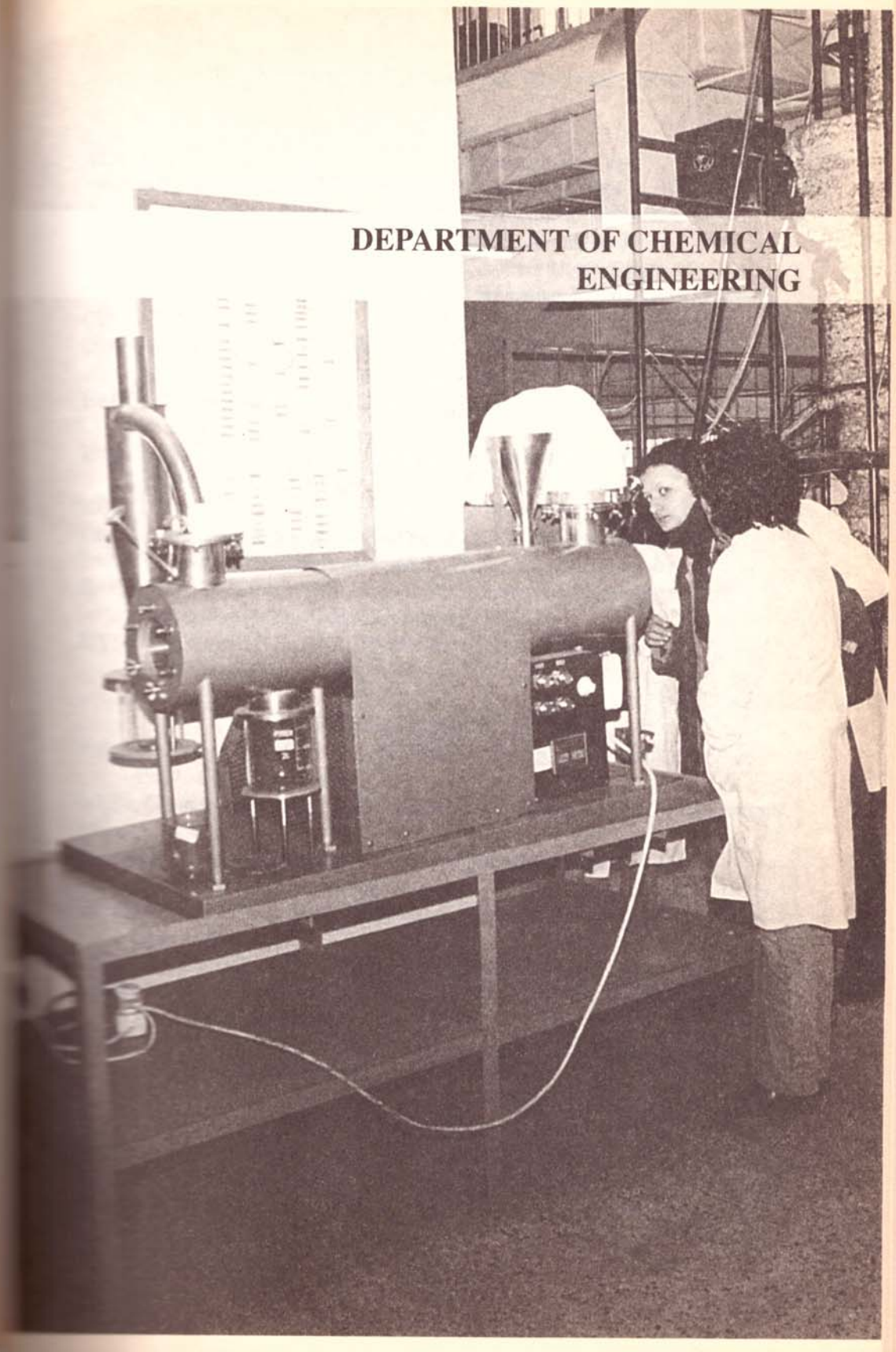
DEPARTMENT OF CHEMICAL ENGINEERING



DEPARTMENT OF CHEMICAL ENGINEERING

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GENERAL INFORMATION

Education in the Chemical Engineering Department covers not only basic principles of Chemical Engineering but also provides industrial application and research opportunity.

Chemical Engineering Program consists of basic concepts, and their synthesis and applications in process design, studies of various industrial problems and solutions. The education in theoretical and applied topics, introduced in courses, are also supported by laboratory work.

UNDERGRADUATE PROGRAM

One third of the courses are offered in English in the Chemical Engineering Department. A total of 133 credits, that of 162 hours of coursework, is required in the undergraduate program. In addition to the basic engineering courses, 4 years of undergraduate program is composed of courses in the following fields; momentum, heat and mass transfer, chemical engineering thermodynamics, mathematical modeling, reactor design, engineering economics, process control, and technology, and chemical engineering laboratory. A final project is assigned to the students in their last year of study in order to apply their basic Chemical Engineering knowledge into practice.

After completing the 4th semester, undergraduate students perform a summer practice of total 45 working days during the academic break period. Summer practice is composed of two main parts; one is 20 working days of laboratory study, and the other is a 25 working days of process unit study.

LABORATORIES

Brief descriptions of each teaching and research laboratory in the Chemical Engineering Department are provided below:

1. Analytical Chemistry Laboratory
Gravimetric analysis, volumetric analysis, acid-base equilibria, reactions of oxidation-reduction, spectrophotometric analysis, experiments related with the covered subjects are carried out. The experiments that consist of various qualitative and quantitative analyses are also performed in this teaching laboratory.

2. Organic Chemistry Laboratory

Besides experiments designed for general separation and purification techniques, the synthesis of compounds including various functional groups are also conducted in this laboratory are used in undergraduate program. The experiments conducted in this laboratory are related to the following subjects: structure, properties, and classifications of organic compounds; characteristic reactions and synthesis of various functional groups; synthesis, properties and reactions of basic organic compounds such as alcohols, phenols, aldehydes, ketones, ethers, amines, aromatics etc.

