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

M.S. in Food Engineering

Core Courses			ECTS
FE 500	M.S. Thesis	(0-1)NC	26
FE 532	Food Engineering Principles	(3-0)3	9
FE 536	Design of Experiments	(3-0)3	9
FE 590	Research Methods and Technical Report Writing	(2-0)NC	3
FE 598	Seminar I*	(0-2)NC	5
FE 8XX	Special Studies	(8-0)NC	4

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

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

Ph.D. in Food Engineering

Core Courses			ECTS
FE 503	Advanced Food Microbiology* **or**	(3-0)3	7
FE 518	Food and Industrial Microbiology*	(3-0)3	7
FE 511	Advanced Food Chemistry* **or**	(3-0)3	7
FE 525	Advanced Food Biochemistry*	(3-0)3	7
FE 532	Food Engineering Principles*	(3-0)3	9
FE 536	Design of Experiments*	(3-0)3	9
FE 590	Research Methods and Technical Report Writing*	(2-0)NC	3
FE 698	Seminar II	(0-2)NC	5
FE 600	Ph.D. Thesis	(0-1)NC	26
FE 8XX	Special Studies	(8-0)NC	4

*If these courses are taken during M.S. education, there is no obligation to register these courses during Ph.D. education.

Total credit (min.) : 24 (for students with M.S. degree)
Number of courses with credit (min.): 8 (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			**ECTS**
FE 501	Food and Process Engineering Design	(3-0)3	7
FE 502	Advanced Food Quality Control	(3-0)3	7
FE 503	Advanced Food Microbiology	(3-0)3	7
FE 504	Advanced Food Plant Sanitation	(3-0)3	7
FE 505	Advanced Food Technology	(3-0)3	7
FE 506	Optimization Methods in Food Science	(3-0)3	7
FE 507	Advanced Instrumental Methods in Food Analysis	(3-0)3	7
FE 509	Meat and Poultry Processing	(3-0)3	7
FE 511	Advanced Food Chemistry	(3-0)3	7
FE 512	Membrane Processes	(3-0)3	7
FE 513	Food Lipids	(3-0)3	7
FE 514	Food Biotechnology	(3-0)3	7
FE 515	Food Additives, Contaminants and Toxicology	(3-0)3	7
FE 516	Sensory Evaluation of Foods	(3-0)3	7
FE 517	Introduction to Food Process Principles	(3-0)3	7
FE 518	Food and Industrial Microbiology	(3-0)3	7
FE 519	Food Packaging	(3-0)3	7
FE 520	Protein Purification	(3-0)3	7
FE 521	Aseptic Processing Technology	(3-0)3	7
FE 522	Downstream Processing in Biotechnology	(3-0)3	7
FE 524	Principles of Different Fermentation Methods	(3-0)3	7
FE 525	Advanced Food Biochemistry	(3-0)3	7
FE 526	Physical Properties of Food and Biological Materials	(3-0)3	7
FE 527	Enzyme Engineering	(3-0)3	7
FE 528	Functional Foods	(3-0)3	7
FE 530	Heat Treatment and Thermal Processing of Food	(3-0)3	7
FE 531	Biological Systems Simulation and Modeling	(3-0)3	7
FE 533	Enzyme Characterization and Kinetics	(3-0)3	7
FE 534	Multivariate Statistical Analysis for Engineers	(3-0)3	7
FE 535	Statistical Process Monitoring and Quality Control	(3-0)3	7
FE 538	Bioprocess Engineering Principles	(3-0)3	7
FE 539	Molecular Methods for Food Safety Applications	(3-0)3	7
FE 540	Foodborne Bacterial Pathogens	(3-0)3	7
FE 541	Food and Environmental Virology	(3-0)3	7
FE 542	Mycology: Food and Indoor Fungi	(3-0)3	7
FE 543	Food Applications of Nanotechnology	(3-0)3	7
FE 544	Analytical Methods in Food Engineering	(3-0)3	7
FE 545	**Advanced Human Nutrition**	**(3-0)3**	**7**
FE 546	**Molecular Nutrition in Food Science and Dietetics**	**(3-0)3**	**7**
FE 580	Special Topics in Food Engineering	(3-0)3	7

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COURSE DESCRIPTIONS **ECTS**

FE 500 M.S. Thesis **(0-1)NC** **26**
A research topic that can be experimental or/and theoretical has to be pursued. The requirements set by the İzmir Institute of Technology should be fulfilled.

