis (3-0)3 AKTS:7

This is a course to present fundamentals of Daylighting design, analysis, and Daylighting performance of buildings under the basic issues of building physics; and to conduct research methods for these topics. The education method is based on lectures with working assignments and practical exercises. Students will conduct research into each issue of Daylighting in simple problems and report them. The aim is to set a strong link with practice and practical problems

AR 584 Introduction to Building Energy Simulation (3-0)3 AKTS:7

This course develops an understanding on basics of energy efficient architecture and builds on this to develop skills in energy simulation for buildings. The CAD tools are used for the prediction and analysis of a building's energy performance in regard to building physics.

AR 585 Fundamentals of Energy in Buildings (3-0)3 AKTS:7

For improving a perspective focused about energy and thermodynamics; main definitions and fundamentals important to energy are introduced. Properties of pure substances, first and second laws of thermodynamics, fundamentals and applications of air-conditioning are investigated in this course.

AR 586 Heat Transfer in Buildings (3-0)3 AKTS:7

Fundamentals of heat transfer are introduced with applications to energy gains/losses to/from building envelope. Heat transfer mechanisms; heat conduction, convection and radiation are investigated in this course.

AR 588 Introduction to Computational Heat Transfer and Fluid Flow in Building Applications (3-0)3 AKTS:7

Governing equations are obtained for cartesian and cylindrical coordinates. Numerical solution process of the steady-state and transient heat conduction problems are considered; and laminar and turbulent flows and heat transfer problems in computational fluid dynamics are investigated based on building applications.

AR 589 Energy Efficient Lighting Design (3-0)3 AKTS:7

This is a course to present fundamentals architectural lighting design, with its energy efficiency, and its analysis under the basic issues of building physics; and to conduct research methods for these topics. The education method is based on lectures with working assignments and practical exercises. Students will conduct research into each issue of lighting in simple problems and report them. The aim is to set a strong link with practice and practical problems.

AR 590 Integrated Design and Building Information Modelling (3-0)3 AKTS:7

The course focuses on how models created in Building Information Modeling based CAD systems are communicated to analysis tools in other disciplines. Students will be introduced to tools for creating parametric models, and exporting these models into a number of formats in order to carry out analysis for structure, energy, lighting, acoustics as well as cost estimation and construction scheduling. This project based course will, through hands-on exercises, expose the behind the scenes structure of the database and assumptions underlying BIM technology and give students the chance to discover the limits of interoperability that is available with state of the art systems.

Other Departments:

CHE 539 Indoor Air Pollution (3-0)3 AKTS:7

Problem identification and mitigation techniques. Building characteristic. Sampling and analysis methods. Source characterization and control. Building illness concepts. Walk-thorough inspection. Systematic building investigations. Sick building syndrome. Ventilation systems.

CENG 501 Introduction to Statictical Data Processing (3-0)3 AKTS:9

Organization and application of computers and statistical techniques to data processing. Data handling in terms of coding, preperation, acquisition (with and without computers), screening and reduction; summarization, tabulation and analysis; random variables, statistical estimation and hypothesis testing, enumerated data analysis, linear models(regression, correlation, analysis of variance)

CP 790 Statistical Modelling and Forecasting (3-0)3 AKTS:7

Introduction to matrix algebra. Basic econometrics and its applications. Functional forms. Seemingly unrelated regressions. Simple simultaneous equations models. Frontier cost and production functions. Discrete choice. Trasnport demand. Governmental preferences. Nested logit models. Hedonic price theory and applications, and time series models.