

DEPARTMENT OF FOOD ENGINEERING DOCTOR OF PHILOSOPHY PROGRAM IN FOOD ENGINEERING					
COURSE DESCRIPTIONS					
Course Code	Course Name	Core/ Elective	Prerequisite	Credit	ECTS Credits
FE600	Ph.D. Thesis	Core		(0-1)NC	26
<p><b><u>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.</u></b></p>					
FE598	Seminar	Core		(0-2)NC	5
<p><b><u>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 is specified by the student and his supervisor.</u></b></p>					
FE532	Food Engineering Principles	Core		(3-0)3	9
<p><b><u>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.</u></b></p>					
FE536	Design of Experiments	Core		(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 through designed experiments, and Taguchi methods, will also be covered.**

FE8XX	Special Studies	Core		(8-0)NC	4
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**Graduate students supervised by the same faculty member study advanced topics under the guidance of their advisor.**

FE501	Food and Process Engineering Design	Elective		(3-0)3	7
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**Design of equipment, processes and facilities for food, biotechnology and related food process industries.**

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Course Code	Course Name	Core/ Elective	Prerequisite	Credit	ECTS Credits
FE502	Advanced Food Quality Control	Elective		(3-0)3	7

<p><b><u>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.</u></b></p>					
FE503	Advanced Food Microbiology	Core		(3-0)3	7
<p><b><u>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.</u></b></p>					
FE504	Advanced Food Plant Sanitation	Elective		(3-0)3	7
<p><b><u>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.</u></b></p>					
FE505	Advanced Food Technology	Elective		(3-0)3	7
<p><b><u>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.</u></b></p>					
FE506	Optimization Methods in Food Science	Elective		(3-0)3	7
<p><b><u>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.</u></b></p>					
FE507	Advanced Instrumental Methods in Food Analysis	Elective		(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.**

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Course Code	Course Name	Core/ Elective	Prerequisite	Credit	ECTS Credits
FE509	Meat and Poultry Processing	Elective		(3-0)3	7
<p><b><u>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.</u></b></p>					
FE511	Advanced Food Chemistry	Core		(3-0)3	7
<p><b><u>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.</u></b></p>					
FE512	Membrane Process	Elective		(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.**

FE513	Food Lipids	Elective		(3-0)3	7
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**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.**

FE514	Food Biotechnology	Elective		(3-0)3	7
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**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.**

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Course Code	Course Name	Core/ Elective	Prerequisite	Credit	ECTS Credits
FE515	Food Additives, Contaminants and Toxicology	Elective		(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.**

FE516	Sensory Evaluation of Foods	Elective		(3-0)3	7
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**Principles and methods of subjective evaluation of foods. Statistical evaluation and interpretation of data. Correlation and subjective and objective methods.**

FE517	Introduction to Food Process Principles	Elective		(3-0)3	7
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**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.**

FE518	Food and Industrial Microbiology	Elective		(3-0)3	7
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**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.**

FE519	Food Packaging	Elective		(3-0)3	7
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**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.**

FE520	Protein Purification	Elective		(3-0)3	7
<p><b><u>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.</u></b></p>					

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Course Code	Course Name	Core/ Elective	Prerequisite	Credit	ECTS Credits
FE521	Aseptic Processing Technology	Elective		(3-0)3	7
<p><b><u>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.</u></b></p>					
FE522	Downstream Processing in Biotechnology	Elective		(3-0)3	7
<p><b><u>Cell disruption methods, lyric enzymes. Bioproduct recovery via centrifugation, filtration, chromatography, bioaffinity methods. Concentration, drying and packaging.</u></b></p>					
FE524	Principles of Different Fermentation Methods	Elective		(3-0)3	7
<p><b><u>Immersed and solid state fermentations and fermenters. Growth kinetics development of inocula and media for industrial fermentations. Primary and secondary metabolites. Fermentation economics.</u></b></p>					
FE525	Advanced Food Biochemistry	Elective		(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.).**

FE526	Physical Properties of Food and Biological Materials	Elective		(3-0)3	7
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**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.**

FE527	Enzyme Engineering	Elective		(3-0)3	7
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**Structure of enzymes, characterization methods, enzyme kinetics, production, purification and use of enzymes. Immobilized enzymes and their applications.**

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FE528	Functional Foods	Elective		(3-0)3	7



<b><u>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.</u></b>					
FE530	Heat Treatment and Thermal Processing of Food	Elective		(3-0)3	7
<b><u>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.</u></b>					
FE531	Biological Systems Simulation and Modeling	Elective		(3-0)3	7
<b><u>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.</u></b>					
FE533	Enzyme Characterization and Kinetics	Elective		(3-0)3	7
<b><u>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.</u></b>					
FE534	Multivariate Statistical Analysis for Engineers	Elective		(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.

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FE535	Statistical Process Monitoring and Quality Control	Elective		(3-0)3	7
<p><u>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.</u></p>					
FE538	Bioprocess Engineering Principles	Elective		(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.

FE539	Molecular Methods for Food Safety Applications	Elective		(3-0)3	7
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The course is designed to provide up-to-date information in nucleic acid based molecular methods and techniques for detection, identification, characterization and typing of common important foodborne pathogens, mycotoxigenic fungi, food contaminants, allergens and genetically modified organisms (GMOs) 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.

FE540	Foodborne Bacterial Pathogens	Elective		(3-0)3	7
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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.

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FE541	Food and Environmental Virology	Elective		(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**

FE542	Mycology: Food and Indoor Fungi	Elective		(3-0)3	7
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**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 Fungus and Mycotoxins.**

FE543	Food Applications of Nanotechnology	Elective		(3-0)3	7
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**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.**

FE544	Analytical Methods in Food Engineering	Elective		(3-0)3	7
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**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 differential equations and boundary-value problems; Method of separation of variables; Sturm-Liouville Systems; Method of superposition; Similarity transform; Laplace transforms.**

FE580	Special Topics in Food Engineering	Elective		(3-0)3	7
<p><b><u>Contents vary according to interests of student and instructors in charge. Typical topics are food science, food technology, food processing, biotechnology etc.</u></b></p>					
FE590	Technical Report Writing	Elective		(2-0)NC	3
<p><b><u>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.</u></b></p>					