FE 501 Food and Process Engineering Design **(3-0)3** **7**
Design of equipment, processes and facilities for food, biotechnology and related food process industries.

FE 502 Advanced Food Quality Control **(3-0)3** **7**
Principles of Quality Control System design in a food plant with emphasis on total quality management. Review of the statistical background of quality control as applied to food quality attributes. Quality control charts, sampling techniques and acceptance sampling plans as applied to foods and beverages.

FE 503 Advanced Food Microbiology **(3-0)3** **7**
Application of basic microbiological concepts to biotechnology. Cultivation of microorganisms, growth kinetics, continuous culture. Preservation, maintenance and isolation of microorganisms for industrial processes. Cell composition, anabolism and catabolism.

FE 504 Advanced Food Plant Sanitation **(3-0)3** **7**
The role of sanitation in food industry. The relationship of microorganisms to sanitation. Introduction to HACCP (Hazard Analysis at Critical Control Points). Sanitation practices in different food processing systems. Cleaning compounds, sanitizers, waste product handling.

FE 505 Advanced Food Technology **(3-0)3** **7**
Methods of production of dairy, horticultural, meat products. Fats and oils and their products and all other food processing industries including sugar, chocolate, beverage etc.

FE 506 Optimization Methods in Food Science **(3-0)3** **7**
The principles of empirical and model building and optimization are covered. Response Surface Methodology (RSM), Evolutionary Operation (EVOP), Taguchi methods and the philosophy of statistically designed experiments for product/process development are considered.

FE 507 Advanced Instrumental Methods in Food Analysis **(3-0)3** **7**
Theory and application of spectroscopic and chromatographic techniques for food and biological analysis. The content for instruments may include UV-VIS Spectroscopy, GC, HPLC, ICP-AES. Preparation of a project on application of advanced instrumental techniques on food or biological samples will be required from students at the end of the semester.

FE 509 Meat and Poultry Processing **(3-0)3** **7**
To learn the general principles of meat science, to identify and describe the basic physical and chemical components of meat/poultry and their influence on specific attributes of meat and meat/poultry products. To understand the factors that influence meat/poultry quality. To describe the scientific and technological procedures involved in the processing of meat/poultry and preservation of meat/poultry products. To acquaint the student with food safety issues as related to the meat/poultry industry.

FE 511 Advanced Food Chemistry **(3-0)3** **7**

The lesson focuses on structures, characteristics and functions of main food components (carbohydrates, lipids, vitamins, proteins, phenolic compounds and color compounds) and detailed characterization of chemical changes in food quality during processing and storage. The lesson also puts a particular emphasis on food antioxidants and determination of antioxidant activity in foods. The classification and main characteristics of food additives and principles of their applications is also discussed with sufficient details.

FE 512 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, product recovery, wastewater treatment and other industrial processes.

FE 513 Food Lipids **(3-0)3** **7**

To develop a knowledge of basic physical, chemical and biochemical properties of food lipids and application of this knowledge to food processing and quality control.

FE 514 Food Biotechnology **(3-0)3** **7**

Principles of food processing and preservation with emphasis on the application of biotechnology. Treatment of food industry and agricultural wastes. Production of nutrients, fermented food stuffs, processing aids, flavors, functional food ingredients etc. via enzyme, fermentation technology and tissue culture.

FE 515 Food Additives, Contaminants and Toxicology **(3-0)3** **7**

General information on toxicology and toxins, Branches of toxicology, Classification of toxins,Toxic doses, Toxication Mechanism of toxic effects, Mutagens, carcinogens and teratogens in foods, Toxicity tests (acute, subacute, chronic toxicity tests), End-points of assessment in food toxicology (NOAEL,ADI, MTD values), Inherent toxicants in foods (definition, classification, toxic effects), Food contaminants (definition, classification, toxic effects), Acute, chronic and genetic toxicology of naturally occurring food substances, food additives (Safety and legal aspects, functions, uses), Incidence and mode of action of Foodborne pathogenic bacteria, Mycotoxins, Detoxification processes, Residue analysis in foods, Food-drug interactions.

