İZMİR INSTITUTE OF TECHNOLOGY
GRADUATE SCHOOL OF ENGINEERING AND SCIENCES
DEPARTMENT OF CHEMICAL ENGINEERING
CURRICULUM OF THE GRADUATE PROGRAMS

M.S. in Chemical Engineering

Core Courses		Credit	ECTS
CHE 500	Master Thesis	(0-1)NC	26
CHE 591	Technical Writing and Ethical Issues	(3-0)NC	8
CHE 598	Research Seminar*	(0-2)NC	8
CHE 8XX	Special Studies	(8-0)NC	4

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

3 core courses must be taken from the 3 groups of courses given below.		***Credit***	***ECTS***
1.CHE 505	Transport Phenomena	(3-0)3	8
2.CHE 545	Advanced Reaction Engineering	(3-0)3	8
3.CHE 592	Advanced Thermodynamcis or	(3-0)3	8
MSE 503	Materials Science and Engineering Thermodynamics	(3-0)3	8
CHE 507	Solution Thermodynamics and Phase Equilibria	(3-0)3	8

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

Ph.D. in Chemical Engineering

Core Courses		Credit	ECTS
CHE 600	Ph.D. Thesis	(0-1)NC	28
CHE 601	Ph.D. Research Seminar	(0-2)NC	8
CHE 591	Technical Writing and Ethical Issues*	(3-0)NC	8
CHE 8XX	Special Studies	(8-0)NC	4

*This course is not obligatory under the condition that it is taken during master studies.

At least 1 course must be taken from EACH of the 4 groups below at PhD level.		***Credit***	***ECTS***
1.CHE 505	Transport Phenomena	(3-0)3	8
2.CHE 545	Advanced Reaction Engineering	(3-0)3	8
3.CHE 592	Advanced Thermodynamics or	(3-0)3	8
MSE 503	Material s Science and Engineering Thermodynamics	(3-0)3	8
CHE 507	Solution Thermodynamics and Phase Equilibria	(3-0)3	8
4.CE 501	Advanced Analytical Methods in Engineering or	(3-0)3	8
CE 502	Advanced Numerical Methods in Engineering	(3-0)3	8

Total credit (min.) : 21 (for students with M.S. degree)
Number of courses with credit (min.) : 7 (for students with M.S. degree)

Total credit (min.) : 42 (for students with B.S. degree)
Number of courses with credit (min.) :14 (for students with B.S. degree)

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Elective Courses
(All elective courses have 7 ECTS credits)