3. Chemical Engineering Laboratory I

The studies of basic principles and methods of physical chemistry and their applications to chemical engineering are performed. In this laboratory, laboratory applications of principles of physical chemistry, fluid mechanics and heat transfer, the evaluations of experimental data and results, solutions and solubility, determination of molecular weight, chemical kinetics, thermodynamic, conductivimetric and potentiometric measurements, surface chemistry and experiments related to phase behavior of various systems are carried out.

4. Chemical Engineering Laboratory II

The laboratory applications of principles of heat, mass and chemical reaction engineering, instrumental analysis and applied technology based experiments, evaluations of experimental data and results, industrial analysis such as lime, cement, oil, dye, detergent, fertilizer, fuel, gas etc. can be performed in this laboratory for teaching and research purposes. There are new models of elemental analyzer and bomb calorimeter (used for analysis of fuel) among the laboratory equipments.

5. Chemical Engineering Laboratory III

Before graduation, studies on pilot scale models of basic units, which our students may run into in the industry, are provided in this laboratory. The studies are designed for applying the theoretical knowledge acquired in the courses of second, third and fourth years relating to fluid mechanics, heat transfer and separation processes. By the means of the laboratory studies related to applications of chemical and physical principles on chemical process, mass transfer, simultaneous heat and mass transfer, process control, instrumental analysis and applied technology based experiments, pressure drop of fluids, pumps, measurements of velocity, heat transfer via conduction and convection, double-pipe heat exchangers, tube & shell heat exchangers, condensation, distillation, crystallization, size reduction and hydraulic classification, it is aimed to revise the students' knowledge gained in previous years and also to develop and improve students' laboratory skills.

6. Water and Wastewater Laboratory

The analysis of potable water, industrial and domestic wastewater can be achieved considering regulations. Besides general-purpose instruments, the laboratory has a BOD incubator, an oxygenmeter, a UV visible spectrophotometer, and an AL-25 analyzer and a flame photometer. Experimental studies such as chemical and physical properties of water, characteristic parameters of water quality, effects of nitrogenous and phosphorous materials on water pollution, thermal pollution, microbial pollution, river pollution, lake pollution, underground water pollution, sea pollution, models of surface water quality, treatment of domestic and industrial wastewater (mechanical, chemical and biological treatment), criteria for wastewater discharge into receiver medium, water pollution control, criteria for water quality and experiments related to standards are performed in this laboratory.

7. Chemical Reaction Engineering and Catalyst Laboratory

Thermo gravimetric analysis (TGA), gas (GC) and liquid (HPLC) chromatograph and other modern measurement equipment are used for studies of catalytic and non-catalytic kinetics of chemical reactions. In addition, laboratory is equipped with some devices that are used to determine porosity, porosity distribution and surface area of catalyst and porous solid.

8. Corrosion Laboratory

This research laboratory has basic devices that provide opportunities for investigation of behavior of various metals and alloys in different environments from the corrosion point of view and measurement of their corrosion rates.

UNDERGRADUATE CURRICULUM

FIRST YEAR

First Semester

MAT	101	Mathematics I	(4+0) 4
FIZ	103	Physics I	(3+1) 4
KIM	105	General Chemistry I	(3+1) 4
ENF	101	Basic Information Tech. Usage	(1+2) 0
MM	103	Computer-Aided Tech. Drawing	(2+1) 3
ING	113	Technical English I	(3+0) 3
TAR	111	Principles of Atatürk and the Revolution History I	(2+0) 0

Second Semester

MAT	102	Mathematics II	(4+0) 4
FIZ	104	Physics II	(3+1) 4
KIM	106	General Chemistry II and Lab.	(3+3) 4
ENF	102	Basic Computer Science and Fortran Programming	(2+2) 3
ING	114	Technical English II	(3+0) 3
TAR	112	Principles of Atatürk and the Revolution History II	(2+0) 0
KM	102	Introduction to Chemical Engineering	(1+0) 1

SECOND YEAR

Third Semester

KM	211	Basic Principles in Chemical Engineering I	(4+0) 4
MAT	271	Differential Equations	(4+0) 4
KIM	211	Analytical Chemistry	(3+0) 3
KIM	213	Analytical Chemistry and Laboratory	(0+4) 1
TUR	211	Turkish I	(2+0) 0
		Elective Course (non-technical)	(2+0) 2
KM	273	Engineering Thermodynamics	(3+0) 3

Fourth Semester

KM	280	Chemical Engineering Thermodynamics	(3+0) 3
KM	222	Fluid Mechanics	(3+0) 3
KIM	276	Organic Chemistry	(4+0) 4
KIM	278	Organic Chemistry and Laboratory	(0+2) 1
TUR	212	Turkish II	(2+0) 0
		Elective Course (non-technical)	(2+0) 2
KM	244	Physical Chemistry	(3+0) 3

THIRD YEAR

Fifth Semester

KM	321	Heat Transfer	(3+0) 3
KM	377	Numerical Analysis	(3+0) 3
KIM	371	Instrumental Analysis and Laboratory	(2+2) 3
		Technical Elective Course	(2+0) 2
		Technical Elective Course	(2+0) 2
KM	341	Chemical Reaction Engineering	(4+0) 4
KM	200	Summer Practice I	(0+0) 0

Sixth Semester

KM	302	Mass Transfer I	(3+0) 3
KM	306	Mathematical Modeling	(3+0) 3
KM	378	Engineering Economics	(3+0) 3
KM	380	Chemical Engineering and Laboratory I	(1+3) 2
KM	346	Basic Material Science	(3+0) 3
		Technical Elective Course	(2+0) 2

FOURTH YEAR

Seventh Semester

KM	471	Chemical Technology	(3+0) 3
KM	451	Chemical Engineering Design I	(3+2) 4
KM	491	Graduation Project	(0+2) 1
KM	481	Chemical Engineering and Laboratory II	(1+3) 2
KM	473	Process Control	(3+0) 3
		Technical Elective Course	(2+0) 2
KM	300	Summer Practice II	(0+0) 0