FE 516 Sensory Evaluation of Foods **(3-0)3** **7**

Principles and methods of subjective evaluation of foods. Statistical evaluation and interpretation of data. Correlation and subjective and objective methods.

FE 517 Introduction to Food Process Principles **(3-0)3** **7**

A brief survey of chemical process principles with a clear orientation to biotechnology. Material and energy balances. Basic principles of thermodynamics. Kinetics and transfer operations.

FE 518 Food and Industrial Microbiology **(3-0)3** **7**

Relationship of microorganisms to food manufacture and preservation, industrial fermentation and processing. Cultivation of microorganisms, growth kinetics, continuous culture. Preservation, maintenance and isolation of microorganisms for industrial processes.

FE 519 Food Packaging **(3-0)3** **7**

Overall scope of this course is to introduce general packaging concepts applied to preservation and distribution of food products. Properties of packaging materials, theoretical aspects of diffusion and permeability and packaging requirements for specific types of foods will also be covered.

FE 520 Protein Purification **(3-0)3** **7**
Cell disintegration and clarification of the extract. Precipitation and salting out. Gel filtration and other chromatography methods. Aqueous two phase systems. Reverse micelles, liquid membranes, dialysis, electrophoretic methods, isoelectric focusing, ultra filtration.

FE 521 Aseptic Processing Technology **(3-0)3** **7**
Overview of processing and packaging systems. Thermal processing and fluid flow in continuous heat exchangers. Food microbiology, chemistry and packaging as applied to aseptic processing. Establishing processes for aseptic processing of liquid and particulate foods.

FE 522 Downstream Processing in Biotechnology **(3-0)3** **7**
Cell disruption methods, lyric enzymes. Bioproduct recovery via centrifugation, filtration, chromatography, bioaffinity methods. Concentration, drying and packaging.

FE 524 Principles of Different Fermentation Methods **(3-0)3** **7**
Immersed and solid state fermentations and fermenters. Growth kinetics development of inocula and media for industrial fermentations. Primary and secondary metabolites. Fermentation economics.

FE 525 Advanced Food Biochemistry **(3-0)3** **7**
The lesson makes a through review of the structure and functions of biomolecules, biochemistry of raw and processed food (milk, meat and poultry, sea foods and fruit and vegetables) and biochemistry of food processing (brewing, baking, cheese and yoghurt). A particular emphasis is also put to explain the roles of different enzymes on food quality and processing (polyphenol oxidases, peroxidase, pectinases, proteases, lipases, lipoxygenase, lysozyme, lactoperoxidase ect.).

FE 526 Physical Properties of Food and Biological Materials **(3-0)3** **7**
Deformation, flow and textural properties of food materials. Properties of powders and flow of particulate solids. Instrumental methods for measuring physical properties of foods and food quality. Functionality and physical stability.

FE 527 Enzyme Engineering **(3-0)3** **7**
Structure of enzymes, characterization methods, enzyme kinetics, production, purification and use of enzymes. Immobilized enzymes and their applications.

FE 528 Functional Foods **(3-0)3** **7**
Health potential foods such as dietary fiber, limonoids, antioxidants, essential oils, peptides and proteins, lactic acid bacteria, etc. Application of functional materials, low allergen foods.

FE 530 Heat Treatment and Thermal Processing of Food **(3-0)3** **7**
Determination of thermal inactivation parameters (for enzymes, biologically active compounds, microorganisms and bacterial spores). Modes of heat transfer, heat penetration measurement, heat penetration curves, methods of determining lethality of thermal processes (the graphical or general method, Ball formula method), conventional thermal processing, aseptic processing, surface sterilization, commercial sterilization systems. Evaluation of the probability of spoilage from a given process. Examples of thermal process and heat treatment calculations.