	Credit	ECTS
CHE 508 Transport Phenomena II	(3-0)3	7
CHE 509 Ceramic Processing	(3-0)3	7
CHE 510 Crystallization	(3-0)3	7
CHE 511 Polymer Physics	(3-0)3	7
CHE 512 Polymer Chemistry	(3-0)3	7
CHE 513 Techniques For Microstructural Characterization of Materials	(3-0)3	7
CHE 514 Plastics Engineering	(3-0)3	7
CHE 515 X-Ray Diffraction	(3-0)3	7
CHE 516 Thin-Film and Interface Microanalysis	(3-0)3	7
CHE 517 Corrosion	(3-0)3	7
CHE 518 Adsorption	(3-0)3	7
CHE 519 Cement Chemistry	(3-0)3	7
CHE 520 Material Concepts in Catalysis	(3-0)3	7
CHE 522 Advanced Heat Transfer	(3-0)3	7
CHE 523 Biochemical Engineering I	(3-0)3	7
CHE 524 Composite Materials	(3-0)3	7
CHE 525 Combustion Phenomena	(3-0)3	7
CHE 526 Advanced Fluid Flow	(3-0)3	7
CHE 527 Nonlinear Phenomena	(3-0)3	7
CHE 529 Gas Control Processes in Air Pollution	(3-0)3	7
CHE 530 Polymer Processing	(3-0)3	7
CHE 531 Characterization and Processing of Particle	(3-0)3	7
CHE 532 Process Synthesis	(3-0)3	7
CHE 533 Mass Transport in Environmental Engineering	(3-0)3	7
CHE 534 Advanced Mass Transfer	(3-0)3	7
CHE 536 Membrane Processes	(3-0)3	7
CHE 537 Microporous and Mesoporous Materials	(3-0)3	7
CHE 540 Particulate Matter Control Processes in Air Pollution	(3-0)3	7
CHE 542 Water and Waste Treatment	(3-0)3	7
CHE 544 Industrial Waste Treatment	(3-0)3	7
CHE 548 Biochemical Engineering	(3-0)3	7
CHE 549 Catalytic Surface Science	(3-0)3	7
CHE 550 Catalysis	(3-0)3	7
CHE 551 Sol-Gel Synthesis of Catalytic Materials	(3-0)3	7
CHE 553 Supercritical Fluid Technologies	(3-0)3	7
CHE 555 Statistics for the Analysis of Measurement Systems and Experimental Data	(3-0)3	7
CHE 560 Optimal Design of Chemical Systems	(3-0)3	7
CHE 564 Organic Coatings Technology	(3-0)3	7
CHE 565 Fundamentals of Polymer Science	(3-0)3	7
CHE 566 Polymer Solution Thermodynamics	(3-0)3	7
CHE 567 Carbon Dioxide Sequestration	(3-0)3	7
CHE 568 Bioengineering Polymers	(3-0)3	7
CHE 580 Special Topics in Chemical Engineering	(3-0)3	7
CHE 588 Advanced Process Control	(3-0)3	7
CHE 590 Technical Report Writing	(3-0)NC	7
CHE 594 Zeolites Synthesis, Modification and Catalytic Applications	(3-0)3	7
CHE 595 Fundamentals of Electrochemical Engineering	(3-0)3	7
CHE599 Digitalization in Engineering	**(3-0)3**	**7**

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COURSE DESCRIPTIONS

CHE 8XX Special Studies (8-0)NC 4
Graduate students supervised by the same faculty member study advanced topics under the guidance of their advisor.

CHE 600 Ph.D. Thesis (0-1)NC 28
Orginal research work done by the student supervison of an advisor and Writtenn in the graduate thesis format.

CHE 601 Ph.D. Research Seminar (0-2)NC 8
1. A presentation of the latest developments of the student's own thesis work.
2. Attending the presentations by other graduate students.
3. Attending the presentations by people invited from outside the department.

CHE 500 Thesis (0-1)NC 26
A research topic which can be experimental and/or theoretical has to be pursued. It should fulfil the requirements stated in the rules set by İzmir Institute of Technology for Graduate Program.

CHE 505 Transport Phenomena I (3-0)3 8
Transport by molecular motion. A review of viscosity. Thermal conductivity. Diffusivity. Transport in laminar flow in one dimension. Momentum, energy and shell balances. Equations of change in isothermal, nonisothermal and multi component systems. Transport in laminar flow with two independent variables.

CHE 507 Solution Thermodynamics and Phase Equilibria (3-0)3 8
Principles of phase equilibria with application to binary and ternary systems. Relationships between phase diagrams, solution thermodynamics and thermochemistry. Measurements and control of thermodynamics variables. Practical applications of phase diagrams.

CHE 545 Advanced Reaction Engineering (3-0)3 8
Fundamentals of chemically reacting systems with emphasis on synthesis of chemical kinetics and transport phenomena. Topics include: Kinetics of gas, liquid, and surface reactions; transition state theory; surface adsorption, diffusion and desorption processes; mechanism formulation and sensitivity analysis; nonideal flow reactors; residence time distribution and dispersion models; multiphase reaction systems; nonlinear reactor phenomena. Examples drawn from different applications; including heterogeneous catalysis, polymerization, combustion, biochemical systems and materials processing.