Eighth Semester

KM	482	Chemical Engineering and Laboratory III	(1+3) 2
KM	452	Chemical Engineering Design II	(3+2) 4
KM	474	Mass Transfer II	(3+0) 3
KM	492	Research Project	(3+2) 4
		Technical Elective Course	(2+0) 2

TECHNICAL ELECTIVE COURSES FOR THE THIRD YEAR

KM	324	Environmental Impact Assessment	(2+0) 2
KM	325	Environmental Chemistry	(2+0) 2
KM	326	Steam Systems and Energy Efficiency	(2+0) 2
KM	328	Liquid Crystal Dyes	(2+0) 2
KM	329	Occupational Health and Safety	(2+0) 2
KM	330	Laser Dyes	(2+0) 2
KM	331	Energy Efficiency and Energy Management in Industry	(2+0) 2
KM	337	Introduction to Biochemistry	(2+0) 2
KM	339	Water Technology	(2+0) 2
KM	341	Porous Materials	(2+0) 2
KM	344	Fuel Cells	(2+0) 2
KM	348	Plastic Materials	(2+0) 2
KM	350	Quality and Environmental Management Systems	(2+0) 2
KM	352	Geothermal Energy and Application	(2+0) 2
KM	360	Natural Gas and Its Applications	(2+0) 2
KM	361	Electrochemistry	(2+0) 2
KM	362	Solar Energy Technology	(2+0) 2
KM	364	Energy Technology	(2+0) 2
KM	366	Environmental Pollution	(2+0) 2
KM	367	Corrosion and Protection from Corrosion	(2+0) 2

KM	368	Introduction to Transport Phenomena	(2+0) 2
KM	370	Water Pollution and Sources	(2+0) 2
KM	372	Biochemical Reaction Engineering	(2+0) 2
KM	374	Air Pollution and Removal Methods	(2+0) 2
KM	376	Coal	(2+0) 2
KM	382	Introduction to Optimization	(2+0) 2
KM	384	Cement and Concrete	(2+0) 2

TECHNICAL ELECTIVE COURSES FOR THE FOURTH YEAR

KM	444	Catalysts and Catalytic Reactions	(2+0) 2
KM	446	Novel Separation Technique	(2+0) 2
KM	448	Organic Technologies	(2+0) 2
KM	450	Inorganic Technologies	(2+0) 2
KM	455	Cathodic Protection	(2+0) 2
KM	457	Biochemical Separations	(2+0) 2
KM	459	Reactor Design	(2+0) 2
KM	460	Petroleum Refining Technology	(2+0) 2
KM	461	Factory Organization	(2+0) 2
KM	462	Polymer Technology	(2+0) 2
KM	463	Basic Processes	(2+0) 2
KM	466	Petrochemical Technology	(2+0) 2
KM	468	Textile Dye and Dyeing Technology	(2+0) 2
KM	469	Adsorption	(2+0) 2
KM	470	Control Engineering Problems	(2+0) 2
KM	472	Biotechnology	(2+0) 2
KM	475	Fluidized Bed Reactor Design	(2+0) 2
KM	476	Computer Applications in Chemical Engineering	(2+0) 2
KM	477	Industrial Wastewater Treatment	(2+0) 2
KM	478	Dynamic Simulation and Control of Chemical Processes	(2+0) 2
KM	480	Boron Technology	(2+0) 2

NON-TECHNICAL ELECTIVE COURSES

TOS	201	Marketing	(2+0) 2
TOS	202	Behavioral Science	(2+0) 2
TOS	203	Public Relation	(2+0) 2
TOS	204	Sociology	(2+0) 2
TOS	205	Labor Law	(2+0) 2
TOS	206	History of Art	(2+0) 2

TOS	207	Administration Science	(2+0) 2
TOS	208	Sociological Structure of Turkey	(2+0) 2
TOS	209	Economical Analysis	(2+0) 2
TOS	210	Public Personnel Administration	(2+0) 2
TOS	211	Environmental Regulation	(2+0) 2
TOS	212	Technological Administration	(2+0) 2

UNDERGRADUATE COURSE DESCRIPTIONS

KM 102 Introduction to Chemical Engineering (1+0) 1
Introduction to chemical engineering, education and chemical processes. Scope. Present and future of chemical engineering in industry. Occupational safety. Engineering ethics.

KM 211 Basic Principles in Chemical Engineering (4+0) 4
Basic concepts, dimensions and unit systems. Material and energy balances, applications to physical and chemical systems.

KIM 211- Analytical Chemistry (3+0) 3
Errors in chemical analyses. Random errors in analyses, statistic for data treatment and evaluation, gravimetric and titrimetric methods. Aqueous–solution chemistry, ionic equilibrium. Equilibrium calculations in complex systems. Theory of neutralization titration, titration curves for complex acid/base systems. Precipitation titrimetry, complex formation titrimetry. Introduction to electrochemistry.

KIM 213 -Analytical Chemistry Laboratory (0+4) 1
Semi-micro qualitative analysis of cations and anions, determination of quantity with volumetric method.

KM 222 Fluid Mechanics (3+0) 3
Fluid statics and applications. Fluid dynamics. Viscosity, velocity gradient, laminar and turbulent flow, boundary layer. Bernoulli equation. Friction losses. Compressible fluids. Flow meters. Flow around submerged bodies. Flow in packed beds. Mixing of fluids Valves and fittings. Pumps, fans, compressors.

KM 244 Physical Chemistry (3+0) 3
General properties of gases, liquids and solids. Kinetic theory of gases. Chemical kinetics and reaction mechanisms. Phase rule, phase equilibrium and diagrams. Pure components, binary and multi-component systems. Chemical equilibrium. Surface chemistry. Electrochemistry.

KM 273 Engineering Thermodynamics (3+0) 3
Thermodynamic equilibrium, temperature and reversibility concepts. Work and heat. First law of thermodynamics for closed and open systems. Ideal and real gases, equations of state. Thermodynamic properties of pure substances. Second law of thermodynamics. Entropy. Third law of thermodynamics. Compressors. Power cycles. Cooling and low temperature processes.

