İZMİR INSTITUTE OF TECHNOLOGY
GRADUATE SCHOOL OF ENGINEERING AND SCIENCES
DEPARTMENT OF BIOENGINEERING
CURRICULUM OF THE MS PROGRAM IN BIOENGINEERING

Core Courses

BE 500	M.Sc. Thesis	(0-1)NC ECTS 26
BE 598	Research Seminar*	(0-2)NC ECTS 9
BE 501	Principles of Bioengineering I	(3-0)3 ECTS 9
BE 502	Principles of Bioengineering II	(3-0)3 ECTS 9
BE 503	Research and Ethics in Bioengineering	(3-0)3 ECTS 9
BE 8xx	Special Studies	(8-0)NC ECTS 4

Elective Courses

BE 511	Statistics for Bioengineers	(3-0)3 ECTS 8
BE 512	Biomolecular Engineering	(3-0)3 ECTS 8
BE 513	Bioprocess Engineering	(3-0)3 ECTS 8
BE 514	Fundemantals of Medical Engineering	(3-0)3 ECTS 8
BE 515	Nanoscale Bioengineering	(3-0)3 ECTS 8
BE 516	Biomedical Device Technologies	(3-0)3 ECTS 8
BE 531	Introduction to Biomaterials Science	(3-0)3 ECTS 8
BE 532	Protein Engineering Principles	(3-0)3 ECTS 8
BE 533	Biopolymers	(3-0)3 ECTS 8
BE 534	Macromolecular Science and Engineering	(3-0)3 ECTS 8
BE 535	Drug Delivery Systems	(3-0)3 ECTS 8
BE 536	Bioprinting	(3-0)3 ECTS 8
BE 537	Personalized Medicine	(3-0)3 ECTS 8
BE 538	Neuroengineering	(3-0)3 ECTS 8
BE 539	Synthetic Biology	(3-0)3 ECTS 8
BE 540	Bioimaging Techniques	(3-0)3 ECTS 8
BE 541	Biophotonics	(3-0)3 ECTS 8
BE 542	Cellular Mechanobiology	(3-0)3 ECTS 8
BE 543	Biomicroscopy	(3-0)3 ECTS 8
BE 544	BioMEMS: Fabrication Technologies and Applications	(3-0)3 ECTS 8
BE 545	Microfluidics	(3-0)3 ECTS 8
BE 546	Stem Cell Biology and Technology	(3-0)3 ECTS 8
BE 547	Tissue Engineering and Regenerative Medicine	(3-0)3 ECTS 8
BE 548	3D Cell Culture	(3-0)3 ECTS 8
BE 549	Nanomedicine	(3-0)3 ECTS 8
BE 591	Special Topics in Bioengineering	(3-0)3 ECTS 8

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

Total credit (min.): 21
Number of courses with credit (min.): 7
Total ECTS credit (min.): 120

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COURSE DESCRIPTIONS

Core Courses

BE 500 M.Sc. Thesis (0-1)NC ECTS 26
Under supervision of an advisor, students write a master thesis about the experimental and/or theoretical research topic they choose based on the courses they have taken.

BE 598 Research Seminar* (0-2)NC ECTS 9
The course is composed of literature search, data collection, data analysis and reporting on the master thesis topic chosen by students under the guidance of their advisors.

BE 501 Principles of Bioengineering I (3-0)3 ECTS 9
Course content aims to integrate principle concepts of engineering that is commonly used in bioengineering practice. Content include engineering mathematics; statics; solid mechanics; kinematics and kinetics; fluid dynamics; basic thermodynamics; circuit elements and electronic design; heat and mass transfer.

BE 502 Principles of Bioengineering II (3-0)3 ECTS 9
This course starts with the discussion of structure and chemistry of biological molecules, enzyme kinetics, DNA replication and repair, gene expression. Followed by the recombinant DNA technology, subcellular organization, cell motility, signaling and cell division. Specific examples in applications in medicine, bionanotechnology and tissue engineering are also addressed.

BE 503 Research and Ethics in Bioengineering (3-0)3 ECTS 9
This course starts with the discussion of research methods and techniques that are commonly used in bioengineering. The students are expected to write and present a research proposal utilizing the techniques they learned. Following research techniques the class will focusing on ethical concepts in bioengineering, using specific case studies.

BE 8xx Special Studies (8-0)NC ECTS 4
Graduate students study on special topics regarding his/her thesis under the guidance of his/her thesis advisor.