CHE 591 Technical Writing and Ethical Issues (3-0)NC 8
The course includes how to write a technical report, a scientific paper, a thesis, etc., and comminicate effectively.

CHE 592 Advanced Thermodynamics (3-0)3 8
Solution thermodynamics. Theory and applicaton. Phase equilibria. Chemical reaction equilibria. Thermodynamic analysis of processes.

CHE 598 Research Seminar (0-2)NC 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. To this seminar engineers, specialists and scientists can be invited in order to create public opinion on the environmental problems.

CE 501 Advanced Analytical Methods in Engineering (3-0)3 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 502 Advanced Numerical Methods In Engineering (3-0)3 8
Numerical methods for solving non-linear equations. Finite difference method for solving elliptic,parabolic and hyperbolic equations in one and two dimensions. Irregular regions. Derivative boundary onditions.ayleigh-Ritz method. Finite element method for solving elliptic, parabolic and hyperbolic equations in two dimensions.

MSE 503 Materials Science and Engineering Thermodynamics (3-0)3 8
Advanced thermodynamic treatment of inorganic materials. Application of the laws of thermodynamics to chemical behavior of materials. Multicomponent systems, phase and chemical reactions equilibrium. Themodynamics of phase transformations. Introduction to surface thermodynamics

CHE 508 Transport Phenomena II (3-0)3 7
Transport in turbulent flow. Transport between two phases. Interface momentum transfer. Interface energy transport. Interface mass transfer. Transport by radiation. Transport in large flow systems.

CHE 509 Ceramic Processing (3-0)3 7
Principles and methods involved in the synthesis and processing of oxide and non-oxide ceramics. Fundamentals of compound synthesis. Precursor preparation. Particle size control. Purification. Solid-fluid phase sintering. Grain growth and densification. Impurity effects. Processing related defects. Traditional methods. New processing techniques, eg. sol-gel, freeze-dry, etc., for bulk and thin-film preparation.

CHE 510 Crystallization (3-0)3 7
Review of the nucleation and crystal growth theories. BCF and surface nucleation theories. Review of crystal growth techniques from super saturated solutions, melts, gas-phase through CVD and MBE and PVD.

CHE 511 Polymer Physics (3-0)3 7
Emphasis on statistical analysis of the molecular structure of high polymers. Topics: Spatial configuration of the isolated polymer chain. Morphology in amorphous and semi-crystalline polymers. Polymer blends. Liquid crystal polymers. Rubber elasticity.

CHE 512 Polymer Chemistry (3-0)3 7
Emphasizes on the statistical and kinetic aspects of polymer synthesis. Condensation. Addition. Anionic, cationic and heterogeneous polymerization processes, emphasizing molecular weight. Stereoregularity and composition. Molecular structure property relationship used to establish design principles for polymer materials developments. Introduction to techniques for polymer processing.

CHE 513 Techniques for Microstructural Characterization of Materials (3-0)3 7
Current methods of directly examining the microstructure of materials. Optical microscopy, SEM, field-ion microscopy. TEM. X-ray topography. STEM.

CHE 514 Plastics Engineering (3-0)3 7
Chemistry of polymerization. Mechanisms in polymerization reactions. Production, properties and fabrication of plastic materials of industrial importance. Rheology of polymers and polymer solutions.

CHE 515 X-Ray Diffraction (3-0)3 7
Diffraction theory and its relationship to structural determination in solids. Focuses on applications of X-rays.

CHE 516 Thin-Film and Interface Microanalysis (3-0)3 7
The science and technology of a variety of microanalytical techniques including Auger electron spectroscopy, Rutherford back-scattering spectroscopy, secondary ion Morn spectroscopy, ion-scattering spectroscopy and x-ray photoelectron spectroscopy.

CHE 517 Corrosion (3-0)3 7
Thermodynamics and kinetics of electrode reactions in aqua-corrosion of metals and alloys forms of corrosion. Various methods of corrosion testing. Methods of corrosion control including alloy selection, water chemistry, design rules, anionic and cathodic protection and coatings. Extension to environmental degradation of ceramics and polymers.