KIM 276 -Organic Chemistry (4+0) 4
Bonding and isomerism in organic compounds, nomenclature, classification of organic compounds by their functional groups, synthesis, reactions and reaction mechanisms of organic compounds.

KIM 278 -Organic Chemistry Laboratory (0+2) 1
Separation and purification techniques of organic compounds, Determination of melting and boiling points, recrystallization, sublimation, extraction, distillation, Application of organic synthesis methods.

KM 280 Chemical Engineering Thermodynamics (3+0) 3
Thermodynamic properties of pure substances and mixtures. Heat of solution and heat of dilution. Auxiliary functions. Thermodynamic properties of multi-component systems, partial molar properties, fugacity, activity. Phase equilibria in single and multi-component systems.

KM 302 Mass Transfer I (3+0) 3
Diffusivity, molecular diffusion and Fick's Laws. Mass transfer coefficients in laminar and turbulent flows. Interface mass transfer. Mass transfer theories. Analogies. Continuous and stage operations. Gas absorption and distillation.

KM 306 Mathematical Modeling (3+0) 3
Mathematical modeling of chemical and physical processes. Application of ordinary and partial differential equations to chemical engineering problems. Analytical and computer techniques. Regression and experimental modeling.

KM 321 Heat Transfer (3+0) 3
Heat transfer by conduction Natural and forced convection heat transfer. Heat transfer in systems involving phase changing. Heat transfer by radiation. Heat exchanger design and applications.

KM 341 Chemical Reaction Engineering (4+0) 4
Rate expressions, isothermal and ideal, batch and flow reactors, data analysis. Multiple reactor system. Multiple reaction systems, selectivity. Homogeneous and heterogeneous systems. Design equations for non-isothermal systems.

KM 346 Material Science (3+0) 3
Basic structure of materials. Physicochemical, thermal and mechanical properties of material, test methods. Classification of materials. Iron and steel. Stainless steel. Non-ferrous metals. Plastics. Refractive materials. Cement, lime, plaster. Composite materials.

KIM 371-Instrumental Analysis and Laboratory (2+2) 3
Classification of analytical methods. Electromagnetic radiation. Instrument for optical spectroscopy. Molecular UV and visible spectroscopy. Molecular fluorescence, phosphorescence and chemiluminescence. Atomic spectroscopy based upon flame and electro thermal atomization. Emission, infrared, X- ray spectroscopy. Analysis of surfaces with electron beams. Mass spectroscopy. Thermal methods (TG, DTA, DSC). Electro analytical chemistry. Chromatographic separations.

KM 377 Numerical Analysis Methods (3+0) 3
Solution of linear and non-linear equations and equation systems. Numerical methods for interpolation, integration and differentiation. Solution for ordinary differential equation systems. Statistical analysis. Data analysis. Regression and correlation.

KM 378 Engineering Economics (3+0) 3
Introduction to economics. Basic concepts and laws of economy. Supply-demand mechanism and flexibility. Cost estimation. Interest. Amortization. Investment profitability. Preparation of preliminary feasibility reports on selected topics.

KM 380 Chemical Engineering Laboratory I (1+3) 2
Experiments related to physical-chemistry, fluid mechanics and heat transfer principles. Evaluation of experimental data and results, and reporting.
Special Evaluation

KM 451 Chemical Engineering Design I (3+2) 4
Design of equipments used in chemical industry, and determination of optimum operating conditions. Various pipeline, storage tank, heat exchanger, separation process and reactor design project. Cost analysis. Computer-aided design applications.
Special Evaluation

KM 452 Chemical Engineering Design II (3+2) 4
Complete design of a selected chemical process. Flow chart selection, examination and preparation. Investigation of the process from flexibility, safety, operatibility, controllability and environmental effects points of view. Mass and energy balances. Selection and design of equipments. Detailed economical analyses of processes.
Special Evaluation

KM 471 Chemical Technology (3+0) 3
Fundamentals of chemical technology. Water preparation and waste water purification methods in industry. Sulphuric acid, nitric acid and ammonia productions. Gas fuels. Synthetic organic chemicals. Polymers and plastics. Various chemical technologies.

KM 473 Process Control (3+0) 3
Basic process elements, components and controllers. Study of open and closed circuit systems. Frequency response methods. Process application.

KM 474 Mass Transfer II (3+0) 3
Evaporation. Liquid-liquid and solid-liquid extraction. Drying. Cooling towers. Filtration. Crystallization. Adsorption and ion-exchange. Grinding.

KM 481 Chemical Engineering Laboratory II (1+3) 2
Experiments related with heat transfer, mass transfer and chemical reaction engineering principles. Instrumental analysis and technology applied experiments. Evaluation of experimental data and results, and reporting.
Special Evaluation

KM 482 Chemical Engineering Laboratory III (1+3) 2
Experimental studies related with the applications of chemical and physical principles to chemical processes. Mass transfer, simultaneous heat and mass transfer, process control instrumental analysis and applied technology based experiments. Applications in laboratory and out of laboratory.
Special Evaluation

KM 491 Graduation Project (0+2) 1
Study on a project, which requires synthesis of knowledge gained in the chemical engineering program.
Special Evaluation

KM 492 Graduation Research Project (3+2) 4
Bring up the students on a selected topics in chemical engineering and theoretical, experimental, and/or computer-aided detailed studies.
Special Evaluation

TECHNICAL ELECTIVE COURSES FOR THE THIRD YEAR

KM 324 Environmental Impact Assessment (2+0) 2
Definition of environmental impact assessment (EIA), EIA regulations, EIA process, EIA methods and techniques.

KM 325 Environmental Chemistry (2+0) 2
Scope of environmental chemistry. Discussion of important relevant concepts of chemistry and introduction of basic environmental chemical concepts. Acid-base chemistry and its significance in environmental chemistry. Dissolution and chemical precipitation chemistry, chemical precipitation reactions in water and waste water treatment. Coordination chemistry, oxidation and reduction chemistry and its environmental chemistry applications.