Elective Courses

BE 511 Statistics for Bioengineers (3-0)3 ECTS 8
This course is designed to equip bioengineering students with essential statistical tools to be used for the interpretation of data from biomedical research. Content include variation; probability; distributions; hypothesis testing; ANOVA; distribution free tests; correlation; regression; survival analysis

BE 512 Biomolecular Engineering (3-0)3 ECTS 8

This course starts with the discussion of structure and function of biomolecules that play role in decoding the genom and transformation of energy. This is followed by enzymatic catalysis, active transport, metabolism of macromolecules and molecular recognition. In addition, design and production of novel proteins, genomes and cells, and biomolecular treatment methods will be addresed.

BE 513 Bioprocess Engineering (3-0)3 ECTS 8

The course is designed to cover applications of engineering principles on bioprocesses where raw materials are biologically converted into valuable chemicals. It emphasizes enzyme kinetics and technology, bioreaction kinetics, design and control of bioreactors and fermentors, downstream processes of bioreaction products.

BE 514 Fundemantals of Medical Engineering (3-0)3 ECTS 8

Cells, tissues, fundamentals of organs and systems physiology, homeostasis, human anatomy, basic information about cardiovascular, respiratory, digestive, renal, endocrine, immune, nervous, muscular and sensory systems, biomedical devices, bioelectric, artificial organs, biomaterials, biomechanics, bioimaging systems will be covered. Practical issues related to the design of medical devices will also be discussed in the course.

BE 515 Nanoscale Bioengineering (3-0)3 ECTS 8

During the course properties of nanomaterials, characterization of nanomaterials, applications of nanomaterials for bioengineering approaches, and production of nanoscale tools for modern biotechnological research will be discussed.

BE 516 Biomedical Device Technologies (3-0)3 ECTS 8

This course will introduce the students to the foundations of biomedical devices. The properties of a variety of sensor materials will be studied, and the structures of sensors for a variety of biomedical signals will be examined. The applications of the sensors used in the clinical practice will be covered.

BE 531 Introduction to Biomaterials Science (3-0)3 ECTS 8

The course introduces classes of biomaterials citing their use in life sciences and technologies. This introductory course discusses material bulk and surface properties, material characterization techniques, biological responses to biomaterials, and issues regarding the production of biomaterials.

BE 532 Protein Engineering Principles (3-0)3 ECTS 8

This course starts with the discussion of structure and biochemistry of proteins, genetic, biochemical and chemical techniques used in protein production and characterization. Followed by amino acids the building blocks of proteins, motifs found in protein structure, rational and combinatorial methods used in protein engineering. These topics will be explained with specific examples and applications.

BE 533 Biopolymers (3-0)3 ECTS 8

During the course structure and properties of biopolymers, biological and technological importance of biopolymers, production of biopolymers and their industrial importance will be discussed.

BE 534 Macromolecular Science and Engineering (3-0)3 ECTS 8

The course covers the following topics: introduction to macromolecular systems commonly used in bioengineering applications, physical and chemical properties of macromolecules,

characterizations, polymerization mechanisms, fundemantals on macromolecular architectures, examples of macromolecular systems used in biotechnology.

BE 535 Drug Delivery Systems (3-0)3 ECTS 8

This course has been designed to introduce fundemantals, strategies and materials used in controlled drug delivery systems to bioengineering students. The course covers pharmacokinetics/pharmacodynamics fundemantals, drug diffusion and permeation, controlled drug release concept, strategies and kinetics, macro-, micro- and nano-carriers, and specific examples of drug delivery systems.

BE 536 Bioprinting (3-0)3 ECTS 8

Following topics will be covered in this course; properties of bioprinting materials, natural and artificial bioink materials, bioprinting techniques, applications of bioprinting.

BE 537 Personalized Medicine (3-0)3 ECTS 8

Topics covered in this course will include current and future applications of genomics in medicine, pharmacogenomics, next generation sequencing technologies, genome-based healthcare technologies, therapeutic response, personalized implants.

BE 538 Neuroengineering (3-0)3 ECTS 8

Existing neurotechnologies for analyzing brain signals and for treating neurological and psychiatric diseases; biophysical, biochemical, anatomical principles governing the design of current neurotechnologies, with a goal of encouraging innovations of a new generation of therapies will be covered during the course.