CHE 518 Adsorption (3-0)3 7
Adsorption and adsorbent materials. Physical properties of adsorbent materials. Porous materials. Diffusion in porous materials. Heat and mass transfer in porous materials.

CHE 519 Cement Chemistry (3-0)3 7
A review of hydraulic bonding materials. Production and bonding mechanisms of Portland cement. Classification of cement and their application areas. Review of the current research on cement, concrete and concrete composites. Dependence of the mechanical properties on processing, temperature and time

CHE 520 Materials Concepts in Catalysis (3-0)3 7
Catalytic materials, structural aspects. Crystallite morphology. Adsorption/desorption kinetics. Binding energies. Interface relations between metals and support materials. Electronic properties of non-metals. Disorder in multicomponent metal oxides. Metal-electrolyte interfaces. Metal oxide catalyst. Industrial examples.

CHE 522 Advanced Heat Transfer (3-0)3 7
Steady, unsteady, multidimensional conduction in different geometries. Basic equations for convection, laminar, free-forced convection. Turbulent convection. Analogy between heat and momentum transfer. Radioactive energy transfer in enclosures with and without an absorbing emitting medium.

CHE 523 Biochemical Engineering I (3-0)3 7
The kinetics of enzyme, catalyzed reactions. Applied enzyme catalysis. Metabolic stoichiometry and energetics. Kinetics of substrate, utilization, product formation and biomass production in cell cultures.

CHE 524 Composite Materials (3-0)3 7
Behaviour, processing and desing of composite materials, especially fiber composites. Emphasis is on the chemical and physical processes currently employed and expected to guide the future development of the technology.

CHE 525 Combustion Phenomena (3-0)3 7

Chemistry and physics of combustion. Kinetically controlled combustion phenomena. Diffusion flames in liquid fuel combustion. Combustion of solid fuels. Flames in premixed gases, heat transfer in furnaces.

CHE 526 Advanced Fluid Flow (3-0)3 7
Inviscid 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.

CHE 527 Nonlinear Phenomena (3-0)3 7
Nonlinearity and stability. Mathematical theories of chaos. Fractal approach to nonlinear dynamics. Solutions in fluid flow and macromolecules. Selected examples from polymers, ceramics, zeolites, coal, catalysts, and biomaterials.

CHE 529 Gas Control Processes in Air Pollution (3-0)3 7
Properties of gases and vapors. Incineration. Absorption. Adsorption. Control of VOCs. Control of SO_x. Control of NO_x. Control of gaseous motor vehicle emissions.

CHE 530 Polymer Processing (3-0)3 7
Polymer processing techniques: Extrusion, injection molding, blow molding, rotational molding, thermoforming, casting and foaming.

CHE 531 Characterization and Processing of Particle (3-0)3 7
Characteristics of particle systems. A review of individual and bulk particle properties. Particle size measurement techniques and an analysis of the particle size distributions. Transport and mixing in particle processing. Size, reduction and a review of the grinding process. Agglomeration of particles in these systems. A review of the beneficiation processes in particle systems.

CHE 532 Process Synthesis (3-0)3 7
Application of nonlinear and mixed integer optimization in the area of process synthesis and chemical engineering. In particular, the synthesis of heat exchanger network, distillation and separation columns, reactor networks with with complex reactions and chemical processes consisting of reactor-seperator-recycle systems.

CHE 533 Mass Transport in Environmental Engineering (3-0)3 7
Mass transport equations of environmental engineering processes. Equations of sorption kinetics in continuos flow reactors. Transport equations of fixed film exchange. Electrodialysis. Biological processes. Fixed culture processes and suspended culture processes.

CHE 534 Advanced Mass Transfer (3-0)3 7
Mechanism and theory of mass transport. Transport under laminar and turbulent flow conditions and with large fluxes. Mass transfer and simultaneous chemical reaction. Multicomponent systems. Applications in specific unit operations.