KM 326 Steam Systems and Energy Efficiency (2+0) 2
Steam formation, situations preventing the heat transfer in steam systems, cavitation (water hammer) and its effects on the systems, condense recovery, functions and types of steam traps, design of main steam line.

KM 328 Liquid Crystal Dyes (2+0) 2
Liquid crystal structures and classification. Application of liquid crystals. Properties and structures of liquid crystal dyes. Dye manufacturing.

KM 329 Occupational Health and Safety (2+0) 2
Occupational health, health hazards in the workplace. Industrial safety, accidents, fires, explosions, occupational health and safety regulations. Risk in chemical processes, risk analysis.

KM 330 Laser Dyes (2+0) 2
Laser types and applications. Properties of organic-dye laser. Classification and chemical structures of laser dyes. Dye manufacturing.

KM 331 Energy Efficiency and Energy Management in the Industry (2+0) 2
A general perspective of energy use in Turkey. Nature of Turkish industry, efficient use of fuels and combustion systems, importance of insulation, improvements in heat transfer efficiency, waste heat recovery. Energy management program. Monitoring of energy consumption and target formation.

KM 337 Introduction to Biochemistry (2+0) 2
Chemistry of biological molecules. Amino acids. Proteins. Nucleic acids. Carbohydrates. Lipids. Enzymes. Enzyme-substrate interactions. Coenzymes.

KM 339 Water Technology (2+0) 2
Properties of water. Physical and chemical treatments. Preparation of water used in industry. Disinfections. Steam boiler and cooling water preparation.

KM 341 Porous Materials (2+0) 2
Porous structures. Zeolites, clay minerals etc. Natural materials and their properties. Porous material synthesis. Industrial applications. Determination of properties of natural and synthetic porous materials.

KM 344 Fuel Cells (2+0) 2
Fundamental aspects of fuel cell systems and types of fuel cells. Principles of operating of fuel cells, fuel processing, characteristics of fuel cell systems. Alkaline, phosphoric acid, molten carbonate, solid oxide and solid polymer electrolyte fuel cells, their researches, developments and applications.

KM 348 Plastic Materials (2+0) 2
Plastic materials and additives. Usage of the plastics. Environmental effects of plastics. Plastic wastes recycling.

KM 350 Quality and Environmental Management Systems (2+0) 2
Definitions of quality and environmental management systems and their developments. ISO 9000 and ISO 14000 standard series. Applications of ISO 9001 and ISO 14001 to a plant.

KM 352 Geothermal Energy and Applications (2+0) 2
Geothermal energy, sources, physical and chemical properties. Use of geothermal energy. Power plants based on geothermal fluid, electricity production methods. Evaporation. Crystallization. Cooling by absorption. Usage in green houses.

KM 360 Natural Gas and Applications (2+0) 2
Properties and composition of natural gas. Recovery, pretreatment, transportation. and storage. Usage as raw material for chemical products. Measurement, control and safety systems.

KM 361 Electrochemistry (2+0) 2
Electrolysis law. Electrolyte solutions and ion decomposition. Electrical conductivity. Electromotor force, measurement and calculation. Galvanized batteries, systematic analysis of batteries, classification of electrodes. Corrosion.

KM 362 Solar Energy Technology (2+0) 2
Sun and solar energy. Sun collectors. Water heating systems using solar energy. Photovoltaic batteries. Cooling by solar energy. Sun pools. Use of solar energy in distillation and drying processes.

KM 364 Energy Technology (2+0) 2
Energy and resources. Scope of energy conversion, efficiency and cost. Chemical energy, combustion, reversible reactions, batteries and fuel cells. Thermal energy. Nuclear energy. Solar energy. Geothermal energy.

KM 366 Environmental Pollution (2+0) 2
Air, water and soil contamination. Negative effects of environmental contamination. Economic, legal and social effects. Prevention techniques of environmental pollution.

KM 367 Corrosion and Protection from Corrosion (2+0) 2
General concepts of corrosion. Corrosion types. Protection methods from corrosion. Industrial applications.

KM 368 Introduction to Transport Phenomena (2+0) 2
Transport Laws and analogies. Transport phenomena in molecular level and transfer properties. Momentum, heat and mass shell balances and their solutions.

KM 370 Water Pollution and Sources (2+0) 2
Hydraulic cycle, main elements of water quality. Saprobic system. Suspended, colloidal and dissolved solids, Inorganic contamination. Thermal contamination. Toxic and radioactive contamination. Organic contamination. Microbial contamination. Effects of nitrogenous and phosphorous materials on water contamination. Surface water quality parameters and modeling.

KM 372 Biochemical Reaction Engineering (2+0) 2
Definitions of biotechnology, biochemical engineering and biochemical reaction engineering. Cell structure and components. Enzyme kinetics. Enzyme immobilization techniques and kinetics. Cell cultures. Growth kinetics and fermentor design. Mass transfer effects in bioprocess systems.

KM 374 Air Pollution and Removal Methods (2+0) 2
Air pollution and sources. Effects of pollutants and their properties. Air quality standards. Exhaust gases, stack gases. Pollutants removal methods.

KM 376 Coal (2+0) 2
Coal formation and classification. Physical and chemical properties of coal. Coal preparation methods. Washing and drying of coal. High temperature processes. Coal combustion processes and their design.

KM 382 Introduction to Optimization (2+0) 2
Optimization and its development. Engineering applications of optimization. Classification of optimization problems. Linear programming, non-linear programming. Some important unconstrained and constrained optimization techniques. The examples of optimization for specific individual processes.

KM 384 Cement and Concrete (2+0) 2
Cement production, minerologic compounds of clinker, cement types and properties, puzzolanic cements, cement hydration reactions, cement and mortars, properties of fresh concrete, factors effecting concrete quality, concrete additives, instant concrete, alkaline aggregate reactions of concretes, sulphate corrosion of concrete.

TECHNICAL ELECTIVE COURSES FOR FOURTH YEAR

KM 444 Catalysts and Catalytic Reactions (2+0) 2
General properties and structure of the catalysts. Synthesis, preparation techniques and characterization of catalysts. Catalytic reactions and mechanisms. Catalytic reactors.