BE 539 Synthetic Biology (3-0)3 ECTS 8

This course offers an introduction to synthetic biology, which is a new discipline that seeks to enable the predictable engineering of biological systems. This course will discuss the principles that are used by all organisms to perform cellular functions, and how the knowledge gained from studying naturally-occurring biological systems can be used to create artificial gene networks capable of performing new functions. Course content include DNA assembly, protein purification, cell culture, genetic and metabolic engineering, biological circuits, and the broader applications of synthetic biology.

BE 540 Bioimaging Techniques (3-0)3 ECTS 8

This introductory course covers the physical and engineering principles for bio-imaging technologies used in medicine. It reviews the mathematical principles used in signal processing required for such systems, detectors used, and overall systems including the hardware. It covers a broad spectrum of imaging systems starting with x-ray projection imaging, moving on to xray CT, SPECT, PET, MRI and ultrasound.

BE 541 Biophotonics (3-0)3 ECTS 8

During the course introduction of biophotonics, fundamental principles of light, optics, lasers, diagnostic biophotonics, therapeutic applications of biophotonics will be discussed.

BE 542 Cellular Mechanobiology (3-0)3 ECTS 8

This course will focus on the mechanical regulation of molecular events in cellular biology. Course content include general concepts of mechanobiology; cellular framework; cytoskeletal mechanics; membrane mechanics; cellular adhesion and migration; mechanical regulation of cell fate.

BE 543 Biomicroscopy (3-0)3 ECTS 8

Introduction to geometrical and wave optics for investigating the biological sample of interest, functioning of optical microscopes and their advantages and limitations will be covered during the course.

BE 544 BioMEMS: Fabrication Technologies and Applications (3-0)3 ECTS 8

BioMEMS is the application of MEMS (Microelectromechanical Systems) technology in the fields of biomedical and health sciences. Due to their small size (1μm-1mm), BioMEMS have the advantages of low weight, low cost, quick response, high throughput, high efficiency, requiring much less sample/reagent, and easy system integration. BioMEMS found broad applications in disease diagnosis, prevention and treatment. Various BioMEMS products have been developed, such as microfluidic devices, neural interface devices, μTAS (micro total analysis systems), lab-on-a-chip, DNA chips, micro drug delivery system, microsurgical tools, biosensors. This course introduces to students about the fundamentals of BioMEMS technology, typical BioMEMS devices and their applications.

BE 545 Microfluidics (3-0)3 ECTS 8

As the diversity of lab-on-a-chip systems is continuously growing, there is also an increasing demand of a better understanding of the microfluidic phenomena behind the final application. In this concept, this course will provide a theoretical background of microfluidics effects and concepts.

BE 546 Stem Cell Biology and Technology (3-0)3 ECTS 8

Contents include formal lectures covering basic concepts in development and homeostasis; ethical considerations in stem cell research and technology; embryonic stem cells; mesenchymal stem cells; neural stem cells and induced pluripotency. This course also demands students to understand and formally present recent articles in the field of stem cells.

BE 547 Tissue Engineering and Regenerative Medicine (3-0)3 ECTS 8

Following topics will be covered in this course; cells and tissues, extracellular matrix, cell culture, biomaterials for tissue engineering, cell-biomaterial interaction, tissue modeling, tissue development, tissue and organ regeneration, stem-cell differentiation for regenerative medicine applications, tissue engineering methods, artificial tissue and organs.

BE 548 3D Cell Culture (3-0)3 ECTS 8

Biology of cells, cellular interactions, cell function, cell surface molecules, cell response, cell adhesion, cell motility, cytoskeleton, cell differentiation, materials for 3D cell culture, cell-material interaction and techniques in 3D cell culture will be covered during the course.

BE 549 Nanomedicine (3-0)3 ECTS 8

This course has been designed to introduce nanomedicine field to students. The course covers the following topics: properties of biomaterials on the nanoscale, synthesis and processing of biomaterials at nanoscale, biofunctionalization of nanomaterials, smart nanomaterials for drug delivery and imaging applications, micro/nanofluidics for diagnosis and detection, new generation of imaging technologies, nanobiosensors (e.g. lab-on-a-chip), cellular nanomachines, regenerative medicine, including tissue engineering cell and gene therapy.

BE 591 Special Topics in Bioengineering (3-0)3 ECTS 8

This course aims to evaluate and discuss a selected topic in the field of Bioengineering depending on the instructor's expertise.