CHE 536 Membrane Processes (3-0)3 7
Review of the basics of the membrane concepts. Principles of membrane separations. Preparation of ceramic, metallic and polymeric membranes. Application of membrane in stream purification, gas separation, product recovery, wastewater treatment and other industrial processes.

CHE 537 Microporous and Mesoporous Materials (3-0)3 7

Characterization (surface area, porosity etc.). Application areas (adsorption and ion exchange). Heat and mass transfer. Diffusion.

CHE 540 Particulate Matter Control Processes in Air Pollution (3-0)3 7
Properties of particles. Particle behavior in fluids. Theory of particle control mechanisms. Cyclones. Fabric filters. Electrostatic filters. Wet scrubbers. Auxiliary equipment.

CHE 542 Water and Waste Treatment (3-0)3 7
Characteristics of water and airborne wastes treatment processes and kinetics; treatment system design: Process interactions, optimal design, treatment needs related to water supply.

CHE 544 Industrial Waste Treatment (3-0)3 7
Types of industries. Waste sources. Treatment process selection. Development and design. Monitoring and pre-treatment.

CHE 548 Biochemical Engineering II (3-0)3 7
Transport phenomena in bioprocess systems. Design and analysis of biological reactors. Bioprocess economics. Analysis of multiple interacting microbial populations. Mixed microbial populations in applications and natural systems.

CHE 549 Catalytic Surface Science (3-0)3 7
The importance of catalysis for society and the classification of catalysts. The components and structural properties of heterogeneous catalysts. The relationships between surface reactivity with the morphology and electronic structure of surfaces. Expression of surface reactivity via kinetic and transition state theory. The use of model systems in catalysis. Modern experimental techniques that are used to investigate reactions on catalytic surfaces. Molecular (computational) modelling of catalytic surface reactions by Density Functional Theory (DFT) and microkinetic modelling.

CHE 550 Catalysis (3-0)3 7
Analysis of the kinetics of homogeneous and heterogeneous catalytic reactions, mechanisms, kinetics and phase behavior. Application of collision and transition state theories to the estimation of rate constants and calculation of rates over energetically nonuniform surfaces. Discussion of the chemical and physical properties of solid surfaces that influence catalytic reactions and illustration of concepts of catalytic behavior with specific examples from catalytic cracking, reforming, oxidation and hydrodesulfurization, homogeneous hydrogenation. Catalysis by metals. Homogeneous oxidation. Catalysis by metal oxides. Catalyticpolymerization. Acid-base catalysis.

CHE 551 Sol-Gel Synthesis of Catalytic Materials (3-0)3 7
Supported catalysts. Unsupported catalysts. Sol-gel chemistry. Supercritical drying. Atmospheric drying. Catalytic coatings.

CHE 553 Supercritical Fluid Technologies (3-0)3 7
This course provides an overview of basic principles and fundamentals of different supercritical fluid (SCF) technologies and potential application at various industries. It also gives basic knowledge of phase equilibrium, thermodynamics, critical behavior, and transport properties of SCFs. Additionally, this course analyzes the chemical reactions, structures and fundamental properties of supercritical fluids as safe, organic solvent-free systems alternative for the production of new compounds, nanomaterials; extraction of high value products; oxidation of organic compounds. The course of supercritical fluid technologies complies contemporary research and technological advances by using supercritical fluids for increased selectivity and reduced waste in chemical, industrial, pharmaceutical, and biomedical applications.

CHE 555 Statistics for the Analysis of Measurement Systems and Experimental Data (3-0)3 7

Analytical Scientists must use a range of statistical tools in their treatment of experimental data as well as in establishing standard operating procedures of the measurement systems they use. Course participants will learn how to develop a valid analytical program for a measurement system along with statitics needed in the laboratory. Hence, statistical procedures that are most likely to be required will be taught including descriptive statistics, probablitiy distributions, hypothesis testing,analysis of variance, calibration, and outlier testing.