KM 446 Novel Separation Techniques (2+0) 2
Osmosis, pervaporation. The principles and applications of chromatography, membrane, reactive distillation etc. Separation processes.

KM 448 Organic Technologies (2+0) 2
Carbonization of coal and coal chemicals. Petroleum and its products. Petrochemicals. Soap and detergents. Sugar industries. Paper industries. Some other organic technologies.

KM 450 Inorganic Technologies (2+0) 2
Industrial gases. Fertilizers. Cement and silicate industries. Salt and miscellaneous sodium compounds. Chlor-alkali industries. Some other inorganic technologies.

KM 455 Cathodic Protection (2+0) 2
General concepts of cathodic protection. Types of cathodic protection. Cathodic protection of pipes, tanks, heat exchangers, ships etc. Design of cathodic protection systems. Operation and maintenance of cathodic protection systems.

KM 457 Biochemical Separations (2+0) 2
Properties of biochemicals. Basic bio-separation and purification processes of biologically-produced molecules. Filtration. Centrifugation. Extraction. Adsorption. Precipitation. Electrophoresis. Crystallization. Drying.

KM 459 Reactor Design (2+0) 2
Steady and unsteady homogeneous flow reactors, multi phase reactor systems. Rate and selectivity for multiple reactions. Non-ideal flow reactors. Industrial reactors. Optimization, safety and economy. Reactor design. Design projects.

KM 460 Petroleum Refining Technology (2+0) 2
Formation, production and composition of crude oils. Refinery operations. Crude oil distillation, hydro-treating, reforming, catalytic cracking, lube oil units etc. Refinery wastes.

KM 461 Factory Organization (2+0) 2
General information about a factory establishment. Plant layout. Material handling. Work audit and planning. Quality control. Financial management. Wage and salary administration.

KM 462 Polymer Technology (2+0) 2
Polymerization mechanism, polymer structure, molecular weight and classification of polymers. Polymeric reactives and petrochemical monomers. Synthesis methods and processes. Polymeric additives and filler materials. Polymer handling methods. Some industrial polymer processes and engineering.

KM 463 Basic Processes (2+0) 2
Basic principles of industrial processes such as nitration, halogenation, sulphation and techniques used in these processes. Examples for typical industrial processes.

KM 466 Petrochemical Technology (2+0) 2
Development of petrochemical technology. Raw materials. Production methods of various petrochemicals. Petrochemical industry in Turkey and employed technologies.

KM 468 Textile Dye and Dyeing Technology (2+0)2
Theory of dying and printing. Color fastness. Classification and properties of dyestuffs. Dyeing of cellulose, polyester, protein, fibers etc.

KM 469 Adsorption (2+0) 2
Rate equations and equilibrium relations in adsorption and ion exchange. Determination techniques of properties and structure of sorbents. Design of adsorption and ion exchange columns. Industrial applications.

KM 470 Control Engineering Problems (2+0) 2
Introduction and basic information. Transient response analysis of continuous-time systems. Transient response of discrete-time systems. Root-Locus plots. Nyquist plots. Frequency-response plots.

KM 472 Biotechnology (2+0) 2
Morphology, structure and classification of microorganisms. Industrial biotechnology. Enzyme biotechnology. Bio-energy. Environmental biotechnology.

KM 475 Fluidized Bed Reactor Design (2+0) 2
Fluidized bed types. Hydrodynamics. Motion of fluids and solids, heat transfer, mass transfer and chemical reactions in fluidized beds. Design of fluidized bed reactors. Case studies.

KM 476 Computer Applications in Chemical Engineering (2+0) 2
Use of computers in chemical engineering applications and design. Use of various programming techniques in estimation of transport properties, calculations of phase equilibria and design of unit operations in chemical processes.

KM 477 Industrial Wastewater Treatment (2+0) 2
Physical, chemical and biological treatment of wastewater. Case studies for various industries. Characteristics and composition of wastes and applicability of waste treatment technology. Radioactive and thermal pollution control.

KM 478 Dynamic Simulation and Control of Chemical Processes (2+0) 2
The simulation of dynamic systems behavior by using computer. The examples for reaction engineering, thermodynamics, fluid dynamics, heat transfer, mass transfer and separation processes. The investigation of Laplace and time domain dynamics. Feedback controllers and the application examples for the different control systems.

KM 480 Boron Technology (2+0) 2
Boron and boron compounds, ores, reserves. Ore enrichment. Production of refined boron products. Advanced boron and products. Application areas of boron.

NON-TECHNICAL ELECTIVE COURSES

TOS 201 Marketing (2+0) 2
Basic concepts in marketing, marketing environment, marketing information systems and market surveys, consumer markets and consumer behavior, industrial markets and industrial buyer behavior, market segmentation, target market selection and demand predictions. Marketing factors (product, promotion, distribution, price) service marketing, international marketing, direct marketing and internet marketing.

TOS 202 Behavioral Science (2+0) 2
Classical and modern management theories. Human relations. Organizational process. Power and authority. Organizational psychology. Managing and motivational members of the organization. Groups in organizations. Leadership in organizations. Organizational effectiveness.

TOS 203 Public Relation (2+0) 2
Definition of public relations, importance, development, aims of public relations, organization and management of public relations, communications tools of public relations and effective presentation techniques.

TOS 204 Sociology (2+0) 2
Sociological thinking, history of sociology, culture-public-individual relationships, investigation of daily life, non-verbal communication, family, perversions, stratum formation, communication, popular culture, religion, social movements in this century, globalism.

TOS 205 Labor Law (2+0) 2
Labor law, basic concepts of labor law, employer, employee, sub-employee, working place service contract that emancipates service relationships, preparation of service contract, types and liabilities due to service contract, termination of service contract, legal responsibilities of employees, occupational health, occupational safety, basic concepts of collective labor law, unions, collective agreement, strike, lockout.

TOS 206 History of Art (2+0) 2
Definition of art and artist. Naturalism, realism, expressionism, humanism. Types and characteristics of compositions. Paleolithic age, Neolithic age, Anatolian civilizations.