FE 531 Biological Systems Simulation and Modeling **(3-0)3** **7**
This course includes definition of biological systems, model development, simulation techniques. Methods for solving differential equations such as Runge-Kutta, Euler methods will be taught in this course and a computer language (either Fortran or C++) will be used for solving biological system models. Response Surface Methodology can also be introduced to the concept of this course.

FE 532 Food Engineering Principles (3-0)3 9
Principles of fluid dynamics, heat and mass transfer in food processing operations. Formulation of continuum problems using "shell" balances. Velocity distributions in laminar flow. Shell energy balances and temperature distributions in laminar flow and solids. Concentration distributions in solids and laminar flow.

FE 533 Enzyme Characterization and Kinetics (3-0)3 7
Structure of enzymes, enzyme-substrate interaction, multi substrate reactions, specificity of enzymes, control of enzyme activity in cell, enzyme nomenclature, enzyme extraction and purification, determination of enzyme activity, enzyme kinetics, methods of plotting enzyme kinetics data, molecular weight, optimum pH, heat stability, optimum temperature and substrate specificity of enzymes.

FE 534 Multivariate Statistical Analysis for Engineers (3-0) 3 7
The course will cover the statistical tools for the analysis of process data. Basics of matrix algebra, statistics and graphical techniques to describe data, normal distribution, test of normality, hypothesis testing will be introduced first. The methods to compare several multivariate population means will be included. Techniques that are used for modeling and monitoring multivariate processes will be covered; linear regression, principal component analysis, factor analysis, discrimination and clustering analysis will be given to model and classify process data, and also to monitor and diagnose the process. Students who want to take this course should be familiar to a software to perform required matrix operations.

FE 535 Statistical Process Monitoring and Quality Control (3-0) 3 7
This course will focus on the statistical process monitoring and control techniques used in science and engineering. The content covers statistical process monitoring charts for variables and attributes. Descriptive statistics including mean, standard deviation, variance, probability distributions will be given. The concept of univariate charts such as Shewhart, cumulative sum and exponentially weighted moving average charts will be followed by autocorrelation and cross correlation in process data. The techniques for multivariable processes with correlated data will be introduced. The definition and guidelines of experimental design and factorial experiments will be covered.

FE 536 Design of Experiments (3-0) 3 9
This course is about the methods and techniques used in the design and analysis of experiments. It emphasizes the connection between the experiment and the model that the experimenter can develop from the results of the experiment. As an introduction to the course, the fundamental concepts of experimental design, such as randomization and blocking, comparison of treatments, the analysis of variance along with simple graphical techniques will be presented. Factorial and fractional factorial designs with particular emphasis on the two-level design system will be introduced. Fitting regression models, Response surface methods (RSM), which are the tools for process optimization trough designed experiments, and Taguchi methods, will also be covered.

FE 538 Bioprocess Engineering Principles (3-0)3 7
Contents include bioprocess development with an interdisciplinary point of view. Course starts with basic engineering calculations, physical processes, fluid flow, heat & mass transfer and unit operations. Reactor and reaction basics are given and reaction engineering is studied with an engineering point of view but applied to biological processes. Emphasis is given to bioreactor operations and application to biological systems. Course ends with bioprocesses using plant cell cultures and bioreactors. Students are expected to give presentations on such applications.

FE 539 Molecular Methods for Food Safety Applications (3-0)3 7

The course is designed to provide up-to-date information in nucleic acid based molecular methods and techniques for detection, identification, characteriziation and typing of common important foodborne pathogens, mycotoxigenic fungi, food contaminants, allergens and geneticall modified organisms (GMO_s) in the food safety concept. Various genotyping techniques disease or outbreak(s) and to determine their genetic relationships between bacterial strains will be included and application of these techniques for some bacterial species will be presented. In this course principles of nucleic acid based detection/identification techniques, amplification methods, nucleic acid sequencing strategies, molecular strain typing methods, use of molecular techniques to detect and characterize bacterial, viral, fungal and parasitic pathogens, molecular laboratory standardization, proficiency testing, quality control and novel approaches to all these subjects will be expressed.