CHE 560 Optimal Design of Chemical Systems (3-0)3 7

Introduction to process design. Flowsheets for chemical processes. Synthesis of multicomponent separation sequences and reaction paths. Heat exchange networks integration. Optimization. Process economics. Simulation of chemical processes.

CHE 564 Organic Coatings Technology (3-0)3 7

Importance and uses of organic coatings (paints). Film formation (curing) mechanisms. Paint production process. Sectoral classification and relevant aspects of coatings business. Fundamentals of corrosion and the role of organic coatings in corrosion protection. Mechanisms of corrosion, substrate-coating interactions and their effect in corrosion. Characterization and measurements of corrosion.

CHE 565 Fundamentals of Polymer Science (3-0)3 7

Introduction to polymers. Structure. Polymerization processes. Molecular weight of polymer and determination. Physical states. Mechanical properties. General properties. Analysis of polymers.

CHE 566 Polymer Solution Thermodynamics (3-0)3 7

Properties of polymer solutions. Phase equilibria of polymers. Correlative and predictive models in polymer solutions to accurately describe polymer processes Applications.

CHE 567 Carbon Dioxide Sequestration (3-0)3 7

Introduction to Carbon Management, Greenhouse gases and global warming, Ways to stabilize Carbon Dioxide in the Atmosphere and Carbon Sequestration, Sequestration in Geological Formations, in Unmineable Coal Seams, in Aquifers, in Abondoned Oil and Gas Fields etc, Sequestration in Ocean, Sequsetration in Terrestrial Ecosystem, Soil and Vegetation, Sequestration by Advanced Chemical and Biological Processes, Stabilization by Alternative Energy Sources, Hydrogen Energy, Nuclear Energy, Wind Energy, Solar Energy etc.. A small design project will be assigned to each student.

CHE 568 Bioengineering Polymers (3-0)3 7

This course covers polymer-based systems used in bioengineering applications, their production techniques and new trends in the field

CHE 580 Special Topics in Chemical Engineering (3-0)3 7

Courses not listed in the catalogue. Contents vary from year to year according to interest of students and instructor in charge.

CHE 588 Advanced Process Control (3-0)3 7

State-space transfer functions. Discrete-times models. Multivariable control. Interaction assessment and time delay compensation. Model predictive control.

CHE 590 Technical Report Writing (3-0)NC 7

Conducting research and preparing journal papers, reports and theses. Methods of research, procedures for drafting outlining and revision. Design of layout. Extensive writing practice with journal papers and reports.

CHE 594 Zeolites Synthesis, Modification and Catalytic Applications. (3-0)3 7
This Course is İntended to serve as an introduction to the fascinating class of compounds called zeolites. The structural, physical and chemical properties of zeolites will be given. Zeolite synthesis is covered and parameters involed in synthesis are introduced. Phosphate based zeolites and molecular sieves are presented. Zeolites and molecular sieves characterization and modification are covered. Their use as catalsts will be discussed.

CHE595 Fundamentals of Electrochemical Engineering (3-0)3 7
This course provides a comprehensive overview of the fundamentals of electrochemical engineering and its applications. The course is designed from both a mathematical modeling and an experimental implementation perspective. Theories such as dilute solution theory, Debye-Hückel theory, porous electrode theory, etc. are investigated. Electrostatics, thermodynamics, reaction kinetics, and transport phenomena are covered in terms of electrochemical systems. Basic electroanalytical techniques are covered to establish the foundation for performing experimental studies. As energy storage and conversion research is one of the most widely studied areas in electrochemical engineering, several basic energy-focused electrochemical engineering applications, such as batteries and fuel-cells, are presented in both the fundamental level and the system level.

CHE599 Digitalization in Engineering (3-0)3 7
Theoretical and practical aspect of the digitalization problems, case studies, programming sessions on publicly available datasets on engineering.