TOS 207 Administration Science (2+0) 2
Introduction to the concept of administration. Administration theories, classical, neo-classic and modern theories. Administration duties. Modern administration techniques.

TOS 208 Societal Structure of Turkey (2+0) 2
Foundation of national state in Turkey, development of capitalism, stress between the elite-statist and traditionalist-liberals, efforts to generate a national bourgeois structure, origins of classes that make up the layer system, capital bourgeoisie, income distribution and new public faces of Islam.

TOS 209 Economical Analysis (2+0) 2
General market demand and supply balance. Price formation. Firm theory. National income. General macro economic balance.

TOS 210 Public Personnel Administration (2+0) 2
Principles and objectives of personnel administration. Differences between public-private sectors' personnel administration. Employment of a personnel. Rights, responsibilities, obligations, classifications, validation, motivation, discipline, judgment and public personnel lay-offs.

TOS 211 Environmental Regulation (2+0) 2
Environmental Law both in Turkey and in the world. Turkish Environmental Regulation, Constitution, Environmental Law. Institutions. Direct or indirect environment related other laws. Related regulations. International conventions ratified by Turkey. Court Decisions.

TOS 212 Technological Administration (2-0+0) 2
Choice of technology. Technology transfer. License agreements. Foreign capital investments. Patent, know-how and trademark agreements. R&D studies, technoparks, technological policies.

GRADUATE PROGRAM

The Master of Science (M.S.) program has two options: thesis and non-thesis options. The main objective of M.S. program with thesis is to provide students the skills of conducting research, evaluation and interpretation of information. This program requires successful completion of at least 7 courses with a minimum total number of 21 credits, one seminar course and a dissertation study. The seminar course and dissertation study do not have credit points and their assessment is based on a categorical grading as "successful" or "unsuccessful". The goal of the M.S. with non-thesis option program is to provide students a deeper theoretical knowledge in the their area of interest and to improve their skills for applying theory into practice. The program requires successful completion of at least 10 courses with a minimum total number of 30 credits and a term project course. The term project course has also no credit points and it is graded as "successful" or "unsuccessful".

Besides, main courses such as transport phenomena, chemical engineering mathematics, advanced chemical reaction engineering, advanced thermodynamics, advanced process control, graduate seminar, there are technical elective courses such as catalysis, fluidization, multicomponent distillation, water technology, fuel technology, corrosion, computer aided design etc. in the graduate curriculum of Chemical Engineering Department.

The main objective of Doctor of Philosophy Program (Ph.D.) is to provide opportunities for the students to develop skills for conducting independent research, interpretation of scientific events by examination through a broad and focused line of thought, and identifying essential steps for reaching new syntheses. The dissertation prepared at the end of the Ph.D. study has to accomplish at least one of the following objectives: to introduce a novel innovation into the field, to develop a new scientific method, to apply a known-method for a new area. The Ph.D. program requires successful completion of at least 7 graduate courses with a minimum total number of 21 credits, a proficiency exam, a dissertation proposal and dissertation study and defense.

The research carried out within the graduate program is concentrated on the subjects of chemical reaction engineering and catalysis, momentum, heat and mass transfer, corrosion, process control, environmental problems, technologies and fuel.

GRADUATE COURSES (FALL)

KM	501	Water and Waste Water Technology	(3+0) 3
KM	503	Industrial Processes	(3+0) 3
KM	507	Numerical Methods in Chemical Engineering	(3+0) 3
KM	509	Optimization	(3+0) 3
KM	511	Transport Phenomena	(3+0) 3
KM	513	Chemical Engineering Mathematics	(3+0) 3
KM	515	Advanced Chemical Reaction Engineering	(3+0) 3
KM	517	Advanced Thermodynamics	(3+0) 3
KM	537	Advanced Fluid Mechanics	(3+0) 3
KM	521	Phase Equilibrium Calculations in Chemical Engineering	(3+0) 3
KM	539	Advanced Mass Transfer	(3+0) 3
KM	543	Combustion	(3+0) 3
KM	531	Energy and Energy Technology	(3+0) 3
KM	541	Material Science	(3+0) 3
KM	545	Biochemical Processes	(3+0) 3
KM	550	Process Analysis	(3+0) 3

GRADUATE COURSES (SPRING)

KM	504	Corrosion	(3+0) 3
KM	514	Multicomponent Distillation	(3+0) 3
KM	516	Catalysis	(3+0) 3
KM	520	Petrochemical Technology	(3+0) 3
KM	522	Fuel Technology	(3+0) 3
KM	524	Air Pollution and Control	(3+0) 3
KM	526	Advanced Process Control	(3+0) 3
KM	528	Quality Control in Chemical Industry	(3+0) 3
KM	532	Crystal Chemistry	(3+0) 3
KM	536	Fluidization and Fluidized Bed Technology	(3+0) 3
KM	540	Advanced Separation Processes	(3+0) 3
KM	542	Computer Aided Design	(3+0) 3
KM	546	Zeolite Science and Technology	(3+0) 3
KM	538	Advanced Heat Transfer	(3+0) 3
KM	552	Process Simulation	(3+0) 3
KM	598	Seminar	(0+0) 0

DESCRIPTIONS OF GRADUATE COURSES
FALL SEMESTER

KM 501 Water and Waste Water Technology
Preparation of drinking and industrial water. Classification of industrial and residential waste water. Physical, chemical and biological water purification methods. Legal limitations and regulations.

KM 503 Industrial Processes
Heat loss during combustion. Efficiency calculations in steam production. Combustion of sulfur. Pyrite furnaces. Oxidation of sulfur dioxide in catalytic converters. Production of sulfuric acid, lime and soda. Unsteady state processes.

KM 507 Numerical Methods in Chemical Engineering
Advanced methods for numerical solutions of ordinary and partial differential equations.

KM 509 Optimization
Univariate and multivariate search methods. Linear programming. Constrained and unconstrained optimization. Term projects.