FE 540 Foodborne Bacterial Pathogens (3-0)3 7

The course is designed to recognize and describe various aspects of common important and emerging bacterial foodborne pathogens and their associations with various types of foods, to explain their associations in human diseases, to ascertain the possible routes by which pathogenic bacteria enter into food chain and/or contaminate foods of various kinds. This course will also provide up-to-date information in detection (isolation and identification) conventional cultural and rapid methods of foodborne bacterial pathogens, their characteristics, virulence factors and mechanisms of pathogenesis. Epidemiology/incidence, reservoirs and possible modes of transmission, specific food vehicles, environmental factors that affect growth of bacterial foodborne pathogens and measures to prevent or reduce diseases they cause will be expressed.

FE 541 Food and Environmental Virology (3-0)3 7

Introduction to Food and Environmental Virology, Molecular Virology of Human and Animal Viruses in Food, Viruses with Potential for Food-borne Transmission, Conventional and Molecular Methods of Virus Detection in Foods, Survival and Transport of Enteric Viruses in the Environment, bacteriophages in Food Virology, Epidemiology of Viral Food-borne Outbreaks, Prevention and Control Strategies Against Food-borne Viruses

FE 542 Mycology: Food and Indoor Fungi (3-0)3 7

Introduction to Foodborne and Indoor Fungi, Fungal Taxonomy, Food Mycology including Fungal Growth, Spore Biology and Heat Resistant Fungi, Mycotoxigenic Fungi; Mycotoxins and other Fungal Metabolites (primary and secondary) including Volatile Compounds; Enumeration, Isolation and Identification of Foodborne Fungi, Detection and Enumeration of Mycotoxigenic Moulds; Effects of Moulds in Foods; Role of Fungi in Food Production; Food spoilage by Molds, Prevention and Control Strategies Against Foodborne and Indoor Fungu and Mycotoxins.

FE 543 Food Applications of Nanotechnology (3-0)3 7

Use of nanoscience and nanotechnology in food area, production methods of nanomaterials, food grade micro/nano particles usable in industry, characterization of these nanomaterials, health effects and safety regulations of nanofoods.

FE 544 Analytical Methods in Food Engineering (3-0)3 7

Introduction to the initial and boundary value problems in Food Engineering and related fields; Ordinary differential equations; Series solutions of ordinary differential equations; Legendre, Bessel Functions and Eigenfunction Expansions; Fourier series; Partial differental equations and boundary-value problems; Method of separation of variables; Sturm-Liouvillle Systems; Method of superposition; Similarity transform; Laplace transforms.

FE 545 Advanced Human Nutrition (3-0)3 7
An indication of the macro and micro nutrients metabolism in human and introduction of main organ systems that play a role in human nutrition. To develop knowledge about approaches on personalized nutrition regarding food derived nutrients.

FE 546 Molecular Nutrition in Food Science and Dietetics (3-0)3 7
The content of this course including; Introduction of the basic of the human genome and its relation to dietary nutrients. To indicate application of the molecular nutrition another scientific area. To teach steps of research planning on molecular nutrition and to introduce basic techniques of nutritional science. To discuss molecular nutrition and health-related scientific journals.

FE 580 Special Topics in Food Engineering (3-0)3 7
Contents vary according to interests of student and instructors in charge. Typical topics are food science, food technology, food processing, biotechnology etc.

FE 590 Research Methods and Technical Report Writing (2-0)NC 3
Teaches the basics of scientific research methodology and techniques. Explains the ethics of scientific (mis)conducts in research methodology and scientific writing. Instructs the principles of technical report and scientific article writing.

FE 598 Seminar I (0-2) NC 5
A seminar must be given by each M.S. student on his research area which is graded by an academic member of the staff. The topic of the seminar is specified by the student and his supervisor.

FE 698 Seminar II (0-2) NC 5
A seminar must be given by each Ph.D. student on his research area which is graded by an academic member of the staff. The topic of the seminar is specified by the student and his supervisor.

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

FE 600 Ph.D. Thesis (0-1) NC 26
Original research work done by the student under supervision of and an advisor written in the graduate thesis format.