KM 511 Transport Phenomena
Properties of transport. Study of momentum, energy and mass transport with similar methods. Similar mechanism in transport processes, velocity distribution in laminar and turbulent flow, temperature and concentration distribution, transport between phases.

KM 513 Chemical Engineering Mathematics
Vectors and tensors. Determinants and matrices. Advanced analytical methods for solution of ordinary and partial differential equations. Applications to chemical engineering problems.

KM 515 Advanced Chemical Reaction Engineering
Kinetics of complex homogenous and heterogeneous reactions. Selectivity in catalytical reactions. Heat effects in reactors and stability. Axial and radial temperature variations in tubular reactors. Catalytic and non-catalytic multi-phase, fixed and fluidized bed reactors.

KM 517 Advanced Thermodynamics
Laws of thermodynamics. Calculation of thermodynamic properties of fluids and steam diagrams. Thermodynamical analysis of chemical engineering processes.

KM 521 Phase Equilibrium Calculations in Chemical Engineering
Equations of states, thermodynamic functions and equilibrium. Fugacity and activity coefficients, calculations of enthalpy and entropy differences. Basic principles of experimental methods in phase equilibrium. Computer applications.

KM 531 Energy and Energy Technology
Energy and types of energy. Energy technology based on fossil fuels, environmental effects of energy conversion, biological carbon equilibrium. Renewable energy sources. Geothermal energy and solar energy. New energy sources, nuclear energy, wind energy etc. Thermodynamical and economical analysis of energy conversion systems.

KM 537 Advanced Fluid Mechanics
Viscous and non-viscous flow, solution of Navier-Stokes equation. Buffer layer. Introduction to turbulence. Drag-flow separation. Introduction to Rheology.

KM 539 Advanced Mass Transfer
Mass transfer by diffusion and convection. Basic conservation laws and transfer mechanism for multi component systems. Mass transfer theories. Buffer layers. Interfacial mass transfer. Mass transfer with chemical reactions.

KM 541 Material Science
Molecular and atomic forces and bonds. Molecular structure, formation and properties of complex molecules. Polymers, ferrous alloys, semi-conductors. Techniques for material characterization.

KM 543 Combustion
Properties of fuels and selectivity. Principles of combustion and its thermochemical kinetics. Flame progression and stability. Homogenous and heterogeneous combustion. Designs of burners, furnaces and other combustion systems. Stack design.

KM 545 Biochemical Processes
Structure of microbiological systems, transfer processes and reaction kinetics. Fermentation, waste treatment and applications to other biochemical processes.

KM 550 Process Analysis
Computer use in chemical engineering education and principles of computer applications. Process analysis. Numerical compilation and engineering programming. Database programming, preparation of electronic chemical engineering handbook information, handbook information, spread sheet analysis and applications to chemical engineering design problems.

SPRING SEMESTER

KM 504 Corrosion
Principles of corrosion theory. Pourbaix diagrams. Experimental techniques in corrosion. Passivity. Corrosion types. Corrosion control, cathodic and anodic control, inhibitors.

KM 514 Multicomponent Distillation
Vapor-liquid equilibria of multicomponent systems. Key components and their selection. Short-cut and detailed design calculations. Minimum reflux ratio, tray number, column height and diameter calculations, tray design, efficiency.

KM 516 Catalysis
Physical and Chemical Properties of catalysts. Mass and heat transfer in catalytically systems. Diffusion and effectiveness factor for porous solids. Mechanisms of catalytically reactions. Deactivation of Catalysts.

KM 520 Petrochemical Technology
Raw materials, side products and products in petrochemical industry. Production methods.

KM 522 Fuel Technology
Formation of fuels, their compositions and properties. Coal carbonization. Petroleum refinement. Products and properties of petroleum. Synthetic liquid fuel production. Natural gas. Synthetic gas fuels. Transport, storage and combustion of fuels.

KM 524 Air Pollution and Control
Air pollutants, sources and causes, environmental impacts and atmospheric distribution models. Air pollution control technology and design. Standards and regulations. Term projects.

KM 526 Advanced Process Control
Analysis and design of advanced control systems. Multi-loop control systems, feed-forward and ratio controls. The design of multivariable control systems. Computer aided process control.

KM 528 Quality Control in Chemical Industry
Basic concepts. Types of quality control, statistical techniques sampling and tolerances. Cost and accuracy. Organization. Standards and regulations.

KM 532 Crystal Chemistry
Basic laws of crystal mathematics, physics and chemistry. Properties of crystal lattice. Internal crystal structure. Crystal characterization with X-ray diffraction method.

KM 536 Fluidization and Fluidized Beds
Basic principles of gas and liquid fluidization, regimes and characterization. Mixing and transport of solid particles. Bubbling and circulating fluidized beds. Spouted beds. Three-phase fluidized beds. Heat and mass transfer, chemical reactions in fluidized beds. Industrial applications. Modeling techniques.

KM 538 Advanced Heat Transfer
Multi-dimensional conduction. Natural and forced convection. Boiling and condensation. Thermal Radiation. Thermal boundary layer analysis.

KM 540 Advanced Separation Processes
Flow chart preparation for separation processes. Applications of chemical engineering principles to separation of multi component systems. Adsorption, desorption, membrane and other new separation processes.

KM 542 Computer Aided Design
Basic principles and techniques used in computer aided design of chemical processes. Models for thermodynamical properties. Regression. Modeling of unit operation equipments and reactors. Flow chart preparation. Term projects.

KM 546 Zeolite Science and Technology
Structural, physical and chemical properties of zeolites. Zeolite types and techniques for characterization. Zeolite synthesis. Ion exchange in zeolites. Diffusion and adsorption in molecular-sieve zeolites. Zeolite catalysts. New developments in uses and applications.

KM 552 Process Simulation
Introduction to basic principles of process analysis. Modeling and simulation techniques in chemical engineering. Computer applications to classical engineering problems. Classification of transport processes and modeling of population equations. Numerical examples and their solutions with computers in chemical engineering design problems.

KM 598 Seminar (Non-Credit)
Presentation of graduate research results in seminal form.